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Poster Session 1/4:15–6:00 p.m.

AGING: ATTENTION AND EXECUTIVE FUNCTIONS

E. WILDE, S. LANGENECKER, L.A. BIELIAUSKAS, R. WELSH, P. ELDEVIK, B.A. STEINBERG, & S. BERENT. *Age Differences in Functional Activation Using Complex Embedded Visual Figures.*

The current study extends our previous findings of cognitive and functional activation differences in visual spatial functioning between 5 younger (age 20–30) and 4 older (age 70–84) cognitively intact adults utilizing items adapted from the Southern California Figure/Ground Visual Perception Test. Our adapted measure contains three types of items: (1) overlapping items, where the subject must determine whether a single line drawing (lower part of the screen) exists in exactly the same orientation within a constellation of three overlapping figures (upper part of the screen), (2) embedded items, where the subject must determine whether the target item (below) is embedded within a complex drawing (above), and (3) control items where the subject must determine whether the stimulus target item (below) is the same or different than an item portrayed above. Given the relative difficulty of embedded items, we hypothesized that differences both in location and extent of activation would be different in older versus younger adults. Consistent with other reported findings reflecting greater neural recruitment of frontal areas in older subjects, we found increased activation in bilateral prefrontal cortex, and medial frontal cortex (including supplementary motor cortex and anterior cingulate), of our older subjects when compared to younger subjects. This finding extends previous research with memory, attention, and inhibition, adding another domain of function where older adults demonstrate more frontal and extraneous areas of activation when compared to younger adults.

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H. DUMKE, W.J.L. THORNTON, & M. ROY. *Everyday Problem-Solving and Decision-Making in Aging: A Meta-Analytic Review.*

We report a meta-analytic review investigating speed, process, and quality of everyday problem solving and decision making in aging. Thirty-two studies with an aggregate of 3091 participants were drawn from a variety of experimental contexts (i.e., medical, consumer, financial, managerial, etc.). Effect sizes were calculated to reflect between group (old vs. young)

differences across three domains: (1) decision time, (2) amount of information used, and (3) quality of solutions. In addition, we developed a reliable method of coding task familiarity within each study. Results revealed moderate to large effects indicating longer “decision times” with age, however these effects were significantly attenuated when participants had a high degree of task familiarity. In addition, moderate effects were observed for “amount of information” with older adults using less information to make a decision regardless of degree of familiarity. Older adults displayed poorer quality of solutions under conditions of little or average previous experience with the task, however there was a trend toward attenuation of this effect when participants had high task familiarity. Thus, while moderate to large age effects emerge across three domains assessing “everyday” problem solving and decision making in aging, task familiarity moderates these effects by both decreasing response latencies and increasing the quality of solutions. In contrast, familiarity does not appear to moderate the amount of information required for decision-making with age.

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P. GUINThER, H. DAVIS, & F. KELLER. *A Life-Span Assessment of Subjective Organization and Frontal Lobe Functioning.*

A life-span assessment of subjective organization, recall, and frontal lobe functioning was conducted on 1414 participants ranging in age from 5 to 90 years. Subjective organization is an encoding process that involves chunking individual items into larger units of organization, which enhances recall. The frontal lobes have been implicated in this process, suggesting that age-related deficits in subjective organization and recall may be related to a deficient in frontal lobe functioning. Findings from the Rey Auditory Verbal Learning Tests, the Paired Frequencies method for measuring subjective organization, Wisconsin Card Sort Test, Temporal Order Test, and Tower of London test generally showed a quadratic pattern across age, with deficits in performance among children and elderly participants. As hypothesized, summed recall scores correlated with the measure of subjective organization, $r(1407) = .52$. However, subjective organization exhibited fairly weak correlations with measures of frontal lobe functioning; the highest correlation was with the Temporal Order test, $r(480) = .27$. Subjective organization appears to be too subtle to detect with global measures of frontal functioning, but may be partially responsible for age differences in recall.

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P. REKKAS & S. MURTHA. Equating Task Complexity Across Age Groups Does Not Reduce the Impairment Observed in Central Executive Functioning.

Introduction: It has been proposed that in order to perform two tasks at once, the *central executive* (CE) must allocate varying degrees of processing capacity to one or both of the working memory slave systems and then co-ordinate all subsequent demands. Elderly participants do not generally perform as well as young participants on dual task measures. It could be argued that the age discrepancy seen is not due to an impairment in the CE, but to overall differences in cognitive complexity/difficulty between experimental conditions. In order to mitigate the effects of task complexity between the age groups in the present study, memory load was titrated to reflect individual span capacity. *Method:* 30 elderly, 30 young, had to hold in memory a titrated list of consonants 0 to 10s. They did this either without any distracting secondary task (unfilled condition) or while simultaneously performing secondary tasks (filled condition) that varied in complexity (articulation, digit reversal). *Results:* The elderly recalled fewer consonants than the young. This was most evident when comparing recall performance on the unfilled condition with the filled conditions. Although we anticipated this with the more complex digit reversal condition, it was unexpected to see a reduction in % correct observed with concurrent performance on the more automatic "articulation" task. *Conclusion:* Our data revealed that despite controlling for individual differences in span capacity between the young and elderly, performance was worse for the elderly with the introduction of concurrent task demands particularly when both tasks engaged the same slave systems.

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H. DAVIS, R. CORNWELL, & F. KELLER. Tower of Hanoi Performance Across the Life-Span: 5–90 Years of Age.

The Tower of Hanoi puzzle is a problem-solving task belonging to the category of puzzles known as transformation problems: A goal must be reached through a series of moves that are controlled by procedural rules. We investigated the effects of age on TOH performance in subjects from 5 to 90 years of age. Parametric aspects of number of trials, number of rings, intertrial interval, and inter-session interval were established in order to avoid floor or ceiling effects on performance. Five-to-nine-year-olds and individuals in the 70s and 80s were impaired when asked to solve a 3-ring puzzle 5 times and a 4-ring puzzle 5 times ($p < .001$). Individuals in each decade of life from the 20s through the 80s were tested on a 5-ring puzzle. Significant deficits were detected for the performance of the 70–80-year-old age groups ($p < .01$). The elderly's poor acquisition could be ameliorated with extra practice trials or by pretraining on easier 3- and 4-ring versions of the Tower of Hanoi puzzle, however the ability to generalize the underlying strategy remained impaired ($p < .01$). Methodology previously used to demonstrate learning of the Tower of Hanoi puzzle in amnesic patients was employed with the elderly. This procedure significantly reduced the elderly's impairment on Tower of Hanoi performance and they showed increased comprehension of the deep solution strategy of the puzzle.

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S. FELDSTEIN, H. DAVIS, R. CORNWELL, & F. KELLER. Tower of London Performance Across the Life-Span: 5–90 Years of Age.

The Tower of London (TOL) task has been used to differentiate frontally impaired patients from normal individuals, and to assess performance differences among different age groups. It has been shown in previous research that the developmental trajectory of the frontal lobes and the late life decline of frontal cortex offer an explanation for poorer performance on measures of executive function at the extremes of the lifespan. Comparison of performance at both the individual and the group levels corroborates this evidence. We examined normative TOL performance across the lifespan, from 5 to 89 years of age, in a sample of 1281 individuals. A quadratic trend was detected when comparing groups at 5 year intervals

from 5 to 19 years old and 10 year intervals for each decade thereafter. More errors were made in the 5–9 and 10–14 year old groups than in the groups ranging from 15 to 60 years of age ($p < .0005$). The 70- and 80-year-old groups performed more like the 10–14 year olds. Year by year analyses conducted on individuals ranging from 5 to 19 years of age revealed a monotonic decrease in errors, leveling off at about age 14. Correlations between TOL, temporal order, Wisconsin Card Sort, and Stroop color word are modest but significant, ranging from .26 to .37 in absolute magnitude. Combined results indicate that TOL may be used normatively to compare potentially impaired individuals, and further, that the measure may be substantively different from other standardized measures of frontal lobe function.

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N. ZOOK, M. WELSH, P. RETZLAFF, E. ALM, V. EWING, & H. WAKKINEN. Tower of London–Revised and WAIS–III Performance in Older Adulthood.

There is recent neuropsychological evidence of a sub-clinical decline in executive functions associated with normal aging. This study explored this decline in terms of performance on an executive function task, the Tower of London–Revised (TOL–R), and on fluid and crystallized intelligence tasks. Sixty-three older adults (50–90 years old) were tested on the TOL–R and two subtests from the WAIS–III, Matrix Reasoning and Vocabulary, and were compared to a sample of thirty-five younger adults (M age = 19.63). The TOL–R and Matrix Reasoning tasks exhibited similar developmental trends, with stability from young adulthood to the decade of the 50s and decline thereafter. In contrast, Vocabulary performance increased from the young adult group to the 50–59 year old group, and demonstrated only small declines in the older age groups. The age group differences on these three measures were not accounted for by group differences in education. For the older adult groups, multiple regression analyses demonstrated that age explained 19% of the performance variance on the TOL–R. Matrix Reasoning performance explained a significant amount of additional variance in TOL–R performance (R^2 change = .18) that was unaccounted for by the variable of age alone. This study also indicated that the TOL–R maintained a high level of internal consistency ($\alpha = .78$) within the older adult sample. The fact that performance on the TOL–R is not impacted by educational level or by declines in reaction time with age suggests that this task may be a reliable and sensitive tool for identifying executive function changes across development.

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G. HOPP, R. DIXON, E. STRAUSS, & A. MOLL. Effects of Executive Function on List Learning in the Elderly.

Research shows that as people age there is a differential pattern of decline in executive functioning (EF). Healthy elderly adults maintain the ability to anticipate and set goals while declining in concept formation, plan implementation, monitoring, and cognitive flexibility. Executive function has been shown to have an impact on both working and explicit memory systems. This study investigated the impact of changes in EF and performance on a list learning task in neurologically intact young-old (NI : $n = 22$; $M_{age} = 67.5$ years) and old-old ($n = 20$; $M_{age} = 80.0$ years) adults, as well as older adults with Parkinson's disease (PD : $n = 20$; $M_{age} = 72.5$ years). Participants with PD recalled fewer list words on the California Verbal Learning Test (CVLT) than their NI counterparts. However, once the variance associated with the executive tasks of verbal fluency and the California Card Sorting Test (CCST) was removed, performance on the list learning task was no longer significantly related to group membership [$F(2,57) = 2.50, p = .09$]. Group membership remained significant on the measures of EF after the variance associated with performance on the CVLT was removed [$F(4,114) = 3.38, p = .014, \eta^2 = .20$]. While performance on the CVLT was influenced by performance on the tasks of executive function, list learning task ability did not have a significant effect on

EF. These findings highlight the importance of declines in executive abilities on memory function in the later stages of the lifespan.

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S. MILLER, J. BEDWELL, N. YANASAK, & J. ALLISON. Age Effects on the Stroop Color-Word Task as Measured by the fMRI BOLD response.

There is considerable interest in using functional magnetic resonance imaging (fMRI) to describe age-related differences of functional neuroanatomy in both normal and pathological aging processes, as well as for assessing potential treatment effects for cognitive dysfunction. We have previously shown primary visual system effects of the BOLD response in healthy older adults compared to younger adults using a flickering checkerboard presented to separate visual fields. Here, we explored frontal activation differences using a well-established interference task, the Stroop, in two groups: younger adults; (M age = 20.6, SD = 2.0; 5M/5F; N = 10; mean MMSE = 30, SD = 0) and older adults (M age = 73.7, SD = 5.5; 5M/5F; N = 10; mean MMSE = 28.3, SD = 3.0). As expected, both younger [$F(1,9) = 66.5, p < .001$] and older groups [$F(1,9) = 65.2, p < .002$] showed a robust Stroop interference effect on reaction time (RT) behavioral data. Additionally, age group had a significant interactive effect on RT of the Stroop effect [$F(1,18) = 17.9, p < .001$]. BOLD activation measures indicated similar prefrontal activation in both groups. However, mesial frontal activity was less obvious in older adults, who also showed relatively greater dispersion of parietal area activation during the Incongruent portion of the task compared to younger adults. For both groups, anterior cingulate activity was only minimally noted. Our data suggest that the inhibitory process underlying the Stroop effect may be specific to prefrontal control attentional set, but reflected by somewhat different neural systems in older compared to younger adults. Findings are discussed in terms of allocation of neural system resources and overall percent intensity changes.

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S. WOOD, H. DAVIS, E. BUSTOS, & F. KELLER. Decision-Making in Older Adults: An Examination of the Gambling Task.

Decision-making was examined in older versus younger adults using a task designed by Bechara and colleagues. Two of the decks have low payouts, but lower losses and two have high gains and higher losses. Over trials, successful participants draw more from the "good decks." This task was developed to assess Damasio's somatic marker hypothesis related to frontal lobe functioning. Two predications may be made regarding the performance of older adults: (1) older adults would do more poorly secondary to frontal lobe changes, or conversely (2) older adults would do better on this task as their ability to use affective information improves with age. 28 younger adults (18–30) were compared to 13 older adults (65+) on the gambling task. Results suggest that overall there was no difference in performance across four blocks of trials between the groups ($p = n.s.$). However, when the effect of new learning was covaried using Rey Recall Trial 6, the predicted means for older adults approached significance ($p = .08$) in comparison to young adults (older adults $M = 12$ good cards/block; younger adults $M = 2$ good cards/block). The results from this study suggest that while the overall "product" of decision-making may be identical in older and younger adults, the underlying process is likely to be different with older adults switching to a reliance on affective versus analytic decision making strategies, optimizing performance on tasks that load on memory and executive functioning.

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C. RODRIGUEZ-ARANDA & K. SUNDET. Are "Frontal Tests" Suitable for the Study of Executive Functions in Normal Aging?

It has been stated that executive functioning declines during the normal aging process. Assessment of these cognitive functions is typically done

using clinical tests. However, insufficient data exist regarding the specific functions assessed by these tests, and the relationship between them in normal aging subjects. The present study determined the factor structure of 4 tests purportedly measuring executive or frontal activity in a sample of healthy aging subjects. WCST, Stroop Test (ST), COWAT, and Digits Backwards (DB) subtest of the WAIS-R were administered to 101 participants ranging in age from 20 to 88 years of age. The MMSE was also administered to exclude cases of possible dementia. The sample was divided into four age groups: 20 to 39, 40 to 59, 60 to 69, and over 70 years of age. Results revealed that all test scores declined in the older groups compared to the youngest groups except the COWAT. A Principal Components Analysis with varimax rotation identified 4 factors with eigenvalues greater than 1, which accounted for over 74.2% of the variance. WCST loaded on Factor 1, ST on Factor 2, DB on Factor 1 and 2, while COWAT loaded mainly on Factor 3. Factor 4 corresponded to FMS of the WCST. Additionally, we investigated the effect of age, gender, education and verbal knowledge in the obtained factor scores. Vocabulary subtest of WAIS-R was used to determine lexical level of the participants. Multiple regression analyses revealed that only the second factor (Stroop) was sensitive to changes associated with normal aging.

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B. KEYS, D. BARCH, & T. BRAVER. Age Differences in Inhibitory Control: Exploring the Role of Self-Initiated Processing.

Older adults demonstrate impaired inhibitory function on some cognitive tasks but not others. Although self-initiated processing is dependent upon the prefrontal cortex, an area that declines with increased age, the role of self-initiated processing has not been examined in relation to age differences in inhibitory function. Based on insights from the memory and aging literature and prefrontal cortex theories of aging, this study predicted that age differences in inhibitory function should be *largest* on tasks with greater demands for self-initiated processing and *smallest* on tasks providing greater environmental support to engage inhibition. To test this primary hypothesis, older and younger adults completed a computerized battery of inhibitory tasks: Stroop, A/X version of the Continuous Performance Test (A/X-CPT), garden path sentences, go no-go, and the stop-signal paradigm. Participants also completed a simple processing speed task. Results demonstrated significant age differences in performance on the AX-CPT, the Stroop and the stop-signal, although the magnitude of the group differences for the Stroop and the stop-signal were relatively small. Results did not support the hypothesis that age differences in inhibition occur as a function of increased demand for self-initiated processing during task performance. The A/X-CPT revealed the largest age differences in performance, implying that older and younger adults may differ in how they use contextual information within a task situation. More specifically, the pattern of A/X-CPT data obtained suggests that qualitative differences in the use of context information may be related to age differences in inhibition.

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E. WOO & M. SCHMITTER-EDGEcombe. Effects of Age and Divided Attention on Memory Components of a Conceptual Task.

This study investigated the effects of age and divided attention on memory performances using a conceptually driven task, the category exemplar generation (CEG) test. Thirty-six younger adults and 36 healthy older adults studied word lists in full and divided attention conditions. Participants' memory for the word lists was tested by presenting them with category names that either appeared with the word "old" or "new." In the "old" condition, participants were instructed to respond with two instances of the category that were previously presented in the word lists. If they could not think of an old word, they were to produce the first two appropriate instances that came to mind. In the "new" condition, they were told to come up with two novel instances of the category that had not been

previously studied. The process-dissociation procedure was then used to derive estimates of controlled and automatic components of memory. We found that old-old adults (70–84 years) exhibited poorer conscious recollection than both younger (18–24) and young-old adults (59–69). In contrast, no age differences were found in estimates of automatic memory. For the younger and older adults, the divided encoding manipulation reduced both the consciously controlled and automatic estimates of memory. The results suggest that the few prior findings of age deficits in priming on the CEG may have been an artifact of contamination from conscious retrieval processes. They also indicate that the opportunity for greater semantic processing enhances the conceptual priming of both younger and older adults.

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O.L. REY & L. MURRAY. Attention Assessment in the Elderly: Different Methods Produce Different Results.

In this study, we examined whether certain scoring and administration modifications might enhance the suitability of the Test of Everyday Attention (TEA) for use with elderly populations. Previous research indicates that performance of older adults on some TEA subtests does not correlate well with their performance on other batteries. Additionally, because of the normalization of the scores, elderly adults achieving only 15% to 25% accuracy on these subtests place at an average level of performance, leading to a ceiling effect. Therefore, we compared the performances of 30 healthy and 30 brain-injured, elderly adults on standardized and experimental versions of two TEA subtests. The Visual Elevator (VE), a visual, self-paced task, was altered in its scoring procedure whereas the Elevator Counting with Reversal (ECR), an auditory, fixed-speed task, was modified to slow stimulus presentation rate. Results showed that subjects with brain damage obtained significantly lower scores on the modified compared to the standardized VE task, whereas the control group showed no significant change. On the ECR, controls showed improved performance on the experimental task, but little change was observed in subjects with brain damage. Compared to the standardized versions, experimental task performances more highly correlated with other measures of working memory and attentional shifting included. These results suggest that addition of these test modifications allowed a more precise assessment of attentional processes in the elderly, and thus have the potential to improve discrimination of normal cognitive decline from early pathology.

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R. HOLTZER, B. RAKITIN, & Y. STERN. Dual-Task Performance in Old Age.

Dual-task performance has been reported preserved in healthy elderly providing that the primary and secondary tasks are processed concomitantly via non-competing channels (visual and auditory). The present study was designed to evaluate whether manipulating the extent of overlap between visual and verbal tasks has an age effect on concomitant allocation of attention. A delayed match-to-sample (DMS) paradigm (visual analogue of the Sternberg task) served as the primary visual task. Digit Span (5-digit strings) served as the concomitant verbal task. In the first dual task, overlap was limited to the retention period of each trial of the (DMS) task. In the second condition, overlap between the visual and verbal tasks was complete; the participants studied the stimulus set while listening to the first 5-digit string, repeated the string and studied a second string during the retention period and then repeated the digits while responding to the visual probe. Dual-task performance was comparable between young and old participants when overlap was limited to the retention period of the DMS. However, age related deficits in concomitant allocation of attention emerged in the complete overlap condition. Old participants showed poorer encoding of digit strings and a decrease in response accuracy to the DMS visual probe. This suggests that dual-task ability may be compro-

mised in old age when the extent of overlap between visual and verbal tasks is carefully manipulated.

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M. CROSSLEY & M. HISCOCK. Age Effects on Dual-Task Performance: 5- and 10-Year Follow-Up Studies.

Of 92 original participants in a dual-task study of normal aging, 36 remained healthy and accessible, and were retested in 5-year and 10-year follow-up studies. Young ($n = 9$), middle-aged ($n = 11$), and older ($n = 16$) participants, with average ages at the 10-year testing of 40.6, 63.1, and 79.3 years, respectively, completed tests of memory and attention, and a dual-task study combining speeded finger-tapping with either *easy* (speech repetition) or *difficult* (letter generation verbal fluency) speaking tasks. On tests of memory the expected age group differences were evident, but memory remained remarkably stable across 10 years for each group. In contrast, performance on measures of speeded visual attention declined across time for all of these healthy participants. Single-task performance on speeded finger-tapping, speech repetition, and speech fluency declined across the 10-year study period for all age groups, and significant Study Period (baseline, 5-year, 10-year) \times Age Group interactions reflected greater loss across time for the older groups. As expected, interference during dual-task tapping (controlling for single-task performance) was greater for the oldest group at each test period, and was greater while concurrently performing the difficult compared to the easy speaking task. In contrast to expectations, interference did not increase across study period, and age group did not interact with study period or with task difficulty. Longitudinal results are consistent with the well-documented age-related decline in speed of processing. Attentional capacity and some memory functions appear to be relatively stable, at least as measured by these tasks conducted with a small sample of healthy participants over a 10-year study period.

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K. SHAMLIYAN & S. MURTHA. Aging and Decision-Making Time: Does Exercise Speed up the Process?

Introduction: Physical fitness helps to maintain a high concentration of oxygen in the blood. Aerobic exercise has also been shown to attenuate the decline observed after the age of 20 in the body's ability to transport oxygen from the air to the blood. Subjects with a mild state of hypoxia (low oxygen levels in the blood) produce more errors and longer times when finding a solution to a problem. Individuals who are aging and not engaging in aerobic activity may indirectly produce a hypoxic state in the brain. Keeping the oxygen level high with consistent vigorous exercise might be a partial solution to attenuating cognitive decline observed in the elderly. There is some debate, however, whether engaging in chronic physical activity actually improves cognition or simply improves the speed of the motor response. Research suggests that simple reaction time (RT) is enhanced if the person is physically active, regardless of age. Choice reaction time (CRT—a test that involves quickly and accurately making a decision), however, is slower in older participants regardless of activity level. *Methods:* We administered the Yale Physical Activity Survey to 27 subjects ranging in age from 50–90 years and assessed them on motor speed with a cued choice reaction (CCRT), and CRT. *Results:* Preliminary analysis indicates that the more the subject engaged in vigorous activity the faster their CCRT ($r = -0.4$) was, but there was no negative correlation between activity level and CRT ($r = .03$). This relationship holds for the 50–59 year olds but not the older subjects (60–69 or 70–90 years). *Conclusion:* Engaging in chronic vigorous activity is correlated with enhanced motor speed in those <60 years of age but has no positive influence on cognitive functioning as assessed by a choice reaction time test—at any age.

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T. AUDET & M. D'AMOURS. Compensatory Driving Strategies and Cognitive Decline in Older Drivers.

Older drivers were shown to present high accident rates per mile driven and to be more often at fault when involved in accidents than most other age groups. Cognitive functions are known to deteriorate in later adulthood and it is widely believed that these deficits contribute to bad driving record. The idea that compensatory driving strategies (like avoiding difficult driving situations) may compensate for cognitive decline is a popular one, but the supporting evidence remains scarce. The aim of the present study was to verify if there is an association between cognitive decline and the use of compensatory driving strategies by older people. Drivers ($n = 154$) from three different age groups (65–69, 70–74 and more than 75 years old) were classified as *great*, *medium*, and *low* users of compensatory driving strategies by means of a questionnaire. They were then evaluated using neuropsychological tests measuring perception, attention, memory and reaction time. Results showed a significant decline in cognitive performance with age, but did not show a difference in scores for cognitive functions between great, medium or low users of compensatory driving strategies. It is therefore difficult to assert that older drivers would compensate by themselves the impact of cognitive decline in their ability to drive since there seems to be no relation between cognitive decline and the use of compensatory driving strategies.

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CHILD BRAIN INJURY**K. O'TOOLE & K. NIELSEN. Acute and Long-Term Neuropsychological Effects After Surgery for Pediatric Cerebellar Arteriovenous Malformation.**

Little information exists on neuropsychological manifestations and follow-up of children with arteriovenous malformations (AVM). The cause of AVM is unknown although clotting of a blood vessel during prenatal development has been proposed. Our previous studies of 5 children with AVM in 3 different brain locations found that acute cognitive deficits were localized. We are now conducting follow-up evaluations. The first patient, a normally-developing boy (age 9), presented with headache, nausea, and rapid loss of consciousness due to cerebellar AVM-related hemorrhage and respiratory failure. Surgery consisted of suboccipital craniectomy, evacuation of hematoma, resection of the AVM and ventriculostomy. Initial brain CT showed large posterior fossa hemorrhage extending into the left cerebellar hemisphere, complete effacement of fourth ventricle and mild dilation of third and lateral ventricles. CT at 5 months post-surgery noted stable postoperative changes. (CT scans will be presented.) Neuropsychological findings at 7 months and 3 years post-surgery were remarkably similar, with only slight improvement in motor function. Intellectual and academic functioning were preserved. Performance on memory and executive measures suggested adequate abilities, but deficits in motor functioning had pervasive deleterious effects, as most measures require motor responses. Findings suggest long term stable localized deficits in pediatric AVM with only slight improvement over time, but without cascading effects on adjacent or distant areas often found in other acquired brain injury or disease. Studies on the additional patients will assess generalizability of results for other affected locations of the brain in pediatric AVM.

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S. NICHOLS, S. WALLER, D. TRAUNER, & D.C. DELIS. Performance of Children With Early Focal Brain Damage on a New Test of Concept Formation.

Children who sustain focal brain damage early in infancy can fare surprisingly well if the damage is circumscribed. However, recent studies suggest that they can exhibit long-term deficits in some areas, including executive

functions and adaptive and social skills. We used the Twenty Questions task to examine concept formation and problem-solving skills in 18 children (age 8–15) with pre- or perinatally acquired, unilateral, focal lesions (FL group) resulting from strokes. Each FL child was matched by age, sex, and socioeconomic status to two controls. The task involved identifying target pictures from a hierarchically structured array by asking the fewest yes/no questions possible. The FL group required significantly more questions to solve the problems, even when I.Q. was used as a covariate. They asked significantly more questions that eliminated only single items (e.g., "Is it the spoon?"), a concrete and inefficient strategy, rather than using the task's categorical structure to formulate more abstract questions. They also tended to initiate questioning more slowly. Within the FL group, children who had seizure disorders were significantly more likely to use a single-item strategy. There were no significant effects for laterality of lesion, and poor performance was not restricted to children with frontal lesions. Performance on the task correlated significantly with some other measures of executive, memory, and adaptive functioning. These results suggest that early, focal brain damage can have a long-term impact on the ability to utilize semantic category information for effective problem solving. Furthermore, seizure activity may be associated with diminished concept-formation skills.

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J. WISNOWSKI, S.W. ANDERSON, & H. DAMASIO. Long-Term Outcome Following Focal Brain Damage Acquired Prior to Age 10.

There has been limited long-term follow-up of children who sustain focal brain lesions, leaving little data to guide prognosis. Childhood brain damage in circumscribed neural areas results from stroke, tumor resection, focal trauma, and other etiologies. The neurophysiological and neuropsychological implications of early focal injuries for subsequent development are likely to differ from the relatively well-studied sequelae of childhood closed head injury. In this study, we examined long-term outcome in academic, occupational, intellectual, and social/emotional domains in 14 subjects who sustained focal brain damage prior to age 10 and who now are adults (7 vascular, 4 surgery, 3 other). MRI revealed lesions in frontal, temporal, and occipital regions (5 right, 4 left, 5 bilateral). Thirteen had completed high school; 4 of these received special education services; 7 had completed at least 1 year of post-high school education. Mean academic achievement scores were in the average range for reading, spelling and math (34th, 27th, and 27th percentiles, respectively). Nine were fully employed or college students, with 4 of these at skilled labor or professional levels. Overall, intellectual abilities were not impaired (M VIQ = 98; PIQ = 94). Seven subjects had normal social-emotional functioning, and 7 had at least mild impairment. All those with severe impairments ($N = 4$) had prefrontal cortex damage. The findings indicate: (1) substantial variability in long-term outcome following focal brain damage acquired in childhood, and (2) significant influence of lesion location, with considerable functional impairment associated with prefrontal damage contrasted to good adaptation to the deficits resulting from damage to posterior areas.

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A. BALLANTYNE, A. SCHATZ, D. RAMENOFKY, N. CARRICK, & D. TRAUNER. Clock Drawing in Children With Early-Onset Stroke.

Clock-drawing tasks have been used for over 60 years as a way of assessing neurological status in adult patients. No information is available on clock drawing performance in children with neurological damage. We have collected clock drawing data on children with focal brain lesions ($n = 20$) from pre- or peri-natal stroke, and normal comparison subjects ($n = 21$), ages 7 to 17 years. Drawing conditions included a free-draw task, a copy task, and a time reading and setting post-test. Children ages 7, 9, 11, 13, 15, and 17 years were tested. By age 9 years, 100% of the control subjects passed the post-test, indicating mastery of the concept of time. In contrast, there were 3 focal lesion children (all with left lesions) who had

not mastered the concept of time by age 9 years. In terms of quantitative analyses, as age increased, children in both groups made significantly fewer errors on both free-draw and copy tasks. For both tasks, the focal lesion group made significantly more errors than did the normal comparison group. In particular, the focal lesion group made more time-setting errors and misplacement errors. On both free-draw and copy, there were no overall score differences between the right hemisphere and left hemisphere lesion groups, although some qualitative differences were observed. Results indicate that although children with early strokes may perform more poorly on clock drawing in comparison to their normal peers, lateralized differences are much more subtle than those seen in adults with strokes. These findings have implications for brain reorganization after early focal brain injury.

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P.E. ANDERSON, S. NEWTON, & G. DEVEBER. Developmental and Adaptive Outcome of Pediatric Perinatal and Presumed Perinatal Stroke Patients at 2-Year Follow-Up.

Pediatric patients presenting with stroke in the perinatal period have been described by parents as having cognitive or developmental difficulties. This study employed the Bayley Scales of Infant Development (BSID-II) and the Vineland Adaptive Behavior Scales-Survey Edition (VABS) to assess 21 patients (9 males, 12 females) enrolled in a pediatric stroke outcome study with presentation of stroke signs of the arterial ischemic (AIS; $n = 16$) or the sinovenous thrombosis (SVT; $n = 5$) type in the perinatal period (i.e., diagnosed within 1 week of birth). Infarcts were classified as left ($n = 8$), right ($n = 11$) or bilateral ($n = 2$). All patients were assessed at 2 years post-stroke (± 2 months). Relative to the normative samples, the whole group, and the AIS group, had lower scores on the Mental and Motor indices of the BSID-II and all but the Communication index of the VABS. Children with left hemisphere infarcts performed more poorly with respect to Daily Living and Socialization. Children with right hemisphere infarcts performed more poorly on BSID-II indices, as well as on Daily Living, Motor and the Adaptive Behavior Composite. Males performed more poorly on BSID-II indices, and all but the Communication and Motor indices of the VABS. Females performed more poorly on the BSID-II Motor index and all but the Communication and Motor indices of the VABS. The results are discussed with reference to neurocognitive effects of cerebral infarcts in older infants and children and underline the need for further investigation of this group.

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P.E. ANDERSON, S. NEWTON, E. FUIJKSCHOT, & G. DEVEBER. Parent-Reported Change in Aggression and Expression of Anger After Childhood Stroke: A Pilot Study.

Behavior change, specifically an inability to control anger and aggression, has been reported in adult patients following stroke. Post-stroke changes in aggression and anger control, while observed clinically, have not been formally reported in the pediatric stroke literature. In this pilot study, the Aggression subscale of the Behavior Assessment System for Children Parent Rating Scales (BASC) was completed by parents of children and adolescents enrolled in a pediatric stroke program. Parents also used a 5-point Likert scale to indicate whether there was a post-stroke difference in their child's level of aggression or expression of anger, and whether this behavior interfered with family functioning. Of 26 completed questionnaires, 23% ($n = 6$) yielded a T score equal to or greater than 1 standard deviation above the mean on the BASC Aggression subscale, with 2 ratings exceeding a T score of 65 (i.e., within the defined clinical range). More than one-quarter (27%; $n = 7$) of respondents reported that their child's current level of aggression or expression of anger disrupted the functioning of their family. These early data are the first to report that aggression and expression of anger may be of clinical concern in a subset of children with stroke. Further study with a larger pediatric stroke sample

is needed to identify relationships between stroke variables and reported post-stroke change in level of aggression or expression of anger, as well as to examine the effects on family functioning.

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S. MOSCH, A. LANSING, D. TRANEL, & J. MAX. Neuropsychological Recovery in Childhood Versus Adult-Onset Brain Lesions.

Neural plasticity remains poorly understood. Some evidence suggests that children with focal brain lesions experience fairly full recovery (e.g., due to brain reorganization), while other evidence suggests that such children show persistent cognitive/behavioral impairments. The domains under consideration may be a critical factor: for example, recovery from early damage to language-related structures may be much more complete than recovery from early damage to "executive" structures. We had the opportunity to take advantage of an extensive registry of focal lesion patients as a powerful and novel approach to address this question, by directly comparing long term outcomes after childhood versus adult onset lesions that were neuroanatomically matched. We hypothesized that children would have similar chronic neuropsychological profiles, compared to their adult counterparts. We studied 13 child-adult pairs of left hemisphere lesion patients and 16 child-adult pairs of right hemisphere lesion patients, who were matched based on neuroanatomical region, extent of involvement, and etiology (stroke). Long-term outcome data were collected in the domains of intellectual functioning, academic skills, memory, speech and language, visual perception, and executive functions. In general, children performed similarly to their adult counterparts across numerous neuropsychological measures, and considerable, albeit incomplete, recovery was evident in both groups. However, there were some domains in which children performed worse than their adult matches, for example, reading skills. Our results have implications for theories of neural plasticity, and for remedial strategies to be implemented with young stroke patients.

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C. RONCADIN, J.L. ARCHIBALD, M. BARNES, R. SCHACHAR, & M. DENNIS. Parent Ratings of Executive Function After Childhood Closed Head Injury.

Executive dysfunction, the inability to organize one's own life and learning, is a common problem after childhood closed head injury (CHI). Questionnaire instruments to measure executive dysfunction are of very recent coinage, although tools to measure behavioral disorder and/or clinical psychiatric dysfunction (e.g., parent and teacher questionnaires or semi-structured psychiatric interviews) have long been applied to the study of behavioral outcome after childhood CHI. We evaluated parent ratings of executive function using the Behavior Rating Inventory of Executive Function (BRIEF). Participants were 116 children who had sustained a CHI at least 15 months prior to the parent ratings, grouped by injury severity (*mid* = 44; *moderate* = 37; *severe* = 35). Relative to the normative group, the CHI group had elevated T scores on each of the two BRIEF indices, the Behavioral Regulation Index (measuring the ability to inhibit attention, shift attention, and regulate emotions), and the Metacognition Index (measuring working memory function and the ability to initiate, plan, organize, and monitor activities). In addition, they had elevated T scores in seven of the eight BRIEF sub-scales. Compared to those with less severe CHI, children with severe CHI had more elevated T scores on each BRIEF index. Scores on the Metacognition Index were elevated with an older age at injury and a longer time since injury. Parent ratings of executive function on the BRIEF are sensitive to severity of childhood CHI and to some of the age and recovery time moderators of CHI outcome.

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S.C. HEATON, E.B. FENNELL, D.A. BECKER, D.M. GRIBBINS, & O.E. PUYANA. The Relationship Between Attention and Memory Impairments in Acute Childhood Traumatic Brain Injury.

Attention and memory impairments are common in children who have sustained a traumatic brain injury (TBI). Deficits are most prominent in moderate to severe TBI and many children have persisting deficits. Previous studies of childhood TBI typically focused on single dimensions of attention or memory, although these constructs are generally accepted to be multidimensional in nature. Even less is known about the relationship between deficits in these domains. The current study seeks to characterize the relationship between performance on multidimensional tests of attention and memory in acute childhood TBI. Pilot data are presented for participants ages 6–16 recruited after sustaining mild, moderate, or severe TBI approximately 6 weeks prior to assessment. Participants completed the Children's Memory Scale (CMS) and the Test of Everyday Attention for Children (TEA–Ch) as part of a larger assessment battery. Index scores from the CMS included: Verbal and Visual Immediate and Delayed Memory, General Learning, General Memory, and Delayed Recognition. Subtests of the TEA–Ch measured the following dimensions of attention: selective, sustained, and attentional control/switching. Significant correlation coefficients were noted between measures within each of the attentional domains and CMS composite indices. However, there did not appear to be much specificity in terms of the dimensions of attention assessed. Results further indicated that General Learning performance in acute childhood TBI is more related to all attentional domains than to other measures of general cognitive functioning such as intelligence scores and/or report of behavioral symptoms. Whether attention predicts to memory outcomes in pediatric TBI is under investigation.

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Z. YETKIN, H. LEVIN, D. MENDELSON, & P. PURDY. Evaluation of Word Fluency in Children With Traumatic Brain Injury Using fMRI.

Purpose: Expressive language impairment including reduced word fluency is commonly documented in children with traumatic brain injury (TBI). Neuroanatomic correlates of word fluency in normals as well as patients with brain tumor or epilepsy have been well documented using functional MRI (fMRI). The aim of this study was to assess functional MR imaging of word fluency in children with TBI. *Materials and methods:* Eight healthy controls and three children with TBI were studied. Functional images were acquired using a 1.5 T scanner while subjects were performing a silent word generation task. Cues for word generation were presented through headphones. Functional images of the brain were analyzed using cross-correlation analysis. *Results:* All healthy subjects showed consistent activation of left frontal, Broca and Wernicke's regions, bilateral superior temporal gyri, posterior parietal, and basal ganglia. In children with TBI, regions of brain activation included additional regions of activation in bilateral frontal and medial temporal lobes. The pattern of activation was not consistent among children with TBI. *Conclusion:* fMRI using silent word generation task provides consistent activation in healthy controls. The regions involved in the task and the extent of the activation in each region varied in children with TBI compared to those of controls. Observed differences in fMRI findings between groups may indicate reorganization of the regions involved word generation after TBI.

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M. PRASAD & L. EWING-COBBS. Language Skills Following Traumatic Brain Injury in Very Young Children.

Although young children with moderate to severe traumatic brain injury (TBI) have been found to have reduced performance on formal measures of expressive and receptive language skills, conversational language skills have not been addressed following TBI in very young children. Language development was prospectively evaluated in infants and preschoolers with

inflicted brain injury, accidental brain injury, and normal controls. Conversational language samples were collected for children older than 2 years of age and analyzed using the Systematic Analysis of Language Transcripts. Mean length of utterance was related to injury severity at baseline and at 1 year post-injury. Children with severe brain injury had shorter utterances than children with moderate brain injury and normal controls. Children with TBI, regardless of injury severity, had higher maze scores (repetitions, false starts, reformulations) at baseline. The groups did not differ in the use of pronouns, questions, or negative words. The presence of abuse was not a significant factor in conversational language scores. These findings suggest very young children with TBI show dysfluencies. Depending on age, children received either the Clinical Evaluation of Language Fundamentals or Sequenced Inventory of Communication Development. Expressive scores were significantly related to severity of brain injury. Receptive language performance was significantly lower for infants with severe brain injuries across all 3 time points. This study indicates that language impairments are present in conversational speech and on formal measures in very young children with TBI.

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C. RONCADIN, J.B. RICH, J. PASCUAL-LEONE, & M. DENNIS. Working Memory and Inhibitory Control After Early Childhood Closed Head Injury.

Recent models assert that inhibitory control (IC) is part of the working memory (WM) system, instantiated when information must be kept out of or removed from WM. We tested the hypothesis that traumatic brain injury in early childhood would disrupt the development of and relation between these cognitive resources. Participants were 26 children who sustained a closed head injury (CHI) before age 8 (and at least 18 months before testing) and 26 age- and sex-matched controls. The CHI group was divided equally into Mild (coma score of 13–15) and Moderate-Severe (coma score of 3–12) subgroups. Participants, who were between 6 and 13 years of age at testing, completed WM and IC tasks adapted from Diamond et al. We formulated performance efficiency scores that accounted for the trade-off in speed and accuracy. Efficiency of IC and WM maintenance was comparable in both groups. In contrast, efficiency of WM manipulation was poorer in the CHI group. Within the CHI group efficiency scores were highly correlated, whereas WM maintenance was unrelated to WM manipulation and IC in controls. For WM maintenance, small effect sizes were found in mild and moderate–severe *versus* control comparisons, whereas for WM manipulation and IC, the moderate–severe *versus* control comparison yielded large effect sizes and the mild *versus* control comparison yielded small effect sizes. These results suggest that early childhood CHI impairs WM and IC and changes the developmental relation between them. This study contributes to our knowledge of the sources of abnormal cognition after childhood CHI.

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K.O. YEATES & B.G. ENRILE. Implicit Memory in Children With Congenital and Acquired Brain Disorder.

We studied implicit memory in children with myelomeningocele and shunted hydrocephalus, children with severe traumatic brain injuries, and a control group of children with orthopedic injuries. There were between 27 and 30 children in each group, all from 8 to 15 years of age. The groups did not differ in age, gender, race/ethnicity, or socioeconomic status. All children had Full Scale IQs of at least 70. They were administered a fragmented picture identification task and a semantic decision-making task. The tasks provided measures of three forms of implicit memory: perceptual priming, conceptual priming, and skill learning. Both tasks provided measures of skill learning. The groups did not differ on either measure, but none of the groups showed evidence of significant skill learning on either task. Perceptual priming was assessed using the fragmented pictures task. All 3 groups showed significant perceptual priming, but children with myelo-

meningocele and shunted hydrocephalus displayed significantly less perceptual priming than the controls, whereas the difference between children with traumatic brain injuries and controls was not significant. Conceptual priming was assessed using the semantic decision-making task. All three groups showed significant semantic priming. Contrary to expectations, the children with myelomeningocele and shunted hydrocephalus showed significantly more semantic priming than the controls, but the difference between children with traumatic brain injuries and controls was not significant.

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S. WADE, T. BROWN, & V. MEIER. A Family Problem-Solving Intervention for Child Brain Injury: Initial Findings.

This project sought to facilitate family adaptation following pediatric brain injury using a standardized Problem Solving Skills intervention (PSS). PSS consisted of 7, 90-min core sessions providing training in problem solving and behavioral strategies for responding to TBI sequelae. Based on their profile of needs, families could receive 4 individualized sessions to address unresolved stresses. Participants included families of children, aged 5–16 ($M = 10.75$ years), who sustained a moderate to severe TBI ≤ 18 months prior to study participation ($M = 9$ months). Parents and children completed a 2-part questionnaire regarding opinions about the program, knowledge of program content, and changes in family relationships. Thirteen families received the intervention (M sessions = 8). Outcome data were available from 15 parents and 8 children. Findings indicated that the program was successful and well received. Parents and children rated the program as extremely helpful (parents $M = 9.25/10$; children $M = 9.63/10$). All indicated that they would recommend the program. Parents rated the problem solving process as easy to use ($M = 9.42/10$) and 100% said they would use it in the future. All parents endorsed increased knowledge in program content areas including: understanding of their child's injury and awareness of strategies to improve attention and behavior. 100% reported that they understood and got along with their child better. All participating fathers and 67% of mothers reported feeling less stressed. Overall, these findings suggest that PSS holds promise as a structured intervention to facilitate family coping following TBI.

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M.D. RIS, K.O. YEATES, N. WALZ, N. WALLER, & R. AMMERMAN. Is There a Neurobehavioral Taxon in Spina Bifida/Hydrocephalus?

Spina bifida/hydrocephalus is associated with multiple types and degrees of neuropathology including deformation of the cerebellar tonsils, elongation of the pons and medulla, agenesis of the corpus callosum, aqueduct abnormalities, and tectal "beaking." Although children with spina bifida and hydrocephalus are at increased risk for neurodevelopmental problems, particularly in certain domains, we do not know whether this risk should be understood as continuously distributed, discontinuous in nature, or both. In other words, do the multiple underlying pathologies impart a risk to neurobehavioral development that is taxonic or non-taxonic? To examine this question, we pooled the results from two completed studies of children with spina bifida and hydrocephalus resulting in an overall sample of 80 children ranging in age from 8 to 17 years who underwent extensive neuropsychological evaluations. Indicators were pre-selected on the basis of the extant literature on hydrocephalus and will be subjected to multiple taxometric analyses and consistency tests (e.g., MAXEIG, L-Mode). Given the limited sample size, convergence of evidence from multiple approaches is critical. The results promise to shed new light on the nature of the neurobehavioral phenotype among children with spina bifida and hydrocephalus, and will have implications for theoretical models that posit threshold effects in neurologic disorders.

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K. EDELSTEIN, M. DENNIS, K. COPELAND, D. FRANCIS, M. BRANDT, S. BLASER, R. HETHERINGTON, & J. FLETCHER. Procedural Motor Learning in Children With Spina Bifida.

The cerebellum is part of a neural circuit involved in procedural motor learning. We examined how congenital cerebellar malformations affect performance on a procedural learning task involving mirror drawing. Participants were 74 children with spina bifida myelomeningocele (SBH), a neural tube defect that results in lesions of the spinal cord and dysmorphology of the cerebellum and requires shunt treatment for hydrocephalus, and 27 typically developing controls. The task involved learning to trace the outline of a star while looking at the reflection of the star in a mirror. Participants completed 10 acquisition trials and, after a 3h delay, completed 10 retention trials. Three measures were derived for each trial: time to complete the trace, area traced outside the outline of the star (area error), and number of times the outline of the star was crossed (cross error). All participants improved their performance of the task, as demonstrated by increased speed and accuracy across trials. During the acquisition phase, children with SBH took longer than controls to trace the star, made larger numbers of both types of errors, and required a greater number of trials to reach their optimal level of performance. Although the rate of change in performance was the same for both groups by the end of the acquisition phase, children with SBH were still slower and made more errors than controls on trials 10 and 20. The data will be discussed with reference to MRI-derived qualitative and quantitative analyses of cerebellar dysmorphology. The results suggest that congenital cerebellar dysmorphology impairs the acquisition and retention of a motor learning task.

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T. HOPYAN-MISAKYAN, G. SCHELLENBERG, & M. DENNIS. Perception of Rhythms With a Strong or Weak Metric Structure in Children with Spina Bifida.

Rhythm is a flow of time, a series of time intervals marked by, for example, tones or steps in a dance. Information about time establishes a rhythm's metric structure. Subjective accents and their flow in time constitute a metric clock. A strong clock is induced by accents regularly distributed in time (ticks synchronized with accented tones); these are ratios expressed as small integer values (1:2). A weak clock is induced by irregular distribution of accents; these are larger integer values (1:5) or non-integer values (1:2.5). Strong clock rhythms are easier than weak clock rhythms to discriminate and reproduce. Moreover, fMRI studies in normal adults have shown strong cerebellar activation during rhythm discrimination and different patterns of cerebellar activation depending on whether the discrimination involves strong clock or weak clock rhythms. We studied whether children with congenital malformations of the cerebellum could capitalize on the presence of a strong clock during the perception of rhythms. Spina bifida myelomeningocele is a neural tube defect that involves spinal cord lesions and dysmorphologies of the cerebellum. Participants were 36 children aged 10–19 years, 18 with spina bifida and hydrocephalus (SBH group) and 18 pair wise matched controls (CON group). The groups did not differ on the weak clock rhythms but the SBH group performed more poorly on the strong clock rhythms, showing that they benefited less than controls from the presence of a strong metric structure. Neurodevelopmental disorders involving dysmorphology of the cerebellum are associated with deficits in the perception of rhythm.

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R. BURMEISTER, H. J. HANNAY, K. COPELAND, M. HISCOCK, & J. FLETCHER. ADHD in Children with Spina Bifida Meningocele.

The prevalence and characteristics of Attention Deficit Hyperactivity Disorder (ADHD) were examined in children with spina bifida meningocele (SBMM) with shunted hydrocephalus. The sample consisted of 205 children (ages 6–16), including normal children ($n = 41$) and children with SBMM with shunted hydrocephalus ($n = 164$). The prevalence of

ADHD, based on SNAP-IV Parent Rating Scale cutoff scores, was 31%. Fourteen children (8.5%) met criteria for ADHD-Combined Type (ADHD-C) and ADHD-Predominantly Hyperactive-Impulsive Type (ADHD-HI), and 37 children (22.5%) met criteria for ADHD-Predominantly Inattentive Type (ADHD-I). It was hypothesized that children with SBMM would perform worse than controls, and children with SBMM classified as ADHD would perform worse than those classified as non-ADHD on cognitive and behavioral measures of attention/executive function. A one-way ANOVA was conducted on the cognitive measures, and a one-way MANOVA was conducted on the behavioral rating measures. The SBMM children performed significantly worse than the control group on all cognitive and behavioral measures. No significant differences were found between children classified as ADHD and non-ADHD or between the ADHD subtypes on the cognitive measures. However on the behavioral measure, parents and teachers rated the ADHD group as having more executive function problems than the non-ADHD group. Parents but not teachers also rated the ADHD-C group as exhibiting more executive function problems than the ADHD-I group. Teachers' ratings of hyperactive/impulsive behavior may be different from parents due to medication in the classroom or greater tolerance for verbal disruptions.

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K. DALEN, B. GRINI, L. LÆGREID, & S. BRUARØY. Psycholinguistic Abilities in Children With Hydrocephalus.

The aim of the present study was to investigate language problems among children with hydrocephalus (HC). The Illinois Test of Psycholinguistic Abilities (ITPA) was administered to 60 children with HC; 43 boys and 17 girls. Age group 4.0–9.11 years, mean age 6.3, born between 1980–1996. All children were living in the western part of Norway. Thirty-seven children had congenital HC and 23 had acquired HC. In order to make the groups as homogenous as possible, children with spina bifida, brain tumor, mental retardation, or a foreign mother language were excluded. Different medical and demographic variables and the age norms of the ITPA were correlated. The results demonstrated both for the total mean score and for the different single tests to be within ± 1 SD as compared with the normative data. None of the medical variables predicted scores on the ITPA, neither did gender. Chronological age correlated with psycholinguistic age showed a weak, positive correlation ($p = .017$). Aspects like the quality of the normative data, individual test profiles, and the utilization of alternative tests are discussed.

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L.K. AYR, K.O. YEATES, & B.G. ENRILE. Arithmetic Skills in Acquired and Congenital Brain Disorders.

Arithmetic skills were assessed in 22 children with myelomeningocele and shunted hydrocephalus, 28 children with severe traumatic brain injuries (TBI), and 27 children with orthopedic injuries, all from 8 to 15 years of age. The groups did not differ in age, gender, or ethnicity, and all children had a WISC-III Verbal Comprehension of Perceptual Organization index score of at least 80. Children in the TBI and orthopedic injury groups were at least 1 year post-injury. All children completed the WRAT-3 Reading and Arithmetic subtests, as well as a subtraction task consisting of 20 problems of varying difficulty. The groups did not differ significantly on the WRAT-III Reading subtest. The myelomeningocele group displayed lower WRAT-3 Arithmetic scores than the TBI and orthopedic injury groups, but the latter 2 groups did not differ from each other. On the subtraction task, the myelomeningocele group attempted significantly fewer problems and answered significantly fewer problems correctly than the other two groups, which did not differ from each other. The groups did not differ in the number of math fact errors or visual-spatial errors, but the myelomeningocele group made more procedural errors than the orthopedic injury group. In a regression analysis controlling for group member-

ship and age, the number correct on the subtraction task was a significant predictor of WRAT Arithmetic performance. In a second analysis, the number of math fact errors and number of procedural errors were independent, significant predictors of WRAT Arithmetic performance. Congenital and acquired brain disorders are associated with distinct patterns of arithmetic skills.

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K. BOYER, K.O. YEATES, & B.G. ENRILE. Children's PASAT Performance Among Children With Myelomeningocele and Shunted Hydrocephalus and Healthy Siblings.

The Children's Paced Auditory Serial Addition Test (CHIPASAT) is designed to assess working memory and information processing speed. We administered the CHIPASAT and other standardized measures of working memory and processing speed to 32 children with myelomeningocele and shunted hydrocephalus, who are known to demonstrate deficits in processing speed, and 27 healthy siblings, all between 8 and 15 years of age. We compared performance in the two groups, and conducted regression analyses to determine the relationship between CHIPASAT performance and other measures of working memory and processing speed. Scores on the CHIPASAT included the number of correct responses at each stimulus presentation rate, as well as the number of correct consecutive responses (i.e., dyads). The latter score insures that children followed task instructions rather than ignoring some numbers, thereby reducing demands on working memory. The siblings performed significantly better than children with myelomeningocele regardless of scoring method, although the magnitude of group differences declined as the rate of stimulus presentation increased. Children with myelomeningocele were more likely than siblings to provide correct but non-consecutive responses, except on the most rapid trial. The WISC-III Coding and Arithmetic subtests accounted for a significant amount of unique variance in CHIPASAT performance after controlling for age, group membership, and WISC-III Verbal Comprehension and Perceptual Organization indexes. The results suggest that the CHIPASAT provides a valid measure of children's information processing speed.

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M. SYMINGTON, L.K. PAUL, A. TURK, & W.S. BROWN. Appreciation of Humor in Primary Agenesis of the Corpus Callosum.

Recent studies have begun to show that individuals with agenesis of the corpus callosum and normal intelligence (i.e., primary ACC) have deficits in fluid intelligence and social processing. For example, recent research revealed impaired paralinguistic processing in adults and children with primary ACC. Comprehension of humor also requires the ability to understand literal and nonliteral meanings, as well as insight into social context and social interactions. The Cartoon Humor Test was given to 11 acallosal children with normal intelligence (ages 7 to 14, FSIQ 80 to 122) and 17 matched controls (ages 8 to 12, FSIQ 83 to 120). In addition, both the Cartoon Humor Test and the Narrative Joke Test were given to 13 acallosal adults (ages 16 to 31, FSIQ 83 to 105) and 23 adult matched controls (ages 18 to 36, FSIQ 84 to 109). On the Cartoon Humor Test, adults performed better than children ($p < .01$), and individuals with ACC (both children and adults) exhibited significantly poorer performance than controls ($p < .01$). No interaction was detected. There was also a trend in adults with ACC towards significantly worse performance than controls on the Narrative Joke Test, ($p = .088$). Taken together, these results suggest a significant deficit in the appreciation of visual and narrative humor among normally intelligent individuals with ACC.

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A. TURK, A. KHATCHIKIAN, L.K. PAUL, & W.S. BROWN. The Corpus Callosum and Psychosocial Recognition: Semantic Analysis of Stories.

In the emergence of higher human cognitive capacities, the corpus callosum appears to play an important role. However, the exact role of the corpus callosum in the development of social cognition has remained difficult to assess and to quantify. Parents of individuals with agenesis of the corpus callosum (ACC) and normal intelligence (i.e., primary ACC) have reported that their children often misread social cues. Recent research has found that individuals with primary ACC are limited in logical coherence and social awareness when creating narratives for the Thematic Apperception Test. This study examined semantic social content of TAT stories from 22 individuals with ACC (12 children ages 7 to 14, and 10 adults, ages 16 to 31), all with normal-range IQs (FSIQ 83 to 122); along with 30 IQ- and age-matched controls. Semantic content was analyzed using the Linguistic Inquiry and Word Count. We were particularly interested in the semantic categories of Emotional and Social Processes. The ACC group used less words pertaining to emotionality [$t(51) = 2.01, p < .05$]. Furthermore, matched controls used 20.7% of their words in the social domain, *versus* 18.4% for the ACC group, a group difference that was clearer for the adults than for the children [$t(24) = 3.27, p < .001, vs. t(26) = 1.53, p = .064$]. These results suggest that the corpus callosum plays a role in the neuropsychological processing of social and emotional content, and/or the translation of social content into imaginative narrative. Correspondence: Warren S. Brown, Ph.D., Travis Research Institute, Fuller Graduate School of Psychology, 180 North Oakland Ave., Pasadena, CA 91101. E-mail: wsbrown@fuller.edu

D. CHARLTON, L.K. PAUL, A. TURK, M. SYMINGTON, J. BUEHLER, & W.S. BROWN. Behavior Ratings in Primary Agensis of the Corpus Callosum.

Recent studies have demonstrated that individuals with agenesis of the corpus callosum and normal IQ (primary ACC), though considered "asymptomatic" by neurology, may have mild cognitive, social, and behavior problems. Using the Achenbach Child Behavior Checklist (CBCL), Brown and Paul examined the social deficits of two young men with ACC. While neither demonstrated severe social or behavior problems, both exhibited elevated levels on the Social Problems subscale. In order to investigate further the social and behavior profiles of children and adolescents with ACC, 18 individuals with primary ACC (FSIQ 74 to 122), 13 children (ages 7 to 12) and 5 adolescents (ages 13 to 18), were administered the CBCL. Significant CBCL elevations ($p < .05$ relative to $T = 50$) were found on the following subscales (most to least deviation from norms): Social Problems, Attention Problems, Thought Problems, Aggressive Behavior, Anxious/Depressed, Somatic Complaints, Withdrawn, and Delinquent Behavior. For 8 subjects (4 children and 4 adolescent) both parent- and self-report data were available. While parent reports for these subjects mirrored those for the entire group, only Social Skills and Attention subscales were elevated on the Youth Self-Report version. Thus, parents of these individuals perceive them as having significant behavioral problems, but the acallosal individuals tend to be aware only of their attention and social behavior problems. Therefore, individuals with primary ACC have a notable pattern of behavioral difficulties, and should not be considered entirely asymptomatic, even though IQ is normal.

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M. FAEREVAAG, S.H. OFTE, & G. CHRISTIANSEN. Challenges Encountered Concerning 8-Year-Old Female Twins With Corpus Callosum Agensis.

The older of the twins has a partial dysplasia of the corpus callosum. She is taller and stronger than her younger sister. She is right-handed and shows interest in reading and writing letters. The younger of the twins has hydrocephalus (shunted) and coarctatio aortae (operated) in addition to the corpus callosum agensis. She has motoric problems that slow her

down in relation to her sister and other children. She has a right hand preference, but has not yet any interest in reading or writing letters. Their condition is viewed as a hereditary recessive condition. The twins have very similar looks. Both have a vocabulary of about twenty words, however their speech is difficult to understand for those unfamiliar to them. They use some sign language in addition to spoken language. The communication between the twins is lively, but not understandable to others, as it does not contain any words as such. Mentally it seems that they function at a level two to three years below their chronological age. The twins are discussed in relation to communication and language abilities, cognitive functions and challenges in assessing, testing and teaching them. Correspondence: M. Faerevaag, Eikelund Resource Centre, PB 6039 Postterminalen, N-5892 Bergen, Norway. E-mail: Margaret.K.Faerevaag@statped.no

A.G. URNES. Corpus Callosal Agensis, More Than a Nonverbal Learning Disorder? A Single-Case Study.

Callosal pathology has been found in studies of children with behavior disturbances or learning difficulties. Complete neuropsychological assessments in these cases are sparse and findings are diverse. This case study presents a 13-year-old girl with a complete callosal agensis, referred for evaluation due to persisting social difficulties and emerging learning problems. Achenbachs Child Behavior Checklist score was in the clinical range on the subscales of aggressive behavior and social problems. Academically, reduced performance was reported in mathematics, while reading and writing abilities were excellent. Neuropsychological test results showed prolonged time on bilateral tactile discrimination tasks. She was left-handed. Fine motor speed was normal in her dominant left hand and significantly reduced in the nondominant hand. Visual gestalt tests were performed with great difficulties, while visuospatial processing was superior. Word fluency and rote verbal learning was normal, while the understanding of complex verbal material was reduced. A dichotic listening task showed no right ear preference, an indication of a bilateral language representation. General processing speed was reduced on the Posner test, while attentional and problem solving functions otherwise were normal. Verbal IQ was 82, significantly weaker than performance IQ (99). This is the opposite of what Rourke suggests, in his theory, identifying corpus callosum agensis as a typical example of a nonverbal learning syndrome. This case shows that a complete callosal agensis may lead to compromised brain function with specific neuropsychological deficits both in the verbal and nonverbal domain.

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CROSS-CULTURAL ISSUES IN NEUROPSYCHOLOGY

A. SCHWEIGER, L. NOIFELD, D. JAFFE, T. DWOLATZKY, & E. SIMON. Rapid Access to Word Meaning Without Stroop Effect in English As a Second Language.

Explanations of the interference effects on Stroop tasks are centered on the 'involuntary,' automatic processing of word meaning. But does rapid access to meaning of words per se compel this automaticity of processing? To examine this question, two groups were compared: one of 82 native English speakers, the other of 43 college, non-bilingual students, all proficient in English reading as a second language (having studied English since 5th grade). Both groups took a computerized test battery (MindStreams by NeuroTrax) which includes measures of processing speed, attention, spatial ability and executive functions, on which the groups did not differ. The Stroop sequence was presented in a forced-choice paradigm, where participants had to press rapidly one of two mouse buttons corresponding to the correct choice appearing on the screen. On task (1) the decision required to judge the color of neutral words (e.g., CAT in blue color), on task (2) decision made to a color-word appearing in white (e.g., RED in white color), and on task (3), the interference task, decision

required to the color of color-words (e.g., RED in blue color). *Results:* no reaction-time differences were found between the groups on task (2), indicating rapid access to meaning by non-English speakers. Reaction times were significantly longer on the interference task (3), the Stroop effect, and also on task (1), but only in English speakers. Non-English speakers showed no reaction-time differences among the three tasks. The results indicate that rapid access to meaning need not be automatic in a second language; implications for semantic activation theories are discussed.

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L. WALKER & A. SMITH. Neuropsychological Norms for African Americans.

Neuropsychological assessment is utilized to evaluate the variety of cognitive and behavioral deficits associated with each of the major categories of neurologic disease including, but not limited to traumatic brain injury (TBI). Studies have shown that individuals of lower socioeconomic status have a greater likelihood of sustaining a TBI. TBI produces a variety of cognitive and behavioral deficits that can be identified through neuropsychological testing which can assist in the development of specific rehabilitative strategies that will allow individuals to continue to function occupationally and socially following acquired brain injury. One long standing issue with standardized testing has been the lack of adequate normative test data for non-European Americans. Cross-cultural and psychometric psychologists suggest that ideally separate normative data should be used for different racial groups as is done currently with other demographic factors (e.g., age, gender, etc.). *Objective:* To present normative data for neuropsychological tests for African American adults that are generally overrepresented at the lower end of the socioeconomic (SES) structure where they may be at greater risk of TBI. In the current study, 15 African American CHI patients were recruited from acute care neurological services. Twenty demographically comparable, orthopedic control patients were recruited as well. The patient and control patient groups were similar in demographic features and did not have pre-injury drug/alcohol abuse, dementia, psychiatric disturbance, or neurological illness. Cognitive measures were administered 2 to 5 days post-injury involving orientation, attention, concentration, speech, language, perceptual processes, memory, new learning, and executive functioning.

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M.H. KITNER-TRIOLO, J.E. DONOHUE, M.K. EVANS, & A.B. ZONDERMAN. Association of Age With Attention and Executive Function Mediated by SES.

Some investigators attribute racial differences in neuropsychological performance to disparities in educational opportunities and cultural acculturation, both of which are related to socioeconomic status (SES). The present study examined differences in the pattern of the correlations of age with measures of attention and executive function in three adult samples of middle-class Whites, middle-class Blacks, and low SES Blacks matched for age and sex. Subjects were 170 White (BLSA-W) and 171 Black (BLSA-B) participants from the Baltimore Longitudinal Study of Aging, and 169 participants from the Healthy Aging in Nationally Diverse Longitudinal Sample (HANDLS) residing in low SES Baltimore City neighborhoods. Participants were administered the Wechsler Adult Intelligence Test (WAIS): Digits Forwards and Backwards, and the Mini-Mental State Examination (MMSE). After eliminating participants with MMSE scores ≤ 24 , there were significant associations between age and digits forward (total & maximum span) in BLSA-W and BLSA-B, but not in HANDLS. Age was also associated with digits backward in BLSA-W, but had no such significant relationship in BLSA-B and HANDLS. There were no significant differences in education between BLSA-W and BLSA-B participants ($M = 16$ years), but both had significantly more years of education than HANDLS participants ($M = 12$ years). Despite these differences in educational attainment, the pattern of correlations for digits forward and digits backward were unchanged after adjusting for years of educa-

tion. These results suggest that age-associated changes in cognitive performance may not differ as a function of race but may differ as a function of socioeconomic status.

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B. GEYER, J. HILL, S. KELLER, & J. BARTLETT. Updated Inner-City Norms for the Raven's Coloured Progressive Matrices.

It has been argued that tests of nonverbal or visual reasoning ability, such as the Raven's Coloured Progressive Matrices (CPM), are more "culturally and educationally fair," and therefore, more accurate methods of assessing reasoning abilities across cultures. Other research has shown that performance on nonverbal measures varies considerably between regions and ethnicities, is not culture-free, and should be investigated further. The current CPM norms are based mainly on White school districts, and sparse, outdated norms for ethnic subgroups in various regions of the United States (e.g., Mexican, African American). The collection of CPM norms for regions serving a low-income African American community has been described as a specific priority. Our sample included 206 predominantly African American, normal inner-city youth, ages 7 to 13; we compared their performance against published norms of the CPM. The results showed that, on average, inner-city youth scored 6.2 points lower than current U.S. published norms indicate. Yet African American children scored an average of 1.5 points higher than previously published norms for the African American population. In addition, Newark Latino children scored 1.8 points higher than published norms for Puerto Rican children. These results show that nonverbal tests such as the CPM are not culture-free as is often assumed. Local norms may more adequately represent the performance of children of different cultures.

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J. CORY, L. BUKI, & E. CHAVEZ. Sociocultural Influences on Neuropsychological Test Performance: The Case of Acculturation Status in Latinos of Mexican Origin.

As the population of the United States becomes progressively more diverse, clinical neuropsychologists are increasingly called upon to assess individuals from non-majority ethnocultural and linguistic backgrounds. However, the neuropsychological literature provides limited guidance regarding the impact of sociocultural factors on cognition, and how these factors influence neuropsychological measurement in non-majority populations. Acculturation status is a moderator variable with demonstrated importance for psychometric testing with ethnocultural and linguistic non-majority populations, yet the construct has not been thoroughly investigated. Data for this investigation were obtained as part of a larger study of moderator variables in neuropsychological testing with community-dwelling Latinos of Mexican origin. Eighty adult participants of Mexican cultural or national origin were randomly assigned to complete linguistically-equivalent neuropsychological measures in either their English- or Spanish-language format. All participants were from the Denver, CO Metropolitan Area, were bilingual (per systematic screening) and healthy (per health history screening). Acculturation was measured using the ARSMA-II. Analyses of variance showed that neuropsychological test performance was significantly influenced by linear acculturation status in the case of a number of measures, such as WAIS-R Block Design, EIWA Diseño de Bloques, and Color Trails 1 & 2 (English and Spanish conditions). This study supports the importance and viability of examining the impact of cultural variables on neuropsychological testing. Practical implications for the ethical practice of neuropsychological testing with Latinos of Mexican origin are discussed.

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A. BLAIR, M. NICOLOFF, L. MARMOL, W. ADAMS, L. SCHOCK, & G. SHAVER. Normative Data for the CVLT-II, BNT, COWA and RCPM Based on a Bilingual Mexican-American Community Sample.

Interest in the effects of culture and bilingualism on neuropsychological performance has only recently begun to culminate in hard data. A review of the literature for studies utilizing Hispanic subjects reveals that 16 of 21 studies from the last decade have focused on the elderly. A total of 8 studies used healthy community volunteers and no studies have been identified that have utilized individuals from the Pacific Northwest. Participants in the present study were 57 Mexican-Americans aged 18 to 51 years who are community dwellers in Washington and Oregon. The sample was nearly equal in numbers by gender, status as urban or rural dwellers, and status of birthplace as United States or Mexico. Subjects were screened for neurological and medical problems, substance abuse and low intellectual functioning. Performance on the CVLT-II, BNT, COWA, and RCPM is evaluated by age, gender, acculturation level, years of education and location of education. Raw and standard scores are provided for the CVLT-II Trials 1, 1-5, List B, and Short-Delay Free Recall. Significant differences in performance by acculturation level were identified for the BNT and COWA but not for the CVLT-II.

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R. LECUSAY, A. ARDILA, P. SUAREZ, F.L. WILKIE, D. LEE, M. CONCHA, R. MOLINA, S. O'MELLAN, & K. GOODKIN. Cross-Cultural Adaptation of the Boston Naming Test in HIV-1+ Hispanics.

We constructed an acculturated Hispanic NP battery for HIV-1 infected individuals. Of particular interest in this study was the task of determining comparable level of difficulty for English and Spanish items in tests measuring language abilities, like the Boston Naming Test (BNT). A panel of Spanish-speaking and bilingual neuropsychologists, physicians, and staff constructed a new, Spanish-language BNT borrowing items from the versions of the BNT from the USA, Colombia, and Spain. In determining the order of presentation, the panel attempted to maintain the order of the original USA version. However, some items were shifted by panel consensus, guided by 6 levels of difficulty (1 level for every 10 items of the 60 item test), in order to reflect for each item the level of difficulty and familiarity for Hispanics. Fifty-four Hispanic subjects were administered the new Spanish-language version of the Boston Naming Test (BNT). Subject responses were analyzed to determine the frequency of correct responses for each item. There was a correspondence between a decrease in percent of correct responses and an increase in level of difficulty. After comparing the order based on responses and the order of items in the panel-constructed test, we found that in 16.7% of the words there was a discrepancy of 10 or more items in order of presentation. These words were then rearranged to reflect the order of difficulty suggested by the analysis of responses. The resulting new Hispanic version of the BNT is presented.

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R. LECUSAY, A. ARDILA, P. SUAREZ, F.L. WILKIE, D. LEE, M. CONCHA, R. MOLINA, S. O'MELLAN, & K. GOODKIN. Cross-Cultural Adaptation of the WAIS-R Vocabulary in HIV-1+ Hispanics.

The process of standardizing neuropsychological tests in another language holds many challenges. One is determining a comparable level of difficulty for English and Spanish items in tests, e.g., the WAIS-R Vocabulary, measuring language abilities. A panel of Spanish-speaking and bilingual neuropsychologists, physicians, and staff constructed a new, Spanish-language version of this test. This was accomplished by borrowing items from the vocabulary subtest of the WAIS-III (Spanish version) and the EIWA (*Escala de Inteligencia Wechsler para Adultos*) as well as by translating de novo the remaining items from the WAIS-R. Items were ordered into four frequency groups guided by the use of a Spanish word frequency dictionary. The ordering within the groups was determined by their pres-

entation in the WAIS-R. Last, some items were rearranged in order to accommodate Spanish word frequency and familiarity, per consensus of the panel. Fifty-four Hispanic subjects were administered this Spanish-language version of the WAIS-R vocabulary. Subject responses were analyzed to determine the frequency of correct responses for each item. There was a correspondence between a decrease in percent of correct responses and an increase in level of difficulty. After comparing the order based on responses and the order of items in the originally administered test, we found that in 17% of the words there was a discrepancy of 10 or more items in order of presentation. These words were then rearranged to reflect the order of difficulty suggested by the analysis of responses. The resulting new Hispanic version of the WAIS-R vocabulary is presented.

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C.G. ARMENGOL. Measures of Executive Functions in Spanish: Adaptation and Normative Data on Two D-KEFS Subtests.

The assessment of executive functions has received much attention in the past ten years. The recently published D-KEFS allows for a process-oriented assessment of a range of abilities subsumed under this rubric. In this study, the Color-Word Interference and Card Sorting subtests were adapted to Spanish and data were collected on 94 elementary school Mexican children. On the Color-Word Interference task, a variant of the Stroop paradigm, two conditions are tested: (1) naming the color ink of a color word discrepant with the color of the ink, and (2) alternating between naming the discrepant ink color, and reading the color, as prompted by a cue (enclosed in a box). Data revealed no time differences between the two interference conditions, but on the alternating condition children made more errors. Card sorting in Mexicans paralleled that of Americans, with equivalent number of categories attained, more perceptual than verbal sorts. A 4-way repeated measures MANOVA, Gender \times Age \times Type of Sort (verbal vs. perceptual) \times Structured-Unstructured Sorting, was performed on the Mexican data. Two two-way interactions were significant: (1) Category \times Gender; and (2) Category \times Structure. Girls provided more perceptual than verbal sorts, but this difference was not found for the boys. For the structured condition, verbal classification was facilitated, but no differential effect was obtained for the perceptual sorts. In sum, these adaptations in Spanish yield similar results to the original normative sample. Further research is necessary to investigate gender differences obtained in perceptual versus verbal sorts.

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M. TSUNEMOTO, D. FUJII, & A.M. WYLIE. Cultural Differences in Predicting WAIS-III IQ Scores in Schizophrenia.

The purpose of this study was to develop short forms of the Wechsler Adult Intelligence Scale-Third Edition (WAIS-III) for different ethnic groups and compare the predictive accuracy with an established WAIS short form, the Kaufman 4, in a schizophrenic sample. Subjects were divided into three groups based on ethnicity: (1) Asians ($n = 30$); (2) Whites ($n = 44$); and (3) Pacific Islanders ($n = 28$). Stepwise regression analyses were run for each group with Full Scale IQ (FSIQ) as the dependent variable. Scores on the WAIS-III subtests, with the exception of Symbol Search, LN Sequence, and Object Assembly, were used as predictor variables. Results of the regression equations were significant ($p < .001$) for each ethnic group for the first study. IQ estimates were then calculated and compared with estimates based on the Kaufman 4 formula. Our regression based formula was significantly more accurate at predicting IQ scores than the Kaufman 4 for Asians and Whites but not Pacific Islanders. Implications for possible culture-specific short forms were discussed.

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R. CHAN. Dimensionality of the Chinese Version of the Cognitive Failures Questionnaire.

This study aimed to examine the measurement properties of the Chinese version of Cognitive Failures Questionnaire (CFQ) using the Rasch model analysis. This model allows us to construct linear measures from ordinal scale. In this technique, one first transforms different performance raw response scores to a “logit” metric. Then, each raw performance score is transformed to a linear logit scale of “difficulty” along which different levels of difficulty can be directly compared with one another. A total sample of 262 subjects (102 patients with traumatic brain injury (TBI) and 160 normal controls) were recruited. Equal interval measures of CFQ were developed that exhibited good reliability and validity. The item and subject separation were found to be 3.29 (similar to Cronbach alpha of 0.92) and 5.57 (Cronbach alpha of 0.97). Principal component analysis of correlations among standardized residuals showed that all 25 items cohered to define a single construct of general cognitive failure. A common metric on the individual item scores was also established to discriminate patients from the normal controls. In conclusion, these findings indicate that Rasch Model analysis can offer us an alternate method to determine the measurement properties of the CFQ as well as to set up an efficient profile measure of everyday life cognitive failures to discriminate patients from normal controls.

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A. ISOMURA & A. WISNIEWSKI. Spatial Explicit Memory Performance Among Japanese Americans and European Americans: Gender and Ethnic Differences.

This study investigated gender and ethnic differences in spatial explicit memory performances among Japanese Americans and European Americans. It was hypothesized that (1) males perform better than females on spatial memory tasks and (2) Japanese Americans perform better than European Americans on spatial memory tasks. Thirty Japanese Americans (15 males; 15 females) and thirty European Americans (15 males; 15 females), age 18 to 35 years, were administered the Rey-Osterrieth Complex Figure (ROCFT). Immediate and Long Delayed Recall Trials of the ROCFT were administered. In addition, Japanese American participants were administered the Suinn-Lew Self-Identity Acculturation Scale (SL-ASIA) and information on generation in the United States was collected. The data partially supported that hypothesis that males perform better than females on the ROCFT. More precisely, male participants performed significantly better than female participants on the ROCFT Delayed Recall. However, additional analyses revealed that gender differences on the ROCFT Delayed Recall was significant only for European Americans and not for Japanese Americans. Further, the data supported the hypothesis that Japanese Americans perform better than European Americans on the ROCFT. Additional analyses indicated that ethnic group differences on the delayed recall of the ROCFT was significant only for females but not for males. These findings provide support of the need for separate norms for gender and ethnic groups. Limitations of the study, particularly with respect to generalizability, and future directions are also addressed.

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A. SALEEM, D. KENDALL, L.J.G. ROTH, & L.M. MAHER. The Effects of Written Language Directionality on Thematic Role Assignment.

Purpose: To explain a sentence production deficit in aphasia, language-specific directionality of writing has been proposed to influence thematic role assignment. Testing this hypothesis, we report comparisons of thematic role assignment in English (rightward) vs. Arabic (leftward) writers. *Methods:* Groups (20 each) of monolingual Arabic or English males participated. Stimuli included reversible, unidirectional (action away from agent), picturable action verbs. Subjects were to draw stick figures showing actions of verbs presented. Drawings were scored for relationships between figures performing the unidirectional action. *Results:* The inter-

action between languages and thematic roles in the position of drawn figures was not significant ($p = .07$). Arabic subjects drew agents significantly more to the right ($M = 15.60$ cm, $SD = 4.52$) than where they drew patients ($M = 14.9$ cm, $SD = 4.40$; $p < .001$), and more to the right than where English-speaking subjects drew agents ($M = 13.32$ cm, $SD = 3.28$) or patients ($M = 12.01$ cm, $SD = 3.31$). Furthermore, English-speaking subjects drew agents significantly more ($p < .001$) to the right than they drew patients. *Discussion:* These results do not confirm a written language directionality effect upon thematic role assignment. Additionally, the results of the English speaking group suggests variability in spatial processing of thematic roles that cannot be accounted for by directionality of written language, and suggests the need for further investigation.

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F. CONSTANTINIDOU, M. SARAP, & N. PELTIER. Native Language and Cognitive Performance: A Comparison Between Greek and English Speakers.

Research suggests that the linguistic structure of a given language may influence memory performance. This study compared verbal and non-verbal memory patterns in English and Greek speakers. An English battery and an equivalent battery adapted in Greek were used. Thirty-four native Greek speakers (ages 16–46, $M = 26.53$, $SD = 7.58$) and 47 native English speakers (ages 16–50, $M = 25.62$, $SD = 5.8$) participated. The groups were matched in age, gender, and education. *T*-test analyses ($\alpha = .01$) indicated that English speakers recalled a significantly greater number of digits during the Digits Forward ($p < .0001$) and Backward ($p = .0001$) of the WMS-III. There were no group differences on nonverbal tasks such as the visual span forward and backward of the WMS-III ($p = .154$ and $p = .045$ respectively). There was no difference on the Rey Complex Figure recall ($p = .943$). Greek subjects were significantly slower on Trailmaking A ($p < .0001$) and B ($p < .0001$). A MANOVA compared the subjects on the Rey AVLT versions. There was no significant difference between the two groups on the total number of words learned across the 5 learning trials ($\alpha = .05$, $p = .687$). Learning patterns were similar and the interaction effect was not significant ($p = .260$). The group differences in auditory span tasks and Trailmaking tasks may be due to linguistic differences. Specifically, English numbers (the ones used for the digit span) and letters are typically monosyllabic while all Greek numbers and letters are multisyllabic. Greek speakers may require more processing time, which in turn could affect performance. The monosyllabic advantage was absent on the AVLT due to the task demands on working memory, and because the English and Greek AVLT incorporate bisyllabic words.

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HEMISPHERIC ASYMMETRIES

R. PROPPER, K.A. PHANEUF, M. LAMENDOLA, J. RIVELLI, J. COTTER, A. COREY, & J. PHANEUF. Superior Autobiographical Memory in Mixed- Versus Strong-Handers.

Increased interhemispheric interaction has been associated with superior episodic memory ability on tests of recall and recognition for word lists, as well as for real-world experiences of autobiographical events. There is evidence that the cerebral organization of mixed- and strong-handers differ, with mixed-handers having greater interhemispheric interaction, and therefore increased reliance on episodic memory on standard laboratory tasks. The present research was designed to investigate handedness differences in memory for real-world autobiographical events. *Method:* 23 mixed- and 22 strong-handers [established via the Edinburgh Handedness Inventory (EHI), mixed $EHI \leq +80$ and ≥ -80 ; Strong $EHI \geq +85$] recorded 10 unusual life events, as soon as possible after an event occurred, over the course of 6 days. Unusual events could be insignificant (i.e., stubbing

one's toe) or significant (i.e., attending a funeral). One week later, participants recalled the gist of as many items as possible. Recall accuracy was determined by 100% agreement between two judges blind to subjects' handedness. *Results:* One-way ANOVAs on signal detection analyses of d' and $\log \beta$ revealed increased accuracy (d') in mixed- ($M = 2.39$, $SD = .58$) compared to strong-handers ($M = 1.91$, $SD = .90$) [$F(1,43) = 4.69$, $p < .05$] and a more conservative response bias ($\log \beta$) in mixed- ($M = .96$, $SD = .34$) compared to strong-handers ($M = .72$, $SD = .46$) [$F(1,43) = 4.30$, $p < .05$]. *Discussion:* Results support and extend previous findings of increased episodic memory in association with increased interhemispheric interaction from artificial laboratory conditions to real-world autobiographical memories.

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S. CHRISTMAN & T. BROWN. Right-Handers Exhibit a Later Transition From Childhood Amnesia to Autobiographical Memory.

Inspired by brain imaging data indicating bilateral versus unilateral neural activity during episodic versus semantic memory processing, respectively, Christman and Propper demonstrated that task and subject factors associated with increased interhemispheric interaction were also associated with superior episodic memory. Given the importance of the corpus callosum in mediating interhemispheric interaction, it was hypothesized that the onset of myelination of the corpus callosum at the age of 4–5 years may be partly responsible for the offset of childhood amnesia at around the same age. To test this hypothesis, early memories of mixed- and strongly right-handed subjects were examined using the methodology of Bruce, Dolan, and Phillips-Grant. This methodology provides an estimate, not of the earliest episodic memory, but of the age at which the episodic/autobiographical memory system becomes dominant over the semantic memory system. Because mixed-handedness is associated with a larger corpus callosum, it was predicted that mixed-handers should display an earlier dominance of the episodic memory system. Participants were asked to provide early childhood events that (1) they explicitly remember *versus* (2) that they knew had happened but could not remember. The average of the ages for these two events was used as an indicator of the age at which the episodic memory system becomes dominant. This age was 4.54 for strong-handers and 3.89 for mixed-handers, confirming the potential importance of callosally mediated interhemispheric interaction in the formation of episodic memories.

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D. KADEL & G. ANDREWS. Bilateral Field Advantage and Practice: Implications for Stimulus Complexity.

Previous studies used multiple blocks of trials and manual response times (RT) to assess processing of visual stimuli with right-handed participants. Processing of complex tasks required more coordination of the hemispheres producing a larger bilateral field advantage (BFA) score. A pattern-matching task (PMT) was reported by several studies to be more complex and resulted in larger BFA than a letter-matching task (LMT). BFA decreases with task repetition suggesting that as the task becomes less taxing the hemispheres require less splitting of duties. However, no study has investigated a possible practice effect for RT or accuracy across the blocks of trials. Left- and right-handed male (21) and female (15) participants performed 8 blocks (48 trials each) of a LMT and a PMT. There was a significant difference in BFA between the two tasks with higher BFA for the LMT. Practice effects for RT and accuracy were found for both tasks. Participants responded significantly faster and more accurately in latter blocks for both unilateral and bilateral presentations. The pattern of these practice effects differs between the LMT and PMT. A ceiling effect occurs by Block 3 for both RT and accuracy for the PMT, but significant improvement in RT and accuracy continues to Block 7 for the LMT. These results suggest that the LMT is the more complex task. The completion of additional blocks may be necessary for the LMT to become more automatized

and thus comparable to the PMT. Including left-handed participants may influence the differences between this and previous studies.

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G. ANDREWS & D. KADEL. Handedness and Sex Effects: Bilateral Field Advantage and Task Complexity.

Research suggested that a person's sex and handedness effect brain development and cognitive processing. Left-handed individuals were found more frequently in higher range intelligence groups and cognitive disability groups. Interhemispheric transfer time studies of persons with learning disabilities support predictions that left-handed participants would have slower response times (RT) and a higher bilateral field advantage (BFA) than right-handed participants on letter-matching tasks (LMT) and pattern-matching tasks (PMT). Earlier studies suggested that women have more coordination of functioning between hemispheres than men. Research would predict that women would have higher BFA scores than men for LMTs and PMTs. In the current study, comparisons of manual RT and accuracy using a LMT and a PMT indicated that left-handed participants (11) were significantly slower on the LMT for unilateral presentations than right-handed (25) participants. There was no difference in accuracy between the groups. The BFA for left-handed participants for the LMT was significantly higher than for right-handed participants, but not for the PMT. These results indicate that the LMT was a more complex task, and left-handed participants required greater coordination of the hemispheres to complete the task. Sex (male = 21, female = 15) did not significantly affect RT or accuracy for either of the stimulus tasks, nor was there a BFA difference between men and women. These results suggest that handedness influences processing of visual information, but sex does not impact performance on these decision-making tasks. Thus it will be important to evaluate handedness in studies involving bilateral field advantage.

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R. PROPPER, N. LAWTON, & M. PRZYBORSKI. A Naturalistic Assessment of Sleep Architecture as a Function of Handedness.

Self-report data have suggested sleep quantity and quality differences between the strongly- and mixed-handed (e.g.: Coren and Searleman, 1987; Hicks, Pellegrini, & Hawkins, 1979). Laboratory based studies have reported handedness differences in physiological measures of sleep (e.g.: Nielsen, Abel, Lorrain, & Montplaisir, 1990), but these inquiries have not attempted to replicate self-report data. Thus, the possibility exists that there are handedness differences in home-based sleep, however no previous studies examining this issue have been conducted. *Method:* 14 mixed- and 14 strong-handers (Edinburgh Handedness Inventory [EHI; Oldfield, 1971]) (Mixed EHI $\leq +70$ and ≤ -70 ; Strong EHI $\leq +75$) matched for age, test date, and gender, used REMView, a home-based sleep monitor that can distinguish between Wake, REM, and NREM (Ajilore, Stickgold, Rittenhouse, & Hobson, 1995). Participants followed their normal weekday schedule on the night they used REMView. *Results:* Results revealed significantly shorter sleep latency, greater number of minutes in NREM, a lesser percentage of time in bed in REM, greater propensity to wake in the morning from NREM, and greater awareness of nocturnal awakenings in the mixed-, relative to the strongly-handed. A marginally significant effect of sleep period (time from sleep onset to final morning waking) suggested a longer sleep period in the mixed-handed ($p = .08$). *Discussion:* The unreliability of self-report data as measures of actual sleep quantity or quality is discussed. The relationship between the anomalous cerebral organization of mixed-, relative to strong-handers, is proposed as a possible mechanism by which handedness differences in sleep can be organized within a neuroanatomical framework.

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K. YOSHIZAKI, A. NAGATANI, Y. SUZUKI, & T. HATTA. The Effects of Learning Experience on Bihemispheric Processing.

The purpose of our study was to examine the effect of learning experience on the benefits of bihemispheric processing. The right-handed university students participated in the two sessions. In Session 1, the subjects were given the paired-associated learning task, in which the subjects were required to memorize the pairs of a label (a letter of Kana script) with a random-shape. Immediately after the learning task, both a Kana and a random shape were tachistoscopically presented in the unilateral (UVF) and the bilateral visual-fields (BVF): Test 1. The subjects were asked to decide if a pair of the Kana-shape was the same or different. In Session 2, the same paired-association learning task was given to the subjects and then the subjects were again given the same Kana-shape matching task (Test 2) as Test 1. It was assumed that the degree of association between the shape and Kana script in Test 2 would be stronger than that in Test 1 and that the processing load in Test 1 would be higher than that in Test 2. The results showed that while in Test 1 a unilateral visual-field advantage appeared, there was no difference between UVF and BVF in Test 2. These results did not support the previous findings, in which as processing load in the task increased, the bilateral visual-field advantage enhanced. These findings suggested that the balance of processing load between hemispheres would have an influence on the benefits of bihemispheric processing. Correspondence: *K. Yoshizaki, 56-627, Ishigane, Iwasaki-cho, Nissin, Aichi, 470-0131, Japan. E-mail: yoshizak@asu.aasa.ac.jp*

S. CHRISTMAN & K. GARVEY. Bilateral Eye Movements Increase Stroop Interference: A Role of Interhemispheric Interaction.

Left-handers exhibit greater Stroop interference than right-handers under conditions of central (but not lateral) presentation. This was interpreted as reflecting greater interaction in left-handers between left hemisphere processing of the verbal dimension and right hemisphere processing of the color dimension. Greater interhemispheric interaction in left-handers was presumed to arise from the presence of larger corpus callosa in left-handers. The current study examined effects of bilateral horizontal saccadic eye movements on Stroop interference. Since lateral eye movements result in selective activation of the contralateral hemisphere, bilateral eye movements should result in bilateral cerebral activation. In turn, it was hypothesized that eye movement-induced bilateral activation should increase interhemispheric interaction and thus Stroop interference. Twenty participants ran through two blocks of a standard Stroop color-word task. Half of the participants engaged in 30 s of bilateral saccadic eye movements immediately before the second block of trials. There were no differences between the two groups for the initial block of trials ($p < 1$). For the second block, the no eye movement group showed reduced interference (consistent with practice effects), while the eye movement group showed increased interference, with the eye movement group exhibiting significantly greater interference ($M = 194$ ms) than the no eye movement group ($M = 63$ ms). Thus, bilateral eye movements appeared to enhance interhemispheric interaction. Implications for *eye movement desensitization and reprocessing* (EMDR) are discussed.

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C. MOHR, P. BRUGGER, H.S. BRACHA, T. LANDIS, & I. VIAUD-DELMON. Does Vision Influence Lateral Spatial Deviations in Whole-Body Movements?

Animals turn away from the hemisphere with the more active dopamine (DA) system. Therefore, in humans, interhemispheric DA asymmetries have been assumed to underlie lateralized whole-body movements. To investigate whether the heterogeneous findings reported across studies of human body motion result from different task conditions, we assessed several lateralized whole-body movement tasks in a within-subject design in 36 healthy right-handed subjects. We investigated three tasks known from the literature: (1) long-term spontaneous turning (total number of 360° turns during 20 hr), (2) visually directed locomotion (the number of veers while walking blindfolded straight ahead towards a previously seen goal at the end of a 20 m long corridor) and (3) stepping (degree of spatial

deviation to one side when instructed to step blindfolded on a given spot for 1 min). Individual side preferences in one task were unrelated to side preferences in another task. The only task which revealed a significance side bias was the long-term turning task; the deviation was to the left. Our results indicate that lateral biases in whole-body movements are not necessarily comparable across tasks. Since long-term turning, performed with eyes open, showed a left-sided bias, visually directed locomotion and stepping, measured while the subjects had eyes closed, exhibited no bias. We suggest that vision might enhance attention towards the left hemisphere. This view is supported by animal and patient studies showing reduced neglect after light deprivation.

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C. MOHR, P. BRUGGER, H.S. BRACHA, T. LANDIS, M. FATHI, & I. VIAUD-DELMON. Dopamine Mediated Aspects of Whole-Body Movements in Healthy Subjects.

We found that lateralized performance for different whole-body movement tasks are not comparable. This observation contradicts the general assumption that not only in animals but also in humans whole-body movements are directed away from the hemisphere with the more active dopamine (DA) system. In order to assess the link between side preferences in whole-body movement tasks in human and DA, 40 healthy right-handed subjects were randomized to receive either a single dose of levodopa (200 mg Modopar^{DR}) or placebo in a double-blind design. Subjects were asked to perform two tasks: visually directed locomotion (walking blindfolded straight ahead towards a previously seen goal at the end of a 20 m long corridor) and stepping (stepping blindfolded on the spot for one minute). In the stepping task, the degree of deviation did not differ between the levodopa and placebo group. In the visually directed locomotion task, we found a decreased veering tendency, particularly pronounced for right-sided deviations, in the levodopa compared to the placebo group. The absence of any significant finding with regard to the stepping task might indicate that DA controls predominantly tasks which are directed towards a goal beyond grasping space. Future experiments (manipulating movement directioning, i.e., within vs. beyond peripersonal space) are needed in order to differentiate between these different accounts.

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UNILATERAL STROKE: IMPAIRMENTS AND RECOVERY**D. KENDALL, A.B. MOORE, & L.J.G. ROTH. An Inventory of Cognitive Deficits in Chronic Unilateral CVA Patients: Helping Us Determine Where to Put Our Rehabilitation Efforts.**

Introduction: Stroke is the major handicapping chronic condition in adulthood, occurring in 3–500/100,000 individuals per year with 50% displaying persistent cognitive deficits. Unfortunately there is little information to guide the selection of treatment candidates or to inform researchers about good targets for their rehab research efforts. *Purpose:* The purpose of this study was to investigate the prevalence of cognitive/linguistic deficits in individuals with unilateral CVA with the hope that this information about the prevalence of different forms of cog disorders might inform the selection of treatment initiatives. *Methods:* Included 143 individuals (54 women, 89 men) w/unilateral CVA (age range 27–85 years; education range 6–20 years). Subjects presented to the Brain Rehabilitation Research Center at the Gainesville VAMC for inclusion in rehabilitation research studies and all were at least 6 mo. post-stroke. The screening included a neuro exam, medical HX and comprehensive neuropsychological and speech/language evaluations using standard measures. *Results:* (Deficit; % yes). Executive function: 92; Memory: 85; Psychomotor: 67; Anomia: 49; Aphasia: 41; Agraphia: 39; Agrammatism: 37; Alexia: 37; Attention: 27; Limb apraxia: 25; Apraxia of speech: 14. *Discussion:* These

data would suggest that the more common cognitive deficits were deficits of frontal executive function, memory, psychomotor function and language. Based on the fact that these deficits appear to commonly appear as lasting effects of unilateral stroke, these might warrant clinical or research attention regarding treatment.

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A.L. HOLLINGSWORTH, A.M. CIMINO-KNIGHT, K.M. HEILMAN, J.A. MCHONE, C. SMITH HAMMOND, & L.J.G. ROTH. Judgments of Impairment in Limb Apraxia.

With left hemisphere damage, limb apraxia is reported to occur less frequently than aphasia. Examiner insensitivity in recognizing apraxia may account for this difference. The purpose of this study was to compare the sensitivity of raters who received traditional textbook instruction with raters who received explicit clinical training. Subjects were 42 speech pathology students, Group A (practical praxis training, $n = 22$) and Group B (didactic training, $n = 20$). All subjects attended a lecture on limb apraxia and read a description of the disorder from a textbook. All subjects viewed 30 transitive pantomimes and rated the accuracy of each gesture. The accuracy of these pantomimes was also judged by experienced raters. Then, Group A was shown a training video where the instructor gave explicit instruction in the identification of each praxis error type. Group B received a two hour lecture on neurologically induced communication disorders. Subsequent to the training period, both groups were asked to judge the accuracy of the original pantomimes. Both groups were comparable in initial performance (Group A 51% accuracy; Group B 47% accuracy). Group A demonstrated a significant improvement ($p < .005$; 77%). Group B demonstrated no significant change ($p > .100$; 45%). These results indicate that inaccuracy on the first viewing can be explained by rater insensitivity and this insensitivity may be a significant contributor to the frequency and degree of limb apraxia detected and reported. Thus, the less frequent occurrence of apraxia than aphasia following left hemisphere injury might be related to observer training.

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J.L. PRESTOPNIK, K.Y. HAALAND, R.T. KNIGHT, & R.R. LEE. Hemispheric Dominance in the Parietal Lobe for Open and Closed Loop Movements.

Some have suggested that the left hemisphere is dominant for controlling open loop, ballistic movements, which are less dependent on sensory feedback and more dependent on motor programs. In contrast, closed loop movement control, which is less dependent on motor programs, has been attributed to the right hemisphere. However, other studies have not supported this distinction. We examined this issue by assessing ipsilateral aiming movements in the left (LCVA) or right (RCVA) hemisphere stroke patients and normal controls using their left (LNC) or right (RNC) hand. Aiming movements, to a target that moved once (80, 120, 200, or 300 mm), or twice (80 to 120 mm or 200 to 300 mm) were performed with or without hand feedback. The LCVA group's performance was impaired in the initial ballistic component of the movement, particularly in the velocity measures, and these effects were uninfluenced by visual feedback. In contrast, the RCVA group showed no abnormalities in the initial component, but their final error was poorer than the RNC group. However, patients with right parietal damage showed deficits in the initial component, but in contrast to the left parietal group, the deficits were greater when visual feedback was not available. These results emphasize the importance of the parietal lobes in open and closed loop control and suggest that the left parietal lobe is more important for open loop control and the right parietal lobe is more important for closed loop control.

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S.M. GREEN, J.B. RICH, & N.W. PARK. Moderators of Verbal Cueing Effects on Novel Naturalistic Actions in Stroke.

Stroke patients often have difficulty learning new multistep actions in everyday life, such as transferring from a wheelchair. Previously, we found that stroke patients learned novel naturalistic action sequences faster and with fewer errors in a verbal cueing compared to a no-cue condition. In the current study, we investigated the patient characteristics and conditions under which verbal cueing might enhance action performance. Ten stroke patients (4F, 6M, M age = 72.3 years, M educ = 13.4 years, 3 left-hemisphere stroke, 7 right hemisphere) completed six novel naturalistic action sequences comprising 6–8 steps each (e.g., making a compass, a birdfeeder, an ear guitar) immediately following a demonstration. The experimenter verbally described the action sequence while demonstrating it on three tasks (verbal cueing), and demonstrated silently on the other three (no cue). The two conditions were blocked and counterbalanced. Four patients benefited from the verbal cueing, 2 performed better in the no cue condition, and 4 performed the same in the two conditions. Analyses revealed that the 4 patients who benefited from verbal cueing had better neuropsychological performance across domains compared to the 6 who did not. The findings suggest that stroke patients who are functioning at an overall higher cognitive level appear to be able to use and benefit from verbal cues as a compensatory strategy. In those with more compromised cognitive function, the extra verbal information may actually impede performance.

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T. NISHIKAWA, J. OKUDA, K. ITOH, Y. IKEJIRI, & M. TAKEDA. Conscious Hemiasomatognosia Due to Callosal Infarction.

Background: Conscious hemiasomatognosia is a rare symptom that the patient experiences loss of the perception of one half of his body. Most of the reported cases are due to subcortical lesions. *Objective:* We report a case of this symptom caused by callosal infarction. *Methods and results:* A 50-year-old, right-handed man suddenly began to stutter and became aware of a feeling of his right extremities. He had no paresis in the upper and lower extremities. He stated that sensation was weaker on the right and was easily lost when the stimulus was out of sight, although his perception of pain, temperature, vibration, joint position, and two-point discrimination was intact on the basis of a standard sensory examination. There showed a localization deficit in verbal response to tactile stimulation of the left fingers (ipsilateral motor-corresponding response was normal), defective cross-replication of hand postures, suppressed discrimination of complex stimuli by the left hand in the qualitative tactile extinction test, and auditory suppression of the left ear in the verbal dichotic listening test. In these tests, the patient constantly stated that he was not confident about perceptions on the right side, where he actually showed correct responses, but he did not suspect any problems on the left side where misrecognition actually occurred. *Conclusion:* Conscious hemiasomatognosia without severe sensory deficit can occur in some cases of callosal disconnection. Cognitive processing and its conscious awareness can be dissociated.

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C. VICKERY, R. NAKASE-THOMPSON, M. SHERER, S. GONTKOVSKY, E. MANNING, & P. GIROUX. Serial Assessment of Visuo-perceptual Functioning in Early Recovery Following Traumatic Brain Injury and Stroke.

The Mississippi Visuo-perceptual Screening Test (MVST) is proposed as a method to identify impairments in visual and spatial perception early in rehabilitation and to document patients' ability to engage in visuo-perceptual problem solving during early recovery. The guiding principles in the development of the MVST were brevity, portability, and repeatability. The MVST requires approximately five minutes to administer and consists of 46 items in 9 subscales (100 points total) assessing visual scanning, facial discrimination and memory, part-to-whole mental manipulation, line angle estimation, topographical orientation, left-right discrimination, mental

rotation, and visuoconstruction. MVST total score for 151 controls was 97.9 ($SD = 2.6$) with only 3% of controls falling below 92. Mean MVST total score of 30 traumatic brain injury (TBI) patients approximately 39.8 days post-injury was 74.2 ($SD = 15.5$), and total scores for 14 right hemisphere stroke patients was 60.4 ($SD = 16.1$) approximately 23.0 days post-injury. TBI patients re-tested with the MVST 11.8 days after the first administration showed improvement (85.5, $SD = 10.1$), as did the stroke patients (72.3, $SD = 18.0$) when retested 10.8 days after the first administration. This suggests that the MVST is sensitive to cognitive changes across time, presumably with patients' increasing capacity to perform visuo-perceptual problem solving. MVST total score correlated with Visual Form Discrimination ($r = .71, p < .001$) and Line Bisection total errors ($r = -.66, p < .001$). These findings suggest that the MVST is a promising, brief method to serially assess TBI and stroke patients' capacity to engage in visuo-perceptual problem solving in early recovery.

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A.C. VISSER-KEIZER, M.J.J. GERRITSEN, B. MEYBOOM-DE JONG, B.G. DEELMAN, & I.J. BERG. Subjective and Objective Recovery in Cognitive Function After Stroke.

Performance on neuropsychological tests can improve as time after stroke passes. On the other hand, stroke patients can become increasingly aware of cognitive deficits after stroke, causing greater complaints of cognitive disturbances. Within this study, 85 first-ever ischemic stroke patients were assessed neuropsychologically at 3 (T1) and 15 months post-stroke (T2). A control group consisting of 65 elderly, matched to patients on age and gender, were also assessed with an interval of 1 year. Before neuropsychological assessment, stroke patients were asked to rate post-stroke changes in memory, mental speed, planning abilities and orientation. At T1, stroke patients were significantly impaired on all cognitive tasks compared to control subjects. At T2, stroke patients were significantly more impaired in memory, complex mental speed, reasoning and orientation, but not in visuo-motor mental speed. Analysis of test performance of stroke patients demonstrated no improvement from T1 to T2. Subjective ratings showed that stroke patients reported greater changes in memory, mental speed and planning abilities at T2 compared to T1. Agreement between subjective and objective cognitive change was only slight to fair. Contrary to expectations, stroke patients did not show improvement in cognitive functioning from 3 to 15 months post-stroke. Probably, most recovery took place within the first months after stroke. In contrast, patients reported greater changes in memory, mental slowness and planning abilities. An increasing confrontation with cognitive dysfunction within the 1st year after stroke, which might lead to greater awareness, could explain this discrepancy.

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G. NYS, M.J.E. VAN ZANDVOORT, E. DE HAAN, P. DE KORT, & L. KAPPELLE. Cognitive Functioning of Subacute Stroke Patients and After Recovery.

Cognitive impairments are common in stroke patients. Subacute neuropsychological examination (4–18 days post-stroke) has been scarcely performed. It is important however for both clinical and theoretical reasons: neuropsychological deficits such as neglect, amnesic syndrome, etc., have been shown to negatively affect functional and emotional outcome. The presence (or absence) of cognitive deficits should be taken into account in order to optimize the rehabilitation program. Furthermore, from a more theoretical point of view, initial cognitive manifestations are thought to reveal "pure" neuropsychological syndromes before spontaneous recovery or compensatory strategies take place. A pilot study was promising with respect to feasibility of early neuropsychological examination. In the current study, we included 90 first-ever symptomatic (ischemic or haemorrhagic) stroke patients determined according to clinical and neuro-radiological criteria. In 75 of 90 patients, neuropsychological testing could be performed in 6 major cognitive domains (intellectual reasoning, lan-

guage, visuo-perception and construction, memory, executive functioning and attention) in the subacute phase and at 6 months post-stroke. Basic and instrumental ADL, post-stroke depression and quality of life were assessed as additional outcome measures. A control group ($N = 35$) without neurological history was assembled as a reference sample. Results demonstrated good feasibility of the early neuropsychological examination in more than 80% of first-ever symptomatic stroke patients. In the subacute phase, 1 in 4 patients presented with characteristic neuropsychological syndromes (e.g., anosognosia, unilateral neglect, amnesic syndrome, visual agnosia etc.). Prognostic validity of cognitive function and functional recovery are discussed in light of the outcome at 6 months post-stroke.

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B. DIAMOND, J. DELUCA, & J. RICHARDS. Physiological Discrimination of Confabulations From Realities in ACoA Aneurysm.

Ruptured and repaired aneurysms of the anterior communicating artery (ACoA) may result in amnesia, executive dysfunction and sometimes confabulation. Confabulation has been characterized as a disorder in awareness, retrieval, and/or memory-executive dysfunction. The goal of this study was to disentangle these issues by determining if confabulations could be discriminated from realities in the absence of awareness using implicit, physiological measures. Participant WP was given a visual computerized assessment consisting of question and response options tapping autobiographical and episodic memory. These questions had previously elicited confabulatory responses. Heart rate (HR), blood pressure (BP) and mean arterial pressure (MAP) were recorded continuously during the task. Analysis of *incorrect* versus *correct* but unselected responses showed mean differences of: systolic (+8.2); diastolic (4.8) and arterial pressure (+5.3) mm of mercury. Physiological measures discriminated *correct*, but unselected response options from confabulatory response options ($p = .003$). The most salient finding to emerge is that there was a dissociation between behavioral and physiological systems in their ability to discriminate confabulation from reality. That is, physiological measures displayed significantly lower activity in response to correct but unselected response options versus confabulatory response options. Thus, memory for the reality was intact to the extent that it was accessible via implicit or unaware mechanisms but was not retrievable via aware and effortful processes.

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Paper Session 1/4:45–6:30 p.m.

ADHD: ASSESSMENT & IMAGING

S. MOSTOFSKY, J. SCHAFER, A. BOYCE, A. FLOWER, M. GOLDBERG, M. DENCKLA, & J. PEKAR. Differences in Frontal-Striatal fMRI Activation During Finger Sequencing in ADHD.

In order to understand the neural basis of ADHD-associated deficits in motor response preparation, functional magnetic resonance imaging (fMRI) was used to examine activation associated with finger sequencing in a group of nine children with ADHD (M age 10.64 years) and 13 control children (M age 10.9 years) without history of ADHD or other neurologic/psychiatric disorders. Thirty-second blocks of right-handed finger sequencing (RHFS) were alternated with blocks of left-handed finger sequencing (LHFS) and blocks of rest. fMRI group data were analyzed using separate random effects models designed to determine signal change patterns associated with RHFS and LHFS in children with ADHD and controls. Random effects analyses were also used to examine between-group differences in activation during RHFS and LHFS. In children with ADHD and controls, activation (uncorrected $p < .001$) associated with RHFS and with LHFS was seen in the primary motor and sensory cortices (predominantly contralateral), supplementary motor area (bilateral), basal ganglia (bilat-

eral), and cerebellum (predominantly ipsilateral). Statistical contrast (two-sample *t* test) between the two groups revealed that children with ADHD show greater activation in a region within the right premotor cortex (Brodmann area 8) during both RHFS and LHFS, as well as increased activation in the right striatum during RHFS; controls show greater activation in a left premotor region during LHFS. The findings suggest increased involvement of right premotor and subcortical regions in association with preparation, including sequencing, of motor responses by children with ADHD, with controls exhibiting more left-lateralized brain activity.

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E. VALERA, L. SEIDMAN, J. BIEDERMAN, & S. FARAONE. An fMRI Study of Working Memory in Adults with ADHD: Gender Differences.

Adult ADHD is associated with functional impairments in multiple life domains (e.g., education, work, marriage) and is also associated with poorer performance on various tasks of neurocognitive functioning, including working memory. Although most research has focused on ADHD in males, the importance of examining potential differences between males and females is becoming increasingly recognized. We used functional magnetic resonance imaging (fMRI) and a 2-back task to test the hypothesis that prefrontal activation during working memory would be differentially abnormal in adult females *versus* adult males with ADHD. A sample of un-medicated adults with DSM-IV ADHD ($N = 15$; 9 males and 6 females) and controls ($N = 15$; 9 males and 6 females) was recruited from an ongoing study of adult ADHD. A 2-back task of working memory was used to probe prefrontal function, and the blood oxygenation level dependent (BOLD) fMRI response was used as a measure of neural activity. Preliminary results using statistical parametric mapping indicate that, relative to controls, adult women with ADHD show less activation in several areas of the frontal cortex. Men did not show this same effect. These data are consistent with other research demonstrating reduced cerebral glucose metabolism for adolescent girls with ADHD compared to controls. Interestingly, although ADHD women showed less activation in several frontal regions, performance data (correct responses and mean reaction time) on the 2-back task did not differ between ADHD women and controls. Implications and directions for further research are presented.

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K.E. CALARCO, S.N. MATTSO, B. ROBERTSON, & E.P. RILEY. Heavy Prenatal Alcohol Exposure or ADHD? Errors Make the Difference.

Deficits in attention and hyperactivity are hallmarks of heavy prenatal exposure to alcohol and children with such exposure are often diagnosed with attention deficit hyperactivity disorder (ADHD). Whether the profile of attention deficits in children with heavy prenatal alcohol exposure is the same as the profile of nonexposed children with ADHD has been under debate, with previous studies suggesting conflicting results. The current study compared children with ADHD, with or without heavy prenatal alcohol exposure, on a test of sustained visual attention, the Test of Variables of Attention (TOVA). Three groups of children participated: children with heavy prenatal alcohol exposure diagnosed with ADHD, nonexposed children diagnosed with ADHD, and nonexposed controls. Diagnoses of ADHD were made using a structured psychiatric interview and groups were matched on age, sex, SES, and ethnicity. Omission and commission errors, suggesting inattention and impulsivity, respectively, were analyzed by repeated measures ANOVA. The three groups differed on both types of errors, but in different ways. Children with heavy prenatal alcohol exposure were different from children with ADHD (and similar to controls) on errors of commission but different from controls (and similar to children with ADHD) on errors of omission. These results suggest that while inattention is representative of children with ADHD with or without heavy prenatal alcohol exposure, impulsivity is more specific to non-

exposed ADHD children and that these types of errors may be used to distinguish children with heavy prenatal alcohol exposure from non-exposed children with ADHD.

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D. SLAATS-WILLEMSE, H. SWAAB-BARNEVELD, E. VAN DER MEULEN, & J. BUITELAAR. Evidence for a Familial Subtype of ADHD Based on Cognitive Deficits.

Although the precise etiology of ADHD is still unknown, there is much evidence that genetic factors play an important role. In most family-genetic studies on ADHD the focus is on the description of a behavioral phenotype. However, these behavior descriptions can impede identification of the genetic risk factors in ADHD, because they are at risk of being colored by personal interpretations of parents, teachers and clinicians. Assessment of cognitive measures, on the contrary, is objective and can detect deficits in brain functioning that may be linked to an underlying susceptibility to ADHD. In this study we examined executive functioning of (1) 25 ADHD-probands, aged 7 to 16 years, with family history of ADHD (i.e., those with at least one sibling with diagnosed ADHD); (2) their discordant siblings (25), aged 7 to 17 years; and (3) 25 normal controls matched on age, IQ and sex. The controls were matched on the discordant siblings. We used measures of sustained attention (speed, accuracy, time on task behavior), and several well-known inhibition tasks. The results showed that the ADHD probands performed significantly worse than normal controls on these measures ($p < .05$). More strikingly, the discordant siblings also scored worse than the normal controls. They had a position in between the ADHD probands and the controls. These findings indicate that siblings (of ADHD probands) without the behavioral expression of the disorder have ADHD related deficits in brain functioning. The results strongly suggest that subtyping based on cognitive measures can help identify genetic susceptibility to ADHD.

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T. BOWERLY, A. RIZZO, J.G. BUCKWALTER, L. KIM, C. SHAHABI, U. NEUMANN, J. PAIR, & L. HUMPHREY. A Virtual Classroom for Assessing ADHD.

The pilot study evaluated a virtual reality head-mounted display “classroom environment” for the assessment of attention deficit hyperactivity disorder (ADHD). The virtual classroom scenario presents a standard classroom environment containing desks, plants, a teacher, blackboard, pictures on the walls, a large window looking out onto a street with vehicles and a playground, and a pair of doorways through which activity occurs. Within the virtual classroom, participants were presented with an “AX” continuous performance test (CPT) on the blackboard and attention performance and other motor activity (head-turning, arm/leg-shaking) were recorded while classroom distracters (i.e., activity and sounds) were systematically presented. Ten ADHD diagnosed children (aged 8–12) were compared to 10 undiagnosed control children. VR exposure consisted of three conditions presented for 10 minutes each. Condition 1 measured performance on the “AX” task without distractions. Condition 2 was the same task with distractions included. Condition 3 consisted of a more realistic “ecologically valid” attention task requiring the integration of audio and visual attention processes. Standard psychometric tests were administered to all participants. It was found that ADHD children made more omission and commission errors, showed greater levels of hyperactivity, and displayed more distractibility in response to distractions than normal controls. Virtual classroom measures were highly correlated with traditional ADHD measures. The virtual classroom brings specific assets and improvements to the existing procedures and protocol for the assessment of ADHD. These assets and improvements strongly support the con-

tinued development and refinement of this virtual assessment tool. Our ongoing and future research plans will also be discussed.

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Symposium 1/4:45–6:30 p.m.

APOLIPOPROTEIN E ϵ 4 ISOFORM AND RISK OF ALZHEIMER'S DISEASE: NEUROCOGNITIVE IMPLICATIONS

Organizer and Chair: James A. Levy
Discussant: Glenn E. Smith

J. LEVY, M.W. BONDI, B. SMALL, R. PARASURAMAN, R. CASELLI, & G. SMITH. Apolipoprotein E ϵ 4 Isoform and Risk of Alzheimer's Disease: Neurocognitive Implications.

The ϵ 4 allele of the apolipoprotein E (ApoE) is a well-established risk factor for sporadic onset of Alzheimer's disease. Although a considerable amount of research has been conducted during the last decade on the neuropsychological effects of APOE ϵ 4, several important questions remain. Foremost is whether a cognitive footprint or phenotype is associated with the presence of the ϵ 4 allele independent of Alzheimer-related risk. There is evidence of subtle attenuation of episodic memory as a function of ϵ 4 presence in cognitively normal adults at risk for dementia, yet the qualitative nature of this effect is unclear. A better understanding of diminished new-learning ability before the threshold of clinical impairment is reached merits exploration, in particular for the prospect of prophylaxis. In addition, ApoE ϵ 4 also is linked to problems with component attentional mechanisms among at-risk individuals; a review of these recent findings is provided as well as the suggestion of a relationship between early attention and memory loss. Insights from functional neuroimaging are presented to underscore issues in characterizing the neurocognitive underpinnings of the ϵ 4 allele. To these ends, an expert panel has been assembled, including James Levy from the National Institute of Mental Health, Bethesda, MD, Mark Bondi from the University of California at San Diego, San Diego, CA, Raja Parasuraman from the Catholic University of America, Washington, DC, Brent Small, University of South Florida, Tampa, FL, and Richard Caselli from Mayo Clinic, Scottsdale, AZ. Glenn Smith from the Mayo Clinic, Rochester, MN is the discussant for the symposium.

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B. SMALL, C. ROSNICK, L. FRATIGLIONI, & L. BACKMAN. Apolipoprotein E Genotype and Cognitive Performance in Normal Aging: A Quantitative Review.

In the current study, the influence of apolipoprotein E (APOE) genotype on cognitive performance in normal aging will be examined in two ways. First, we examine this relationship in a sample of older adults both before and after preclinical dementia cases have been excluded. Participants consisted of 114 very-old adults ($M = 81.8$ years) taken from the Kungsholmen Project, who were evaluated at 3- and 6-year follow-ups. Cognitive performance was indexed by multiple measures of memory, verbal, and visuospatial functioning. The result indicated no significant baseline differences in cognitive performance as a function of APOE status (ϵ 4/non- ϵ 4). Greater 3-year decrements were observed for measures of word recall,

word recognition, and face recognition among ϵ 4 carriers. However, after eliminating individuals who would go on to develop dementia at the 6-year follow-up assessment, the differential rate of change as a function of APOE status was no longer statistically reliable. Second, we will provide a quantitative review of existing literature on cognitive performance and APOE genotype. In this meta-analysis, we examine the presence and magnitude of potential deficits to cognitive performance across a variety of studies and measures of cognition. In addition, the influence of potential moderators (e.g., age, dementia status) will be examined. Taken together, this data- and literature-based evidence should provide a fuller description of the influence of APOE on cognitive functioning in normal aging.

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M.W. BONDI, K.L. LANGE, D.P. SALMON, & D.C. DELIS. Verbal Memory During the Preclinical Period of Alzheimer's Disease: Influence of APOE Genotype.

A subtle decline in episodic memory often occurs prior to the emergence of the full dementia syndrome in non-demented older adults who develop Alzheimer's disease (AD). The APOE- ϵ 4 genotype may engender a more virulent form of AD that hastens this decline. To examine this possibility, we compared the rate of decline in episodic memory during the preclinical phase of AD in individuals with or without at least 1 APOE ϵ 4 allele. Nondemented normal control (NC) participants, nondemented older adults who subsequently developed dementia within 1 or 2 years (i.e., preclinical AD), and patients with mild AD were examined with two commonly employed tests of episodic memory, the Logical Memory subtest of the Wechsler Memory Scale-Revised and the California Verbal Learning Test. Results revealed a precipitous decline in verbal memory abilities 1 to 2 years prior to the onset of the dementia syndrome, but there was little effect of APOE genotype on the rate of this memory decline. The presence of an APOE- ϵ 4 allele, however, did have a differential effect on the sensitivity of the two types of memory tests for tracking progression and made an independent contribution to the prediction of conversion to AD. Results are discussed in relation to the extant literature and a model of the progression of episodic memory decline during the preclinical period is proposed.

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R. CASELLI, E. REIMAN, D. OSBORNE, G. ALEXANDER, & K. CHEN. Brain Imaging and Cognitive Studies of Asymptomatic APOE ϵ 4 Carriers.

Predictors of normal aging and AD have been extrapolated from clinical data following autopsy diagnosis, but APOE has made it possible to compare individuals of known risk without waiting for autopsy. In a cohort whose mean age was 31, PET showed reductions in posterior cingulate and parietal cortices in APOE ϵ 4 carriers (similar to AD). However, when we compared educationally sensitive psychometric and functional measures of intellectual achievement between ϵ 4 carriers and noncarriers (NC), we found no differences. Compared with asymptomatic NC, ϵ 4 homozygotes (HMZ) and heterozygotes (HTZ) 50–65 years of age had abnormally low PET measurements of regional glucose metabolism in the same brain regions. HMZ had abnormally low metabolism in additional prefrontal regions. HTZ had abnormally high 2-year rates of metabolic decline. Compared with NC, HMZ and HTZ had abnormal low MRI measurements of gray matter density in several brain regions and an effect of ϵ 4 gene dose on 2-year rates of whole brain atrophy. Neuropsychological test scores did not differ between groups, but HMZ had significantly stronger relationships between older age and lower scores on tests sensitive to prefrontal function (particularly WAIS-R digit span), ratings of daytime somnolence and lower memory scores; and ratings of anxiety and lower scores on problem-solving tests. In conclusion, abnormalities in brain function and brain structure in ϵ 4 HMZ and HTZ precede the onset of mild

cognitive impairment or dementia. Cognitive differences are not readily apparent in early adulthood, but older age and stressful conditions may exacerbate cognitive difficulties in $\epsilon 4$ HMZ.

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R. PARASURAMAN, P. GREENWOOD, & T. SUNDERLAND. ApoE- $\epsilon 4$ Gene Dose Effects on Attention and Working Memory in Nondemented Adults.

Healthy, nondemented adults with the $\epsilon 4$ allele of the apolipoprotein E (ApoE) gene show altered brain physiology prior to old age. This suggests that they should also exhibit cognitive deficits, but few studies have reported effects of ApoE- $\epsilon 4$ on cognition in middle age and before dementia onset. Some studies have also failed to detect cognitive deficits in ApoE- $\epsilon 4$ carriers, possibly due to the use of insensitive instruments or because component processes underlying task performance were not analyzed. We recently showed that ApoE- $\epsilon 4$ carriers exhibit deficits in two components of spatial attention, shifting attention following invalid location cues, and adjusting the spatial scale of attention during visual search. We extended these findings by investigating the effects of $\epsilon 4$ on both attention and working memory. Healthy, medically screened individuals of mean age 58 were categorized by ApoE- $\epsilon 4$ gene dose (0, 1, or 2 alleles). In a spatial working memory task, accuracy of memory for spatial location decreased with $\epsilon 4$ dose, but with overall accuracy unaffected. We also examined a novel "attention to memory" task in which the memory display was preceded by a location cue of varying precision. Precue precision improved memory for spatial location overall, but this effect declined systematically as $\epsilon 4$ gene dose increased. The selective influence of ApoE gene dose on both attention and working memory in middle age suggests that this gene is associated with general, though small, effects on cognition prior to old age and the onset of dementia. This is consistent with the appearance of a cognitive phenotype in middle age.

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J. LEVY, J. BERGESON, K. PUTNAM, R. PARASURAMAN, P. GREENWOOD, F. LALONDE, R. COHEN, & T. SUNDERLAND. The NIMH Alzheimer's Disease Risk Study: Genetic Influence on Neuropsychological Findings.

There is growing evidence that the $\epsilon 4$ allele of the apolipoprotein (ApoE) gene is associated with relative preclinical deficits in individuals at risk for Alzheimer's disease on measures of episodic memory and component processes of attentional shifting. However, little is known about the qualitative nature of the $\epsilon 4$ -related memory effect or the relationship between episodic memory and attentional shifting. We examined the effect of ApoE status on comprehensive neuropsychological results from 161 healthy adults (M age = 59 years) from the NIMH longitudinal study of risk for Alzheimer's disease at baseline. Although mean scores on all cognitive measures were within normal limits, the presence of the $\epsilon 4$ allele was associated with significantly lower total scores on the WMS-R Logical Memory II subtest and percent of information retained after delay ($p < .05$ on both measures). Logistic modeling of $\epsilon 4$ -allele status suggested that delayed prose recall explained the greatest amount of variance. The current results may be understood in light of putative $\epsilon 4$ -related preclinical accumulation of cardinal Alzheimer pathology in the entorhinal cortex (EC) and an emerging role for EC in the formation of context-specific memories. Measures of attentional shifting were differentially associated with new-learning indices between and within tasks, suggesting that overall $\epsilon 4$ -mediated attentional decline may constrain learning capacity at acquisition, but that attentional shifting may be independent of context-specific learning. In sum, the presence of the $\epsilon 4$ allele was associated with subtle changes in context-bound verbal learning and early processing constraints on more attention-mediated measures of episodic learning.

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Symposium 2/4:45–6:30 p.m.

NEW TECHNOLOGIES IN NEUROPSYCHOLOGICAL REHABILITATION

Organizer and Chair: Maria T. Schultheis

Discussant: David Tulskey

M.T. SCHULTHEIS. New Technologies in Neuropsychological Rehabilitation.

Technology has served to influence growth in a variety of professional fields. Evolving technologies such as virtual reality, telerehabilitation and near-infrared spectroscopy may offer new opportunities and unique assets for research and clinical aspects of neuropsychological rehabilitation. The primary purpose of this symposium is to introduce a variety of new technologies which may offer unique opportunities for extending current neuropsychological studies and interventions. Advantages such as improving the ecological validity of behavioral and functional measures, increasing the distribution of services and portability, which may allow the extension of services beyond the laboratory and into the community are all examples of benefits offered through the technologies to be presented. In addition to providing a background and rationale, each presenter will discuss one neuropsychological application, as an example of ongoing research in this pioneering area. Zabel et al. will introduce near-infrared spectroscopy, a technology that offers functional and portable neuroimaging. Rizzo and Schultheis will discuss current work in the application of virtual reality, a technology that allows the development of interactive, 3-D, functional testing environments. Rizzo will specifically discuss child applications of VR, while Schultheis will present some adult studies, specifically on driver assessment research. Ricker will discuss the evolving area of telerehabilitation and the unique challenges and opportunities clinicians may face with remote treatment. In closing, Hart will present ongoing research with the application of "personal orthoses" or portable, personal computer devices. Discussion of future research and potential applications of these emerging technologies will be emphasized.

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T.A. ZABEL, D.M. LOREMAN, & D.L. CHUTE. New Developments and Potential Neuropsychological Applications of Near Infrared Spectroscopy (nIRS).

Near infrared spectroscopy (nIRS) is emerging as a possible candidate for low-cost, portable monitoring of cerebral blood volume and oxygenation in humans. As nIRS utilizes low intensity light rather than radioactive tracers or magnetic fields, it can theoretically be used to safely monitor cognitive processes over longer periods of time than most current forms of functional brain imaging. Recent nIRS development efforts have focused upon expanding the portability of the technology to permit wireless data transmission and on-the-fly data interpretation. With these projected advances, we anticipate the development of personal, wearable functional brain imaging devices. While the technology remains largely unproven at this time, new developments may well initiate an expansion of neuroimaging tools into clinical neuropsychological practice as well as the introduction of hemodynamically-based cerebral monitoring into applied settings, e.g., the workplace, home, and school. We discuss the spatial, temporal, and behavioral resolution of nIRS, as well as the current state of validation efforts. Additionally, we describe one potential application of nIRS, i.e., educational neuroimaging, as an illustration of its potential use and the manner in which it may expand the neuropsychologist's role in the applied school setting. Educational neuroimaging refers to a set of anticipated applications of nIRS technology, including the investigation of brain-related processes during "real-world" learning tasks, serial scanning to identify developmental trajectories of learning and skill mastery, and the identification of "optimal" periods of cerebral perfusion and responsiveness for attention and learning.

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A. RIZZO. Virtual Reality Applications for Childhood CNS Disorders.

Virtual reality (VR) technology offers new options for the creation of innovative tools to target the assessment and rehabilitation of cognitive/functional processes in persons with CNS dysfunction. While much of the research in this area initially focused on adult populations, VR applications are now being tested with children having a range of clinical disorders. Work has begun on training autistic children “street-crossing” and fire safety skills in VR. Children with cerebral palsy and other types of motor impairments have been trained to operate motorized wheelchairs in VR with reported success. Spatial awareness has also been trained in children with similar motor impairments using a VR simulation of important landmarks in a school building (i.e., fire exits, bathrooms, etc.) with results producing good generalization. Similar findings were also reported for teenagers with developmental disabilities for a supermarket search and navigation training system. These results suggest that VR cognitive/functional applications can be usefully applied to these age/clinical groups with improvements seen to generalize to real world functional tasks. The presentation will briefly review this application area and discuss our own research program targeting ADHD within a VR classroom scenario. The user-centered design process needed to develop this application in a safe and efficient manner will be presented along with a review of data from a series of clinical trials with the evolving system. The presentation will conclude with a discussion of the relevant issues for the safe use of this technology by children and a vision for future application design and development.

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M.T. SCHULTHEIS. Virtual Reality in the Assessment of Functional Tasks.

Virtual reality (VR) is an emerging technology that holds a variety of potential benefits for many aspects of adult neuropsychological assessment and rehabilitation. In particular, VR allows the development of interactive, functionally relevant environments, which may serve to enhance the ecological validity of current neuropsychological methodology. Opportunity for graduated exposure of stimuli and the ability objectively record all behavioral responding are unique aspects of VR that are not available using traditional tools. Public transportation training, navigation through virtual cities and evaluation and re-training of instrumental activities of daily living (i.e., kitchen tasks) are just some examples of prior studies incorporating the use of VR. The current presentation will exemplify one application of VR, the use of a VR-Driving Simulator (VRDS) for the assessment of driving ability following acquired brain injury (ABI). Specifically, VRDS permits the development of relevant, realistic and interactive driving scenarios that can provide objective and quantifiable measures of driving behaviors and can be presented at varying levels of challenge and complexity. When coupled with the immersive features offered through a head mounted display (HMD), the VRDS may allow drivers to experience the sense of “real-life” driving, resulting in behavior and responsiveness that may be more predictive of actual driving ability. Preliminary findings from a study comparing performance on VRDS between ABI and healthy participants will be presented. Evaluation of specific VRDS driving measures (e.g., speed management, lane deviation, scanning) and the potential for VRDS to increase standardization and consistency of protocols, enhance clinical intervention and recommendations will be discussed.

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J.H. RICKER. Telerehabilitation in Neurologic Rehabilitation.

“Telerehabilitation” refers to the application of telecommunication technologies in providing remote assessment, support, and intervention to individuals with disabilities. It is a subcomponent of the growing field of telemedicine. Recent developments in telecommunication and related technologies have led to advances in postacute and rehabilitative care. Using telephone, cable modem, or digital connections, along with personal com-

puters or dedicated-use remote hardware, clinicians can conceivably provide ongoing assessment and treatment to patients at either remote clinics, or in the client’s own homes. Telerehabilitation holds particular promise for individuals who live in remote or underserved areas. The ability to deliver rehabilitation services to remote areas is critical, as the impairments acquired by individuals in remote areas can result in permanent disability or loss of function because of lack of appropriate rehabilitation. Currently, the absence of large-scale randomized controlled trials demonstrating clinical or cost effectiveness of telerehabilitation has precluded many payers from reimbursing for services. “Best use” or “evidence-based” guidelines do not exist, but it has been suggested that telerehabilitation could become an important modality to payers who are seeking to extend postacute care into nonclinical settings. The benefits for payers, providers, and individuals with disabilities could be substantial. This presentation will review current telerehabilitation applications and research, and will discuss opportunities for neuropsychologists in the development of telerehabilitation services for neurologic rehabilitation populations.

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T. HART. Portable Computer Technologies in Neuropsychological Rehabilitation: Applications and Potentials.

The revolution in information technology has brought advances to both research and clinical practice in neuropsychological rehabilitation. As computer systems have become progressively smaller, there has emerged the potential for using portable electronic devices, such as hand-held computers and personal digital assistants, as cognitive orthoses for persons with traumatic brain injury (TBI) and other acquired brain injuries. Several published reports have demonstrated the utility of portable devices for this purpose, and additional trials are underway. In addition to questions of efficacy and effectiveness, researchers and clinicians are grappling with questions pertaining to the application of these technologies: Who will be able to use them, for what purposes? What are the most effective methods of training and support for both clients and clinicians? What problems and obstacles must be overcome before portable devices achieve widespread use in rehabilitation? Following a brief review of previous studies using portable electronics in brain injury rehabilitation, these and other issues will be discussed in the context of an on-going program of clinical research. The presentation will provide results from (1) a series of clinician focus groups and a formal survey process which examined expectations and perceived barriers to the use of portable technology for rehabilitation of cognitive/behavioral deficits; (2) an efficacy trial in which portable voice organizers were used to help persons with severe TBI to remember therapy goals; and (3) a new multi-center project seeking to provide systematic data on the client characteristics, task demands, and device features associated with successful use of portable electronic devices as memory/organizational aids.

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Symposium 3/4:45–6:30 p.m.

**SPORTS-RELATED CONCUSSION:
FOCUS ON HIGH SCHOOL ATHLETES**

**Organizer and Chair: Kenneth Podell
Discussant: Mark Lovell**

K. PODELL. Sports-Related Concussion: Focus on High School Athletes.

Sports-related concussion has become a very important area of research in neuropsychology in general, and traumatic brain injury (TBI), in particular. In a few short years much has been studied and learned about sports-related concussion in adults. However, as with traumatic brain injury, little is known about the effects of sports-related concussion in the younger

populations such as teenagers. Evidence exists suggesting that younger brains (e.g., teenagers) are not fully matured (i.e., myelination) and are more vulnerable to catastrophic effects from TBI (e.g., second impact syndrome). However, clinically, it is this population that sports-related concussion work has shown its greatest demand and interest by the general public. Thus, it's imperative that we focus upon this group in terms of basic and clinical research. This symposium presents evidence on sports-related concussion emphasizing high school athletes. The symposium covers a wide range of basic and clinical research aimed to better educate neuropsychologists on features that might differ in this population relative to what is already known about sports-related concussion and TBI in adults. Using large samples, this symposium will discuss recent neuroimaging and pathophysiological findings in sports-related concussion, basic psychometric properties of a commonly used sports-related concussion computerized program, base-rates of concussion symptomatology in high school and college athletes, and recovery curves of cognitive functioning found in college and high school athletes on computerized cognitive testing. The discussant, Dr. Mark Lovell, is one of the leading authors and researchers in the field of sports-related concussion.

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M. FIELD, M. COLLINS, M. LOVELL, J. BECKER, J. MAROON, & D. MARION. Neuroimaging and Neurocognitive Recovery After Sports-Related Concussion.

Introduction: The pathophysiology and long-term effects of cerebral concussion are poorly understood. Current standards of care for the management of athletes after a concussion do not utilize physiological or neurocognitive measures for return of play. In this pilot study, we explored the ability of functional MR imaging (fMR) and computerized neuropsychological testing in identifying significant abnormalities among athletes with concussive injuries over time. *Study Design:* Neuropsychological data was acquired using a battery of computerized neuropsychological measures called ImPACT (Immediate Post Concussion Assessment and Cognitive Testing). Baseline ImPACT data was collected in each athlete. After concussion, the ImPACT analysis was repeated and a fMR brain-activation was measured utilizing a working-memory task (n-back). Functional MR data was compared with the computerized neuropsychological testing and clinical symptoms in 3 post-concussive athletes and 3 control athletes. As symptoms resolved, ImPACT and fMR activation was re-evaluated and compared to immediate post-concussive data and baseline data. *Results:* ImPACT testing identified marked changes from baseline in the post-concussive period. In the concussed patient, depressed fMR activation in the prefrontal and inferior parietal cortex and abnormal activation in the cerebellum was seen. As ImPACT data returned to pre-concussive values, brain activation generally improved in these regions. *Conclusions:* The utilization of functional or physiological neuroimaging in the analysis of neurocognitive deficits and recovery after cerebral concussion may provide an objective and physiological means to manage mild traumatic concussive injury in athletes. Furthermore, such technologies may help validate the abnormalities commonly seen with neurocognitive testing.

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G. IVERSON, M. LOVELL, K. PODELL, & M. COLLINS. Computerized Neuropsychological Testing in Sports-Related Concussion: Reliability and Validity of ImPACT®.

This study provides extensive information regarding the psychometric properties of ImPACT (Immediate Post-Concussion Assessment and Cognitive Testing), a computerized neuropsychological test battery designed to assess recovery from sports-related concussion. Test-retest reliability was examined in 49 healthy amateur athletes who completed the battery at least twice, with an average retest interval of 14 days (range = 7–21). Standard errors of measurement and the standard error of difference were

calculated to generate confidence intervals for change, based on reliable change methodology. The internal structure of ImPACT was examined through a series of exploratory factor analyses in large samples of healthy high school and college students, and concussed amateur athletes (sample sizes ranged from 120 to 800). There were minor variations in the factor structure, based on sample characteristics, but 2- or 3-factor solutions consistently emerged. Validity was investigated with 120 amateur athletes who completed preseason testing and who were evaluated within three days of sustaining a concussion. Concurrent criterion validity was examined by determining whether the composite scores were sensitive to the acute effects of concussion. Divergent validity was studied through an intercorrelation matrix of the composite scores at preseason and at post injury. Convergent validity was explored by correlating the composite scores with specific items from the post-concussion scale, for the post-injury assessment. This series of psychometric analyses demonstrated that ImPACT has well-defined stability and internal structure. The concurrent, divergent, and convergent validity analyses support clinical inferences regarding outcome from concussion in amateur athletes.

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K. PODELL & S. AHMAD. Base-Rates for Concussion-Related Symptoms in High School and Collegiate Athletes.

Sports-related concussion research is a new and emerging area of interest in neuropsychology. While the literature is growing rapidly for adults, it is less well understood for younger individuals whose brains may not be fully matured. It is standard practice to compare baseline concussion symptomatology to post-concussion symptomatology, as part of evaluating recovery from sports-related concussion. Thus, understanding base rates is critical in being able to understand and determine recovery from sports-related concussions. Base-rate reporting of concussion symptoms is known for adults, but to date has not been studied in younger populations. Data will be presented analyzing the self-report of high school (HS) and collegiate (C) athletes on 21 commonly reported concussion symptoms. The data was recorded during preseason baseline testing via computer from numerous sports on over 2,500 athletes (HS: $n = 1,100$ and C: $n = 1,600$). Symptoms were rated on a 7-point Likert-type scale. Total symptom scores were analyzed by level (HS vs. C), gender, and prior history of concussion. Results will also be discussed in terms of frequency of the different symptoms reported, if prior history of concussion predisposes athletes to higher base-rate reporting, gender effects, age differences, and similarities and differences between what has been reported in the literature for adults and the current samples.

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M. COLLINS. Recovery and Return to Play Following Sports-Related Concussion in High School Athletes.

Sports-related concussion is one of the most hotly debated topics in sport medicine. Much of this debate centers on the safe determination of return to participation after a concussion. From a pathophysiology standpoint, most experts believe that symptoms of sports concussion are related to acute metabolic dysfunction. The determination of lingering difficulties associated with concussion has traditionally proven problematic for a variety of reasons. First, mainstream neurodiagnostic techniques, such as CT scan and MRI, though invaluable in discerning more serious intracranial pathology (e.g., skull fracture, hematoma, parenchymal lesion), are generally insensitive in measuring the subtle effects of concussion. Further, due to obvious reasons, relying on the self-report of the athlete may also prove ineffective. Given these outlined issues, ancillary neurodiagnostic assessment strategies have proven critical to the safe management of the concussed athlete. Further, such techniques have provided a valuable research paradigm for which to gain a better understanding of this elusive injury. At the forefront of these approaches is the utilization of neuropsychy-

chological testing. This presentation is designed to (1) discuss the utilization of ImPACT, a computerized neuropsychological test instrument, for the management of sports-related concussion, (2) present data examining symptom and neurocognitive recovery curves in over 100 concussed high school athletes; (3) examine predictors of outcome following concussive

injury; and (4) present data regarding cumulative effects of concussion in high school athletes.

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THURSDAY MORNING, FEBRUARY 6, 2003

Poster Session 2/8:00–9:30 a.m.

ASSESSMENT IN SPECIFIC COGNITIVE DOMAINS

P.S. FASTENAU, S.A. PRYOR, R. GAHIMER, & B.C. LEJEUNE. Short Forms and Alternate Forms for the CELF-3: Reliability and Validity.

Rationale: The CELF-3 is a well-standardized and validated measure of language but it takes 45 min to obtain Receptive, Expressive, and Total Language Index scores. There is no formal short form for screening, nor are there alternate forms for retesting. In this study, we aimed to identify reliable and valid short forms and alternate forms. *Method:* Archival test scores were analyzed for 148 children with neurological, linguistic, and psychiatric disorders: 30 children were ages 6–8 years ($M = 7.7$, $SD = 0.9$); mean IQ was 99.2 ($SD = 15.3$), and 47% were girls, 82% right-handed, 87% White, and 13% African American; 118 children were ages 9–18 years ($M = 13.3$, $SD = 2.5$); mean IQ was 95.7 ($SD = 15.2$), and 35% were girls, 86% right-handed, 95% White, and 5% African American. Odd and even scores were computed for each subtest, and subtests were correlated with the receptive, expressive and total composite scores. *Results:* Odd and even half-forms correlated highly with one another for all subtests, $r = .78-.95$, $M = .89$, $Mdn = .90$. Concepts & Directions (CD) correlated .90 with receptive language, and Formulated Sentences (FS) correlated .91 with expressive language. Used together in multiple regression analyses to predict the total language score, CD & FS yielded a Multiple R of .95 in both younger and older children. *Discussion:* Using odd items or even items provides two equivalent alternate forms for repeated testing. CD and FS are good single subtest screenings for receptive and expressive language, respectively; together, they provide a reliable and valid estimate of the Total Language Index in a 15-min screen.

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J.D. THOMAS & A.M. PODRAZA. Will the Real WIAT–II Reading Comprehension Score Please Stand Up? A Case Study.

In 2001, The Psychological Corporation published the Wechsler Individual Achievement Test–II (WIAT–II) the long awaited successor to the original WIAT. One of the more radical changes involved the method by which the Reading Comprehension subtest is administered. McCloskey reported that this test is administered by item set rather than the traditional basal-ceiling approach. In order to address difficulties clinicians experienced with the use of the reverse rules when testing *low functioning examinees*, revised norms were published based on a conversion from the Total Raw Score to a Weighed Raw Score. The following case study demonstrates that there may be a potential problem with the WIAT–II Reading Comprehension subtest in some children with *average intelligence*. A 13-year, 11-month-old, right-handed girl, who was in the 8th grade, was administered a comprehensive neuropsychological evaluation that included the WIAT–II on 9/14/2001. A prior (January 2000) WIAT revealed a Standard Score of 109 on the Reading Comprehension subtest. On examination, she received a Wechsler Abbreviated Scale of Intelligence Full Scale IQ of 96. Her WIAT–II uncorrected Reading Comprehension was 44. Using the conversion table of revised norms, she received

a Standard Score of 83 on the Reading Comprehension subtest. However, she was also administered the WIAT Reading Comprehension subtest that resulted in a Standard Score of 99, consistent with the previous testing. In light of these results, clinicians may wish to consider cross-validating WIAT–II Reading Comprehension score with other benchmark measures of reading comprehension ability.

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P.K. SHEAR, A. JAK, B.K. LEBOWITZ, K.M. FARRELL, & M.A. STEED. Word Reading as a Predictor of Wechsler IQ in Healthy Young Adults.

Word reading tests are commonly used to estimate premorbid intellectual ability; it is not clear, however, how intelligence scores from these tasks compare to those derived from the most recent versions of the Wechsler IQ scales. This study compared American National Adult Reading Test (ANART) scores to IQ values obtained from the Wechsler Abbreviated Scale of Intelligence (WASI). We also administered the Wide Range Achievement Test 3 (WRAT–3), to explore the consistency of the results across these two reading tasks. Participants included 98 undergraduates (56% female; 85% White) from a large public university, with a mean age of 19.5 ± 1.8 years, who completed the WASI, ANART and WRAT3 in a counterbalanced order. Individuals were excluded for histories of learning disability, serious neurologic illness or injury, or extensive use of drugs or alcohol. We also excluded those who achieved WASI FSIQs that fell outside the range of possible ANART scores (82–128). Participants had a mean WASI FSIQ of 105.2 ± 8.2 (range = 82–124; scores normally distributed). Intraclass correlations suggested a moderate relationship between WASI VIQ and both the ANART ($\kappa = .35$) and the WRAT3 ($\kappa = .37$). In the full sample, the ANART scores (109.2 ± 5.5) were slightly but significantly ($p < .001$) elevated in comparison to the WASI VIQs (105.2 ± 9.3). In addition, however, the degree of discrepancy between the ANART and WASI was systematically related to level of intelligence. Specifically, as WASI FSIQ decreased, individuals were significantly more likely to receive ANART scores that were increasingly elevated in comparison to their WASI VIQ ($r = -.81$, $p < .001$).

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D. J. SCHRETLEN, C.A. MUNRO, S. MEYER, & G.D. PEARLSON. Using the NART to “Postdict” IQ Scores Obtained 5 Years Earlier.

Although many studies have correlated National Adult Reading Test (NART) performance with concurrent IQ, far fewer have examined how well the NART “postdicts” IQ scores obtained previously. Here we report preliminary data from the first 61 of 214 Johns Hopkins Aging, Brain Imaging, and Cognition study participants who returned for five-year follow-up. Each participant completed the NART, a 7-subtest short form of the Wechsler Adult Intelligence Scale–Revised (WAIS–R), and a battery of other neuropsychological tests both at entry into the study and a mean of 5.3 years later. Analyses revealed that the test–retest reliability of NART Full Scale IQ estimates was exceptional ($r = .97$). Follow-up NART performance correlated with prior WAIS–R Full Scale IQ scores ($r = .68$) just as well as it correlated with concurrent WAIS–R Full Scale IQ scores ($r = .67$). Including demographic variables in multiple regression analyses sig-

nificantly improved the prediction of both previous (multiple $R = .76$) and concurrent (multiple $R = .73$) WAIS-R Full Scale IQ scores. These findings demonstrate that the NART has exceptional test-retest reliability, and that it estimated actual WAIS-R Full Scale IQ scores obtained 5 years earlier just as well as it estimated concurrent WAIS-R Full Scale IQs.

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M. ZAKRZEWSKI & G. IVERSON. Clinical Utility of the WTAR for Estimating Premorbid Functioning in Neuropsychiatry.

The Wechsler Test of Adult Reading (WTAR) is a newly published instrument designed to estimate premorbid intellectual and memory functioning in individuals who may have experienced declines in these areas. The WTAR is a word reading task that utilizes psychometrically sophisticated algorithms combining the test score with demographic variables to predict performance on the WAIS-III and the WMS-III. This is the only prediction model currently available to estimate both premorbid intellectual and memory functioning. There are no independently published studies examining the use of this instrument in clinical settings. The purpose of this study is to examine the clinical utility of the WTAR in the context of an inpatient neuropsychiatry unit. Four case examples are presented involving complex combinations of psychiatric and neurological issues. Patient A is a 53-year-old man with 14 years of education who was diagnosed with Parkinson's disease and schizoaffective disorder. He performed poorly on the WTAR, necessitating the use of the demographic-only prediction model. Patient B is a 25-year-old man with a history of 2 severe traumatic brain injuries complicated by prior diagnoses of conduct disorder, alcohol abuse, and fetal alcohol syndrome. Patient C is a 19-year-old man with features of obsessive compulsive disorder, Asperger's disorder, Tourette's syndrome, and catatonia. Patient D is a 57-year-old man with a history of psychotic depression and a marked decline in cognitive functioning over a 6-month period. The clinical utility, limitations, and interpretive issues regarding the use of the WTAR in this population are examined.

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G. JONES, N. CRAIG, B.A. STEINBERG, L.A. BIELIAUSKAS, G.E. SMITH, & R.J. IVNIK. Age- and AMNART-Adjusted MOANS Norms for the AVLT.

In a previous study using data from the Mayo Older Americans Normative Studies (MOANS) database, we demonstrated that older individuals' performances on the Rey Auditory Verbal Learning Test (AVLT) and Visual Spatial Learning Test (VSLT) were more closely related to their measured intelligence (Mayo age-adjusted WAIS-R FSIQ) than to their educational attainment; based on those results, tables of age- and FSIQ-adjusted norms were developed for each test. Because measures of sight-reading are frequently used to estimate overall premorbid functioning, we repeated our study in order to explore the adequacy of Mayo age-adjusted Wide Range Achievement Test-Revised (WRAT-R) Reading subtest scaled scores and National Adult Reading Test (AMNART) scaled scores as brief alternatives to FSIQ scores with the AVLT. (Because MOANS participants did not complete the VSLT and either the AMNART or WRAT-R, we were unable to repeat this portion of our previous investigation.) As expected, Mayo age-adjusted AVLT scaled scores were more strongly correlated with Mayo age-adjusted AMNART scaled scores ($r = .124-.367$, $n = 356$), than with Mayo age-adjusted WRAT-R scaled scores ($r = .082-.255$, $n = 367$). Interestingly, AMNART scores and years of education were associated with comparable unique increments in AVLT score variances in multiple regression models (.137-.016). (In our previous study, education made a negligible contribution to AVLT scores after FSIQ was entered into the regression model.) Based on these results, we constructed tables of age- and AMNART-adjusted norms for the AVLT.

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N. CRAIG, G. JONES, B.A. STEINBERG, L. BIELIAUSKAS, G.E. SMITH, & R.J. IVNIK. Age- and AMNART-Adjusted MOANS Norms for the WMS-R.

In a previous study, we demonstrated that older individuals' performances on the Wechsler Memory Scale Revised (WMS-R) were more strongly associated with their measured intelligence (Mayo age-adjusted WAIS-R FSIQ) than with their education level. Because sight-reading is often used to estimate premorbid cognitive functioning, we investigated the adequacy of the American National Adult Reading Test (AMNART) and the Wide Range Achievement Test-Revised (WRAT-R) Reading subtest as brief alternatives to FSIQ. The strength of the associations between scores from the WMS-R and either the AMNART or the WRAT-R were compared. The AMNART demonstrated stronger correlations with WMS-R summary and subtest scaled scores in all but two cases (with differences in the correlations ranging from $-.097$ to $.145$). AMNART scores were also more strongly correlated with Mayo age-adjusted WMS-R scores ($r = .161-.472$, $n = 356$) than was years of formal education ($r = .088-.310$, $n = 1054$). The AMNART correlations were less robust, however, than the correlations with the WAIS-R FSIQ ($r = .276-.631$). Finally, the AMNART scores were associated with larger unique increases in WMS-R scaled score variances in multiple regression models (.015-.150) than was education (.000-.005). Based on these results, we developed tables of age- and AMNART-adjusted norms for the WMS-R indices.

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K.N. TIERNAN, K. SCHENK, M. SHIMONOVA, D. SCHOLLAERT, D. SWADBERG, P. BOORKMAN, & M. CHERRIER. An Examination of the Validity and Reliability of a Novel Route Test in Healthy Older Adults and AD Patients.

The Puget Sound Route Learning Test (PSRLT) is a novel test of spatial memory that measures how well people can learn and recall a specific route. In the present study we examined the validity and reliability of older men and women on the PSRLT. Twenty-nine healthy controls and 9 Alzheimer disease (AD) and mild cognitive impairment (MCI) subjects were administered the PSRLT and Dementia Rating Scale (DRS) 5 times approximately 3 weeks apart. A comparison of PSRLT total score performance with DRS scores revealed a high correlation with the memory (.603) and initiation/preservation (.593) subscales. The total DRS score is significantly correlated (.745) with the scores received on the route test for both healthy older controls and AD patients. A comparison of AD, MCI and controls on the PSRLT was significantly different among groups ($p < .01$), demonstrating good sensitivity to spatial memory abilities. However, an examination of performance across trials revealed a significant increase in scores, suggestive of a significant practice effect ($p < .05$). In the normal control group, it was shown that men are performing better than women with increased percentage of correct sequences of the route. Results suggest that although the PSRLT is a good measure of spatial memory and sensitive to differences in diagnostic groups, the observed practice effects may limit its use.

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R.M. BUSCH, K.M. FARRELL, K. LISDAHL-MEDINA, & R. KRİKORIAN. Corsi Block-Tapping Task Performance as a Function of Path Configuration.

Since its development in 1971 as an analog to verbal memory procedures, the Corsi Block-Tapping task has been used as a measure of spatial memory. The task requires subjects to reproduce novel block-tapping sequences. The number of blocks in a sequence is a determinant of item difficulty, and, typically, several sequences of the same length are grouped at a level. A standard set of items has never been developed for this task, and inconsistencies in performances within levels have been demonstrated in association with different path configurations. This study investigated item consistency by analyzing the performances of 94 undergraduate sub-

jects on a block-tapping task that involved 5 quasi-randomly determined sequences at 9 levels of difficulty. Cochran Q test comparisons were conducted on the items within the levels. Differential difficulty was found only for certain items at Levels 7 and 8. Pairwise comparisons were conducted to determine the specific items for which performance was discrepant. In addition, the path configurations for these items were analyzed. Discrepant performance was evident for items with more complicated paths (more crossings). The findings suggest that this version of the Corsi task is relatively consistent. Performance was more heterogeneous at higher levels (7 and 8), reflecting more complicated path configuration and greater span capacity load. The findings indicate that differential intralevel item consistency should be considered in developing spatial memory tasks that involve configural processing. In the absence of such an analysis, interpretations concerning sustained attention ability based on failures within level may be spurious.

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K.M. FARRELL, K.L. MEDINA, R.M. BUSCH, & R. KRİKORIAN. Developmental Normative Data for the Corsi Block-Tapping Test.

The Corsi Block-Tapping task has been utilized as a measure of spatial memory in both clinical and experimental contexts for several decades. It calls for individuals to reproduce block-tapping sequences of increasing length and yields an index of immediate memory span capacity for spatial information. However, a standard set of block-tapping items has never been developed. The test items used in our laboratory were generated using quasi-randomly derived sequences that have been shown to be uniform with respect to difficulty within each span level. This study evaluated developmental changes in span capacity from childhood (M age = 7 years) to early adulthood (M age = 21 years) in a nonclinical sample with average range intelligence ($M = 106$). Mean span capacity ranged from 5 for first graders to 7.2 for undergraduates, and span capacity increased incrementally and linearly with increasing age. There was no gender difference in span capacity. *Post-hoc* comparisons indicated that the span capacity of eighth graders ($M = 6.9$) was not statistically different from that of the young adults ($M = 7.1$), suggesting that individuals at age 13 possess span capacity for spatial information equivalent to that of adults. The linear increase in capacity with age indicates that spatial working memory develops throughout childhood, which has been observed in other studies. We also have shown that development of capacity plateaus in early adolescence. Finally, this study provides a normative database for children and adults for this widely used measure of spatial memory.

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A. LYONS-WARREN & T. HERSHEY. The Spatial Delayed Response Test: Modifications and Applications.

Spatial Delayed Response (SDR) task, a modified version of the Ocular-Motor Delayed Response task, measures spatial working memory and long-term memory within a single computerized delayed-response paradigm. The SDR task requires subjects to focus on a central cross while a dot flashes elsewhere on the screen. After a delay period, during which subjects perform a target detection task, subjects must recall the location of the dot by pointing to the screen. This task can vary memory delay and load and uses an easily administered and automatically scored manual response procedure. We have used the SDR test to study working memory and long-term memory in normal development and aging, in children and adults with type 1 diabetes, temporal lobe epilepsy, Parkinson's disease (PD) and schizophrenia. We found short delay (≤ 15 s) deficits in PD and schizophrenia and long delay (≥ 60 s) deficits in temporal lobe epilepsy. We also acquired data from over 300 normal control subjects, ages 7–80 years. Children, ages 7–19, showed improved performance with age at short and long delays ($p < .05$), whereas adults, ages 20–80, showed decreased performance with age at short and long delays ($p < .01$). Age and performance at a short delay had a curvilinear relationship when the

entire lifespan (7–80) was considered ($p < .05$) such that children and older adults had poorer performance than young adults. Accordingly, the SDR test is an easily administered, well-validated and sensitive tool for assessing working and long-term memory across varying conditions and ages.

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S. BORGARO & G. PRIGATANO. A Modified Version of the PCRS for Use on an Acute Neurorehabilitation Unit.

The Patient Competency Rating Scale (PCRS) is a 30-item questionnaire that was developed to assess awareness of deficits in patients following brain injury. Its items were initially constructed for use on post-acute brain injured patients. The purpose of this study was to develop a psychometrically sound version of the PCRS for use on an acute neurorehabilitation unit. Of the 30 PCRS items, 19 were retained for their applicability to an inpatient neurorehabilitation setting. These items were administered to a heterogeneous sample of 108 acute neurological patients on a neurorehabilitation unit. A principle components factor analysis with varimax rotation yielded a five factor solution, which together accounted for 69% of the variance. However, two items were dropped from factor one because of low correlations, and factors four and five were dropped because of too few item loadings. A second factor analysis was done on the resulting 13 items. A three factor solution was yielded and accounted for 66% of the variance. These 13 items comprise the final revised version of the PCRS. Acceptable internal consistencies were then calculated on Factors 1 ($\alpha = .87$), 2 ($\alpha = .81$) and 3 ($\alpha = .78$), and on the total revised PCRS score ($\alpha = .82$). Results of this study document the psychometric properties and the potential clinical use of a briefer version of the PCRS for use on an inpatient neurorehabilitation unit.

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T. BENNETT, B. ROPER, & R. LINDO. Relationship of the RBANS to Functional Impairments in the Elderly.

The Repeatable Battery for the Assessment of Neuropsychological Status (RBANS) is a brief test originally designed for assessing dementia in the elderly. The RBANS has been shown to be effective in differentiating dementia patients from controls, but it has not been compared to functional rating scales, which are relevant to the diagnosis of dementia. The Nurses' Observation Scale for Geriatric Patients (NOSGER) is a measure designed to assess a wide range of functional domains in the elderly via ratings obtained from family members or other observers. The NOSGER has been shown to have good test-retest and interrater reliability, as well as good concurrent validity. In a series of 52 patients referred for neuropsychological assessment, RBANS index scores showed only modest correlations with family ratings of several NOSGER domains, specifically basic activities of daily living (ADL) and independent activities of daily living (IADL). In addition, the RBANS total score was significantly correlated with patients' ability to perform ADL's and IADL's ($r = -.26$ and $-.27$, respectively). This suggests that the RBANS may inform the clinician somewhat regarding patients' functional impairment. Nevertheless, rating forms of patient self-care abilities could provide unique information in both the diagnosis of dementia and the assessment and management of patients' functional difficulties.

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M. KEIL & J. SUHR. Relation of Neuropsychological Tests to Measures of Real-World Functioning.

Neuropsychological assessment is frequently requested for answering questions about real-world functioning. The ecological validity of neuropsychological instruments in making such predictions about older adults remains largely unknown. Only a handful of studies have examined relations among cognitive and functional abilities, but results suggest a moderate relationship between performance on everyday tasks and global scores on cogni-

tive screening instruments. Specific relations of moderate strength have been detected between executive functioning, visuospatial skills, verbal fluency, and performance on clinical simulation tasks (e.g., using a telephone, remembering a grocery list), but not memory tasks. The present study evaluated the relations among a comprehensive range of neuropsychological tests, including the Repeatable Battery for the Assessment of Neuropsychological Status (RBANS), IADL performance, prospective memory, and self- and caregiver-report of everyday cognitive functioning, in outpatients referred for dementia-evaluation. Preliminary results reveal strong and significant associations between total IADL score and RBANS delayed memory; this relation improved when prospective memory total score was combined with total IADL score. In a stepwise multiple regression analysis using RBANS subscale scores, RBANS delayed memory accounted for the most variance in IADL performance. In a second stepwise regression, RBANS total score accounted for the most variance in IADL total score among Controlled Oral Word Association (COWA), Trail Making Test (TMT), Temporal Orientation Test, age, education, and Geriatric Depression Scale score. Of all assessment variables, only TMT (Part B) and COWA were significantly associated with self-reported and caregiver report of cognitive concerns, respectively.

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K. SCHMIDT & P. MATTIS. Evidence of Equivalence Between the Mattis Dementia Rating Scale and a Parallel Form.

Over the past several decades, many screening instruments have been developed to aid in the identification and evaluation of cognitive decline in individuals suffering from memory disorders. The Mattis Dementia Rating Scale (MDRS) is a frequently employed measure of mental status among older adults in both research and practice. This standardized measure has well-established validity and reliability; however, its frequent and repeated use, especially within the context of longitudinal clinical research (i.e., efficacy studies for pharmacological interventions), poses limitations with regard to practice effects. Thus, we have developed a parallel form (PDRS) of the MDRS to assist professionals in acquiring data for changes in memory functions over time. The main goal of our study is to provide evidence of equivalence between the MDRS and PDRS in a heterogeneous sample of adults over age 60 with no reported diagnosis of dementia. Pilot data ($n = 10$) suggest that the new parallel form is equivalent to the original MDRS based on Total Score as well as scores on the 5 subscales (Attention, Initiation/Perseveration, Construction, Conceptualization, and Memory). Consequently, the PDRS should find widespread use in both research and clinical arenas.

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NEUROPSYCHOLOGICAL CHANGES ASSOCIATED WITH HIV

C.P. MILLIKIN, L.L. TRÉPANIÉ, & S.B. ROURKE. Verbal Fluency Components in HIV: Relationship to Disease Severity and Depression.

Adults with HIV-infection are at risk for frontal-striatal brain system dysfunction. This risk increases with illness progression (i.e., AIDS). Individuals with HIV/AIDS are also at risk for depressed mood, which may be associated with frontal-subcortical dysfunction. The present study examined the impact of disease severity (symptomatic HIV infection *versus* AIDS) and depressed mood on verbal fluency components. Previous research suggests that switching (the ability to switch between phonemic or semantic clusters) is associated with frontal-striatal functioning, whereas clustering (the ability to generate words within clusters) provides an index of temporal lobe system integrity. Individuals with AIDS were expected to show reduced switching but normal clustering. Depressed mood was expected to interact with disease severity such that participants with AIDS and depressed mood would show disproportionately poorer switching.

Verbal fluency protocols (FAS and Animals) of 188 adults with HIV infection (63% with AIDS, 45% with depressed mood) were scored for total switches and average cluster size following the method of Troyer et al. Mean age and education for the sample were 41.2 (8.3) and 14.5 (2.7) years, respectively. AIDS diagnosis, but not depression, was associated with poorer performance on switching (FAS and Animals, $p < .05$). Neither AIDS diagnosis nor depression was associated with clustering performance. Overall, these results are consistent with findings of frontal-striatal dysfunction in adults with HIV infection. Temporal systems mediating clustering appear to be intact. Future research should examine the effect of antiretroviral therapy on the functional integrity of these brain systems.

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M. NOZYCE, D. PEARSON, S. NICHOLS, B. KAMMERER, D. GAUGHAN, & M. HUGHES. Using Neuropsychological Testing to Predict Survival in Pediatric HIV Infection.

Pediatric AIDS Clinical Trial Groups (PACTG) use neurodevelopmental assessments, holding the Wechsler Intelligence Scale for Children (WISC) to track the central nervous system functioning of infants and children with HIV infection. This study analyzed WISC-R data from seven pre-HAART PACTG anti-retroviral treatment protocols to describe patterns of subtest scores and to examine whether these test results predict survival. Data were analyzed using least squares univariate and multivariate regression models. Survival analysis included a proportional hazards stepwise regression model stratified by study. Results show that after 48 weeks on anti-retroviral therapy, overall Performance sub-test scores, Block Design and Picture Completion, significantly increased, but Coding did not. The Vocabulary score increases with anti-retroviral treatment, but Digit Span and Arithmetic scores do not. For each one point increase in Verbal IQ score, the hazard decreased by 3%. For each one point increase in the Picture Completion subtest, the hazard increased by 17%. Adjustments were made for CD4%, English fluency, Performance IQ and Vocabulary subtest. Higher Vocabulary, Digit Span and Arithmetic subtest scores were independently associated with increased survival. In conclusion, WISC-R scores significantly predicted survival in HIV-infected, school age children even after immunological variables were taken into account. Survival was particularly poor in children whose verbal functioning was low relative to their nonverbal functioning. This pattern of functioning, which is different from that seen in adults, might serve as a clinical indicator of advancing CNS impact of the virus and supports neuropsychological testing as part of standard clinical care.

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P.A. KLAAS, P. WOLTERS, S. MARTIN, S. ZEICHNER, & R. HAZRA. A Comparison of Verbal and Nonverbal Learning and Memory in Children With HIV-1.

Previous research has found that children with HIV-1 who do not manifest symptoms of CNS involvement, perform within the average range on the CVLT-C. To further investigate memory function, two nonverbal memory tests were administered (Visual Selective Reminding-VSR, and Memory for Location-MFL, from the Test of Memory and Learning-TOMAL) to a group of 13 children who had also been given the CVLT-C. The group means for both non-verbal and verbal tests with a learning component were within the average range of functioning ($SS = 10$ and 9.7 , $SD = 4.5$ and 1.9 , respectively). The group was somewhat below average on the MFL, which assesses visual memory span ($SS = 6.9$, $SD = 4.2$). Performance on the VSR was correlated with overall learning performance on the CVLT-C ($r = .63$, $p = .02$). MFL was not correlated with performance on the first trial of List A. The Delayed VSR component was correlated with the combined delayed recall measures from the CVLT ($r = .67$, $p = .02$). Dividing the groups according to presence of CNS deficits (10 without and 4 with CNS compromise) resulted in a finding of Average performance for children with HIV who do not display symptoms of CNS

compromise. Children with HIV associated CNS compromise had significantly lower scores on both the learning and delayed recall of the VSR and on MFL. Children with HIV are not likely to exhibit deficits in the areas of Learning or Memory unless they have CNS involvement.

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K. GOODKIN, F.L. WILKIE, R. MOLINA, M. CONCHA, A. ARDILA, R. LECUSAY, P. SUAREZ, D. LEE, & D. RIGG. Validation of Clinical MCMD Diagnosis by NP Performance and Functional Status.

Background: The diagnosis of minor cognitive-motor disorder is relevant to the treatment of HIV-1 infected individuals in the HAART era. This diagnosis has been shown to predict the occurrence of HIV-1 associated dementia. **Methods:** One hundred twenty-one HIV-1+ participants in a longitudinal neurocognitive study were clinically evaluated for the diagnosis of MCMD based upon medical history and physical evaluation and review of systems for American Academy of Neurology criteria of MCMD. All cases were reviewed for two of the six requisite MCMD symptoms, associated minor functional status deficits, and absence of other etiologies. Study participants were administered an extensive neuropsychological (NP) test battery as well as the Sickness Impact Profile (measuring functional status in daily life activities). Those with and without MCMD were compared by student's *t* tests on NP and SIP measures. **Results:** A total of 20 participants were defined with MCMD and 101 without MCMD. Those with MCMD consistently showed lower overall NP performance and performance across domains (e.g., logical memory–delayed, visual reproduction, figural visual scanning, variable interval reaction time). Those with MCMD also showed increased dysfunction [e.g., overall (physical and psychosocial categories), alertness, mobility, body care and movement, social interaction, and home management]. **Conclusions:** It can be concluded that a clinical diagnosis of MCMD maps well to performance deficits in objective NP tests as well as a standardized measure of functional status in daily life activities. The diagnosis of MCMD might be promulgated for greater use in clinical settings and for more active treatment referral.

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F.L. WILKIE, K. GOODKIN, A. ARDILA, R. LECUSAY, P. SUAREZ, M. CONCHA, D. LEE, R. MOLINA, & S. O'MELLAN. The Effects of HIV-1 Infection on Cognition in Hispanic Younger and Older Adults.

A scant literature suggests that increasing age may be a risk factor for HIV-1 associated dementia. Despite disproportionately increasing numbers of Hispanics infected with HIV in the USA, few neuropsychological tests sensitive to the cognitive effects of this disease have been standardized in Spanish. For the purposes of this study, we translated into Spanish most of the neuropsychological tests in the long battery recommended by the NIMH Neuropsychology Workgroup on AIDS. Our approximately 3 to 3.5 hour battery measures processes in the following cognitive domains: attention, learning and memory (verbal and visual), information processing speed, abstraction/executive functions, visuoconstructive/visuospatial, language, and motor. The preliminary findings from this ongoing study are presented on the effects of clinically symptomatic HIV infection on cognition in young (ages 18–39 years) and older (>50 years) primary Spanish speakers tested in Spanish. A main effect of age was most commonly observed, with a main effect of HIV serostatus less frequently observed and only minimal evidence for Age × HIV Serostatus interactions. Such an interaction effect may be evident on the Logical Memory (WMS–R) measure. The data emphasize the need to control for a wide range of potentially confounding variables (e.g., mood, substance use, nutritional status, comorbid illnesses, fatigue, and pain, amongst others).

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A. GONGVATANA, T. MARCOTTE, M.J. TAYLOR, R. GONZALEZ, D.J. MOORE, C. CAREY, W. MILLER, I. GRANT, R.K. HEATON, & THE HNRC GROUP. Use of Ethnicity-Corrected Norms in Assessing African American and White HIV-Infected Men.

HIV infection can cause brain dysfunction and neuropsychological (NP) impairment, with increased risks of impairment occurring at later stages of the disease. In the past, NP norms used to detect impairment in HIV and other diseases have not been corrected for ethnicity; also, despite the well known differences in NP performances among normal people with different ethnicities, most NP norms have been based upon largely White (WH) samples. This has led to inflated impairment estimates among minority groups, especially among African Americans (AAs). The current study examines whether recently developed ethnicity-corrected NP norms can remedy this situation within the context of HIV infection. We administered a battery of 20 NP tests to 175 AA and 485 WH HIV-infected adults. NP results were converted to demographically-corrected *T* scores, using (1) previously published norms that correct for age, education, and sex, but not ethnicity, and (2) newly developed norms that also correct for AA and WH ethnicities. The *T* scores were then converted to “deficit scores” that reflect the number and severity of impairments (*T* score < 40) on the NP battery. An ANOVA using summary NP deficit scores that were not corrected for ethnicity yielded highly significant effects for both disease stage [Centers for Disease Control Stages A, B, C; $F(2,576) = 27.6, p < .001$] and ethnicity [$F(1,576) = 117.6, p < .001$]. With ethnicity-corrected deficit scores, the effect of disease stage was again highly significant [$F(2,576) = 20.4, p < .001$] but the ethnicity effect was eliminated [$F(1,576) = .03, p = .87$]. It is concluded that the new normative corrections provide more balanced and accurate indications of disease-related NP impairment in these two HIV-infected groups.

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C.P. MILLIKIN, M.H. HALMAN, C. POWER, & S.B. ROURKE. Fatigue in HIV/AIDS Is Associated With Depression and Cognitive Complaints.

Fatigue and depressed mood are common in HIV-infection. The relationship between these symptoms and neuropsychological functioning is poorly understood, particularly in symptomatic infection/AIDS. This study examined the associations among fatigue, depressed mood, subjective neurocognitive complaints, and objective neuropsychological performance in HIV/AIDS. Seventy men with HIV-infection (27 adults with symptomatic HIV-infection but without AIDS diagnosis and 43 with AIDS diagnosis) completed a neuropsychological test battery and self-report measures of fatigue (Fatigue Severity Scale), depressed mood (Beck Depression Inventory), and subjective neurocognitive complaints (Patient's Assessment of Own Functioning). Mean age and education in the sample were 39.9 (8.9) and 13.6 (3.2) years, respectively. High levels of fatigue were endorsed by participants. Fatigue severity was related to depressive symptoms but not to AIDS diagnosis or medication status. Verbal learning and motor function was worse in participants with AIDS, but neuropsychological functioning was not significantly correlated with fatigue or depression. Depressive symptoms and fatigue were independently associated with subjective neurocognitive complaints. These results suggest that fatigue in HIV/AIDS is associated with depressive symptoms and subjective neurocognitive complaints. Individuals with HIV-associated fatigue should be screened for depression. Neither fatigue nor depression appear to affect neuropsychological functioning in HIV/AIDS. Future research is needed to examine qualitative aspects of fatigue in HIV-infection and to develop appropriate treatments.

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A. YAMAMOTO, B.P. ROURKE, & S.B. ROURKE. Impact of Medical and Neurobehavioral Status on Health-Related Quality of Life in HIV/AIDS.

Examination of health-related quality of life (HRQOL) has become an important consideration as increases in survival are associated with highly

active antiretroviral therapy. This study was a prospective examination of the reliability and clinical utility of the Medical Outcomes Study–HIV HRQOL instrument (MOS–HIV). Factor analysis of the MOS–HIV was conducted at baseline on 240 participants with HIV, reducing the 34 items to 6 factors (dimensions): Mental Health, Health Distress, Overall Health, Cognitive Function, Functional Status, and Physical Function. Follow-up data were available for 100 participants 1.3 years later. Test–retest reliability was high for all 6 MOS–HIV dimensions (intraclass correlation coefficient range = .73–.91). Regression analyses were used to determine the contribution of neuropsychological (NP) status, depression, AIDS status, and medical symptoms on HRQOL dimensions. Results indicated that depression and medical symptoms were significant predictors of MOS–HIV factors, with depression more highly related to mental health domains and medical symptoms more highly related to physical health domains. NP status, particularly psychomotor efficiency, was significantly associated with all HRQOL dimensions but Mental Health. Changes in MOS–HIV dimensions over 1.3 years were associated with changes in depression and medical symptoms. NP status was consistent across both time points and was not generally predictive of changes in HRQOL. Demographic variables, CD4 counts, and AIDS status were generally weak and inconsistent predictors of HRQOL dimensions. Overall, these results suggest that there are several medical and neurobehavioral predictors of HRQOL, and treatment of depression and medical symptoms may result in significant improvements in HRQOL.

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S.B. ROURKE, S.L. CARTER, C.P. MILLIKIN, S. MURJI, L.L. TRÉPANIÉ, C. BRANDYS, & M.H. HALMAN. Neurobehavioral Interventions for Cognitive Impairment in HIV/AIDS.

The purpose of this study is to evaluate the effectiveness of neurobehavioral interventions to improve everyday functioning and neuropsychological (NP) impairments in HIV/AIDS. As part of an ongoing neurobehavioral intervention study (Neuro-RESTORE Project), 22 adults with HIV-associated minor cognitive/motor disorder (MCMD; $n = 10$), HIV-associated dementia (HAD; $n = 6$), or “atypical” NP profiles (“spotty” NP impairments but not MCMD or HAD; $n = 6$) were randomized to 10 weeks of Attention Process Training (APT) plus compensatory strategies or APT alone (3 sessions per week). Measures of mood and cognitive complaints, NP functioning, and everyday functioning were obtained at baseline and post treatment. Achievement of individualized treatment goals was measured using Goal Attainment Scaling (GAS). Following treatment, there were significant reductions in subjective cognitive complaints and depressive symptoms. No consistent changes were observed in NP functioning, but significant changes were observed beyond expectations on the GAS. The MCMD and Atypical groups improved generally more than 1 SD beyond expectations on the GAS, while the HAD group showed minimal expected change. The preliminary results suggest that neurobehavioral interventions can be effective in reducing cognitive and mood symptoms and helping to improve everyday functioning, particularly in those with milder NP impairments.

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C. HINKIN, K. MASON, D. THRASHER, T. FARCHIONE, M. ROPACKI, M. STEFANIAK, R. SCHUG, S. CHOVAN, S. CASTELLON, D. HARDY, M. LAM, & R. DURVASULA. Cognitive Dysfunction and Regimen Complexity Predicts Medication Adherence Among HIV+ Adults.

Although the widespread usage of highly active antiretroviral therapy in the treatment of HIV infection has led to considerable improvement in morbidity and mortality, unless patients are rigorously adherent (i.e., at least 90–95 percent of doses taken), viral proliferation may ensue and treatment resistant strains of the virus will emerge. The present study was designed to determine the extent to which neuropsychological compro-

mise and medication regimen complexity is predictive of poor adherence in a convenience sample of 137 HIV infected adults. Medication adherence was objectively tracked through the use of electronic monitoring technology (MEMS caps). Participants were administered a comprehensive battery of neuropsychological tests. Results of two-way ANOVA revealed that neurocognitive compromise ($p < .001$) as well as complex medication regimens ($p < .001$) were associated with significantly lower adherence rates. A significant interaction effect ($p < .001$) was also seen in which cognitively compromised participants on more complex regimens had disproportionate difficulty with adherence. Results of logistic regression analysis revealed neuropsychological compromise to be associated with a 2.3 times greater risk of adherence failure. Older age (>50 years) was also found to be associated with significantly better adherence. These data suggest that HIV-infected adults with significant neurocognitive compromise are at risk for poor medication adherence, particularly if they have been prescribed a complex dosing regimen. As such, treating physicians are encouraged to adopt simpler dosing schedules with more cognitively impaired patients.

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L.A. SCHAEFER, D. DORFMAN, & S. MORGELLO. CMV Encephalopathy Treated With Foscarnet and Ganciclovir: A Case Study.

Cytomegalovirus (CMV) encephalopathy is an often-undiagnosed opportunistic infection in HIV-infected patients. However, the neuropsychological presentation of this disorder is not well documented. We present a case study of a 31-year-old woman with AIDS and CMV retinitis who developed progressive cognitive impairment. She was found to have titer-proven (and later, confirmed during autopsy) cytomegalovirus encephalitis, and was treated with the antiviral agents foscarnet and ganciclovir. Neuropsychological evaluation was performed at the outset of treatment, and repeated 11 days and 25 days later. Initial testing revealed severe deficits in memory and executive functioning, with milder deficits in attention, language, visuospatial conceptualization, and praxis. The patient met criteria for a dementia (Mattis DRS 107/144). The pattern of her deficits was most consistent with a frontal-subcortical dementia. Upon follow-up evaluation, the patient's cognitive deficits remained largely unchanged despite clinical impressions that she had improved and was more alert. The findings of this case suggest (1) that CMV encephalopathy may present neuropsychologically as a frontal-subcortical dementia; and (2) that antiviral treatment of CMV encephalopathy with foscarnet and ganciclovir has little, if any, effect on the cognitive aspects of this disorder. Correspondence: David Dorfman, Ph.D., Department of Psychiatry (Box 1230), Mount Sinai School of Medicine, New York, NY 10029-6574. E-mail: lynnandmarc@aol.com

M. CHERNER, R.K. HEATON, R.J. ELLIS, M. RIVERA MINDT, C. YOUNG, J.H. ATKINSON, I. GRANT, & THE HNRC GROUP. Effects of Aging on Neuropsychological Functioning in People With HIV Infection.

The effects of aging on the presentation of HIV associated neurocognitive disorders are largely unknown. We compared the neuropsychological profiles of 67 HIV+ study participants who were at least 50 years old at the time of their assessment ($M = 53$, $SD = 3.8$), to those of 56 participants who were 35 years old or younger ($M = 32$, $SD = 3.2$). The older and younger groups did not differ statistically with respect to years of education, proportion of women or ethnic minority representation, percent with AIDS, or mean CD4 count. The younger group had higher mean viral burden in both plasma (4.1 vs. 3.2 log, $p < .001$) and cerebrospinal fluid (2.7 vs. 2.2 log, $p < .01$), and tended to have a greater proportion of subjects who were not receiving antiretroviral treatment (41% vs. 22% untreated, $p = .08$). Raw test scores in a comprehensive neuropsychological battery were converted to demographically corrected T scores as available for each measure; minimally, all scores were corrected for effects of normal aging. Clinical ratings of impairment were assigned to each participant's global performance as well as to 8 domains of cognitive func-

tioning. The proportion of globally impaired subjects in the older group was 10% greater than in the younger group (64% vs. 54%), and the older group tended to have higher rates of impairment across most ability domains, but no differences reached statistical significance. Although further studies with larger and older-age samples are needed, the present results fail to detect an interaction between aging and HIV infection on neuropsychological performance.

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C.A. SMITH, W.G. VAN GORP, E. RYAN, S.J. FERRANDO, & J.G. RABKIN. HIV Dementia Scale: Comparing the Original and Modified Versions.

Background: A number of brief screening measures, including the HIV Dementia Scale, Mental Alteration Test, the Executive Interview, and the HIV Dementia Assessment, have been designed or adapted to quickly screen for HIV-associated dementia. Of these, the HIV Dementia Scale (HDS) has received widespread acceptance, being incorporated into an increasing number of study designs and analyses. One aspect of the HDS, the anti-saccadic eye movement trial, has been criticized for being too difficult for nonneurologists to administer. With this, a modified version of the HDS (mHDS), which eliminated the anti-saccadic eye movement trial, has been developed. **Objectives:** We sought to compare the utility of the HDS and the mHDS in screening for abnormal neuropsychological performance. **Methods:** Ninety HIV-seropositive men and women enrolled in a longitudinal research study completed a battery of neuropsychological (NP) tests. Cognitive "abnormality" was defined as performance that deviated ≥ 2 standard deviations below the mean on at least 2 NP measures. **Results:** HDS scores below 11 demonstrated 33% sensitivity and 87% specificity. mHDS scores below 7.5 demonstrated 43% sensitivity and 80% specificity. Performance on the HDS or mHDS was independent of gender, ethnicity, age, and education. **Conclusions:** Given the classification rates noted above, both the HDS and mHDS lack sufficient sensitivity to assess for neuropsychological abnormality. Intact performance on both measures (that is performance above established cut-off levels) contributes to a significant number of false negative errors, suggesting a more complete NP battery should be administered in those cases in which subtle neurocognitive deficits are suspected.

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R. DURVASULA, H. MYERS, C. HINKIN, & K. MASON. The Impact of HIV and Alcohol-Related Problems on Neuropsychological Performance.

While the independent neuropsychological effects of HIV infection and alcohol use have been well documented, little work has examined the interactive effect of alcohol use and HIV on NP function. The present study examines 334 African American men (200 HIV-, 133 HIV+). Participants were grouped on the basis CAGE assessed alcohol-related problems as follows: no history of alcohol use, current drinker with no history of problems, drinker with history of 1–2 problems, and drinker with history of 3–4 problems. Results reveal significant alcohol effects for measures of visuoconstruction and motor speed. Individuals with 1–2 drinking problems scored significantly higher on a measure of visuoconstruction (EIWA Block design) ($p < .009$) than those with 3–4 drinking problems, but contrary to expectations, those with 1–2 drinking problems were significantly faster than those with no history of alcohol use ($p < .04$) on a measure of motor speed (Grooved Pegboard). Significant HIV serostatus effects were noted for measures of motor speed and reaction time, with HIV+ men evidencing significantly slower motor speed as assessed by the Grooved Pegboard ($p < .01$), and slower reaction time on the sequential reaction time subtests of the CalCAP ($p < .04$). Serostatus effects were in the expected direction, while alcohol effects were variable. Future work examining the interactive effect of alcohol use and serostatus should

employ diagnostic measures of alcohol abuse, as well as multiple indices of alcohol use.

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C. CAREY, J. RIPPETH, R.K. HEATON, R. GONZALEZ, D.J. MOORE, A. GONGVATANA, J. MARQUIE BECK, I. GRANT, & THE HNRC GROUP. Effects of Methamphetamine Dependence and HIV Disease Stage on Neuropsychological Performance.

Preliminary evidence suggests that methamphetamine (METH) dependence may have an additive effect on the neuropsychological (NP) deficits associated with HIV infection. This study examined the effects of HIV disease stage (AIDS, nonAIDS) and METH dependence on NP performance in a sample of HIV-infected individuals ($n = 147$). Four groups matched on demographics were compared: (1) METH+/AIDS ($n = 36$); (2) METH+/nonAIDS ($n = 34$); (3) METH-/AIDS ($n = 35$); (4) METH-/nonAIDS ($n = 42$). The METH+ groups met DSM-IV criteria for methamphetamine dependence but were at least 10 days abstinent at time of NP testing. The 2 METH+ groups did not differ significantly in self-reported METH use. All 4 groups were similar in the percentage of individuals on antiretroviral (ARV) treatment. A comprehensive NP battery was administered and demographically corrected T scores were used to derive a summary global deficit score (GDS). A cutpoint ensuring 85% specificity was determined within a separate but demographically comparable METH-/HIV- control group ($n = 58$), and was used to classify participants as NP-impaired or NP-normal. Chi-square analysis indicated a significant difference in the rates of NP impairment across the 4 groups [$\chi^2(3, N = 147) = 11.5, p < .005$]. Pairwise comparisons demonstrated that all 3 risk factor groups (METH+/AIDS, METH+/nonAIDS, and METH-/AIDS) had significantly higher rates of NP impairment (64%, 44%, and 46% respectively) than the METH-/nonAIDS group (26%) ($ps < .05$). Results suggest that in HIV infected subjects, the NP deficits associated with methamphetamine dependence may be more deleterious in those who have AIDS.

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M. REGER, D. MARTIN, S. COLE, & G. STRAUSS. The Relationship Between Viral Load and Cognitive Functioning in HIV Patients.

Since the introduction of highly active anti-retroviral therapy, measures of viral load reveal undetectable levels of the circulating HIV virus in many AIDS patients. Therefore, it is important to examine the relationship between viral load and neuropsychological functioning. Cognitive functions were tested with a standardized neuropsychological battery consisting of 34 test scores that were grouped by cognitive domain. Participants ($N = 156$) were grouped based on CDC stage (asymptomatic, symptomatic, AIDS), current plasma viral load (undetectable, low, moderate) and highest historical plasma viral load (low, moderate, and high). MANOVAs conducted on each of seven cognitive domains revealed no significant differences in neuropsychological performance between groups based on current viral load, highest historical viral load, or HIV acuity level. These results suggest that plasma viral load does not predict cognitive functioning. Other measures, such as CSF viral levels or length of exposure to high viral loads, may better characterize the neuropsychological functioning of HIV patients.

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DEMENTIA SYNDROMES

S. WETTER, G. PEAVY, M. JACOBSON, J. HAMILTON, D.P. SALMON, & C. MURPHY. Olfactory Event-Related Potentials in Huntington's Disease.

Individuals with HD are impaired on olfactory assessments. However, research has been limited to psychophysical measures of olfaction. HD

patients' performances on more objective measures of olfactory information processing have not been reported to date. The present study investigated olfactory functioning in HD using such a measure: the olfactory event-related potential (OERP). Olfactory and auditory ERPs were recorded monopolarly from Fz, Cz, and Pz electrode sites in 8 patients with HD and 8 age- and gender-matched control participants. The stimuli were amyl acetate (1492 ppm) and a 500 Hz tone, presented in 2 separate sessions with a 45-s inter-stimulus interval. The latencies and amplitudes of ERP components N1, P2, N2, and P3, as well as interpeak amplitudes N1–P2, N1–P3, and N2–P3, were assessed. Results demonstrated that individuals with HD were delayed compared to controls on all components of the OERP, especially the P3 component. The effect size for OERP P3 latency ($\eta^2 = .72$) was larger than for the auditory P3 ($\eta^2 = .24$), which has been previously shown to be delayed in HD. In addition, the effect size for an odor identification test ($\eta^2 = .38$) is also not as robust as the OERP. These findings extend our understanding of the olfactory deficits in HD, and suggest that the OERP may be an important tool for future research with this population.

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M.C. CAMPBELL & J.C. STOUT. Decreased Autonomic Reactivity to Monetary Loss in Huntington's Disease.

Huntington's disease (HD) is associated with a decline in performance on the Bechara Gambling Task (BGT). Accounts of decision-making processes have implicated a role of the autonomic nervous system in guiding choices in the BGT, as evidenced by the inability of individuals with damaged ventromedial (VM) prefrontal cortices to develop somatic responses to guide their decisions on the BGT. To examine the possible role of autonomic activity in guiding the performance of HD participants, we studied skin conductance responses (SCRs) in a new group of 15 HD participants and 16 healthy controls (HC) while completing a computerized version of the BGT. The results replicated the performance decrement in HD that we observed in our previous study, and showed that HD was associated with abnormal SCRs in the task. Specifically, while the HC group showed elevations in SCRs following both winning and losing selections, HD showed these increases only during winning selections and were significantly hypo-responsive to losses. Furthermore, unlike previous studies of VM patients, both groups exhibited normal anticipatory SCRs to the disadvantageous selections. These findings are consistent with the possibility that a failure of the autonomic nervous system to encode loss associated with a particular decision may be detrimental for learning task contingencies, or avoiding negative outcomes.

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D. BADENES, O. GELONCH, A. ROJO, L. CASAS, N. CERULLA, & M. AGUILAR. Personality and Cognition: Preclinical Study in Huntington's Disease.

Huntington's disease is an autosomal dominant neurodegenerative condition characterized by a progressive, usually choreiform movement disorder, dementia and psychiatric disturbances, ultimately leading to death. The pathologic hallmark of Huntington's disease is progressive atrophy of the striatum, especially involving the caudate nucleus. Clinical manifestations include abnormalities in all 4 domains of basal ganglia function. Specifically, Huntington's disease results in abnormalities of body movements, eye movements, emotions and cognition. *Objective:* To study the cognition and personality features in relatives of patients that require a genetic study of Huntington's disease. *Methods:* A neuropsychological battery (RBANS, Stroop test, FAS, Semantic Fluency and cubes of WAIS) and a personality test was administered (16 PF5) to 11 people (6 women and 5 men). The evaluation was carried out previously to the genetic study. *Results:* The prediction was positive for 6 patients (3 men and 3 women). There were no statistically significant differences on any of the tests. Nevertheless, clinically relevant differences in the personality profile were observed between both groups (positive vs. negative). Concerning the cognitive tests, differences were observed in the clinical profile

related to attention capacities and executive functions (Stroop). *Conclusions:* Being a small sample, the data obtained do not allow us to obtain decisive results. However, different tendencies were observed related to the personality and cognition profiles. By enlarging the sample we hope to obtain more conclusive results.

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S. WYLIE & J. STOUT. Enhanced Distractor Competition During Action Selection in Huntington's Disease.

Huntington's disease (HD) is characterized by a progressive degeneration of the neostriatum, a structure that receives the majority of cortical inputs into the basal ganglia. One model of basal ganglia function proposes that inputs from cortex represent action commands, and the basal ganglia function to select from the pool of commands a "winning" command to guide action. The current study tested the hypothesis that action selection in HD would be altered under task conditions in which multiple commands compete for the control of action. In particular, it was predicted that HD subjects would show poor inhibition for competing, but irrelevant, action commands as revealed by increases in response time and error rates. Twelve HD and age-matched healthy controls (HC) performed a variant of the Flanker Task, which is used in cognitive psychology to study competition from distractors during action selection. HD subjects showed greater response time slowing relative to HC when distractors were associated with actions that competed with the target action. In addition, higher ratings of chorea within the HD group were associated with increased errors associated with the selection of competing actions. These findings suggest that one consequence of HD may involve a disruption to inhibitory processes that operate during action selection and provide support for the plausibility of the action selection model of basal ganglia function.

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H. WESTERVELT, R. STERN, & G. TREMONT. Odor Identification Deficits in Diffuse Lewy Body Disease.

The presence of olfactory deficits, especially odor identification deficits, has been well established in both Alzheimer's disease (AD) and Parkinson's disease (PD). The presence of olfactory deficits in diffuse Lewy body disease (DLBD) is also likely given the overlap of clinical symptomatology and neuropathology with AD and PD. However, to date, there has been only 1 published report of olfactory functioning in patients with DLBD, with only cursory evaluation of odor detection abilities. We report here on the neuropsychological functioning and odor identification performance using the Brief Smell Identification Test (BSIT) in a series of 4 patients with probable DLBD and 2 patients with possible DLBD presenting for neuropsychological evaluation at a large, urban medical center. All six patients demonstrated olfactory impairments, and 5 of the 6 appeared completely anosmic. In comparison with 6 patients with AD matched on age, level of cognitive functioning, and degree of dementia, the patients with DLBD made twice as many errors on the BSIT. The possible etiology of these deficits and the implications of these findings in providing a useful clinical tool for differential diagnosis of dementia are discussed.

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J. BAILIE, P. GILBERT, P.J. BARR, & C. MURPHY. Odor Identification Deficits in Lewy Body Disease.

Two recent reports suggest that odor detection may be impaired in patients with Lewy body disease (LBV). Two-alternative, forced-choice assessment of odor detection threshold is a classic method for assessing olfactory function. Twenty-one LBV patients, 21 AD patients and 21 controls, matched for age, gender, and DRS scores, were assessed with the San Diego Odor Identification Test, a rapidly administered test of olfactory function. Percent correct was computed for 6 common odors. Both the

LBV and AD patient groups were impaired on odor identification relative to the control group. Of the 21 LBV patients, 10 identified none of the odors and 4 identified 1. None correctly identified all 6. The results suggest profound impairment in olfactory function in the LBV population and suggest that a simple, rapidly administered test can be useful in detection deficits in this population.

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V. INGRAM, M. KELLY, & G. GRAMMER. Wernicke-Korsakoff Syndrome Following Uvulopalatopharyngoplasty for Sleep Apnea.

Wernicke's encephalopathy, the acute neurological condition, and Korsakoff's psychosis, the severe amnesic state that follows this encephalopathy, are most commonly associated with malnutrition that can accompany alcoholism. Specifically, a nutritional deficiency in thiamine, often observed in chronic alcoholics, causes lesions in multiple brain structures including the thalamic nuclei, hypothalamus, and mamillary bodies. A dense amnesia, tendency toward confabulation, and personality change are the primary symptoms noted in the Korsakoff's stage of the disease, however executive functioning deficits are also identified in patients, presumably as a result of damage to the frontal network systems. Although primarily identified in chronic malnourished alcoholics, Wernicke-Korsakoff's syndrome has also been documented in other cases of gross malnutrition including that seen in stomach cancer, anorexia nervosa, and gastrectomy. The current case however portrays an adult male with documented Wernicke's encephalopathy following surgical treatment (Uvulopalatopharyngoplasty) for Obstructive Sleep Apnea. The morbidly obese patient lost nearly 100 pounds over the initial 9 weeks of surgical recovery when he refused to eat secondary to pain. Neuropsychological evaluation was conducted 4 weeks following diagnosis and treatment for Wernicke's encephalopathy, and findings demonstrate a gross amnesic state consistent with Korsakoff's. Serial assessment following an experimental treatment with Reminyl was also conducted. This unusual case demonstrates the deleterious neuropsychological effects of a nonalcohol-related thiamine deficiency, and the potential for improvement with the use of a cholinesterase inhibitor.

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C. BISHOP, R. STERN, & D. JAVORSKY. Nine-Year Longitudinal Case Study of Progressive Dementia Pugilistica.

Dementia pugilistica (DP), also known as "punch drunk" syndrome or chronic traumatic encephalopathy, frequently occurs after multiple blows to the head and may either progress or may remain stable at any severity level. There is increasing evidence that DP is a major risk factor for, and shares similar pathogenesis with, the development of other neurodegenerative conditions, including Alzheimer's disease (AD), Parkinson's disease (PD), and diffuse Lewy body disease. We report on a 41-year-old patient with DP secondary to blows received during a professional boxing career. He demonstrated moderate to severe neuropsychological deficits despite suffering only 1 knockout during his 6–10-year career and despite normal neuroimaging studies. Four successive neuropsychological evaluations over a 9-year time span documented continued declines in his cognitive functioning 15 years after the termination of his boxing career, revealing deficits in aspects of attention, mental control, memory, motor skills, executive functioning, language, and spatial skills. His most recent evaluation revealed the most prominent declines to date, with significant decreases in memory and executive functioning and the development of bilateral motor dysfunction. He also demonstrated profound anosognosia for cognitive, psychiatric, and physical deficits. Olfaction skills were within normal limits, a surprising finding given that olfaction is typically compromised in AD and PD. Despite his moderate to severe cognitive deficits, the patient was able to successfully sustain competitive employment and continued to perform basic and instrumental activities of daily living indepen-

dently, although his family noted functional declines at home, marked mood changes, driving difficulties, and problems maintaining childcare responsibilities.

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K.P. RANKIN, H.J. ROSEN, J.H. KRAMER, M. WEINER, N. SCHUFF, & B.L. MILLER. Left Frontal Volume Is Negatively Related to Agreeableness in FTD.

Recent investigations of the neuroanatomy of complex social behaviors suggest that the underlying brain circuits involve multiple cortical and subcortical structures. The neuroanatomic origins of agreeableness have not yet been clearly elucidated. However, frontotemporal dementia (FTD) patients can evidence dramatic alterations in agreeableness arising from frontal and temporal lobe damage. Based on clinical observations, we hypothesized that agreeableness would be negatively correlated with left frontal cortex size and positively correlated with right amygdala volume. First-degree relatives of 11 FTD patients (diagnosed according to Lund-Manchester criteria) were asked to fill out the NEO-Five Factor Inventory to assess the patient's current level of agreeableness. These patients underwent T1-weighted MRI imaging, and gray matter volumes for right and left frontal lobes, anterior temporal lobes, and amygdalas were derived via segmentation and region of interest tracing, normalizing for total intracranial volume. Stepwise linear regressions revealed that 40% of the variance in NEO Agreeableness score was predicted by a model in which left frontal lobe volume was negatively correlated with the NEO Agreeableness scale ($p < .05$). Right amygdala volume was statistically excluded from this model, though it had approached significance for positive correlation with Agreeableness ($p < .10$). This finding replicates a previous study that used a different measure of social functioning, the Interpersonal Adjectives Scale, to delineate a left frontal-right amygdala circuit for agreeableness. These data support the hypothesis that regulation of agreeableness arises from a balanced, mutually inhibitory circuit involving both the left frontal lobe and the right amygdala.

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J. MURPHY, C. LOMEN-HOERTH, J. KRAMER, D. FORSHEW, K.P. RANKIN, S.E. LANGMORE, & B.L. MILLER. Unique Neuropsychological Profiles Exist When Contrasting Patients With Frontal Variant FTD, ALS, and Patients With Comorbid FTD/ALS.

The clinical syndromes of ALS and frontal variant FTD overlap in both familial and sporadic cases, with incidence rates of FTD in ALS reported as high as 48%. Identification of specific deficits may shed light on the anatomic substrates of FTD. The present study compares the neuropsychological profiles of patients with FTD, ALS and comorbid FTD/ALS. A nonselected sample of 30 patients were administered a battery of neuropsychological tests as part of evaluations in memory disorders and ALS clinics. Participants ($N = 30$) included 12 FTD, 9 ALS, and 9 comorbid patients. Groups were matched for age ($M = 57$), education ($M = 15$ years), and gender (22% female). Tukey-corrected ANOVAs were computed with diagnoses included as the independent variable. As predicted, ALS-only patients performed better than both FTD groups on verbal fluency (FAS) ($p < .01$), the California Card Sorting Test ($p < .01$), California Color-Word Interference test subtests ($p < .01$), Block Design subtest of the WAIS-III ($p < .01$) and the MMSE ($p < .01$). The ALS-only group also performed significantly better than the FTD-only group on the visual reproduction immediate memory subtest of the WMS-III ($p < .01$) and the short and long delay of the CVLT-SF ($p < .01$). Of interest are those tests that distinguish between the FTD-only and comorbid groups. Patients with comorbid diseases performed better on California design fluency ($p < .01$) and Block Design ($p < .01$), and more slowly on a California Color-Word Interference test subtest ($p < .01$). It is hypoth-

esized that comorbid patients are diagnosed with dementia earlier in their illness and that sub-clinical dysarthria affected the ALS patients' speaking speed.

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E.J. GEENEN, D.L. NYENHUIS, E. GENCHEVA, & P.B. GORE-LICK. Comparison of VaD Frequency Using NINDS-AIREN and ADDTC Diagnostic Criteria.

Past studies have found that using different diagnostic systems for vascular dementia (VaD) produce a large difference in the estimates of frequency for this disease. The ADDTC and NINDS-AIREN criteria require different cognitive domains and a different number of domains to diagnose VaD. The present study sought to examine the effects these different diagnostic systems had on the frequency of VaD in a post-ischemic stroke population. Demographic and neuropsychological test variables that significantly differentiated the two criteria groups were also explored. Participants ($n = 70$) were patients who had an ischemic stroke within 3–6 months of examination and were at least 50 years old. ADDTC criteria diagnosed VaD in 14.3% ($n = 10$) of the sample while NINDS-AIREN diagnosed VaD in 8.6% ($n = 6$). All 6 participants who met the NINDS-AIREN criteria for VaD also met the ADDTC criteria. The group that met both NINDS and ADDTC criteria was significantly older than the group that met only the ADDTC criteria [$t(8) = 3.64, p = .007$]. Several cognitive measures (e.g., word recall Trial 1, WMS digit span backwards, and Behavior Dyscontrol Scale total score) indicated worse performance in the group that met both criteria sets than the group that only met the ADDTC criteria. These results suggest (1) NINDS-AIREN and ADDTC criteria may not be as discrepant in a post-stroke patient group as in previous studies; and (2) NINDS-AIREN criteria requires greater cognitive impairment than ADDTC criteria.

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B.R. REED, J.H. KRAMER, B. BETZ, & D.M. MUNGAS. Heterogeneous Neuropsychological Profiles in Autopsy-Defined Vascular Dementia.

Clinical comparisons between Alzheimer's disease (AD) and subcortical ischemic vascular dementia (SIVD) have found better memory and worse executive function in SIVD. Heretofore this pattern has not been tested using autopsy-defined cases. *Methods:* Eight of 46 autopsy cases from a prospective study of SIVD had cognitive impairment or dementia consequent to cerebrovascular disease (SIVDpath); AD pathology was absent or mild and vascular pathology, quantified with a whole-brain measure of cerebrovascular disease (CVDpath), was substantial. Neuropsychological patterns were examined using (1) expert ratings of test protocols and (2) quantitative analysis using composite, psychometrically matched, scales for memory (MEM) and executive function (EXEC). *Findings: Expert ratings:* 16 AD and 16 normal cases, clinically defined, were selected to match the SIVDpath cases on age and education. Eight autopsy-defined cases with mixed AD/SIVD pathology were also included. Test protocols for these 48 cases were rated in random order by 4 experienced neuropsychologists who were blind to all other data. Ratings were accurate for AD (sensitivity = 87%, specificity = 77%) but was poor for SIVD (sensitivity = 12%, specificity = 92%), and mixed cases (sensitivity = 12%, specificity = 92%). *Quantitative comparisons:* In 3 of the 8 SIVDpath cases EXEC was lower than MEM (an "SIVD pattern"), while in three others MEM was lower than EXEC (an "AD pattern"). CVDpath scores were considerably higher in the "SIVD pattern" cases (range 14–24) than in the "AD pattern" cases (range 3–9). *Conclusions:* Cognitive profiles in SIVD are variable and difficult to identify. Larger samples may help clarify the pathologic basis of this heterogeneity.

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K. SCHMIDTKE & M. HUELL. Neuropsychological Diagnosis of Small Vessel Disease, Alzheimer's Disease and Mixed Dementia.

Small vessel disease (SVD) affects the basal ganglia and white matter. The separation of SVD from Alzheimer's disease (AD) with minor vascular changes, and from mixed dementia (MD), can be difficult. We examined the test profiles of 18 SVD, 18 MD and 72 AD patients with Mini-Mental score ≥ 16 (tests: object naming, word fluency, word list recall, word list recognition, and a novel Clock Reading test). Discriminant analysis classified 79 to 83% of the cases correctly. AD and MD were distinguished by word fluency scores only, which were considerably lower in MD. Receiver Operator Curve Analysis (ROC) showed that an optimal cut-off score identified 91% of the MD patients correctly (specificity: 65%). SVD and AD were distinguished by word list recognition and Clock Reading scores. Looking for single-variable cut-offs, ROC showed a high sensitivity of 88% and a moderate specificity of 75% for Clock Reading. Sensitivity was still higher for word list recognition (94%), but specificity was low. Results for SVD vs. MD were similar to those of SVD vs. AD. The positive predictive values for SVD vs. AD and MD vs. AD ranged from 37 to 45%. The neuropsychological profiles of AD, SVD and MD are markedly different. Sensitivity indices were high with regard to the separation of vascular and mixed cases from AD. The positive predictive values were not satisfactory, which is related to the higher prevalence of AD and overlap of scores. However, test profiles can make a significant contribution to differential diagnosis in clinical practice. Clock Reading is a promising new test for the separation of AD from SVD and MD.

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J. CHIN, M.J. BAEK, B.H. LEE, S.J. KANG, Y. JEONG, J. KWON, & D.L. NA. The Closing-In Phenomenon in Alzheimer's Disease and Vascular Dementia.

The closing-in phenomenon is the tendency to draw near or into the target when copying figures, which has been found mostly in Alzheimer's disease (AD). We attempted to measure the degree of the closing-in phenomenon and to compare the tendency of the closing-in phenomenon in patients with AD and vascular dementia (VaD). Subjects (57 patients with AD, 39 with VaD, and 33 normal controls) were asked to copy the Alternating square and triangle, starting at the designated place (5 cm below the left margin of the target) and continuing from left to right. Patients with AD and VaD did not differ in age, education, the severity of dementia (Clinical Dementia Rating and MMSE), and the Rey Complex Figure Test copy score. The proximity (Y-axis) of the subject's drawing toward the target was plotted on the 2 mm intervals of the X-axis and the degree of the closing-in was computed by the slope of the regression line. Patients with AD and VaD showed a steeper slope than the controls [$F(2,126) = 3.874, p < .05$]. There was no significant difference, however, between AD and VaD in the tendency of the closing-in phenomenon [$t(94) = .916, n.s.$]. When the presence of the closing-in phenomenon was defined by the slope that was beyond $M + 2 SD$ of the controls, 38.6% of AD and 35.9% of VaD patients showed the closing-in phenomenon. Our study using a new method for measuring the closing-in phenomenon suggests that this phenomenon is not a feature specific only to AD.

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P.J. MOBERG, K. BALDERSTON, D.R. ROALF, B.I. TURETSKY, R.L. DOTY, J.E. DUDA, & M.B. STERN. Meta-Analysis of Olfactory Dysfunction in Alzheimer's, Parkinson's and Huntington's Diseases.

Olfactory dysfunction in Alzheimer's (AD), Parkinson's (PD) and Huntington's (HD) disease has been a topic of increasing interest, with deficits in odor identification, detection threshold, discrimination, and memory being reported. Despite increasing knowledge, controversy has existed about possible differential deficits among these disorders as well as influences of possible moderator variables. To help elucidate this controversy, we conducted a quantitative (meta-analytic) review of the English lan-

guage literature on olfaction in AD, PD and HD. Studies assessing odor identification, detection threshold sensitivity, memory and discrimination were evaluated. Possible moderator variables were also assessed. Homogeneity analysis revealed significant impairment across all olfactory domains in the three patient groups ($d_+ = -.98$, 95% CI = $-1.05 < \delta < -0.90$) and that significant heterogeneity of effect sizes was present [$O(3) = 15.05$, $p = .0017$]. *Post-hoc* contrasts revealed differential deficits for the four olfactory tests across the patient groups. PD patients, while being impaired in odor identification ability, showed significantly less deficit than AD and HD patients who did not differ from one another. With regard to odor detection threshold sensitivity, all three groups differed significantly from each other, with the greatest level of deficit being seen in the HD patients followed by PD and AD patients. HD and AD patients evidenced marked impairment in odor memory, with PD patients showing lesser deficit in this domain. Lastly, analysis did not reveal any impairment in odor discrimination in AD patients, while both PD and HD groups did demonstrate significant deficit. The differing patterns of olfactory deficits appear to generally coincide with the pathology seen in these disorders.

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J.G. SCOTT, M.R. SCHOENBERG, K. DUFF, M. MONNOT, P. FRANCEL, K. BHARUCHA, & A. COLEMAN. Differential Diagnosis of Alzheimer's and Parkinson's Disease Using the RBANS.

The current research compared 51 individuals with Parkinson's disease (PD), 26 patients with Alzheimer's disease (AD) and 19 elderly control subjects using the Repeatable Battery for the Assessment of Neuropsychological Status (RBANS). AD patients meet NINDS-ARDC for probable Alzheimer's. PD patients met criteria for PD both by clinical diagnosis and UPDRS criteria. Control subjects were recruited from independent community dwelling elderly. Subjects were compared on both composite index scores from the RBANS as well as component subtest scores. ANOVA indicated both AD and PD patients were significantly more impaired than controls across all index scores [Immediate memory (IM), Delayed memory (DM), language, Attention (Attn.), and Visuospatial]. However, the groups did not differ on component subtests including Digit Span and Figural copying, indicating that these subtests are insensitive to differentiating normal individuals from PD and AD populations. Post Hoc analysis found differences between PD and AD groups for IM, DM, and Language indexes only, but not for Attn., or Visuospatial indexes. Among component subtests, most components discriminated well among PD and AD groups, with the exception of Coding, Digit Span, Line orientation and figure copying. These results indicate that the RBANS performs well at discriminating among neurodegenerative and normal populations, but does not perform as well at discriminating among different neurodegenerative disorders. Additional research is needed exploring the specific patterns of performance produced by different neurodegenerative disorders as well as discernable patterns produced by different disorders at different stages of the disease progression.

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C. BURTON, E. STRAUSS, D. HULTSCH, & M. HUNTER. Intraindividual Variability in Alzheimer's Disease and Parkinson's Disease.

Studies have shown that older adults and individuals with certain neurological conditions, such as traumatic brain injuries, epilepsy, and Alzheimer's disease (AD), demonstrate greater intraindividual variability (IIV) over short intervals (e.g., minutes, days, weeks) in cognitive functioning than younger adults or healthy controls. Several researchers have suggested that IIV may be a behavioral marker of compromised neurobiological mechanisms associated with aging, disease, or injury. The present study sought to investigate whether IIV is associated with general nervous system compromise or certain types of neurological disturbances by comparing healthy adults, and adults with either AD or Parkinson's disease

(PD), two neurodegenerative disorders with different neuropathology. Participants were assessed on 4 separate occasions on a battery of cognitive, physical, and affective/stress measures. Results indicated that (1) on measures of cognitive functioning, the AD group was more variable than the PD group, which was in turn more variable than the healthy group; (2) the AD group was significantly more variable than both the healthy and PD groups on a physical task (finger dexterity); and (3) poorer cognitive functioning was associated with increased inconsistency across a wide array of tasks, particularly cognitive ones. A tentative conclusion based on these findings, is that increased IIV may be present in all individuals with compromised neurological systems, regardless of the nature of dysfunction. However, this study represents only a preliminary step towards answering this question, which will require the gradual accumulation of evidence from various populations with neurological compromise.

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M.E. GRISS, J.D. EVANS, P.S. FASTENAU, & F.W. UNVERZAGT. CERAD Performance in Alzheimer Disease and Progressive Supranuclear Palsy.

Background. Cortical and subcortical patterns of performance are well established on comprehensive neuropsychological batteries. We report on the profile differences between Alzheimer's disease (AD) and Progressive Supranuclear Palsy (PSP) patients on the brief CERAD neuropsychological battery. *Method.* Indiana Alzheimer Disease Center participants with AD were individually matched to PSP patients ($n = 8$) on age (± 3 years), education (± 2 years), and MMSE (± 4). The CERAD battery incorporates measures of language (Animal Fluency, Boston Naming Test), visuospatial ability (Constructional Praxis), memory (Word List Learning), and affective functioning (Geriatric Depression Scale). *Results.* The sample was primarily Caucasian (94) and male (63%). AD patients did not differ from PSP patients on age (69.6 years vs. 68.5 years), education (12.3 years vs. 12.1 years), or MMSE (20.1 vs. 20.0; all $ps > .50$). ANOVAs indicate that AD and PSP patients performed similarly on Animal Fluency, Boston Naming, and Word List Learning sum recall measures. A trend emerged in which Constructional Praxis was more preserved in AD ($M = 7.9 \pm 2.4$) than PSP ($M = 5.3 \pm 3.3$; $F[1,14] = 3.32$, $p = .09$). PSP participants also endorsed greater subjective symptoms of depression as compared to AD participants [$M = 15.4 \pm 5.1$; $M = 8.0 \pm 6.7$; $F(1,12) = 5.47$, $p < .05$]. *Conclusions.* In this small sample matched for age, education, and dementia severity, differential profiles were present. PSP patients reported more depressive symptoms and greater impairment in visuospatial ability than AD patients.

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M. HUY, K. BOONER, & J. RAZANI. Comparison Study: Neuropsychological Performance in Late Life Psychosis Compared to Right and Left Frontal Temporal Dementia and Alzheimer's Disease.

The performance of 37 patients with late life psychosis (LLP) was compared to 39 patients with dementia [11 patients with left frontal temporal dementia (FTD), 11 patients with right (FTD), and 17 patients with Alzheimer's disease (AD)] on a neuropsychological battery. Groups did not differ in overall IQ, which suggests comparable illness severity across groups. The LLP group outperformed the AD group in basic attention (Digit Span), arithmetic, on all Performance subtests, and visual spatial ability (Rey-Osterrieth copy). The LLP group also outscored the left FTD group on all Verbal subtests, on all Performance subtests, verbal processing speed (Stroop A and B), and verbal executive skills (FAS). Additionally, they obtained significantly higher scores than the right-FTD group on all Performance subtests, some verbal subtests (Arithmetic, Comprehension, and Similarities), and verbal and nonverbal executive tasks (FAS and Wisconsin Card Sorting Test). Groups did not differ in verbal or nonverbal recall tasks. These results suggest that the LLP group exhibits attentional, mental speed, mathematical, and visual perceptual/spatial skills superior

to AD patients; verbal/languages skills, visual perceptual ability, and verbal and nonverbal executive skills greater than those observed in left FTD; and visual perceptual/spatial, mental speed, arithmetic, and verbal and nonverbal executive skills higher than right FTD patients. These findings indicate a pattern of neuropsychological functioning for LLP patients that is distinguishable from patients with left and right FTD and AD and which may be useful in differential diagnosis.

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K.K. ZAKZANIS, J. ANDRIKOPOLOUS, D.A. YOUNG, T. SETHIAN, & Z. CAMPBELL. Neuropsychological Tests That Discriminate Between Late-Onset Schizophrenia and Alzheimer's Dementia.

Late-onset schizophrenia and dementia of the Alzheimer's type (DAT) often present with some pathological behavioral commonalities. Specifically, both illnesses may involve varying degrees of delusional manifestation, apathy, lateral/third-ventricular enlargement, reduced frontal lobe activity, hippocampal atrophy, and dopamine imbalance. Moreover, patients with late-onset schizophrenia and DAT have shown comparable cognitive impairment on standardized neuropsychological tests. As such, a differential diagnosis of the two disorders based on such testing can prove to be difficult. The present study evaluated the neuropsychological test results of 32 patients with late-onset schizophrenia and 32 patients with DAT, to distinguish the tests that best differentiate the two disorders. Results indicate that the WAIS-R Similarities subtest and the California Verbal Learning Test (both short and long delay free recall) correspond to sensitive diagnostic neuropsychological measures that can aid in the differentiation of patients with late-onset schizophrenia and DAT.

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SCHIZOPHRENIA

M. FISHER, J. POOLE, & S. VINOGRADOV. Cognitive Functions Contributing to Source Memory in Schizophrenia.

Source memory is the ability to remember the *origin* of information stored in memory, for example, whether an event actually happened to us, whether we learned of the event from an external source (e.g., a trustworthy friend, a stranger, a history book), or whether it was our own subjective creation (e.g., a theory, fantasy, or plan). Thus, source memory allows us to distinguish public events from our own personal history, and externally observable events from our internal thoughts and feelings. Previous research suggests that source memory deficits may underlie schizophrenia patients' reality distortions (hallucinations, paranoia, delusional beliefs). We tested source memory and other neuropsychological abilities in 127 clinically stable schizophrenic outpatients and 33 healthy controls, to identify cognitive functions that may contribute to source memory failures. Schizophrenic subjects made significantly more source memory errors, and had particular difficulty identifying the source of internally generated items. Multiple regression analysis found that approximately half of the variance in source recall was accounted for by four factors: abstract concept formation, working memory, delayed verbal memory, and delayed visual memory. However, a significant portion of reliable differences in source monitoring ability was unrelated to these measures. These relationships were independent of IQ, age, medications or their side effects. We conclude (1) that executive and episodic memory deficits may contribute to schizophrenic subjects' confusion about the source of memories, and (2) that tests of source memory can provide unique information about the neuropsychological functioning of psychotic individuals beyond what is provided by common neuropsychological measures.

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S. HIRSCHBERG, M. FISHER, J. POOLE, & S. VINOGRADOV. Quality of Life and Source Memory Errors in Schizophrenia.

Cognitive impairments in schizophrenia have gained attention for their role in social and occupational dysfunction as well as for their connection to a subjective decline in quality of life. Of the cognitive impairments associated with such a decline, memory dysfunction appears to play a prominent role. While several studies have focused on the effects of recall and recognition memory deficits on quality of life, little is known about the effects of more specific types of memory dysfunction, such as *source memory*. Source memory (i.e., "source monitoring") is our memory for the specific source of information (i.e., facts, ideas, beliefs, etc.) and involves our ability to make judgments about the origins of the contents of our memory. The present study investigates source memory in 127 clinically stable schizophrenic outpatients and 33 healthy controls. Two separate tasks of source memory were administered—in the first, subjects distinguished between internal and external sources while the second involved distinguishing between two external sources. The results showed relationships between Paranoid schizophrenic subjects' source memory errors and their capacity for interpersonal relationships and between such errors and level of environmental engagement. In contrast, among nonparanoid subjects, source memory errors were related to employment and sense of purpose. Implications in relation to symptomatology of paranoid schizophrenia (i.e., delusions, unusual thought content, hallucinations, etc.) and nonparanoid schizophrenia (i.e., disorganization) are discussed. The results also have significant implications for cognitive retraining programs and further our understanding about the way in which cognition affects dysfunction in schizophrenia.

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R.S. LANCASTER, J. JOHANNESSEN, J.D. EVANS, & P.H. LYSAKER. Patterns of Impairments in Vigilance and Verbal Memory in Schizophrenia.

Persons with schizophrenia experience a wide range of neurocognitive deficits, including impairments in vigilance and verbal memory. Less is understood about how these deficits are related to one another as well as to overall cognitive function. For example, do impairments in vigilance and verbal memory overlap or do they individually contribute to cognitive deficits in schizophrenia? Do individual subtypes exist in which there are selective deficits in vigilance and verbal memory? To address these questions we conducted a cluster analysis of 63 participants with schizophrenia spectrum disorders on the basis of their performance on the Connors Continuous Performance Test and the California Verbal Learning Test. As predicted, 4 groups emerged: good vigilance/good memory ($n = 12$), good vigilance/poor memory ($n = 20$), poor vigilance/good memory ($n = 17$), and poor vigilance/poor memory ($n = 14$). When groups were compared on other measures of neurocognition and symptoms, we found that the poor vigilance/poor memory group were most impaired on measures of executive functioning (Wisconsin Card Sorting Test) and visuospatial functioning (WAIS-III block design). Groups did not differ on age, education, illness duration, estimated premorbid intelligence or level of positive and negative symptoms as assessed by the Positive and Negative Syndrome Scale (PANSS). However, the poor vigilance/poor memory group did have more cognitive symptoms on the PANSS. Taken together, these results suggest that persons with schizophrenia exhibit a heterogeneous profile of performance with regards to vigilance and verbal memory deficits, and that the presence of both deficits may have an additive effect leading to difficulties in higher order cognitive functioning.

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D. FUJII, R. LIKEWISE, & L. IGUCHI. A Comparison of WCST and WCST64 Scores in a Schizophrenic Sample.

The Wisconsin Card Sort (WCST) is one of the most widely used neuropsychological measure for examining cognitive functioning in persons with schizophrenia. It has important predictive validity in that poor WCST

performance has been associated with impaired community functioning. A weakness of the WCST is that it is somewhat lengthy and frustrating for poor performers, thus recently, a short version of the WCST has been developed. The psychometric properties of this new test in persons with schizophrenia, however, have not been established. The current study examines the comparability of the WCST64 with original WCST in a schizophrenic sample. Specifically, we examine whether performances on the two measures yield similar scores. The original WCST test data of 60 patients with schizophrenia spectrum disorder were rescored for the first 64 cards. Percentiles and ranges of each WCST measure were then compared. For the entire sample, significant differences were found for perseverative responses ($p < .01$), and sorts-percentile ($p < .0001$). Ranges for WCST64 and original WCST percentile scores were different in 50% or more of the cases for conceptual level responses, nonperseverative errors, perseverative errors, and perseverative responses, and in 47% for total errors. For conceptual level responses, sort-percentile ($p < .05$), total errors, perseverative errors, and perseverative responses ($p < .001$), ranges were higher for the WCST64. Our results suggest the WCST64 overestimates performances on select measures when compared to performances on the original WCST. Implications for test use and interpretation of the WCST64 with a schizophrenic population are discussed.

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R. CHAN & E. CHEN. Cognitive and Neurological Sign Features of Intense Blinkers in Chronic Schizophrenia.

Blink rate seems to be a marker for schizophrenia and other psychotic disorders. Previous studies suggest that significant difference exists between patients with schizophrenia and normal controls in a resting or relaxing condition, but not cognitively active condition. Given the common neural substrates of blink rate, neurological signs, and some of the neurocognitive functions, it is surprising relatively few studies have been specifically designed to investigate their relationships. This study aimed to explore the relationships among cognitive functions, neurological signs, and clinical symptoms in a group of chronic schizophrenia patients, intense blinkers in particular. A sample of 90 chronic schizophrenic patients was recruited. Blink rate was recorded when participants were in a resting and relaxing condition. The mean blink rate was 24.49 count/min ($SD = 18.15$). Significant correlations were only found between blink rate and global psychopathology of psychotic symptoms ($r = -.3, p = .009$), and disinhibition subscale of soft signs ($r = .26, p = .021$). When the group was further divided into two sub-groups by taking the lower and upper quartiles of their blink rate, i.e., intensive blinker (>75 th %ile; $n = 23$) and rare blinker (<25 th %ile; $n = 23$), intense blinkers exhibited significantly more disinhibition signs than rare blinkers ($z = 2.224, p = .026$). There was also a trend for the intense blinkers to commit more error in a sustained attention task ($p < .1$, effect size = .38). These findings suggest that blink rate is associated with disinhibition signs among chronic schizophrenia.

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S. LANGENECKER, E. TURKEL, J. BATES, J. KANE, D. ROBINSON, & R. BILDER. Competing Motor Programs: Validity, Reliability, and Use With Schizophrenia.

One promising category of neuropsychological tests for determining and characterizing the underlying pathology in the frontal lobes has been called motoric regulation, a subdivision of executive functions. Existing measures of executive functioning are often hampered by the possibility of multifactorial interpretations of failed performance, difficult to understand instructions, and poor detection of frontal lobe pathology. As such, a task modeled after the Motor Sequences Test of Luria has been created for computer administration. To demonstrate the efficacy of the competing motor programs test (CMP), we examined the patterns of performance in first episode schizophrenia (FES) patients (acute and stable) at different

stages of treatment and recovery and compared their performance with that of healthy control subjects with up to eight serial examinations. We also examined improvement in CMP performance in relation to initial status and change with treatment and the relationship of neuropsychological measures to key behavioral indices of CMP variables at initial exam. Significant differences were evident between FES patients and controls in accuracy, number of trials to criterion, failure to attend to negative feedback, and reaction time for opposite trials at initial test. All groups demonstrated improvement with time. Initial CMP performance accounted for 49% of the variance in endpoint executive functioning after controlling for education. Test-retest reliability coefficients ranged from .45 to .65 and correlations with other executive measures ranged from .18 to .54, with 18 of the 20 correlations significant after controlling for initial patient status. Correspondence: Scott Langenecker, 1500 E. Medical Center Drive, Taubman Center, Room F3955, Ann Arbor, MI 48109. E-mail: slangen@umich.edu

I. TORRES, D. O'LEARY, & N. ANDREASEN. Symptoms and Interference Effects in Schizophrenia.

The present study was undertaken to test Frith's model which states that specific symptoms of schizophrenia result from diminished capacity to regulate willed (goal-directed) and stimulus-driven action systems. A total of 107 patients were administered the RAVLT, a task that on interference trials requires individuals to recall target material while suppressing non-target distracting stimuli from memory. Symptom ratings were obtained using Andreasen's SANS/SAPS. Based on the model, it was predicted that negative symptoms would result in diminished recall, reflecting compromised activation of the willed action system. It was also predicted that disorganized symptoms would be associated with heightened interference susceptibility resulting from diminished ability to suppress the stimulus-driven action system. Results indicated that diminished recall was related to negative ($r = -.25, p < .05$), but not disorganized or positive symptoms. Symptom ratings were also evaluated in a subset of patients with intrusion error data ($n = 38$). In this subset, it was found that patients who committed intrusion errors on the interference trials evidenced more disorganized, but not negative or positive symptoms, than individuals failing to commit such errors ($t = 2.1, p < .05$). These findings provide support for Frith's hypothesis that impaired regulation of action systems can explain some of the specific symptoms of this illness.

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A. SIM, J. PEER, A.J. RITCHIE, & W. SPAULDING. The Rey-Osterrieth and RBANS Complex Figure Tasks: A Systematic Comparison.

The present study investigated the equivalency of the RCFT with the complex figure contained within the more recently developed Repeatable Battery for the Assessment of Neuropsychological Functioning (RBANS). The sample consisted of 26 psychiatric inpatients with severe mental illness (primarily schizophrenia spectrum disorders) who were assessed with both the RCFT and the RBANS complex figure tasks. Expanding the findings by Randolph, the present investigation found a significant correlation between both the copy and recall scores of the two measures ($r = .637, p < .001$ and $r = .608, p < .001$, respectively). These results suggest that the RBANS complex figure possesses convergent validity with the RCFT and is a comparable measure of visual memory and visuospatial abilities as the RCFT. Additional analyses revealed, however, that RCFT recall scores had a significant correlation with Trails B scores ($r = -.355, p = .012$) while recall scores from the RBANS complex figure did not yield such a relationship. To the extent that Trails B provides a measure of individuals' information processing abilities, this result suggests that the RCFT may tap into and demand a greater level of executive functioning abilities than the RBANS complex figure. Similarly, analyses found that while the RCFT possessed a significant correlation with Wide Range Achievement Test II-Reading scores ($r = .367, p = .010$), the RBANS complex figure did not possess such a relationship. This result suggests

that the RCFT is more strongly related to intellectual functioning ability than the RBANS complex figure.

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Z. CAMPBELL, D.A. YOUNG, K.K. ZAKZANIS, & E. WEINSTEIN. Measurements of Insight in a Schizophrenic Population: The Relationship Between a Self-Report and an Interview-Based Technique.

We examined the relationship between a researcher-rated and a self-report method of insight assessment in patients with schizophrenia. Previous research has established that a moderate correlation exists between several researcher-rated and self-report insight scales. Hence, we wanted to investigate this association using another combination of assessment techniques. Accordingly, 34 patients with chronic schizophrenia were administered the Scale to Assess Unawareness of Mental Disorder (SUMD) and the Birchwood self-report Insight Scale (IS). We found a significantly lower report of insight on the Birchwood IS, regardless of administration order. These findings suggest that inherent bias within the patient-examiner interaction may be responsible for this discrepancy. A significant, overall positive correlation was observed between scores on the SUMD and the Birchwood self-report IS. Unexpectedly, there was a remarkable difference in correlation with respect to the order of test administration. The “self-report first” group’s scores were strongly correlated; whereas, the “researcher-rated first” group’s scores did not significantly correlate at all. These results demonstrate the importance of investigating the effects of administration order, and question the reliability of other correlational studies between researcher-rated and self-report scales of insight.

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S. BERNS, S. DAVIS-CONWAY, & J. JAEGER. Schizophrenia Case Study: Effectiveness of a New Cognitive Rehab Strategy.

Nonattendance to outpatient psychiatric programs is a widespread problem that has both severe clinical and economic costs. Studies have demonstrated that non-attendance increases rehospitalization and risk of patients harming themselves or others and that non-attendance is related to verbal ability and stability of employment but not psychotic symptoms. We report on a case study utilizing a multiple baseline design to determine whether an electronic assistive device (EAD) could improve the Day Treatment Program attendance of a 25-year-old Haitian man (R.P.) with schizophrenia who demonstrated significant neuropsychological (NP) deficits in executive functioning and memory and severe psychotic symptoms (hallucinations and paranoid delusions). The EAD is an alpha-numeric pager with software that enables prescheduled messages to be sent to the patient. Baseline attendance data was collected for 5 weeks. R.P. was then given an EAD and for 1 month was sent a messages to wake up, to leave for program, and for 80% of his groups (these messages included the group name, location and leader) at the appropriate times. R.P. demonstrated significantly improved attendance for paged groups (baseline average attendance = 41%; experiment average = 68% $t = -4.0, p < .001$) and no improvement for non-paged probe groups (baseline = 18%; experiment average = 29% $t = -.5, p < .70$). This finding suggests that EADs may be a promising neurorehabilitative intervention for increasing treatment adherence in psychiatric populations.

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M. SPITZNAGEL & J. SUHR. Neuropsychological Impairment in Schizotypy: Role of Depressive and Paranoid Symptoms.

Depressive and schizotypal symptoms have long been associated with impaired neuropsychological performance, particularly in executive function and memory. Despite high comorbidity between depression and schizotypy, neuropsychological research frequently ignores or eliminates presence of depression from schizotypal samples. The current study sought to com-

pare neuropsychological performance between depressed and non-depressed schizotypals. It was hypothesized that individuals with symptoms of both schizotypy and depression would display the poorest performance. Eighty-four undergraduate students, screened using the Schizotypal Personality Questionnaire and the Beck Depression Inventory participated. Three groups: depressed schizotypals, non-depressed schizotypals, and a normal control group (non-depressed, non-schizotypal) were compared on a battery containing TMT, WCST, SCWT, COWA, AVLT, DS-coding, and digit span. Contrary to expectations, depressed schizotypals demonstrated better performance on AVLT immediate recall relative to non-depressed schizotypals and normal controls, and better performance on AVLT delayed recall and WCST failures to maintain set compared to non-depressed schizotypals. *Post-hoc* analyses revealed the depressed schizotypal group showed higher endorsement of paranoid/suspicious symptoms of schizotypy than the other groups. This finding is consistent with research findings in neuropsychological performance in paranoid schizophrenics, who demonstrate better performance in comparison to non-paranoid schizophrenics. An important implication of the current findings is that inconsistent findings in neuropsychological research of schizotypy may be due to differences in depression and paranoid symptoms. The current finding supports the idea that schizotypal research methodology would benefit from distinguishing between subtype variations.

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S.C. HEATON, D.V. JESTE, R.K. HEATON, & O. PEDRAZA. Adjusting Neuropsychological Test Performance for Educational Attainment: Impact on the Classification of Adult Schizophrenia Patients and Healthy Controls.

Previous studies have demonstrated that neuropsychological (NP) test performance of healthy individuals is impacted by their demographic characteristics, such as educational attainment. Thus, individuals with higher levels of education perform better on NP tests than those having less education. The use of education-level adjustments in developmentally-based disorders such as schizophrenia has been debated. It has been argued that education corrections should not be made to performance of individuals with schizophrenia since educational attainment may be truncated by the development of psychotic symptoms. We sought to examine the utility of employing NP test norms that corrected for education in 72 schizophrenia patients and 72 healthy controls. Caucasian participants between the ages of 41 and 87 were grouped according to education level (*low*: ≤ 11 , *medium*: 12–14, *high*: ≥ 15 years); these groups were similar in age and gender distributions. Participants were administered a comprehensive NP test battery that assessed 6 cognitive ability areas. Raw scores were transformed using normative data into (1) standard scores that did not adjust for individual education level and (2) standard scores that were education-corrected. Classification rates (NP-impaired vs. NP-normal) across the 3 educational levels were examined for both scoring methods. Results indicated that sensitivity and specificity classification rates using the education-corrected scores were substantially more consistent for both diagnostic groups across the levels of education. Findings support the practice of correcting NP performance for education in patients with schizophrenia.

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S. HILL, M. KESHAVAN, & J. SWEENEY. Neuropsychological Profiles of Psychotic and Unipolar Depression, Schizophrenia, and Healthy Volunteers.

Psychotic depression shares clinical features with both unipolar depression and schizophrenia. However, there is growing clinical, biological, and cognitive evidence distinguishing psychotic and unipolar depression. Clinically, psychotic depression is associated with worse premorbid function, more severe symptoms, longer depressive episodes, poor response to tricyclic medications, and worse prognosis. Neurobiological studies have shown greater structural brain abnormalities, excessive adrenal activity,

and higher cortisol levels in psychotic depression. The present study used an extended neuropsychological battery to compare performance in psychotic depression ($n = 20$) to both unipolar depression ($n = 14$) and schizophrenia ($n = 86$) as well as healthy volunteers ($n = 81$). Groups were matched on age, sex, race, education, SES, and premorbid intellectual skills. Patients were followed clinically for two years to confirm diagnosis. To reduce confounds related to chronic illness, medication or other treatment issues the psychotic depression and schizophrenia groups were assessed after first episode of psychosis but prior to treatment or medication. Unipolar depressed patients were neuroleptic naïve and free of anti-depressant medications for several weeks. Remarkably similar, but less severe, patterns of neuropsychological dysfunction were noted for psychotic depression and schizophrenia. Statistical differences between schizophrenia and psychotic depression were found only for executive function and verbal memory. In contrast, significant profile differences, involving all areas but executive function and attention, were noted for psychotic vs. unipolar depressed patients. These data support the notion of psychotic depression as cognitively distinct from unipolar depression. More importantly, past or present psychosis may parallel a continuum of global neuropsychological dysfunction that includes schizophrenia and psychotic depression.

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J. JAEGER, S. BERNS, & P. CZOBOR. Validation of Neurocognitive Data Reduction Techniques in Schizophrenia.

The use of neuropsychological tests to profile the nature, severity, course, correlates and treatment response of cognitive deficits in schizophrenia has increased steadily. These efforts are significantly challenged by the large number of variables generated and practical difficulties in using statistical data reduction methods to reveal neurocognitively meaningful constructs. Most commonly, cognitive domain subscales are defined by experts "a priori," and individual measures are combined into subscales corresponding to these domains. However the cognitive domains traditionally used derive from delineations validated in focal brain-injured patients, but not necessarily in schizophrenia. In practice, the component tests within each subdomain are arbitrarily selected. Even where validated through psychometric analysis, this validity may not generalize to different samples or within the same sample over time, since covariance matrices may differ. One solution is illustrated in 156 schizophrenia/schizoaffective subjects tested within 6 months of hospital discharge and again after 6 ($N = 143$) and 18 months ($N = 122$). Variables from related "a priori" domains were combined and submitted to principal components analysis. Extracted factor constituents were validated using Cronbach's alpha and item-total correlation thresholds. PCA's were repeated at successive time-points and coefficients of congruence were computed. Five factors were reliable and stable longitudinally: Attention, Working Memory, Learning, Verbal Knowledge, Non-Verbal Functions, Ideational Fluency. Commonly used tests that could not be reliably grouped within these factors were WCST, Grooved Pegboard, Finger Tapping, Stroop and Trailmaking. No separate factor for Short-Term memory was found and non-verbal learning measures loaded with other visual-spatial but not other memory measures.

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M. MATSUI, K. KATO, H. YUUKI, E. YONEYAMA, & M. KURA-CHI. Neuropsychological Profile in Schizophrenia and Schizotypal Personality Disorder.

Neuropsychological impairments have reported consistently in patients with schizophrenia. Schizotypal personality disorder (SPD) subjects do not have many of the confounds seen in patients with schizophrenia, but may have the same pattern of neuropsychological impairment. We investigated the neuropsychological profile in SPD patients as compared to schizophrenic patients. Participants were 15 SPD patients (10 men and 5 women) and 15 patients with schizophrenia (10 men and 5 women) ful-

filled the ICD-10 diagnostic criteria. All participants were administered the Wechsler Adult Intelligence Scale-Revised (WAIS-R), the Wechsler Memory Scale-Revised (WMS-R), the Wisconsin Card Sorting Test (WCST) and the Words Memory test. The results showed almost performance in SPD patients to be intermediate between that of schizophrenic patients and normal subjects. SPD patients demonstrated the same impaired performance on verbal memory and the WCST (errors) as patients with schizophrenia. Impairment of memory organization was remarkable in patients with schizophrenia, while its variance was large in SPD patients. Schizophrenic patients were impaired in arithmetic of the WAIS-R, back digit span of the WMS-R and the number of categories completed of the WCST when compared to SPD patients. In conclusion, SPD patients demonstrate modest cognitive impairment compared to schizophrenic patients. These differences reached statistical significance for some scores suggesting preservation of frontal function to some degree in SPD patients. In contrast, there was no significant difference of memory impairment suggesting temporal lobe dysfunction. As a whole, the pattern of deficits in SPD patients is qualitatively similar to but milder than those seen in patients with schizophrenia.

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J. WOZNIAK, K. DALY, D. KOEHLER, & S. SCHULZ. Cognitive Function During the 1st Year of Adolescent-Onset Psychotic Disorders.

Previous research shows that adolescent-onset psychotic disorders are associated with greater cognitive impairment than adult-onset conditions. Greater impairment in intellectual functioning, memory, and executive function have been reported. However, findings from studies comparing adult patients with adult-onset vs. adult patients who had adolescent-onset are potentially confounded with effects of duration of illness. Therefore, it is critical to study cognitive functioning in adolescent patients. Longitudinal studies of cognitive functioning over the course of adolescent-onset illness will help determine whether it is a more severe form or whether longer duration of illness contributes to greater impairment by adulthood. Initial findings from a study examining specific cognitive functions in adolescents with psychotic disorders are presented. Thus far, 10 subjects (8 male, 2 female), ages 12 to 17, with diagnoses of Schizophrenia, Schizoaffective Disorder, and Bipolar Affective Disorder with psychotic features have been studied. Subjects were tested near onset of psychosis and at 6 and 12 months. Most subjects were on antipsychotic medications. At initial testing, subjects scored significantly below normative range on measures of processing speed, working memory, cognitive flexibility, and verbal learning/memory. Overall, subjects' IQs were intact (M full-scale = 96). Measures of inhibitory control revealed no deficits. No significant performance decline was seen at 6 or 12 months. Rather, stability and mild improvement was seen on most tests. This coincided with a mild improvement in symptoms over this period as measured by the PANSS. Results replicate earlier findings of specific neurocognitive deficits in adolescents and suggest a possible relationship between symptom severity and level of measured deficit.

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N. OJEDA, P. SÁNCHEZ, E. ELIZAGÁRATE, T. EZCURRA, E. IBARROLA, M.A. BERMEJO, & M. ARGEMI. Neuropsychological and Neuropsychiatric Profile of Treatment-Resistant Patients with Schizophrenia.

The results of this study present preliminary data in 70 treatment-resistant patients with schizophrenia compared to nonresistant Sz patients and controls. The sample of patients met schizophrenia criteria based on both DSM-IV and CIE-10. Refractory condition was established according to Kane. Cognitive assessment included several tests of attention/concentration, verbal, visual and working memory, language, executive functions, motor abilities, AVDs, and general intellectual capacity. The neuropsychiatric profile was obtained from the clinical interview, and the administration of 7 clinical scales, including PANNS, BPRS, DAS-WHO,

GAF-EEAG, Mania Young Scale, Insight Evaluation–David, social pre-morbid adjustment (Cannon-Sporer), substance abuse (Likert Scale), and CGI. Differences in performance among groups are analyzed and implications for treatment and cognitive intervention suggested.

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E.-M. LØBERG, H.A. JØRGENSEN, & K. HUGDAHL. The Effects of Previous Drug Use on Neurocognition in Schizophrenia.

Introduction: A history of drug use, especially cannabis, is often seen in schizophrenic patients. This may confound both research and clinical findings regarding neurocognition in schizophrenia. *Method:* To test this, neurocognitive test performance of 29 schizophrenic patients with and without a history of drug use were compared. A comprehensive clinical neuropsychological test battery, including several experimental cognitive tests, was used. The history of drug use was taken both from the patient's records and from a therapist questionnaire, and was also validated through SCID interviews. Of the 13 patients with previous drug use, all had a history of cannabis use, while 8 also had a history of additional drug use. Patients with a history of substance abuse within the past six months were excluded. *Results:* The patients with previous drug use performed better than the patients without previous drug use on several neurocognitive functions, including general adaptive abilities, executive functions, attention, working memory and psychomotor speed. This effect was reinforced when examining only the patients with additional drug use. *Conclusion:* Previous drug use should be considered when examining schizophrenia neurocognition. Alternative hypothesis may explain the better performance of the patients with previous drug use (1) the drug use indicates a better social and general functioning level necessary to obtain drugs; (2) the drug use has had a self medicating effect; calming anxiety and functional decline; (3) the drug use has turned vulnerable individuals psychotic before they entered the usual period of neurocognitive deterioration often seen before psychotic onset.

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M. GAROLERA, E. HUGUÉ, B.M. PARDO, N. ARAGAY, M. ENRÍQUEZ, G. GARRIDO, A. PRATS, V. VALLÈS, L. DELGADO, & J. ALBERNI. Relationship Between Educational Level and Neuropsychological Profile in Patients With Schizophrenia.

Several studies on cognitive impairment in schizophrenic patients suggest that it is linked with developmental difficulties. One indirect measure of premorbid cognitive dysfunction is efficiency in school. *Objective:* The aim of the present study is to explore the relationship between educational level and performance in neuropsychological tests of patients with schizophrenia. *Method:* Forty-seven subjects with schizophrenia (32 males, 15 females; *M* age 29, 29 ± 7.03 ; *M* educational attainment 9.98 ± 2.92 years) were assessed with several neuropsychological tests (general intelligence, memory, attention and executive functions). The measure of educational level was dichotomized in low level (<12 years of education) and high level (>11 years). *T* tests between groups (low vs. high level) were performed for neuropsychological variables. *Results:* We found significant differences between groups for vocabulary ($p = .001$), letters and numbers ($p = .047$), and semantic fluency ($p = .03$) tests. *Conclusion:* Our results suggest only a few neuropsychological domains being related to education. We conclude that educational level is a poor measure to determine compromised cognitive dysfunction in schizophrenic patients. Correspondence: *Maitte Garolera, Hospital de Terrassa, Servei de Psiquiatria, Ctra. Torrebónica s/n, 08227 Terrassa, Spain. E-mail: cepsicologa@csdt.es*

S. BERNS, S. DAVIS-CONWAY, & J. JAEGER. Reliability of Telephone Administration of Neuropsychological Tests.

The recent compelling findings of neuropsychological (NP) correlates of disability in schizophrenia has led to increased use of NP assessment in

studies of longitudinal course, outcome, and intervention efficacy. However, these studies are hampered by the fact that standardized NP tests must be administered in person, which can be expensive and burdensome to the patient. This may cause sampling bias as some patients may be unwilling/unable to travel to the testing site. Also, researchers may choose to use samples of convenience or less frequent followup assessments restricting generalizability of results. This study explores whether selected NP tests could be reliably administered by telephone. While studies of healthy elderly and Alzheimer's subjects support the reliability of telephone NP testing, it has not been studied in psychiatric populations. Forty-four subjects with schizophrenia were administered NP tests selected for their adaptability to telephone administration (California Verbal Learning, Letter Number Span, Digit Span, Controlled Oral Word Association) both in-person and over the telephone approximately 1 month apart, using alternate forms. Subjects were counterbalanced by test form (alternate or original first) and administration order (telephone/in-person first). Multivariate analysis of variance revealed no significant effect of administration order, test form for any NP test, and administration type (telephone/in person) for tests of working memory, semantic fluency and short delay free recall. However, there were differences between telephone and in-person administration on measures of phonemic fluency and immediate attention/recall. Results suggest telephone assessment of selected NP domains can be a valuable option allowing more frequent assessment than currently feasible.

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IMAGING IN TBI

T. VERAMONTI, H. HANNAY, C. CONTANT, & C. ROBERTSON. Prediction of Morbidity Following TBI by Acute Cerebral Blood Flow Measurement.

Changes in cerebral blood flow (CBF) following traumatic brain injury (TBI) may result in an increased risk of further brain damage and worsening of neurologic outcome. Numerous investigations have demonstrated that CBF decreases to levels substantially below normal following TBI and that reduced CBF in the initial hours following injury is strongly predictive of poor global outcome (i.e., death or persistent vegetative state) as measured by the Glasgow Outcome Scale (GOS). However, the association between reduced CBF and morbidity in surviving patients has received little attention. In the present study Xenon-CT CBF measurements were made in 72 severe TBI patients within 24 h of injury. Outcome was measured at discharge and 6 months post-injury using the Disability Rating Scale (DRS). CBF was significantly lower in those patients who died and reduced CBF was associated with increased mortality. To investigate the relationship between CBF and morbidity following TBI, hierarchical regression models were employed, excluding those patients who died from the analyses. Age and Glasgow Coma Scale (GCS) score were entered into the restricted model and accounted for a significant proportion of the variance (14–17%) at each time point. Average CBF accounted for an additional 8–12% of the variance, depending on outcome time point. These findings highlight the importance of acute care variables in the prediction of mortality as well as quality of recovery in patients who survive.

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S. DIKMEN, J. MACHAMER, & N. TEMKIN. Mild TBI With and Without CT Abnormalities.

Objective: Investigate contribution of CT abnormalities to outcome in TBI subjects with GCS 13 to 15. *Design:* Observational cohort. *Setting:* Level I Trauma Center. *Methods:* 178 adult TBI subjects with GCS 13 to 15; 140 cases without and 38 cases with CT abnormalities. These 2 subgroups were compared with 120 general trauma controls on neurobehavioral measures at 1 and 12 months after injury. The TBI and general trauma controls

were non-select cases that were prospectively studied. **Results:** TBI cases with positive CT had more severe brain injuries on other measures of impaired consciousness. At 1 month after injury the CT positive group was significantly more impaired than the trauma control and CT negative groups on all four measures of neuropsychological functioning. At 1 year differences between the TBI groups disappeared but there continued to be greater impairment in the CT positive group compared to trauma controls on a measure of memory. TBI cases regardless of CT findings reported significantly more post traumatic symptoms than trauma controls at 1 and 12 months post injury. **Conclusions:** CT abnormalities in those with GCS of 13 to 15 carry higher risk of impairments especially early after injury but perhaps less than implied by earlier studies. Despite mild injury measured by depth of impaired consciousness, such cases typically have more severe injury implied by length of unconsciousness. The contribution of anatomic lesions versus impaired consciousness to outcome and their implications for classification of injury severity is a topic that needs to be pursued further.

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M.A. COLE, S.K. LAGEMAN, N.K. DIXIT, & W.M. PERLSTEIN. An Event-Related fMRI Analysis of Working Memory in Traumatic Brain Injury.

Patients with traumatic brain injury (TBI) show impaired performance and altered brain activity while performing working memory (WM) demanding tasks. We examined WM-related brain activity in mild (mTBI; $n = 3$) and severe (sTBI; $n = 4$) patients using fMRI while they performed a long-delay version of the "n-back" task (0- to 3-back loads). A 10-s SOA and event-related fMRI acquisition facilitated examination of the temporal dynamics of activity during the course of trials. Functional images were acquired at 3T using a 2-spiral RF pulse sequence (TR = 1250 ms/spiral, TE = 18 ms, FA = 65°, FOV = 20 cm, 23 oblique axial slices, 3.2 mm³ voxels). fMRI data were analyzed following movement correction, mean normalization, linear detrending, 3D smoothing and cross-subject registration using voxel-wise Group \times Load ANOVAs (threshold $p < .01$, 8 contiguous voxels). Contrasts sensitive to activity changes over the course of trials were also conducted. Behaviorally, sTBI performed worse than mTBI, particularly at higher load level (d' ; Group \times Load interaction, $p < .04$). fMRI load main effects generally replicated our previous findings, showing increased activity as a function of increasing WM load. The Group \times Load interaction revealed activation dysfunction in sTBI in regions of dlPFC, Broca's area and parietal cortex. Broca's activity showed a pattern of load- and time-sensitive activity suggestive of ineffective rehearsal strategies in sTBI patients. Neither areas associated with visual encoding or response-related processes differentiated the groups, indicating that WM-related activation differences do not simply reflect generalized inability to activate cortex. Comparisons with non-brain-injured controls will also be reported.

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A.B. FROL, R. DIAZ-ARRASTIA, M. CARLILE, K. KOWALSKE, A. HUDAK, K. THOMAS, & Z. YETKIN. Traumatic Brain Injury and Driving: Neuropsychological and fMRI Findings.

Suitability for driving is an important quality of life issue for survivors of traumatic brain injury (TBI). These determinations are best made by a thorough multidimensional assessment addressing medical, cognitive, visual, motor, and psychiatric considerations. Neuropsychological findings, particularly speed of information processing, complex attention, and decision-making, have important implications for driving performance. Functional magnetic resonance imaging (fMRI) has emerged as a complementary examination of brain function that may also help identify good driving candidates. Individuals recovering from head injuries were compared at least 3 months post injury on a neuropsychological battery and fMRI tasks involving spatial working memory and decision-making. Two

subjects judged by rehabilitation clinicians to have different driving potential had similar findings on neuropsychological assessment of attention and speed of information processing. However, fMRI revealed differential activation of frontal and parietal regions while performing working memory tasks. Further examination of the usefulness of fMRI for driving potential is warranted in this population.

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L.S. SUSSKIND-WILDER, L.C. BAXTER, N.E. ROUNDY, N.E. SAM-PATACOS, S. KRONE, & S.J. JOHNSON. Severity of TBI Is Associated With Medial Frontal fMRI Activation During Self-Reflection.

Deficits in accurate self-awareness as defined by ability to self-reflect on one's strengths and limitations may be among the most potentially compromising sequelae of traumatic brain injury (TBI) in terms of ability to adjust to post-injury life. Using fMRI, we previously found anterior medial prefrontal cortex (AMPFC) activation during a self-reflection task in normal individuals. We hypothesized that in injured patients, there would be a correlation between injury severity (as measured by Glasgow Coma scores; GCS) and the magnitude of brain activity in the AMPFC. Nine TBI patients and 2 patients with non-CNS related injuries were scanned at 2–3 months post-injury while making 'yes/no' responses to aurally-presented statements involving either self-reflection on abilities, traits and attitudes (experimental condition) or basic semantic knowledge (control condition). Individual analyses of brain activity associated with self-reflection were entered into a second level analysis correlating brain activity with each individual's immediate post-injury GCS. A significant relationship ($r = 0.90$) was observed in the AMPFC (Talairach coordinates 2, 10, 62; $T = 4.61$, $p < .001$) reflecting greater activation with higher GCS. The fMRI response associated with self-reflection may be a useful tool in the detection of TBI-related AMPFC dysfunction that may interfere with treatment planning and compromise behavioral outcome.

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F. HILLARY, G. LANGE, J. STEFFENER, H. GIANGRANTE, W. LIU, J.H. RICKER, & J. DeLUCA. Analysis of Working Memory Following Moderate and Severe TBI Using fMRI.

Prior literature has established that individuals with traumatic brain injury (TBI) experience deficits in working memory. The present pilot study examined brain activation patterns on a working memory (WM) task in individuals with moderate and severe TBI compared to healthy controls (HCs). Functional magnetic resonance imaging (fMRI) was performed using a 1.5 Tesla GE scanner during a modified Paced Auditory Serial Addition Test and a control task of auditory attention across three trials. Data have been collected for 5 individuals with TBI and 3 HCs. In this block-design, data were analyzed using Statistical Parametric Mapping (SPM99) software, with a stringent significance level ($\alpha < .001$, voxel extent 8). Preliminary results indicate that most participants with TBI (4/5) showed bilateral, but greater right hemisphere activation, whereas 2/3 HCs showed more left hemisphere activation. When analyzing the frontal lobes in isolation, 4/5 individuals with TBI exhibited extensive bilateral frontal activation or greater right frontal activation. In contrast, all 3 HCs exhibited greater left than right frontal activation. The 1 individual with TBI that showed greater left hemisphere activation had undergone a partial right frontal lobectomy. These findings are consistent with prior studies in TBI and fMRI. Additionally, this pattern of brain activation has been observed in other clinical samples, healthy adults who have been sleep deprived, and the elderly. Thus, right prefrontal cortex recruitment may be a general response to diminished cerebral resources, but in cases of very severe TBI, lesion size and location may influence the pattern of brain recruitment.

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K. DAHLMAN, M. SEWELL, J. SCHMEIDLER, & R. MOHS. Clinical Dementia Rating: Sum of Boxes Supplements CDR Total Score.

Objective: Can future cognitive decline be predicted using Clinical Dementia Rating (CDR), and if so, how? *Method:* Two hundred six nursing home or assisted living residents (M age = 85.7, SD = 8.0, 78% female), classified as non-demented (CDR Total = 0) or questionably demented (CDR Total = 0.5), were followed for an average of 2.6 years. The end point was the first visit with CDR total higher than baseline, or the last visit if there was no cognitive decline. Decline status was predicted, using the six CDR domains and the Sum of Boxes, at the visit 12 months (or longer) before the end point. *Results:* Thirty-eight percent of 98 nondemented, and 57% of 108 questionably demented, declined. Sum of Boxes predicted decline in both nondemented ($t = 2.07$, $df = 69.8$, $p = .043$) and questionably demented ($t = 2.57$, $df = 94.1$, $p = .012$) groups. Cut-offs best predicting decline were ≥ 0.5 for nondemented, and ≥ 1.5 for questionably demented. Orientation also predicted decline in the questionably-demented ($t = 2.29$, $df = 95.4$, $p = .024$). Logistic regression, using all domain scores as predictors, was not significant in either group. In a stepwise logistic regression for the questionably-demented, CDR Total did not predict decline ($\chi^2 = 2.20$, $df = 1$, $p = .138$) but Sum of Boxes contributed additional information beyond the CDR Total ($\chi^2 = 4.67$, $df = 1$, $p = .031$). *Conclusion:* Sum of Boxes may be associated with subsequent change in CDR Total Score.

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Paper Session 2/8:45–10:30 a.m.

INSIGHTS INTO ALZHEIMER'S DISEASE

J. CAOILE, G. ARNOLD, J.G. BUCKWALTER, & S. MCPHERSON. Theory of Mind, Empathy, and Insight in Alzheimer's Disease.

Theory of mind (ToM), the ability of an individual to attribute independent mental states to others, may have implications for some of the behavioral and cognitive deficits observed in persons with Alzheimer's disease (AD). This study examined the associations between insight into one's behavior and deficits, ability to attribute mental states to others (ToM), and capacity to empathize with others. Because ToM does not appear to decline with age, it is an appropriate measure for use in assessing disorders of the aged, such as dementia. Seventeen AD patients and 18 healthy older adults were administered the Theory of Mind Stories, Balanced Emotional Empathy Scale, and the Assessment of Impaired Insight. As predicted, the AD participants showed significant deficits in ToM abilities when compared to the normal group [$F(1,34) = 10.66$, $p < .003$]. The AD patients also showed a lack of insight into their impairments when compared to the control group [$F(1,34) = 6.02$, $p < .020$]. There were no significant differences in scores on the empathy measure between the two groups, and there were no correlations between the three measures when computed across groups. These findings suggest that in addition to a lack of insight, acquired deficits in ToM may explain some of the social and behavioral deficits in AD patients.

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J.C. ADAIR, S.L. RUIZ, J.G. QUINTANA, & J.E. KNOEFEL. Do Vascular Factors Modify Treatment Response in Alzheimer's Disease?

Objective: Cerebrovascular injury likely contributes to dementia in patients with Alzheimer's disease (AD). Do such patients respond differently to treatment compared to patients with "pure" AD? *Methods:* Patients ($n = 46$) who met NINCDS criteria for probable AD were examined before and after 3–4 months of treatment with donepezil (5 mg/d). Patients were divided into "low" or "high" vascular risk based on Hachinski Ischemic Scale (HIS) score or a semiquantitative rating of white matter (WM) signal abnormalities on T2-weighted MRI scans. Patients with clinical

history of stroke, HIS > 5, or cortical infarct on scans were excluded. The brief cognitive battery included the MiniMental State Exam (MMSE), category fluency (CAT), modified Boston Naming Test (BNT) and the Hopkins Verbal Learning Test/immediate recall (HVLIT). Repeat measures ANOVA examined differential response through Treatment \times Group intervention. *Results:* Treatment failed to significantly alter MMSE, BNT or HVLIT scores in either HIS group, though patients in the low HIS group increased CAT scores compared to the high-risk group ($p = .001$). Similar results for MMSE and BNT were obtained when defining vascular risk with MRI. No differential CAT performance was observed between WM groups. In contrast, treatment improved HVLIT scores in patients with no WM abnormality ($p = .014$). *Conclusions:* Patients with isolated AD may accrue more benefit from cholinesterase inhibition than those with mixed vascular and degenerative pathology.

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A. J. SAYKIN, H.A. WISHART, L.A. FLASHMAN, R.B. SANTULLI, C. J. BROWN, L.C. BAXTER, J.S. RAMIREZ, T.L. MCHUGH, & A.C. MAMOURIAN. Gray Matter Reduction in MCI and in Older Adults With Cognitive Complaints.

Significant gray matter (GM) loss occurs in Mild Cognitive Impairment (MCI) and to a greater extent in Alzheimer's disease (AD). Medial temporal lobe (MTL) structures are particularly vulnerable. In MCI, extent of gray matter reduction in MTL predicts progression to AD. Recently, it has been demonstrated that healthy, non-depressed older adults with cognitive complaints are also at increased risk for AD. The aim of the present study was to use voxel-based morphometry to replicate prior findings of GM loss in MCI relative to healthy controls, and to determine whether older adults with cognitive complaints demonstrate GM loss. In this preliminary study, we assessed GM density in demographically equivalent samples of individuals with MCI ($n = 17$), nondepressed older adults with cognitive complaints ($n = 10$), and healthy controls ($n = 11$). Structural MRI scans, including a T1 SPGR 1.5 mm coronal volume and an axial T2 series (to rule out structural lesions), were acquired on a GE 1.5T LX scanner. We assessed GM density using voxel-based morphometry procedures as described by Ashburner & Friston. SPGR volumes were spatially normalized, segmented, smoothed (FWHM = 10), and compared using SPM99. The healthy controls showed greater GM density than either of the other two groups, especially in MTL (all $p < .01$, $k = 3$). MCI patients differed only slightly from neuropsychologically intact participants with cognitive complaints. Voxel-based morphometry and other neuroimaging techniques have the potential to clarify the neural substrates of cognitive complaints in older adults at risk for AD, and to improve early detection and diagnosis of MCI and AD.

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J. RISBERG, L. GUSTAFSON, A. BRUN, E. ENGLUND, & E. RYDING. Posterior Cingulate Cortex in Familial Alzheimer's Disease: A Clinicopathological and Brain Imaging Study.

The degenerative process in Alzheimer's disease (AD) follows a temporal and topographic pattern of early and accentuated involvement of temporal limbic, parietal and posterior cingulate cortices. This is contrary to the degenerative pattern in frontotemporal dementia notably including the cingulate cortex. We have studied a pedigree with four generations suffering from early onset AD linked to a presenilin-1 gene mutation. This family now contains 7 AD cases, neuropathologically confirmed in four cases of three generations. In all four cases the degeneration was most pronounced in the temporoparietal cortex, but also engaged central grey structures such as the claustrum, central thalamic and brain stem nuclei. There was a consistent and severe degeneration in posterior cingulate cortex in contrast to a comparatively spared anterior cingulum. All cases showed a typical temporoparietal symptom pattern and other core clinical features of AD. Other predominant features were increased muscular ten-

sion, stiff stooped gait, rapid loss of weight and a remarkably well-preserved insight. Regional cerebral blood flow (rCBF) was studied repeatedly with 133-xenon inhalation and SPECT methods. The rCBF measurements showed the typical cortical pathology of AD with bilateral decreases in temporoparietal and posterior cingulate cortices, accentuating over time and spreading anteriorly. There was a very good correspondence between clinical, neuroimaging and neuropathological features. Our findings indicate that posterior cingulum is a major locus for functional and structural vulnerability in both familial and sporadic forms of AD, something that might be used for diagnostic purposes together with possible posterior cingulate symptomatology.

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R. AU, A. MCKEE, A. BEISER, M. YOUNG, R. D'AGOSTINO, & P. WOLF. Neocortical Neurofibrillary Changes Associated With Memory Function in the Framingham Study.

Neurofibrillary tangle (NFT) burden appears to be a key neuropathological correlate of memory function in Alzheimer's disease (AD), but whether this holds true for those deemed cognitively normal is less certain. We examined 12 brains of subjects whose cognitive status was documented within 2 years prior to death to determine whether NFT total and regional counts were associated with memory performance. Three men and 9 women from the community-based Framingham Study were administered a neuropsychological test battery. Their average age was 87.5 years (range 67–98) and 50% were college graduates. Of the 9 subjects with known ApoE status, only 1 was ApoE4. Determination of diagnosis at the time of death was made by a review team of neuropsychologists and neurologists, blinded to neuropathological findings. Two subjects were given a clinical diagnosis of probable AD and 2 with vascular dementia. Crude correlations and linear regression, adjusted for age, gender, and education, found that NFT burden for neocortical regions (inferior parietal, middle frontal and superior temporal) were inversely related to performance in verbal and visual memory ($p < .005$ and $p < .039$, respectively) for all subjects. The negative relationship between neocortical NFT and visual memory ($p < .009$) persisted even after removing subjects with dementia. Unlike other studies, we did not find a similar relationship for a NFT summary measure of hippocampus, entorhinal cortex and amygdala. Although based on a small number of subjects, our results suggest that neocortical NFT burden alone may be a significant neuropathological measure linked to memory function, even in non-demented individuals.

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Symposium 4/8:45–10:30 a.m.

**STRUCTURE–FUNCTION RELATIONSHIPS
IN CHILDREN WITH SPINA BIFIDA**

Organizer and Chair: Jack Fletcher

J. FLETCHER. Structure–Function Relationships in Children With Spina Bifida.

Spina bifida meningocele (SBMM) is the most common severely disabling birth defect in North America, occurring in 0.5–1:1,000 live births. Despite congenital defects at the level of spine and brain, most children with SBMM are not mentally deficient and show interesting variations in neurobehavioral outcomes. Recent studies of a large cohort of children and families with SBMM show that variability is due to genetic factors, level of spinal defect, CNS malformations involving the cerebellum and corpus callosum, hydrocephalus, and environmental factors in the early development of children with SBMM. This symposium summarizes recent research on each of these factors, showing relationships of level of spinal defect, genetic factors, CNS factors, and early development with

neurobehavioral outcomes. The discussion emphasizes the value of multidisciplinary approaches involving genetics, neuroimaging, and neuropsychology to the investigation of the development of children with early brain injury. Implications for the understanding of neural plasticity in children with significant early insults to the CNS and for behavior–brain relationships are also addressed.

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S. LANDRY, L. LOMAX-BREAM, & M. BARNES. The Importance of Early Motor and Visual Functioning for Later Cognitive Skills in Preschoolers With and Without Spina Bifida.

Little is known about the neurobehavioral development of children with spina bifida meningocele (SBM) across the first three years of life. As part of a larger study, this report evaluates the role of early motor quality and visual processing relative to later child performance on a standardized, cognitive assessment (BSID–II) in children with and without SBM. 159 (51% with SBM; 48% male) infants were recruited at 6 months of age across sites in Houston and Toronto and evaluated in laboratory settings at 6, 12, 18, 26, and 36 months of age. The ethnic and socio-economic compositions of the samples accurately reflect the local population of the study sites. General linear procedures demonstrated significant differences between infants with SBM and the NC group for early motor quality ($p < .02$), motor contingency learning ($p < .003$), attention shifting ($p < .05$), and visual information processing ($p < .02$). Differences in children's level of language skills across the first three years were predicted by socioeconomic status (SES) and early motor quality while slower rates of growth were predicted by the presence of SBM and lower SES (all p values $< .02$). Similar relations were found for cognitive growth using the BSID–II with less optimal early motor quality, SBM, and lower SES predicting a greater degree of leveling off in growth by 3 years of age. Significant relations between early visual habituation and motor contingency learning with later BSID–II were also found. These results suggest that early motor functioning and visual processing skills predict cognitive development regardless of the presence of SBM. Therefore, these skills may represent a particularly important foundation for later cognitive ability. Correspondence: *S. Landry, Department of Pediatrics, University of Texas-Houston, 7000 Fannin, Houston, TX 77030. E-mail: Susan.Landry@uth.tmc.edu*

J. FLETCHER, H. NORTHRUP, A. BOUDOUSQUIE, I. TOWNSEND, S. INWOOD, D. FRANCIS, K. COPELAND, & M. DENNIS. Genotype–Phenotype Relationships in Children With Spina Bifida.

The genetic basis for spina bifida meningocele (SBMM), the most common severely disabling birth defect in North America, is not well-established. Recent studies of 1,398 offspring, mothers, and fathers by our research program have identified genetic associations involving the 5, 10 methylenetetrahydrofolate reductase variants (MTHFR C677T and A1298C) in the folate metabolism pathway as a marker more prevalent in Hispanic mothers and their offspring. These variants were significantly more common in Hispanic children with upper level spinal defects, suggesting that heritability varies by ethnicity and level of spinal defect. An examination of neuropsychological and MRI data in relation to ethnicity and level of spinal defect was consistent with these findings. Children with upper level defects had significantly lower motor, perceptual-motor, and intellectual functions relative to children with lower level defects. The sample ($N = 242$) did not show the expected lower performance on nonverbal relative to verbal IQ scores. However, children who were White with lower level defects were most likely to show the expected pattern, while children who were Hispanic with upper level defects were least likely to show the discrepant pattern, displaying low scores on both verbal and nonverbal IQ measures. Children who were Hispanic were also more likely to have upper level spinal defects; in the Hispanics with upper level defects, agenesis of the splenium was also significantly more common relative to other ethnicity/spinal defect subgroups. These results demonstrate the value of

multi-disciplinary approaches involving genetic, neuroimaging, and neuropsychological studies of a common cohort of children.

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M. BRANDT, J. FREDERICK, T. IBRIKCI, L. KRAMER, K. DAVIDSON, & J. FLETCHER. Estimation of Brain Tissue Volumes From Magnetic Resonance Scans in Spina Bifida.

Children with spina bifida meningocele have significantly dysmorphic brains due to congenital malformations and hydrocephalus. Brain tissue volumetry from MRI scans was performed on a group of 81 children with SBMM and 22 neurologically normal children. The brain was subdivided by hemisphere and region (precallosal, pericallosal, and retrocallosal) for tissue segmentation analysis. The analysis was performed by a semi-automated procedure that included clustering by a modified fuzzy c-means solution developed specifically for brains that were grossly dysmorphic such as those characteristic of children with SBMM. A Group \times Hemisphere \times Region \times Tissue MANOVA revealed a significant 4-way interaction ($p < .02$). Follow-up analyses revealed that in the SBMM group, increased cerebrospinal fluid (CSF) volumes were found in the posterior (postcallosal) and midline (pericallosal) regions in both hemispheres, but not anterior (precallosal) regions. There were corresponding reductions in both gray and white matter volumes in postcallosal and pericallosal regions. This distribution occurred on the expected posterior-anterior axis with more CSF and greater thinning posteriorly within the group with SBMM, measures of fine motor and memory skills correlated significantly with increased CSF in these regions as well as with an index of the degree of posterior-anterior thinning of the brain. Measures of language skills did not correlate with these volumetric measures. These results parallel animal studies showing that hydrocephalus is associated with loss of white matter and gray matter. The amount of loss is related to the degree of fine motor and memory deficits commonly observed in children with SBMM.

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N. JAIN, H. HANNAY, L. KRAMER, S. BLASER, & J. FLETCHER. Is Visual Interhemispheric Transfer via the Anterior Commissure When the Splenium Is Missing?

An enlarged anterior commissure (AC) has been proposed as a compensatory mechanism for the interhemispheric transfer of visual information when the splenium of the corpus callosum is missing in children with congenital neurodevelopmental disorders such as spina bifida meningocele (SBMM). The relationship between the state of the splenium and the state of the AC was investigated with MRI scans of 164 children with SBMM. Among these children, 15% ($n = 25$) had an intact splenium, 52% ($n = 86$) had a hypoplastic splenium, and 32% ($n = 53$) were missing the splenium. Only 4% ($n = 6$) had an enlarged AC, 64% ($n = 105$) had an intact AC, 27% ($n = 45$) had a hypoplastic AC, and the AC was absent in 5% ($n = 8$). Just 4% ($n = 2$) of the children with an absent splenium had an enlarged AC whereas 36% ($n = 19$) had a hypoplastic AC. The AC was normal for 49% ($n = 26$) and missing for 11% ($n = 6$) of the children with a missing splenium. Contrary to speculation, the data from our large sample of SBMM children having MRI scans indicates that there may be just the occasional case in which the AC is the compensatory mechanism for interhemispheric transfer of visual information in the absence of a splenium. Inspection of the cases with the enlarged AC did not reveal a different pattern of visual laterality results relative to the sample as a whole. The discussion will address compensatory mechanisms in light of the overall pattern of visual and auditory interhemispheric transfer results in children with SBMM and normal controls.

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M. DENNIS, K. EDELSTEIN, K. COPELAND, M. BRANDT, S. BLASER, R. HETHERINGTON, & J. FLETCHER. Perceptual and Motor Timing in Children With Spina Bifida.

The cerebellum has been implicated in perceptual and motor timing. Adults with acquired cerebellar lesions (either childhood or adult onset) have impairments in short-duration timing and temporally regulated movement. We studied whether congenital malformations of the cerebellum produce short-duration perceptual and motor timing deficits of the kind described in individuals with acquired cerebellar lesions. Spina bifida myelomeningocele is a neural tube defect that involves spinal cord lesions and dysmorphologies of the cerebellum. Participants were 100 children aged 8–19 years, 75 with spina bifida and hydrocephalus (SBH group) and 25 typically developing (CON group). Perceptual timing was poorer in the SBH group, who had higher psychophysical thresholds than the CON group for judging duration (around 400 ms), but not frequency (around 3000 Hz). Motor timing was assessed with a tapping task involving paced (tapping to a sound cue) and unpaced (maintaining tapping when the sound cue is discontinued) trials. All participants performed paced trials but the SBH groups had difficulty with unpaced trials: they showed fewer valid trials, and had greater unpaced inter-tap interval variance than the CON group. This variance was associated with response timing rather than motor demands. Results will be discussed with reference to genetic-embryological heterogeneity in spinal lesion level and to MRI-derived qualitative and quantitative analyses of cerebellar dysmorphology. The data support the view that the cerebellum is an important regulator of short duration perceptual and motor timing.

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SYMPOSIUM 5/8:45–10:30 a.m.

HEMISPHERIC DOMINANCE FOR THE COGNITIVE ASPECTS OF MOVEMENT

Organizer and Chair: K.Y. Haaland
Discussant: D.L. Harrington

K.Y. HAALAND. Hemispheric Dominance for the Cognitive Aspects of Movement.

Left hemisphere dominance for movement has received wide support. Studies of patients with unilateral cortical damage have shown that abnormal performance on a variety of motor tasks is more common after damage to the left than the right hemisphere even when patients are tested using the limb ipsilateral to the damaged hemisphere. Support for this view has also been provided in functional imaging studies in healthy individuals, which have reported that left hemisphere activation is greater than right hemisphere activation when performing movement sequences or gestures using the ipsilateral hand. However, more recent investigations suggest that the right hemisphere is also important for mediating cognitive aspects of movement, but in different ways. The purpose of this symposium is to review current research into the neural underpinnings of cognitive-motor processes to better characterize potential explanations for differences between the hemispheres in controlling movement. Kathleen Haaland will begin with a discussion of hemispheric differences in controlling motor sequencing and simple aiming differences in controlling visuospatial and motor attention. Matthew Rushworth will follow by discussing hemispheric differences in controlling visuospatial and motor attention. Angela Sirigu will examine the role of the parietal lobe in forward planning, and Kenneth Heilman will explore the reasons for hemispheric differences in limb praxis. Deborah Harrington will serve as the discussant, integrating the research of the panelists with her work showing hemispheric biases in temporal cognition with the goal of assimilating these distinct lines of

research into a broader framework for understanding hemispheric biases for movement.

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K.Y. HAALAND. Hemispheric Dominance for Sequencing and Aiming Movements.

There is strong evidence for left hemisphere dominance for a wide variety of movements. The evidence is particularly strong for a left hemisphere role in scheduling or timing motor programs during the sequence, when sequences are composed of different responses. Apraxic patients with left hemisphere damage demonstrate additional deficits pre-planning these sequences. Kinematic analyses of simple aiming movements have shown that different parts of the movement are controlled by the left or the right hemisphere. Early work suggested the ballistic transport component of the movement that is more dependent on a motor representation (open loop, feedforward) was dependent on the left hemisphere, while the component of the movement that is more dependent on visual feedback and on-line control (closed loop, feedback) was more dependent on the right hemisphere. Current data suggest that this explanation does not fully describe the results, and other explanations must be considered. This presentation will focus on potential cognitive explanations for these differences in hemispheric asymmetry as well as the differential role of the left and right parietal lobes in aiming.

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M.F.S. RUSHWORTH. The Left Parietal Cortex: Attention and Movement.

It is widely agreed that the parietal cortex mediates visuospatial attention and that this function may be lateralized to the parietal lobe of the right hemisphere in the human brain. Lesion and cell recording studies in the macaque suggest that only a limited part of the parietal lobe mediates visuospatial processes while other areas are more concerned with body and limb centered representations of space. Homologous areas can be identified in the human brain in neuroimaging experiments. Rather than mediating visuospatial attention these areas are concerned with attention to movement. Just as visuospatial attention can be covertly oriented to a location in space, covert motor attention can be directed to an upcoming movement. It has been known for more than a century that both visuospatial and motor attention have measurable effects on reaction times. Interference in these areas induced by lesions or transcranial magnetic stimulation particularly affect the redirecting of motor attention from one movement to another. The parietal areas of the human brain that are concerned with limb centered representations and attention to movement are lateralized to the left hemisphere.

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A. SIRIGU. The Parietal Lobe's Role in Maintaining a Forward Model for Movement.

Motor control theories postulate that during movement execution the CNS generates a forward model, in order to predict the sensory consequences of an action. The parietal cortex may be important in maintaining such a model. In support of this hypothesis, this presentation will first review data obtained by our group: (1) on patients with parietal cortex lesions who show selective impairments in mental movement rehearsal and movement attribution judgment, using a variety of tasks, (2) fMRI results obtained in normal subjects, suggesting that specific parietal areas are involved for imagined, not executed movements. Next, I will discuss findings from a recent study where we asked normal subjects and patients with cerebellar or parietal damage to execute a simple voluntary movement while performing two introspective judgments: (1) the time when they executed a movement (M judgment), and (2) the time when they first intended (W judgment) to execute the same movement. Results showed that normal

subjects and cerebellar patients produced comparable estimates: M-time was judged to occur when button press took place while W-time was estimated as arising in advance with respect to movement onset. Parietal patients failed to anticipate W-time which was judged as occurring close to movement onset. A conscious judgment of the time we intend to perform an action may be based on the ability to anticipate movement unfolding. These results suggest that parietal cortex may play a role in this process.

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K.M. HEILMAN & L.J. GONZALEZ ROTH. Hemispheric Dominance of Cognitive Motor Systems.

The motor system has an almost infinite degree of freedom. Thus, to successfully interact with the environment a person needs to provide the motor system with instructions. In general, there are two forms of motor instructions that need to be provided, "HOW" instructions (e.g., how to posture your forelimb, how to move through space, how fast to move, how to order a series of acts to achieve a goal and how to select the correct tool and action) and "WHEN" instructions (e.g., when to move, when to persist, when to not move, and when to stop moving). Disorders of the "HOW" system are termed apraxia (e.g., ideomotor apraxia, ideational apraxia and conceptual apraxia) and disorders of the "WHEN" system are called intentional disorders (e.g., akinesia, motor impersistence, defective response inhibition and motor perseveration). In this lecture we will provide evidence that whereas the "HOW-PRAXIS" system is controlled by the left hemisphere, the "WHEN-INTENTIONAL" systems are primarily controlled by the right hemisphere.

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Symposium 6/8:45–10:30 a.m.

EXPLORING FRONTAL–BASAL GANGLIA FUNCTIONING WITH QUANTITATIVE MODELS

Organizer and Chair: J. Vincent Filoteo
Discussant: David P. Salmon

J.V. FILOTEO. Exploring Frontal–Basal Ganglia Functioning With Quantitative Models.

Although many of the key structures known to play a role in working memory, attention, and decision-making have been localized to circuitry within the frontal lobes and basal ganglia, our understanding of the exact cognitive mechanisms engendered by these structures is still unclear. In recent years researchers have applied quantitative model-based approaches to better understand the role of these brain structures in cognition. Such an approach has enabled us to go beyond traditional analytic techniques and has allowed for a more in-depth exploration of the exact mechanisms that are carried out by these areas. This symposium will showcase several different quantitative model-based approaches to understanding the role of frontal-basal ganglia structures in certain aspects of cognition. Specifically, Ashby, Eil, Valentin, and Casale will discuss a computational model of working memory and the role of the frontal-basal ganglia circuits. Brown, Caligiuri, Meloy, Zorilla, Kinderman, and Lohr will discuss the application of structural equation modeling to fMRI data in order to more precisely detail the role of various circuits in motor functions and cognition. Maddox and Filoteo will present quantitative modeling of the role of the basal ganglia in categorization learning. Finally, Stout and Busemyer will present models of decision-making in patients with various forms of frontal lobe and basal ganglia dysfunction. Taken together, these presentations will demonstrate the utility of diverse modeling approaches and how going beyond traditional analytic tech-

niques will enable a better understanding of the interplay between frontal and basal ganglia structures in a variety of cognitive processes.

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F.G. ASHBY, S.W. ELL, V.V. VALENTIN, & M.B. CASALE. A Frontal–Striatal Model of Working Memory.

Many studies suggest that working memory is mediated by a distributed network that includes prefrontal cortex and other structures. We describe a computational model of working memory in which the spatial representation of targets is encoded in posterior parietal cortex. During delay intervals, activation in these parietal cells is sustained via parallel, prefrontal cortical–thalamic loops. Activation reverberates in these loops because prefrontal cortical excitation of the head of the caudate nucleus leads to disinhibition of the thalamus (by inhibiting the globus pallidus, which tonically inhibits the thalamus). The model is instantiated as a set of differential equations that describe activation in each cell type within the working memory neural network. We show that, during delayed match-to-sample tasks, the “cells” of the model successfully mimic the firing properties of real cells in posterior parietal cortex, dorsolateral prefrontal cortex, medial dorsal nucleus of the thalamus, globus pallidus, and the head of the caudate nucleus. Next, using the same parameter estimates, we show that the model successfully accounts for human behavioral data in a difficult version of the spatial delayed match-to-sample task. Thus, the cells in the model mimic the behavior of real cells at the same time that the entire network effectively mimics human spatial working memory behavior.

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G.G. BROWN, M. CALIGIURI, M. J. MELOY, L.E. ZORRILLA, S. KINDERMANN, & J. LOHR. fMRI Study of Cortical Motor Loops Underlying Visuomotor Tracking.

Systems neuroscience has identified specific neural loops, passing through the basal ganglia, that underlie complex behaviors. Perhaps the loops we know most about involve the neural substrate of skeletomotor behavior. Much of this knowledge comes from nonhuman primate studies. Although human functional brain imaging studies have investigated components of the skeletomotor loop, little human imaging research has attempted to validate the existence of these loops in their entirety. We used functional magnetic resonance imaging to study focal brain activation in healthy volunteers when performing visuomotor tracking. Participants pressed a force transducer to keep a cursor on a boxcar waveform as it moved from one side of the visual field to the other. We manipulated response hand and direction of boxcar movement (right-to-left or left-to-right) in a counter-balanced within-subject design. Active study conditions were compared with a no-response condition. Whole brain analysis of blood oxygen level dependent (BOLD) contrast revealed greater contralateral than ipsilateral activation in: primary SIM1 hand region, posterior putamen, and the ventral posterior region of the thalamus. These regions are components of the skeletomotor loop described in nonhuman primate studies. Additionally, secondary somatosensory areas in the parietal operculum and posterior insular cortex showed greater contralateral than ipsilateral activation, whereas regions of the cerebellum showed greater ipsilateral than contralateral activation. Thus, the conventional model of a cortico–putamen–thalamic–cortical skeletomotor loop might need to be altered to include secondary somatosensory areas and the cerebellum. We will present the results of hierarchical path analysis to test this hypothesis.

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W.T. MADDOX & J.V. FILOTEO. Modeling Category Learning in Striatal-Damaged Patients.

Exemplar-models imply a critical role of the medial temporal lobes in category learning and have had some success in accounting quantitatively for normal performance. However, recent cognitive neuroscience research provides little support for the involvement of these structures in most

category learning situations. Two systems that have received support are (1) a circuit that includes the frontal lobe and head of the caudate that mediates rule-based category learning and is available to conscious awareness, and (2) a second circuit involving the frontal lobe and the tail of the caudate that mediates information-integration category learning and is not available to conscious awareness. In this talk we review several studies from our laboratory that examined rule-based and information-integration category learning in patients with Parkinson’s disease (PD), patients with Huntington’s disease (HD), and controls. Accuracy-based analyses, as well as quantitative model-based analyses, were performed. Unlike accuracy-based analyses, the model-based analyses allowed us to quantify and separate the effects of categorization rule learning from variability in the trial-by-trial application of the rule. The results suggested that (1) PD patients were normal in the rule-based task whereas HD patients showed an accuracy deficit, (2) PD and HD patients were less accurate than controls in the information-integration condition, and (3) the cause of the accuracy deficits was an impairment in categorization rule learning, and not increased variability in the application of the rule. These results strongly implicate frontal-striatal circuitry in the learning of different types of categorization rules.

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J.C. STOUT & J.R. BUSEMEYER. Formal Models of Simulated Gambling Task Performance in Frontal–Striatal Damage.

Neuropsychological studies often approach the study of complex behavior by relating complex task performance to measurements derived from tasks that measure more basic elements that underlie the complex behavior. In this talk, we present an alternate approach, using mathematical models to reveal individual differences in psychological processing during complex tasks. We describe the application of formal models of decision making to laboratory-based simulated gambling tasks, which have become a popular method for examining decision-making deficits exhibited by people with lesions in the frontal-striatal brain circuits. Performance on these tasks is confounded by complex interdependencies between cognitive, motivational, and response processes, making it difficult to sort out and identify the specific processes responsible for the observed behavioral deficits. We demonstrate how cognitive modeling can reveal psychological processes that interact in the task, such as learning and memory, motivation, and persistence in strategy use. This work has potential for quantifying individual differences in performance either of groups or individual cases.

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Poster Session 3/9:45–11:15 a.m.

ADHD

B. OERBECK, H. TORGENSEN, I. REINVANG, K. SUNDET, & S. HEYERDAHL. Cognitive ERPs in Young Adults With ADHD Versus Congenital Hypothyroidism.

Attention problems are reported in the literature both in attention deficit hyperactivity disorder (ADHD) and congenital hypothyroidism (CH). We wanted to examine whether cognitive ERPs could illuminate the nature of the attentional difficulties in these groups. Event-related potentials, cognitive and behavioral functioning were assessed in young adults with either medicated ADHD ($N = 13$) or early treated CH ($N = 12$) and a CH-sibling control group ($N = 12$). Mean IQ was 105 and did not differ among groups. ERPs were recorded to auditory standard and target events in an oddball paradigm. Subjects responded with button press to stimulus categories defined by pitch differences. Behavioral results showed no group differences in accuracy or reaction time. Significant group differences were found in the early ERP components, tapping sensory processing and attentional triggering. Latency of the P1 and N1 components were significantly delayed in the CH group compared to ADHD and controls. Ampli-

tude differences were significant, with lower N1-amplitudes and higher P1-amplitudes in CH, indicating reduced sensory processing speed and less efficient auditory perception. On the P3 component, there was a delayed latency in the CH group. However, the amplitude was higher in CH compared to ADHD. The results suggest a delay in allocating attention to the target in CH relative to ADHD, but the ADHDs allocated less attention resources to the target. Our study demonstrates that ERP could reveal different underlying processing problems in CH and ADHD. Early thyroxine treatment level was related to P3 amplitude in the CHs, indicating a possible corrective effect of early treatment.

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A. HERVEY, J. EPSTEIN, & J. CURRY. The Neuropsychology of Adults With ADHD: A Meta-Analytic Review.

The neuropsychology of children with Attention Deficit Hyperactivity Disorder (ADHD) has been widely studied. Research suggests deficits in attention, response inhibition, and other areas of cognitive functioning for children with ADHD when compared to normal control groups. More recently, neuropsychological performance in adults with ADHD has been investigated. The present work represents a comprehensive review of the existing empirical literature on the neuropsychological performance of adults with ADHD. In total, 31 published studies were included in this meta-analytic review. Dependent variables from a variety of neuropsychological tests were categorized into 7 broadly defined domains (Attention, Response Inhibition, Other Tests of Executive Functioning, Memory, Processing Speed/Motor Speed, Intelligence, Other). Data from the 31 reviewed studies were statistically analyzed where sufficient data were available. Mean effect sizes weighted for sample size as recommended by Hedges and Olkin were computed between ADHD and normal control group performance for each dependent variable of each test. In addition, comparisons between ADHD and clinical control group performance were made when these data were available. Reviewed data suggest that adults with ADHD continue to demonstrate neuropsychological impairment in several domains consistent with the child ADHD literature, including Attention, Response Inhibition, other tests of Executive Functioning, Memory, and Intelligence. This suggests a developmental trajectory that includes neuropsychological impairment throughout development, and supports an adult diagnosis of ADHD. The implications of specific findings, as well as limitations are discussed.

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R. BURMEISTER & K. KRULL. Profile Analysis of Children With ADHD and Verbal Learning Disability on the DAS.

Children with either attention or learning problems often present clinically with similar complaints of inattention and academic difficulties. While the 2 groups can be distinguished behaviorally, the cognitive profiles of children with either attention or learning disorders have been less clear. Although specific cognitive deficits are theorized for each group, the profile of cognitive abilities across multiple measures has received less attention. The Differential Ability Scales (DAS) was administered to 62 children (ages 6–16) referred to an attention problems clinic. The children were divided into 3 groups by diagnostic category: Attention Deficit Hyperactivity Disorder (AD/HD), Verbal Learning Disorder (VLD), and Combined AD/HD and VLD. Profile analysis was performed on the 6 subtests of the DAS across the 3 groups. There was a significant effect for profile level [$F(2,59) = 3.02, p = .05, \text{partial } \eta^2 = .09$], with the pure AD/HD displaying overall higher performance. Tests of parallelism and flatness were rejected at $p < .05$. A significant interaction was found between the ADHD and VLD groups, with the VLD group displaying significantly lower scores on the Word Definition and Similarities subtest. No significant differences on the reasoning/executive functions subtests were detected. These results suggest that children with either ADHD or VLD may experience equal difficulty with executive functioning. However, these difficulties may differentially arise from reduced abilities in more basic skills (i.e., verbal

expression or internal speech vs. increased distractibility or slowed processing).

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J. WINER, J. GITTEN, K. CORRIVEAU, E. FESTA-MARTINO, & W. HEINDEL. Conditional Associative Learning for Spatial and Object Information in ADHD.

Frontal-subcortical circuitry has repeatedly been implicated by both behavioral and neuroimaging data in many of the deficits seen in Attention Deficit Hyperactivity Disorder (ADHD). The purpose of this study was to distinguish between frontal lobe and basal ganglia dysfunction within the frontal-subcortical circuitry of children with ADHD by comparing their performance on two conditional associative learning tasks: an object task and a spatial task. During an initial training session, subjects learned paired associations between objects or between spatial locations. Subjects were given positive or negative feedback after each trial. Upon reaching criterion accuracy levels and in order to assess negative transfer, subjects learned a second, different set of pairs using the same stimulus set. Consistent with previous studies showing dysfunction on spatial (but not object) associative learning tasks in patients with frontal or subcortical dysfunction, children with ADHD performed equally as well as age-matched controls on the object version of the memory task, but were impaired on the spatial version of the memory task. However, executive function, as assessed by the types of errors the subjects made, including perseverative errors and working memory errors, did not differ significantly between groups. Rather, the children with ADHD exhibited greater difficulty maintaining the learned sets of stimulus pairs compared to controls. Taken together, these results suggest that, within the frontostriatal circuitry, cognitive deficits in ADHD may be associated more with basal ganglia than with frontal lobe dysfunction.

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S.R. MILLER, C.J. MILLER, J. SANCHEZ, G.W. HYND, & J.G. CRAGGS. Association of ADHD Subtype With Right Hemisphere and Social Comprehension.

Social comprehension, a component in the social skills domain, involves empathy for others' experiences and appropriate responses to nonverbal cues. Several authors have highlighted the right hemisphere as playing a role in this area of social functioning. Also, numerous studies have associated ADHD with social skill deficits. Few studies, however, have examined the association of ADHD subtype with both social comprehension and right hemisphere brain morphology. Forty children aged 6 to 12 years underwent MRI, from which the right hemisphere was classified using Steinmetz's subtyping classification system for perisylvian morphology. Children were also classified as ADHD: Predominantly Inattentive Type (PI), ADHD-Combined Type (CT), or clinical controls based on strict clinical criteria. Also, using Behavior Assessment System for Children items, a 12-item scale of social comprehension was constructed. Analysis of current data indicated adequate internal consistency (Cronbach's $\alpha = .78$). Analyses revealed significant differences in social comprehension based on ADHD subtype. Specifically, ADHD: CT, but not ADHD: PI was associated with poor social comprehension compared to clinical controls. To examine the interaction of ADHD diagnosis and brain morphology, data from the three groups were analyzed separately. Differences in social comprehension based on brain morphology were practically nonexistent in the ADHD: PI children and clinical controls, but ADHD: CT children with atypical morphology scored more than 2 points lower on social comprehension than ADHD: CT children with more typical morphology. Thus, atypical right hemisphere perisylvian morphology may be associated with underlying risk in the area of social comprehension for children with ADHD: CT.

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K. BOYER, A. LINCOLN, S. FOSTER, & Z. LAI. The Influence of Working Memory Load on Matching Law Performance in 9- to 12-Year-Old Children.

The matching law states that when several reinforcement contingencies are in concurrent operation, an individual will match relative rates of responding to relative rates of reinforcement. When given the choice of responding under different schedules of reinforcement, normal children behave as predicted by the matching law. However, children with ADHD do not conform their behavior to this law under standard conditions. Rather, they randomly switch from 1 reinforcement schedule to another, apparently unable to discriminate between relative rates of reinforcement. Because children with ADHD have been found to be deficient in working memory, it was proposed that working memory load may influence how children allocate behavior to various reinforcement rates. Twenty-six children without ADHD completed a task designed to place increasing demands on working memory, and at the same time were able to choose between concurrent reinforcement schedules under which to respond. The computer administered spatial working memory task was adapted from a method described Owen et al. Participants were required to search through a number of boats on the screen to collect hidden fish. Fish were hidden inside 1 boat at a time and the participants were required to search until all fish were found using the fewest boat selections possible. The working memory load manipulation and the adaptation of this task to a game like administration was successful with this sample, resulting in increased error ratios associated with increasing items to be searched. There was a trend observed where participants were more likely to allocate responding to reinforcement concurrent schedules as predicted by the matching law when working memory loads were low than when working memory loads were medium or high. However, results generally failed to support the hypothesis that as working memory load increases, deviation from matching law will increase. Several methodological issues that may have led to undermatching were explored. Changes to methods were made and two additional participants are presented as case studies. While the experimental hypothesis was not supported, findings yield important information about matching law research with children. Exactly how working memory influences choice behavior remains unclear. It is possible that the behavioral phenomena described by the matching law can provide an explanation of behavior on higher-order cognitive tasks, but it is more complex and not as easily detected by standard equations, or it takes more time to establish matching patterns. Suggestions for future research are made.

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J. MICHEL, R. McINERNEY, & K. KERNS. Timing of Reinforcement in Children With ADHD.

Behavioral inhibition is often cited as the central deficit in children with ADHD. The ability to self-motivate may also be under-developed in these children. Barkley suggests that the timing of reinforcement in children with ADHD is important, and that reward and punishment are less effective as they move farther away from the point of performance. The Stop Signal paradigm measures inhibition of a prepotent motor response. We developed a new, engaging version of the Stop Signal paradigm called the Fire Fighting Game. A sample of 25 children with ADHD and 25 matched control children (ages 7 to 12) completed the Fire Fighting Game under 3 different reward conditions: (1) no reward; (2) reward earned and delivered immediately after each trial; and (3) reward earned for each trial, but not delivered until the end of the task. Rewards were monetary and based on the 'score' that children achieved. In each condition, children with ADHD showed consistently longer stop signal reaction times (SSRT) than did control children. When rewarded, however, children with ADHD had similar SSRTs to control children without reward. Group differences also emerged in the pattern of responding as a function of reward condition, with a different pattern of findings for total score and number of successful inhibitions. Results of the Fire Fighter task are also compared to other measures of inhibition and executive function. We discuss the relevance of

these findings in terms of current theories of ADHD and implications for working with these children.

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C. HUPPERTZ, H. HEVERAET, R. McINERNEY, & K. KERNS. An Investigation of Timing and Reward in Children With ADHD.

Sagvolden and colleagues investigated in children with ADHD the impact of time between a response and its reinforcer. They suggested that due to an altered dopamine system, children with ADHD have an altered reactivity to reinforcement compared to children without ADHD that results in a shorter and steeper delay-of-reinforcement gradient. This delay gradient magnifies the impact of time, so that only reinforcers delivered soon after a response is made affect future performance. Numerous other researchers have found similarly that children with ADHD show dramatic performance improvements on cognitive tasks only if their performance is rewarded soon after their response. We report the results of a study using a new, computerized adaptation of Sagvolden's apparatus. In our "Clown Task," children saw a clown's face and had to click on its nose to receive animated rewards that were later exchanged for actual prizes. The time between available rewards in two different fixed intervals, followed by an extinction period was manipulated. Thirty children with ADHD and matched control children participated in this study. Our results did not support the pattern of overresponding that Sagvolden observed in children with ADHD. However, we found that children with ADHD were significantly less aware of time as being a critical element for reward, and also that they employed significantly fewer strategies than did controls in attempting to get a reward. We discuss these findings based on current theories of the impact of time on behavior in children with ADHD.

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S. CRAWFORD, B. KAPLAN, D. DEWEY, & B. WILSON. A Continuum of Severity in Attention Deficit Hyperactivity Disorder (ADHD).

Objective: To examine the concept of a continuum of severity in ADHD. **Methods:** Psychometric test performance was compared among three groups of children with ADHD (M age = 11.9 years, $SD = 2.3$): 26 children with ADHD only; 46 children with one other disorder + ADHD; and 46 children with ≥ 2 other disorders + ADHD. The other disorders were reading disability, developmental coordination disorder, oppositional defiant disorder, conduct disorder, anxiety, and depression. Each child was administered the WISC-III and the Wide Range Assessment of Memory and Learning (WRAML). Parents completed the Child Behavior Checklist (CBCL). **Results:** Having ≥ 2 other disorders + ADHD was associated with significantly greater impairments in general memory skills [$F(2, 115) = 5.92, p < .01$], in particular story memory, sentence memory and number letter memory. Children with ≥ 2 other disorders + ADHD had significantly more social problems [$F(2, 94) = 5.21, p < .01$], withdrawn behaviour [$F(2, 94) = 3.51, p < .05$], and tended to have more attention problems [$F(2, 94) = 2.46, p < .10$]. Significantly more girls were in the ≥ 2 disorders + ADHD group [$\chi^2(2, N = 118) = 9.12, p < .05$]. No significant group differences emerged for age, SES, or FSIQ. No sex differences for FSIQ or memory skills emerged. **Conclusion:** The findings provide support for a continuum of severity in ADHD: the more disorders present in addition to ADHD, the poorer the performance on psychometric tests. One key aspect of the Atypical Brain Development model proposed by Gilger and Kaplan is a continuum of severity. Dykman and Ackerman, Faraone et al., and Levy et al. have also reported evidence for a continuum of severity in ADHD.

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P. CIRINO, L.K. WALKER, K. WILD, & M.K. MORRIS. How Well Do Cognitive and Motor Speed Differentiate ADHD, Anxiety, and Depression?

Although impairments on measures of executive function and processing speed have been reported in adults with ADHD, similar difficulties have also been associated with anxiety and with mood disorders. Therefore, it is important to evaluate the ability of processing speed to differentiate among individuals with these clinical disorders. Two-hundred twelve college students referred for learning difficulties (M age = 25.5, SD = 8.1; M WAIS FSIQ = 99.9, SD = 13.7) were selected from a larger sample, excluding those with a learning disability or significant neurological or psychiatric disorder. Five mutually exclusive clinical subgroups were formed: *ADHD inattentive* (n = 37), *ADHD hyperactive/impulsive* (n = 28), *anxiety* (n = 33), *mood* (n = 31), and *clinical controls* (n = 83). Speed measures assessed fine motor skill (WAIS-3 Digit Symbol, Grooved Pegboard), reading specific rate (rapid automatized naming, timed reading measures), and executive skills (e.g., Stroop, FAS, cancellation task). No group differences were evident (all omnibus ANOVAs, $p > .05$), although below average performances were noted for all subgroups on some measures of executive functioning (Trails B, cancellation task). Similar results were obtained when other combinations of subgroups (e.g., collapsing ADHD subtypes, combining mood and anxiety disorders) were examined. These results indicate that discriminating among different clinical groups with measures of processing speed is difficult, and caution should be used when using these measures to aid in differential diagnosis.

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J. GITTEN, E.B. FENNEL, D. DEDE, S. BOGGS, S. MILLER, E. BORDINI, & B. MARIA. Sustained and Shifting Attention Deficits in Children With ADHD.

Children with Attention Deficit Hyperactivity Disorder (ADHD) are frequently impaired on sustained attention tasks thought to reflect frontal lobe dysfunction. Less is known about their ability to shift attention between cognitive sets (within 1 modality), an ability previously associated with cerebellar function. This study compared the performance of 31 children (8–12 years) diagnosed with ADHD (without comorbid conditions) to 31 matched control children on 4 measures: (1) a computerized measure of sustained attention, (2) a computerized measure of shifting attention, (3) the Stroop test which has also been shown to be sensitive to frontal lobe dysfunction, and (4) a smooth pursuit analysis test thought to be sensitive to cerebellar dysfunction. Children with ADHD performed significantly worse than normal controls on the computerized sustained attention measure ($p < .015$) and shifting attention measure ($p < .005$). Significant group differences were not found on the Stroop test or on the number of anticipatory saccades during smooth pursuit. Discriminant function analysis indicated that the computerized tasks alone correctly classified 80% of the subjects, with good sensitivity (74%) and specificity (84%). Results of this study indicate that in addition to having difficulty with sustained attention, children with ADHD are impaired in their ability to quickly shift attention between cognitive sets. Overall, children with ADHD performed significantly worse than controls on computerized measures of sustained and shifting attention, which may reflect frontal lobe and cerebellar function, respectively. Further research into frontal-subcortical-cerebellar pathways in ADHD is necessary.

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R. PAGE, M. COHEN, & G.W. HYND. Analysis of Specific Attentional Functions in ADHD: Implications for ADHD Subtyping.

It has often been hypothesized that ADHD-Combined Type (ADHD-CT) and ADHD-Predominantly Inattentive Type (ADHD-PI) subtypes may be the result of different underlying factors and may be associated with different types of attentional deficits. The current study compared 30 chil-

dren with ADHD-CT and 35 children with ADHD-PI on several neuropsychological variables associated with various aspects of attentional processing. However, it is important to note that only 47 (22 with ADHD-CT and 25 with ADHD-PI) of the participants were assessed with some of the experimental measures. All participants were between the ages of 6 years, zero months and 12 years, 11 months. Participants were evaluated using several neuropsychological measures associated with various aspects of attentional processing in order to test five hypotheses regarding possible subtype differences in specific types of attention. The attentional processes of interest included response activation, sustained attention, encoding/working memory, the focus/execute aspect of attention, and attentional stability. The attentional measures used in this study were taken from the TOVA, the CMS, and the WISC-III. No statistically significant group differences were found for any of the variables reflecting the five aspects of attentional processing. Correlations between the attentional measures and behavioral ratings of attention and hyperactivity as well as other neuropsychological measures are also reported. Finally, weaknesses of the current study as well as future directions for ADHD research are discussed.

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E. JANSIEWICZ, S. MOSTOFSKY, & M. DENCKLA. Impaired Visual Habituation as Assessed by Troxler Fading in ADHD.

We hypothesized that impaired habituation may contribute to off-task (“distractable”) behavior observed in Attention Deficit Hyperactivity Disorder (ADHD). To test this hypothesis, we examined the Troxler effect (the ability to habituate to a peripheral visual stimulus when presented with a competing central visual stimulus) in a group of children with ADHD (N = 23, age range = 8.11–12.67 years, M age = 10.01 years), as compared to a control group (N = 15, age range = 8.07–11.94 years, M age = 10.24 years). Participants completed a computer version of the Troxler task, in which they focused on a central crosshair and pressed a mouse button to indicate habituation to a peripheral stimulus (i.e., fading of a peripheral stimulus, a stationary grey circle 5 mm in diameter). Analysis of variance (ANOVA) with fading time (seconds) as the dependent variable revealed a significant effect of diagnosis [$F(1,36) = 5.088$; $p = .0303$]; ADHD subjects took longer to habituate to the peripheral stimulus than did control subjects. Additional analyses revealed a significant interaction between diagnosis and visual field. Control subjects showed similar fading times to stimuli presented in the right and left visual fields (13.254 s vs. 12.962 s), while the ADHD group showed much slower fading in the right than in the left visual field (18.641 s vs. 15.005 s). Our results suggest that children with ADHD are impaired in their visual habituation, more prominently in the right than the left visual field.

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L. FARMER, D. HILL, R. CAMPBELL, D. WEERS, W. BROOKS, & R. YEO. Neuropsychological and Neuroanatomical Indicators of ADHD Subtypes in Children.

Fourteen children diagnosed with the *inattentive* subtype of ADHD, 15 children diagnosed with the *combined* subtype of ADHD and 25 control children completed a battery of neuropsychological and cognitive tasks. Children underwent magnetic resonance imaging of the brain and volumetric measurements of total brain, dorsolateral prefrontal, orbital prefrontal, parietal, corpus callosum and brainstem regions were obtained. Group differences on cognitive measures were observed with *inattentive* children demonstrating more difficulty than control subjects on tasks reflecting attention and processing speed. Children in the *combined* group exhibited more difficulty on tasks associated with reading achievement. These differences remained significant after controlling for learning disabilities. Group differences were also exhibited on neuropsychological tasks with *inattentive* subjects demonstrating greater impairment on tasks of attention and concentration. Children in the *combined* group performed more

poorly than controls on tasks reflecting working memory and executive functioning. Volumetric calculations revealed that subjects in the *combined* group exhibited decreased total brain volume, right dorsolateral and left parietal volume when compared to controls. Moreover, children in the *inattentive* group exhibited reduced volume in the right parietal and right and left dorsolateral regions when compared to control subjects. Collectively, these results provide support for the contention that the *inattentive* and *combined* subtypes of ADHD are unique and distinctive neurodevelopmental disorders.

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T.M. WELLINGTON, A.L. GREGORY, J.M. MURPHY, & M. SEMRUD-CLIKEMAN. Putamen Volumetric Analysis in Children with ADHD With Psychopathic Traits.

Attention Deficit Hyperactivity Disorder (ADHD) is one of the most prevalent childhood onset disorders and research has found underlying neurological deficits. In addition, little is known about the neurological deficits in 10 to 15% of children with ADHD that continue on to have antisocial problems. This study examined the volumetric differences in the putamen, part of the basal ganglia involved in motor control in boys with ADHD combine with psychopathic traits *versus* a control group of boys. The putamen in 23 archival MRI scans of 12 ADHD combined with psychopathic traits and 11 community control boys were analyzed using Display software. There were no differences found in the total, left, and right putamen volumes across the ADHD or control group. However, there was a significant reversal of symmetry across groups such that the children with ADHD more frequently had a smaller left putamen than right. The control group more frequently had a smaller right than left putamen. A reversal of symmetry in the putamen (as found in the caudate) may relate to ADHD symptomatology particularly when accompanied with psychopathic traits.

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G. SCHRIMSHER, R. BILLINGSLEY, E. JACKSON, & B. MOORE. Caudate Nucleus Volume Asymmetry Predicts ADHD Symptomatology in Normal Children.

The clinical diagnosis of Attention Deficit Hyperactivity Disorder (ADHD) is based on evaluation of behavioral functioning in 3 domains: inattentiveness, hyperactivity, and impulsivity. Caudate and frontal lobe function figures prominently in several neuroanatomical models of attentional functioning. Studies comparing children with and without ADHD have found differences in the size and symmetry of the caudate nuclei. Using multiple regression, we tested the hypothesis that caudate volume symmetry (log left minus log right caudate volume) measured from serial sagittal MRI images in a sample of normal children (12 girls/15 boys, 7.0 to 16.6 years, 81 to 129 IQ) would predict the cumulative severity of parent-reported ADHD diagnostic behaviors beyond variance predicted by age, sex, and level of internalizing problems as measured by the Child Behavior Checklist. The degree of caudate asymmetry significantly predicted cumulative severity ratings of inattentive behaviors ($p = .015$), uniquely accounting for 17.1% of the variance in inattention symptomatology over demographic variables and internalizing problems, which collectively predicted 28.9% of the variance. Caudate asymmetry uniquely accounted for only 4.3% of the variance in cumulative severity ratings of hyperactive/impulsive symptomatology over demographic variables and internalizing problems that collectively predicted 21.2% of the variance. A greater degree of right-to-left caudate volume asymmetry predicted subclinical inattentive behaviors in a sample of children. This finding is congruent with neuroanatomical models of attention emphasizing lateralized alteration in prefrontal/striatal systems. The results support the view that clinical ADHD is the extreme of a behavioral continuum extending into the normal population.

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ATTENTION AND EXECUTIVE FUNCTIONS

R.R. HEITMANN, A.E. ASBJØRNSEN, T. HELLAND, & B.H. JOHN-SON. Attentional Functions in Speech Fluency Disorders.

This study focused on attentional functions in fluency disorders. Psychophysiological indices of activation (electrodermal activity, heart rate variability and skin conductance), were recorded from 9 persons who stutter, 8 persons who clutter, and 9 fluent controls, whilst they performed a series of different tests of attention. The persons who stutter had a significantly longer response time on the Posner's Test of Covert Attention Shift, compared to the other groups, and the effect was most clear when the target appeared in the right visual field. The differences could not be explained by physiological activity as measured by heart rate, skin conductance and heart rate variability. The present results support the hypotheses that stuttering may be associated with impaired focused attentional skills, while cluttering did not seem to be associated with impaired focused attentional skills. However, due to small samples, care should be taken before making firm conclusions.

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M. GREHER. Factor Analysis of a Neuropsychological Model of Attention.

This study involved factor analysis of Mirsky's five factor model of attention, including Encoding (Digit Span), Focusing/Executing (Digit Symbol-Coding, Visual Search and Attention Test), Shifting (Wisconsin Card Sorting Test: Computerized Version-2), Sustaining, and Stabilizing (Continuous Performance Test-Identical Pairs). Eighty healthy adult females participated in the study. A five component solution was generated and elements found to be consistent with the original model included those of encode, focus/execute, and shift. However, Mirsky's model suggests that the sustain element of attention is represented by measures of both accuracy and reaction time. Using the CPT-IP, these measures loaded on to separate factors in the present study. This may be attributed to the fact that reaction time is more dependent on neuromotor response than accuracy, suggesting that the sustain element is multidimensional. In addition, stabilizing attention represented by variability in reaction time on the CPT-IP did not load coherently on to an independent factor. It may therefore not represent a separate element of attention. In general, these inconsistencies between the present study and those of Mirsky may also be attributed the fact that the original model has been traditionally analyzed using principle component analysis. The present study used principle axis factoring, a statistical test which better accounts for naturally occurring error variance. The present findings may therefore offer a model slightly more representative of the various components of attentional processing, suggesting that sustain is itself a multidimensional element, and contradicting the existence of the stabilize element.

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A.K. SOLBAKK, I. REINVANG, S. ANDERSSON, H. NORDBY, A. LUNDERVOLD, & K. SUNDET. The Relation Between Neuropsychological and ERP Measures of Cognitive Speed and Attention.

The objective of this study was to examine the relationship between neuropsychological and neurophysiological measures of mental speed and attention in healthy adults. A total of 96 persons in the age range 19 to 65 years old participated in the study. Event-related brain potentials (ERPs) were recorded during a Dichotic Listening task consisting of "standard" (75 ms) and "target" (25 ms) tones. Participants directed attention towards a specified ear and pressed a button when detecting the target tone. ERP components (Nde and Ndl) reflecting sustained selective attention to attended-channel stimuli were examined. The early Nde is considered a measure of initial stimulus selection whereas the subsequent Ndl reflects

the executive control and maintenance of selective attention. Neuropsychological tests consisted of the Stroop Test, Trail Making Test (A & B), Symbol-Digit Substitution and Digit Span. Pearson correlation coefficients were used to test the relationship between selected ERP parameters and neuropsychological scores. The results confirmed modest, but statistically significant associations between ERP measures and scores on certain neuropsychological tests. There was a positive relationship between Digit Span and Nde amplitude. Nde and Ndl latencies were positively correlated with time used to complete the Trail Making Test-B and the Stroop Test, respectively. The results suggest that the neuropsychological and neurophysiological measures of attention and cognitive speed reflect partly overlapping processes, but the moderate size of the associations indicates that neither class of measure is redundant. Implications for the use of cognitive ERPs in clinical neuropsychological assessment are discussed.

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J. BALDO, D. DELIS, & E. KAPLAN. Role of Executive Functions in Language: Evidence From a New Verbal Reasoning Test.

While executive functions have been studied for their role in memory and attention, less research has focused on the role that executive functions play in language. We were interested in whether patients with focal prefrontal lesions and executive dysfunction on classic tests such as card sorting would also have difficulty drawing inferences on a verbal reasoning task. We used a new version of the Word Context Test, which was originally designed to study language acquisition in children. Participants were shown five sentences, one at a time, and asked to guess the meaning of a highlighted, made-up word, based on the semantic context. The first sentence was very inclusive, with hundreds of possible correct answers (e.g., “A *delz* can be soft or loud”). The subsequent sentences were progressively more narrow so that by the last sentence, the target word was very clear (e.g., “A *delz* is a sound produced from the vocal cords”). We tested 13 non-aphasic, prefrontal cortex patients and 11 age- and education-matched controls. We found that prefrontal patients needed significantly more sentence clues to determine the correct solution. Also, prefrontal patients were less likely to arrive at the correct response, even given the final sentence that made the answer quite apparent. Thus, in the absence of any aphasic disorder, patients with prefrontal cortex lesions were impaired at making language-based inferences on a verbal reasoning task. Implications for the role of executive functions in language will be discussed.

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R.G. MORRIS, M. KOTITSA, B. BROOKS, D. ROSE, P. BULLOCK, & C.E. POLKEY. Virtual Reality Investigations of Executive Functioning Following Focal Prefrontal Cortical Lesions.

Two experiments are presented which used virtual reality to investigate executive functioning in 35 patients with focal neurosurgical lesions of the prefrontal cortex, comparing them to a normal control group. In the first, a virtual *Bungalow Test* was used, simulating decision making and organization. Here, the participants had to search for and organize the removal of items of furniture from a virtual reality bungalow. This showed specific impairments in strategy formation, rule breaking and time based prospective memory. A second task, the *Warehouse Test*, a virtual reality 6 elements test, required the participants to select items from stacks and position them either on a trolley or conveyer belt or to weigh them. The task revealed impairment in the ability to distribute effort evenly between the 3 main procedures and also rule breaking deficits. Overall, the virtual reality tests proved more sensitive to executive dysfunction than established ecologically valid tests of executive functioning.

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R. ZIEGLER, R. SKEEL, & G. RONAN. The Efficacy of Neuropsychological Measures in the Prediction of Social Problem-Solving: Self-Report versus Performance.

Research has failed to identify the cognitive components that comprise the social problem-solving process. The relationship between a specific higher-level measure of formal problem-solving and the social problem-solving model developed by D’Zurilla and Goldfried was investigated. This study investigated the relationship between a neuropsychological measure of executive functioning, the Revised Strategies Application Task (R-SAT), a performance-based social problem-solving measure, the Personal Problem-Solving System (PPSS), and social problem-solving appraisal, measured by the Social Problem-Solving Inventory-Revised (SPSI-R). In addition the discrepancy between self-report measures of social problem-solving and performance measures of social problem-solving was assessed. Non-significant relationships were found between general executive functioning and social problem-solving performance and appraisal ($r = .13$ and $r = .08$, respectively). However, perseveration, as measured by the R-SAT, was inversely related to the number of alternative solutions generated via the PPSS ($r = -.23$). Individuals who demonstrated increased perseveration generated significantly fewer solutions across social dilemmas. Findings indicate a continued need to assess the underlying components of the social problem-solving process. Directions for future research are discussed.

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M. CATO, D.C. DELIS, T. ABILDSKOV, & E.D. BIGLER. Assessing the Elusive Cognitive Deficits Associated with Orbitofrontal Damage: Case Study of a Modern-Day Phineas Gage.

Cognitive deficits following ventromedial orbitofrontal damage (VM-OFD) have been elusive, with most studies reporting primarily emotional and personality changes. The present case illustrates the utility of a process approach to assessing executive functions following VM-OFD. At age 26, C.D., while in the military, acquired bilateral VM-OFD following head trauma. Despite exemplary school and military performances prior to his accident (current Verbal IQ = 119), his subsequent psychosocial history suggests dramatic occupational and social changes, reminiscent of Phineas Gage. Consistent with past studies, C.D.’s scores on the vast majority of traditional neuropsychological measures were average to superior. However, on several new tasks of the Delis-Kaplan Executive Function System (D-KEFS) that combine traditional executive-function tests with new switching procedures (e.g., on Design Fluency and Stroop tests), C.D. exhibited significant impairments. Further, new D-KEFS process measures revealed marked impairments in error rates but not in traditional time-to-completion scores. On the WCST, despite normal perseveration rates and correct verbalization of the sorting concepts, C.D. exhibited impairments on process measures such as “other” responses. On the CVLT-2, C.D.’s recall level was normal, but he was impaired on the new measure, “recall discriminability,” which analyzes recall level relative to intrusions. The current findings suggest that VM-OFD may be associated with a wider spectrum of cognitive deficits than previously characterized, including tendencies to sacrifice accuracy for speed and to adopt liberal response strategies. These deficits may have a more significant cognitive component than previously advanced by theories that link this brain region primarily to personality and emotional changes.

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C. O’REILLY-WOLF, M. WELSH, H. McNEIL, J. EMICK, & S. GONZALEZ. Individual Differences in Self-Efficacy and Tower Task Performance.

Current literature suggests that the Tower of Hanoi (TOH-R) and Tower of London (TOL-R) are isomorphic measures of executive functions (EF) such as inhibition, planning and working memory. However, recent studies have found substantial unshared variance, as well as a difference in difficulty level. Given that the TOH-R is the more difficult task, the degree to which individual differences in self-efficacy (SE) contributed to

performance, over and above other EF processes, was examined. Self-efficacy (SE) was defined as a cognitive construct reflecting a person's belief about his or her ability. Sixty undergraduates ($M = 19.18$) were administered the TOH-R, TOL-R, Stroop, Matrix Reasoning, Spatial Span, and a self-report general self-efficacy questionnaire. The results demonstrated no association between self-reported SE and performance on either tower task. Unexpectedly, the two tower tasks correlated at the maximum level ($r = .70$) given the reliability of each task; therefore, there was less non-shared variance to explain than had been found in previous studies. Moreover, the *same* cognitive skills, working memory and inductive reasoning, significantly predicted performance on both tasks. Some interesting differences between the two tower tasks also were observed. Males significantly outperformed females on the TOL-R, however, the same processes predicted performance in both groups. In contrast, although a gender difference was not found for the TOH-R, working-memory and inductive reasoning predicted more performance variance for males than for females. The two tower tasks assess common processes reflecting both EF (working memory) and fluid intelligence (inductive reasoning); however, the mechanisms underlying female performance on the TOH-R remain unclear.

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D. BEEBE, M. ALOIA, C. WELLS, L. GROESZ, & A. NICHOLS. Sleep Apnea Affects Attention and Executive Functioning: A Closer Look.

Previous narrative and empirical reviews have found that untreated Obstructive Sleep Apnea (OSA) has a deleterious effect on attention and executive functioning. These cognitive domains are heterogeneous, however, so it remains unclear which aspects of each are most affected. We used meta-analytic procedures to review research on untreated adults with OSA that included at least one of 10 pre-selected measures of attention and executive functioning. Twenty-five studies met review criteria, representing 1025 OSA patients and 913 health controls. Two sets of effect sizes were generated. One compared OSA group means against those of healthy controls in case-controlled studies. The other compared all OSA group means against published normative data. The most consistent effect, which was moderate to large based upon conventional cutoffs, was found on Trails B. Well-controlled studies also reported large effects on continuous performance tests, letter/digit cancellation, and the PASAT. Smaller or less consistent effects were noted on the Stroop interference trial, digit span, verbal fluency, and digit-symbol substitution. Though deficits have also been reported on the Category Test and the Wisconsin Card Sorting Test, the very small number of studies that have used these measures limits conclusions. Caution is suggested when comparing findings across tests, as sample compositions varied. Nevertheless, these findings suggest that OSA causes particular problems with vigilance, working memory, and mental processing efficiency. Very brief tests appear to be relatively insensitive to the effects of OSA. Concept formation and mental flexibility may also be areas of significant deficit, but require further investigation. Correspondence: *Dean Beebe, CHMC Psychology Division, 3333 Burnet Ave., Cincinnati, OH 45229. E-mail: dean.beebe@chmcc.org*

D. BEEBE, L. GROESZ, C. WELLS, A. NICHOLS, & K. MCGEE. The Neuropsychological Effects of Obstructive Sleep Apnea (OSA): A Meta-Analysis.

The research literature on the neuropsychological effects of Obstructive Sleep Apnea (OSA) has yielded seemingly contradictory findings, and narrative reviews of this literature are prone to interpretive errors. We used sophisticated meta-analytic models to minimize such errors, with the goal of clarifying the effect of OSA on cognitive functioning. We reviewed research published or presented between 1985 and 2001 that included measures of neuropsychological functioning among untreated adults with OSA. Twenty-six studies met review criteria, representing 1062 OSA patients and 913 healthy controls. Two sets of effect sizes were generated. One compared OSA group means against those of healthy controls in case-controlled studies. The other compared all OSA group means against

published normative data. Within each data set, nine neuropsychological outcome domains were coded. In both data sets, untreated OSA was found to have a negligible impact on intellectual and verbal functioning, but had a substantial impact upon executive functioning. Data were mixed with regard to visual and motor functioning; post-hoc inspection of the data suggested that tests of fine motor coordination or drawing were more sensitive to OSA than tests of simple fine motor speed or visual perception. Data were also mixed with regard to memory functioning, probably related to methodological differences across studies. *Conclusions:* Etiological models should emphasize mechanisms known to affect executive functioning and motor coordination, but not intelligence, verbal functioning, or visual perception. Clinicians should be alert to the co-occurrence of OSA symptoms with declines in executive functioning or coordination. Correspondence: *Dean Beebe, CHMC Psychology Division, 3333 Burnet Ave., Cincinnati, OH 45229. E-mail: dean.beebe@chmcc.org*

Z. CAMPBELL, D. MARRONE, R. MRAZ, K.K. ZAKZANIS, & S.J. GRAHAM. The Functional Neuroanatomy of Planning as a Subset of Navigation Through a Virtual Reality Environment.

We are in the midst of investigating the executive functioning components of human spatial navigation. The majority of previous research has predominantly focused on memory aspects of navigation while neglecting to further define and explain patterns of neuroactivation consistently found within the frontal circuits. We are specifically interested in the planning component of executive function and prior functional studies have only investigated such performance through the use of classical neuropsychological tests (e.g., Tower of London). Using a virtual city, we are implementing a realistic learning scenario in which a participant learns a particular route and portions of the surrounding area. Once trained, the subject participates in a fMRI testing session in which a novel task is introduced to elicit and isolate planning performance. This central task consists of placing roadblocks randomly throughout their path. Furthermore, in line with previous attempts we are also replicating the functional analysis of planning using a classical measure, namely, the Tower of London. The results from a normal healthy volunteer will be presented to help us elucidate the functional neuroanatomy of planning in general and how it specifically relates to visual navigation using an ecologically valid platform of investigation.

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B. SHENAL, S. HINZE, & K.M. HEILMAN. Hemispheric Asymmetries of Response Inhibition.

We wanted to learn if there are hemispheric asymmetries of response inhibition (RI) in normal subjects by using a miscue reaction time (RT) paradigm. Valid cues, presented in 80% of the trials, allow motor response preparation for the right or left hand. Invalid cues, presented in 20% of the trials, slow RT because they require the subject to inhibit the prior motor preparation. This experiment was designed to learn if miscues directed to the right hemisphere (left visual field) were different from those directed to the left hemisphere (right visual field). Thus, lateral motor cues (valid and invalid) and subsequent imperative RT stimuli which indicated which hand to use were presented to either the right or left visual fields of fourteen right-handed college students. The "cost" of RI was calculated by subtracting RT following valid cues from RT following miscues. Analyses revealed a significant effect of cue-field such that the cost was higher if the miscue was presented in left hemisphere (*vs.* right hemisphere), refuting the postulate that the right hemisphere is dominant for RI. These results instead suggest that either the left hemisphere is dominant for mediating RI or that the right hemisphere is dominant for motor activation of both hands. This latter hypothesis is supported by the observation that when the left hand is used, the cost is lower after a right field miscue than when the right hand is used after a left field miscue.

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A. CHEUNG, E. MITSIS, & J. HALPERIN. Behavioral Inhibition and Executive Functions.

Barkley proposed a hybrid model of executive functions which consists of four domains: working memory (nonverbal), internalization of speech (verbal working memory), self-regulation of affect/motivation/arousal, and reconstitution. According to the model, the ability of these functions to operate adequately is dependent upon one's capacity for inhibitory control. Therefore, this model predicts a direct association between measures of inhibitory control and executive functions such that those with deficient inhibitory control should show impairment of executive functions. To test this hypothesis, 38 nonreferred young adults were administered tests of executive functions, along with two laboratory measures of inhibitory control, the Stop Signal task and a go-no-go task, as well as the Barratt Impulsivity Scale (BIS). The Stop Signal Reaction Time (SSRT) was found to significantly ($p < .05$) correlate with performance on Trails B ($r = .52$), categories achieved ($r = -.32$) and perseverative responses ($r = .37$) on the Wisconsin Card Sort Test (WCST), Continuous Performance Test false alarms ($r = .39$), and Competing Motor Programs ($r = .41$), all in the expected direction, such that poorer inhibitory control was associated with increased executive impairment. In contrast, inhibitory control, as measured by go-no-go, did not correlate with any measure of executive function (all $p > .10$), nor did it correlate with the SSRT. Finally, increased cognitive, but not motor, impulsivity, as measured by the BIS was associated with WCST perseverative responses ($r = .36$), Letter-Number Sequencing ($r = -.39$), and Trails B ($r = .36$). Taken together, these findings provide partial support for Barkley's theory that effective executive functions are dependent upon sufficient inhibitory control.

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M. NEWMAN, R. CASELLI, A. HOLLAND, G. ALEXANDER, A. EVANGELISTA, S. McCLURE, C. HARRISON, & E. REIMAN. Incidence of Divorce in Persons at Genetic Risk for Alzheimer's Disease: ApoE $\epsilon 4$.

Our previous work has shown that $\epsilon 4$ carriers are more talkative than noncarriers, and that this correlates with PET measurements of reduced prefrontal metabolism. In this study we explored the possibility that another correlate of frontal disinhibition may be manifest in greater social instability. We therefore examined the rate of divorce as a practical index of social instability in 25 cognitive normal individuals of known ApoE genotype. Participants included 2 individuals with $\epsilon 2/\epsilon 3$ genotype (M age 65.0, SD 4.2 years, M education 19.5, SD 2.1 years, M number of divorces 2, SD .01); 11 with the $\epsilon 3/\epsilon 3$ genotype (M age 56.5, SD 11.0 years, M education 14.4, SD 4.2 years, M number of divorces 2.1, SD .3); 8 with the $\epsilon 3/\epsilon 4$ genotype, M age 56.0, SD 14.1 years, M education 14.7, SD 3.0 years, M divorces 2.1, SD .3); 4 with the $\epsilon 4/\epsilon 4$ genotype (M age 63.0, SD 10.4 years, M education 15.6, SD 2.4 years, M divorces 2.7, SD .9). Examination of number of divorces revealed no significant differences between groups although absolute numbers suggest a trend toward more divorces in $\epsilon 4$ homozygotes. Restricting analysis to those who have experienced multiple divorces revealed a greater incidence of multiple divorces in $\epsilon 4$ homozygotes at a significance level of $p < .05$. Perhaps this phenomenon, like talkativeness, is also related to reductions in frontal lobe activity in $\epsilon 4$ homozygotes. This hypothesis will be addressed in a future study.

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EMOTION**M. CIAMPITTI, J. ROSENBEK, K.M. HEILMAN, L. J. GONZALEZ ROTH, & R.E. BAUTISTA. Seizure-Induced Transient Expressive Aprosodia: A Case Report.**

The inability to express emotional prosody has been described in patients with structural damage to the right frontal lobe. This is typically seen after

cerebrovascular accidents or heat trauma. In this case, we describe a 43-year-old woman who presented with expressive emotional aprosodia with normal comprehension of prosody. This temporary disorder was associated with an ictal manifestation of focal seizures emanating from the right temporo-parietal region as documented by EEG. The head MRI was normal. The patient was started on anti-seizure medication (phenytoin) and her prosody quickly returned to normal. The patient was videotaped before and after drug treatment and 5 experienced speech-language pathologists (SLP) were asked to judge the characteristics of this patient's speech and to diagnose the speech disorder. The raters were unaware of the patient's medical history. Prior to anti-epileptic drug therapy all raters judged her speech as either monotone or impaired in prosody. Two also rated her facial affect as "flat" and 4 described her speech as dysarthric but could not agree on the type of dysarthria. When viewing the segment of the patient's speech after receiving drug therapy, all SLP's rated her speech as normal. Patients with seizures localized to the left temporal parietal region often experience speech arrest. This case demonstrates that isolated expressive aprosodia may be a clinical manifestation of focal seizures of right temporoparietal origin. This case also adds to the body of evidence suggesting that the right hemisphere is dominant for mediating the expression of emotional prosody.

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C. SIDERS, C. CIMINO, & N. GATES. Trait Depression in Perception and Memory of Laterally Presented Emotional Words.

The valence hypothesis states that the left and right hemispheres are specialized for positive and negative information respectively. Recent studies have expanded this hypothesis to emotional memory. The current study explores trait depression influences on the cerebral asymmetries of perception and memory of emotional words. Participants scoring in the upper 20% ($N = 27$) or lower 20% ($N = 25$) of the trait negativity scale of the Depression Adjectives Checklist (DACL) were selected from 583 undergraduate students. Participants completed a lateralized lexical decision making task consisting of 150 n.s. presentations of pronounceable non-words and positive, negative, and neutrally valenced words, followed by tests of immediate recall and recognition. Subjects demonstrated significant left hemisphere advantages in the identification and recognition of positively valenced words and the identification, recall, and recognition of negatively valenced words. For neutral words, the left hemisphere advantage was abolished for identification and recognition tasks and reversed for recall tasks. Finally, in the right hemisphere, positive words were identified less often than neutral words in the high trait negativity group, while no such difference was demonstrated in the low trait negativity group. Although only partially coinciding with the valence hypothesis, the results are consistent with neuroimaging studies demonstrating lateralized right cerebral hemisphere activity during the presentation of neutral material and studies reporting selective left amygdala involvement in emotional memory.

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L.H. PICK, J.C. BOROD, H. EHRLICHMAN, & R. BLOOM. Lexical Expression of Emotion in Stroke: Inter- and Intrahemispheric Effects.

This investigation examined neural mechanisms underlying the expression of lexical (i.e., verbal) emotion. Participants included individuals with left-hemisphere (LH; $n = 13$) and right-hemisphere (RH; $n = 13$) cortical cerebrovascular lesions, which occurred in either anterior or posterior quadrants. Thirteen healthy controls (HCs) were also included. Participants produced narratives based on autobiographical memories of emotional or nonemotional topics. Narratives were transcribed so that nonverbal factors (i.e., face and prosody) were removed and raters could focus solely on the lexical emotional content. The dependent variables of overall emotional content and intensity, positive emotional content and intensity, and negative emotional content and intensity were then analyzed

in accordance with the right-hemisphere and valence hypotheses. The data revealed that the LH group experienced more difficulty processing emotional content and intensity than did the RH-damaged and HC groups for positive, but not negative, emotional ratings. This finding provides some partial support for the valence hypothesis. Regardless of laterality, patients with anterior (i.e., frontal lobe) lesions had reduced emotional output as compared to patients with posterior lesions. Interestingly, among individuals with LH pathology, those with mild residual aphasic symptoms performed more poorly on the tasks than those with intact language functions. As would be expected, narratives based on emotional topics contained more emotional content and intensity than nonemotional narratives. Further, negative emotions were rated with more emotional content and higher intensity than positive emotions. These findings are discussed in terms of lateralization theory, recovery of emotional function, facilitation effects, and methodological issues.

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G. SELKE, C. McDONALD, & D. BOWERS. Retrosplenial Contributions to Verbal Emotion Processing.

Background. Recent functional neuroimaging studies have provided evidence that the retrosplenial (RS) area may play an important role in evaluating emotional stimuli. Our previous research using visual emotional stimuli (pictures) in a patient with a left RS lesion did not support these findings. A reevaluation of the imaging literature revealed that left RS activations were found primarily in studies using emotional verbal stimuli. In this study, we test the hypothesis that emotion processing in the RS region is, at least partly, material-specific. **Methods.** We report follow-up data on a 48-year-old left-handed male following removal of an AVM in the left RS cortex. Experimental measures of emotion processing included psychophysiological reactivity (SCR, startle) to aversive, neutral, and pleasant words and sentences. Responses were compared to age-matched controls ($N = 5$). **Results.** Physiologic reactivity to verbal emotional stimuli was markedly abnormal. While our patient showed normal arousal (SCR) to emotional words and sentences, fear-potentiated startle was significantly reduced to both types of verbal stimuli relative to controls. These findings contrast with his normal physiologic reactivity to emotional visual stimuli (as previously reported). **Conclusion.** Our study represents the first human lesion study to implicate the RS cortex in emotion. In particular, our results suggest that the left RS region may be part of a neural network essential for processing emotionally salient verbal material. These findings corroborate imaging research suggesting that emotion processing within this region may be material-specific.

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G. BROUSSEAU & L. BUCHANAN. Semantic Category Effect and Emotional Valence in College-Age Students.

Patients in the early stages of Alzheimer's disease (AD) show a semantic category effect demonstrating a biological disadvantage on confrontational naming tasks in that AD patients produce more errors naming pictures of biological items than nonbiological items. This biological disadvantage has been explained by models of picture naming that assume multiple lexical memories that relate to the manner by which these items are learned. Biological items are understood with respect to perceptual input whereas nonbiological items are understood with respect to functionality. An alternative hypothesis proposes that these items differ with respect to their emotional valence. We show, through a confrontational naming study using college-age participants, that emotional valence associated with target items predicts reaction times. Moreover, we demonstrate that biological items are generally rated higher in emotional valence. Participants were asked to name as quickly and accurately as possible the items in 45 black-and-white pictures randomly presented by computer and to subsequently rate each item on emotional valence. Biological items were named faster than nonbiological items, and pictures of items rated as

being high in emotional content were named more quickly than those rated as being low in emotional content. This relationship between emotional content and reaction time was more pronounced for the biological items than for the nonbiological items. The findings from this study will be discussed in terms of an alternative to the present theories regarding the biological/nonbiological dissociation in AD picture naming.

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S.J. HALL, J.C. BOROD, M. SLIWINSKI, M. MARTINEZ-PONS, & L.H. PICK. Perception of Facial, Prosodic, and Lexical Emotion Across the Adult Life Span.

Age-related changes in emotional perception across facial, prosodic, and lexical communication channels were examined in 100 healthy normal adults (20–80 years) in the context of the fluid/crystallized theory of intellectual functioning. Emotional perception was expected to be highly related across modalities and was hypothesized as a crystallized ability. Emotional identification and discrimination measures from the New York Emotion Battery were administered. Eight discrete emotions, three positive and five negative, were assessed. Aspects of nonemotional cognitive ability, including crystallized and fluid intelligence and auditory and visual perception, were also evaluated. Results from structural equation models revealed that, though highly correlated, verbal (i.e., lexical) and nonverbal (i.e., facial and prosodic) emotional perception were best characterized as separate from crystallized and fluid intelligence. However, a functional relationship was seen, such that crystallized intelligence significantly influenced verbal emotional perception. Using correlational analysis, emotional perception and fluid intelligence evidenced strong inverse relations to age and strong positive relations to each other. When age was taken into account in the structural model, the relationship between emotional perception and fluid intelligence disappeared, suggesting that some common underlying age-based physiological changes contribute to age-related decline for both of these otherwise disparate abilities. In an attempt to extend the common cause hypothesis to emotional perception, the relationship between age-related decline in sensory functioning and emotional perception was examined. Differences in hearing thresholds did not attenuate age-related variance in emotional perception by an appreciable amount. Correspondence: *Susan J. Hall, Ph.D., North Shore University Hospital Preschool Development Program, 57 Willet Avenue, Hicksville, NY 11801. E-mail: suejhall@aol.com*

M.T. HEINLY, K.W. GREVE, & C.L. JOFFE. A Disruption of Facial Affect Processing in Word Deafness.

Pure word deafness is a rare neurobehavioral syndrome that is characterized by an inability to understand spoken language with intact hearing, speaking, reading, and writing, and the ability to identify non-speech sounds. The lesions associated with this condition effectively deafferent the posterior temporal gyrus from inputs from both hemispheres in part by damaging transcallosal auditory fibers and portions of the optic radiations. W.D. is a 45-year-old male who suffered a stroke in August, 2000. MRI demonstrated an acute lesion of the left temporal lobe and chronic lesion of the right temporal lobe. Eighteen months after the stroke formal testing confirmed his word deafness. A pre-existing high frequency sensory hearing loss was noted on audiological examination. The facial affect subtests of the Florida Affect Battery were administered because the prosody tasks were compromised by the sensory hearing loss. W.D. scored approximately two standard deviation units below the means of published age-matched controls on Identity Discrimination, Affect Discrimination, Name Facial Affect, and Match Facial Affect. Interestingly, on Select Facial Affect he earned a z score of -12.1 . This task involves selecting the correct face in response to, in this case, written emotion word (i.e., happy, sad, angry, frightened, neutral). Thus, he could name facial affect and match affective faces but he could not match the affect word to the affective face. These findings raise the possibility of a very specific disturbance

of visual affect processing in word deafness. The possibility that this deficit is related to an interhemispheric disconnection is considered.

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A. GADE, M. CLAUSEN, H. PALMASON, & A. VOGEL. Recognition of Facial Emotions: Age Effects and Results in Obsessive-Compulsive Disorder and Tourette Syndrome.

Impairments in the recognition of specific basic emotions in faces have been observed in some patient groups. We used the emotional hexagon in a printed version to study this as well as age effects. Neither Tourette patients ($N = 23$, M age 13 years) nor patients with obsessive-compulsive disorder (OCD, $N = 15$, M age 39 years) differed from matched control groups of normal subjects of similar size on any of the emotions. In an ongoing study we also compared 78 patients referred to a memory disorders clinic (age above 60, MMSE 20 or above) with 48 matched normal volunteers, finding a small difference in the recognition of sadness only. Compared to young adults, adolescents performed at highly significantly lower levels in the recognition of fear and disgust. Compared to young adults, elderly subjects performed at significantly lower levels in fear and sadness. Both adolescent and elderly subjects were marginally lower in anger recognition and performed at similar levels as young adults in the recognition of happiness and surprise. We failed to confirm the existence of a specific deficit in OCD of disgust recognition, and we demonstrated an unexpected difficulty among adolescents of disgust and fear recognition in faces.

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A. LAUTZENHISER, A. HART, K. MCBURNEY-REBOL, L.K. PAUL, & W.S. BROWN. Psychophysiological Validation of the Diagnostic Analysis of Nonverbal Accuracy.

Testing of affect and social processing is becoming increasingly important in neuropsychological assessment, particularly in neuropsychological rehabilitation and neurodevelopmental disorders. One test currently being used to assess affective and social processing in traumatic brain injury is the Diagnostic Analysis of Nonverbal Accuracy—Adult Facial Expressions (DANVA2–AF). The DANVA2–AF consists of 24 pictures of adult faces exhibiting four emotional states (happy, sad, angry, and fearful) across two intensities (high and low). It is unclear, however, if the stimuli of the DANVA2–AF elicit a reliable autonomic emotional response, or if it elicits primarily cognitive recognitions. This study tested emotional responses to DANVA stimuli through psychophysiological recording of facial electromyography (EMG) and galvanic skin response (GSR). Results indicate a significant interaction between emotional state and intensity for GSR ($p < .01$). GSR readings were significantly lower for high intensity vs. low intensity “happy” slides, while the opposite relationship was true for high and low intensity “sad” and “angry” slides. Further, the right zygomatic muscle showed a weak trend ($p = .07$) for discrimination between happy and sad slides (across both intensities). The results suggest that the DANVA2–AF elicits distinct emotional responses specific to stimulus types and does not rely solely on cognitive recognition.

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R. GREEN, G. TURNER, W. THOMPSON, B. LIAU, & T. ORTO-LANO. Emotion Perception in Faces in Recently Traumatically Brain-Injured Patients.

Background: In a previous study, we examined the ability of a recently traumatically brain-injured (TBI) group ($M = 2$ months post-injury) to perceive emotions in faces. Emotion perception had yet to be studied in recent TBI; indeed, emotion perception in TBI at any time-point post has been little investigated. We found deficits to be robust, but ceiling effects—using accuracy as the dependent variable (DV)—limited our conclusions.

In this follow-up study, we employed reaction time as the DV to obviate this problem. *Methods:* Participants: recent TBI ($N = 10$); age- and education-matched controls ($N = 10$). Battery: adapted, computerized version of Florida Affect Battery, comprising (1) ‘labeling face-emotion’ and labeling neutral shape (control); (2) ‘discrimination of face-emotion’ and, discrimination of neutral face and neutral shape (controls). *Results:* Group \times Task repeated measures ANOVAs revealed for labeling tasks, a significant main-effect of group ($p < .05$) and task ($p < .01$), and revealed the same for discrimination (both, $p < .01$). Group-by-task interaction was significant for labeling ($p < .05$) and approached significance for discrimination ($p = .076$). Patients were significantly worse on emotion perception tasks than control tasks for both labeling and discrimination. *Conclusion:* Both patients and controls performed worse on emotion perception tasks than on neutral shape and face-processing tasks, but the patient group was disproportionately impaired on emotion tasks. These findings substantiate our previous finding that face emotion perception is disrupted in patients with recent TBI beyond disruptions to processing of other types of visuospatial material. Neural implications are discussed.

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S. KAZANDJIAN & J.C. BOROD. Facial Emotional Expression During Monologues From Unilateral Stroke Patients.

In an earlier study, brief excerpts were examined from the initial portion of emotional monologues of brain-damaged subjects to determine whether the cerebral hemispheres are differentially specialized for facial emotional expression. In the current study, full monologues will be rated for emotional intensity and category accuracy with a new method. A special feature of this study is the comparison of expressions produced during the initial, middle, and last segments of monologues. Eight right brain-damaged (RBD), 8 left brain-damaged (LBD), and 8 normal control (NC) subjects, matched for demographics and lesion location, were videotaped while producing monologues and 4 emotional experiences (happiness, interest, sadness, and fear) and 2 nonemotional events. Five raters were trained using a method adapted specifically for facial expression in monologues. Pilot data, obtained by rating the monologues of 3 subjects, indicate that this method is effective and yielded high interrater reliability, with median intraclass correlation values of .88 for intensity and .86 for accuracy. Examination of these data showed that the LBD expressed emotion more intensely and accurately than the NC and RBD. This observation is consistent with literature suggesting that LBDs may compensate for language deficits via the intact right hemisphere. Analysis of monologue segments indicated greatest intensity and accuracy during the last segment, regardless of emotion type or subject group. The data from all 24 subjects will allow us to verify these preliminary findings.

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C. GOJMERAC, D.T. STUSS, & D. FLODEN. Hemispheric Asymmetry of Approach and Withdrawal Responses to Facial Expressions.

The general objective was to integrate hemispheric specialty of emotional responses and social behavior. We tested the theory that the left hemisphere is specialized for positive emotions and approach behavior and the right for negative emotions and withdrawal. Pictures of facial affect (happy, surprise, anger, fear, sadness, and disgust) were presented individually to the right and left visual fields of normal subjects. In the congruent response condition, the task was to rapidly push forward (approach) or pull backward (withdrawal) on a joystick to respond positive or negative respectively. In the incongruent condition response mapping was reversed. There were 3 key findings. First, we replicated and extended the congruency effect of Chen and Bargh to facial expressions. Subjects were faster to push for positive and pull for negative evaluations. Second, we found partial evidence supporting the approach/withdrawal hypothesis; males showed a trend of faster withdrawal to negative faces in the right hemi-

sphere and faster approach to positive and negative faces in the left hemisphere. Third, with reaction times collapsed across response congruency, females showed a pattern of faster responses to negative faces in the right hemisphere and to positive in the left (valence hypothesis). Males showed a reverse valence effect. The results of this study indicate that emotional valence of social stimuli may be linked to specific behavioral responses, and that males and females may have different neural organizations related to approach and withdrawal systems.

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R. COMPTON, K. WILSON, K. WOLF, & J. DIEPOLD. Worry and Evaluation Influence the Interhemispheric Processing of Emotional Faces.

This study examined how situational and personality factors affect the communication of emotional information between the hemispheres. Participants ($n = 54$) completed a visual perception task that required matching angry and happy facial expressions either within a single visual field or between visual fields. Half of the participants were told that their performance would be observed and evaluated through a 1-way mirror, while for the remainder of the participants the mirror was covered with a curtain. The overall between-field advantage (BFA; between vs. within-field trials [$F(1,50) = 17.81, p = .0001$]) reflected the benefit of sharing processing between the hemispheres. Further, the magnitude of the BFA was influenced jointly by the emotion of the face, the evaluative context, and the worry level of the participant [3-way interaction, $F(1,50) = 6.08, p < .05$]. Participants scoring low on the Penn State Worry Questionnaire (PSWQ) displayed a greater BFA for happy compared to angry faces (regardless of the evaluation condition (Condition \times Face Emotion, *n.s.*). However, for individuals scoring high on the PSWQ, the evaluative context had a different effect on interhemispheric processing for angry and happy faces [Condition \times Face Emotion, $F(1,24) = 4.48, p < .05$]. When worriers were not being evaluated, they exhibited a greater BFA for happy than for angry faces, similar to non-worriers. However, in the evaluation condition, worriers displayed an increased BFA for angry faces and a decreased BFA for happy faces, compared to the non-evaluation condition. These results imply that when worriers believe they are being evaluated, they alter processing priorities to favor the interhemispheric communication of threatening information.

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M. BALCONI & C. LUCCHIARI. Conscious and Unconscious Contributions in Emotional Face Processing.

Current evidence suggests that the process of generating and comprehending an emotion can proceed outside of conscious awareness. In fact, semantic elaboration of emotional information, that includes stimuli categorization and meaning attribution, does not require the contribution of conscious mechanisms. Decoding of facial expression of emotion is analyzed, considering the information elaboration in a condition of subliminal (1 ms) and supraliminal (40 ms) stimulation. The experiments provide brain-event-related potentials (ERPs). In Phase 1, 21 subjects were tested for ERPs measure in presence of congruous or incongruous (morphed) stimuli representing 5 emotions (anger, surprise, happiness, fear and sadness). Ten electrode sites were considered (FZ, Cz, Pz and Oz, F3, F4, C3, C4, P3 and P4). The ERPs correlated allowed to show the presence of a significant semantic effect N400 variation for both subliminal and supraliminal incongruous stimuli. Nevertheless, the 2 negative-going waves present different cortical distribution: N400-like supraliminal effect was more frontally right distributed, whereas the N400-like subliminal effect appeared more right posterior (parietal) distributed. In Phase 2 the subjects were asked to evaluate a new set of stimuli, both target and non-target. The previous unconscious semantic elaboration of the stimuli was revealed by ERPs variations, with different profile for target and non-target stimuli. Specifically, a familiarity effect was observed for the

incongruous target stimuli, with a decrease of the negativity for the N400 peak.

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J. BRAMHAM, R.D. MORRIS, J. HORNAK, & E. ROLLS. Emotional and Social Awareness Following Prefrontal Cortex Damage.

Alterations in emotional and social functioning such as impaired ability to recognize emotions in others, a lack of empathy and poor insight have commonly been reported following prefrontal cortex damage. This study sought to investigate the subtleties of such difficulties in 30 patients with discrete neurosurgical prefrontal cortex lesions using a specifically devised self- and informant-report measure, the Socio-Emotional Questionnaire. The scale was validated against 2 standard measures of brain damage and factor analyzed to reveal 5 subscales. There were no differences between the patient and control groups overall, indicating that such questionnaires measuring wide-ranging individual and subjective differences are somewhat unreliable in detecting prefrontal cortex damage. However, on other measures of everyday functioning, patients with medial and/or dorsolateral damage were found to have increased informant-rated cognitive difficulties in comparison with control subjects. In contrast, patients with damage involving the orbitofrontal region tended to have more difficulties with social and emotional behavior. Patients with bilateral lesions had significantly less insight overall regarding their socioemotional abilities in comparison with the unilateral and control groups. In addition, the right unilateral lesion group showed significantly less insight into their abilities to recognize emotion in others in comparison with the left unilateral group. In conclusion, these results suggest that specific socioemotional and insight deficits may form separate constellations of impairment. Correspondence: *Jessica Bramham, Henry Wellcome Building, Institute of Psychiatry, De Crespigny Park, London SE5 8AF, UK. E-mail: jessica.bramham@slam-tr.nhs.uk*

B. HAREL, K. METEYER, G. JONES, & L.C. MAYES. Contextual Cues in Fear-Conditioned Auditory Startle Response.

Anticipating aversive stimuli potentiates the startle reflex. Contextual cues also potentiate startle, though findings are inconsistent in humans. The present study explored conditioning effect of airblast to the larynx, the effect of a safety signal on contextual fear, and extinction of the conditioned response in 48 adults. The startle probe was a 110 dB white noise presented in 40 ms bursts in the following conditions: no light condition (NLC), paired with a colored light preceding the airblast (threat condition; TC), or paired with a differently colored light signaling absence of the airblast (safe condition; SC). Six trials were presented prior to conditioning and extinction phases to assess habituation; conditioning and extinction were accomplished over 24 and 18 trials respectively. In a condition by phase ANOVA, there was a significant main effect for conditioning [$F(2,1570) = 17.3$], and phase [$F(1,1571) = 33.2$]. *Post-hoc* analysis showed that the startle response increased during TC compared to SC and NLC suggesting that airblast effectively potentiated the startle response. There was also a nonsignificant trend for the startle response to decrease during SC compared to NLC suggesting that the safety signal reduced contextual fear, and there was a reduction in startle to the TC in the extinction phase. The amygdala is a component of the neural circuitry involved in fear conditioning; however, little is known about fear-potentiated startle in children with disorders of affective regulation. This paradigm may be an effective tool for exploring the role of fear and anxiety in these populations.

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T. NICHOLLS, L. NAKHUTINA, & J.C. BOROD. Psychological and Neural Mechanisms of Right-Hemisphere-Mediated Emotion Processing.

There is an abundance of evidence demonstrating that the role of the right-cerebral hemisphere (RH) in emotion perception and expression across

several modalities (e.g., face, prosody, gesture, and speech content). However, few attempts have been made at examining the characteristics that make the RH conducive for emotion processing. This paper consolidates past and current findings and examines why the RH might be preferentially involved in processing emotion. The RH plays a dominant role in nonverbal and integrative functions. It has also been proposed that emotion processing utilizes such functions. We attempt to demonstrate similarities between these proclivities and emotion processing. We reviewed neuroanatomical literature suggesting that the larger volume of RH white matter indicates greater intrahemispheric connectivity, resulting in enhanced capacity for integrative functions. This notion is supported by neurophysiological (e.g., EEG) data, showing greater cohesion in the RH. Additionally, we discuss arousal/attention mechanisms and their relationship to emotion processing. Furthermore, neurochemical evidence suggests that the RH receives stronger norepinephrine innervation than the left hemisphere. The consequence of such an asymmetry is important for attention, arousal, and perhaps even for emotion processing. Finally, we examine current inquiries into the neuropathology of RH-linked syndromes (e.g., Turner's). The white matter model has been proposed to explain nonverbal deficits found in several disorders. Interestingly, individuals with these disorders often demonstrate impairments in social perception, interpersonal relations, and possibly emotion processing.

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EPILEPSY AND MEMORY IMPAIRMENTS

J. McGLONE, D. CLARKE, R.M. SADLER, I. VALDIVIA, & M. PENNER. Vagal Nerve Stimulation Did Not Enhance Memory After 12 Months of Treatment.

Background: Vagal nerve stimulation can be an effective add-on treatment for medically refractory seizures. Clark et al. showed that low amplitude, i.e., non-therapeutic range enhances memory. Prolonged, higher amplitude stimulation parameters may be clinically therapeutic in reducing seizures, but thus far have not proven beneficial to cognition in prior studies that tracked patients over 3 or 6 months. **Objective:** The current study was undertaken to evaluate the neurocognitive outcome of vagus nerve stimulation over 12 months in a clinical sample. **Method:** Three groups of patients with epilepsy underwent neuropsychological evaluation including memory assessment (WMS-III) and self-rating of memory functioning on 2 occasions, i.e., before and 12 months after implantation of a vagal nerve stimulator ($n = 15$), temporal lobectomy ($n = 9$), and a medication only control group ($n = 11$). Depression scores (Geriatric Depression Scale), seizure frequency, and Quality of Life (QOLIE-89) were also analyzed. Grouped data were subjected to an Analysis of Variance and individual change scores were subjected to a reliable change index analysis. **Results:** The patients receiving vagal nerve stimulation were not superior to other groups on any outcome measure 12 months after implantation. Similarly, the percentage of patients who improved beyond measurement error did not differ in any of the three patient groups. **Conclusion:** Vagal nerve stimulation as an adjunctive therapy for seizure control did not enhance memory functioning over a 12-month interval.

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J.C. ALVAREZ-CARRILES & M. WESTERVELD. "Primacy Is to Long-Term Memory as Recency Is to Short-Term Memory"? Analyses From Temporal Lobe Epilepsy Patients.

Serial position effect (SPE) is a frequent phenomenon described in the free recall of a word list. Although different experimental and neuropsychological results suggest a direct relationship between recency effect (RE) and short-term memory (STM) and between primacy effect (PE) and long-term memory (LTM), other evidence raises questions about this classical interpretation. In order to clarify some of these questions, immediate and delayed SPE (primacy, middle, and recency) in a classical word-list test (selective reminding test) were analyzed, as well as its possible relationship with STM and LTM in 2 groups of temporal lobe (left vs. right) epilepsy patients. Both groups were matched in age, education, FSIQ and verbal STM, but they were significantly different in their verbal LTM. Our results demonstrated that, in the immediate condition, both groups showed the typical SPE, with no group difference in its three components. In contrast, in the delayed condition, no SPE was observed in either group. Also, the right temporal lobe group performed significantly better across all the components of the curve. Further analyses showed that while LTM seems to operate in all components in the delayed condition, the STM would only operate in the RE in the immediate condition. Finally, our results suggest that there would be 2 memory processes involved in the learning of the SRT list, different from STM and LTM and conceptually related to the new concepts of episodic buffer or long-term-working-memory, that might be responsible of the primacy and middle effects in the immediate condition.

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M. SITSKOORN, M. SALDEN, R. KAHN, P. VAN RIJEN, & C. VAN VEELLEN. Latent Inhibition in Temporal Lobe Epilepsy Patients and Matched Controls.

Background: Latent inhibition (LI) is a decrement in conditioning to a stimulus as a result of its prior non-reinforced pre-exposure. The apparent benefit of LI lies in learning to ignore irrelevant stimuli. Several studies have cited evidence that lesions to the entorhinal cortex, as well as to the nucleus accumbens, sometimes in combination with the hippocampal formation, reduce LI in rats. Temporal lobe epilepsy (TLE) is characterized by selective mesial temporal pathology. Therefore, a disruption of LI in TLE patients can be hypothesized. **Method:** A visual latent inhibition paradigm was administered to 14 TLE patients (Wyler Grade 3–4) and 16 carefully selected healthy controls. All subjects were pre-exposed to a to-be-conditioned stimulus (CS). The CS was subsequently paired with an unconditioned stimulus (UCS). If TLE patients need fewer trials to learn the CS-UCS association than controls, our hypothesis is confirmed. **Results:** Contrary to our hypothesis, analyses showed a trend for enhanced (instead of reduced) visual latent inhibition in TLE patients compared to controls ($p = .058$). **Discussion:** Successful performance on our task might require relational learning. Several studies show that the hippocampus is critically involved in relational learning. Since all our TLE patients showed hippocampal sclerosis, the present data might be explained in terms of disrupted relational learning. Both groups will be extended and alternative explanations in terms of anti-epileptic medication and neuro-anatomical basis of LI will be discussed.

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R.M. ROTH, B.C. McDONALD, A.J. SAYKIN, B. JOBST, V.M. THADANI, & P.D. WILLIAMSON. Performance on Memory Malinger Tests in Epilepsy.

Few studies to date have reported on the performance of patients with objective evidence of brain abnormalities on memory malingering tests, information vital for appropriate test interpretation. In this study, patients with epilepsy completed tests of memory malingering as well as standard tests of episodic memory and measures of mood and subjective memory complaints. **Participants:** Fourteen adults with epilepsy diagnosed by detailed medical evaluations including laboratory tests, inpatient video-EEG monitoring, and MRI. **Methods:** As part of a comprehensive neuropsychological evaluation, participants completed the Test of Memory Malinger (TOMM), CVLT-II including the forced-choice recognition trial, Squire Memory Rating Scale, BDI-2 and STAI. **Results:** All participants showed perfect performance (50/50 correct) on Trial 2 and the Retention Trial of the TOMM, scoring above specified cutoff criteria for suboptimal performance (<45/50). All subjects also showed perfect or near perfect (15–16

correct of 16 items) CVLT-II forced-choice recognition memory. Findings were observed in the context of varying levels of cognitive impairment, subjective memory complaints, and mood disturbance. No difference on malingering measures was noted between patients with (71%) and without (29%) memory impairment on standardized measures. *Conclusions:* Findings of perfect or near-perfect performance on TOMM and CVLT-II Forced Choice measures by individuals with documented brain abnormalities further supports the contention that suboptimal performance on these measures is suggestive of inadequate effort on cognitive testing. Data collection is ongoing to assess the reliability of these findings in an expanded sample.

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H.R. GRIFFITH, R. PYZALSKI, D. O'LEARY, V. MAGNOTTA, P. RUTECKI, R. SHETH, B. BELL, C. DOW, G. WENDT, M. SEIDENBERG, & B. HERMANN. Neuroanatomical Correlates of Rapid Forgetting in Temporal Lobe Epilepsy.

Temporal lobe epilepsy (TLE) patients commonly complain of forgetfulness. Studies of forgetting in TLE using the typical 30-min delays do not consistently demonstrate accelerated forgetting, but other studies with delays of 24 h or more have demonstrated consistent evidence of forgetting for left TLE patients. Blake and colleagues theorized that rapid forgetting in TLE is a result of left temporal lobe seizures rather than left hippocampal sclerosis. We tested this hypothesis using both verbal and nonverbal learning tasks with 24-h delayed recall and using MRI hippocampal volumes in 49 TLE patients (14 left, 16 right, 14 bilateral, 5 non-lateralizing) and 43 normal controls. TLE patients demonstrated significant 24-h forgetting on the verbal learning task but not on the nonverbal learning task. Left temporal or bilateral temporal TLE had greater forgetting of verbal learning compared to right TLE and controls. Hippocampal volume loss was associated with forgetting of verbal material at 30 minutes but not 24 h, whereas hippocampal volume loss was associated with 24-h forgetting of nonverbal material. Discriminant function analysis demonstrated that neither hippocampal volume nor localization of seizure focus could correctly classify TLE patients who forgot verbal material over 24 h from those who retained verbal material. The discriminant function for nonverbal forgetting over 24 h demonstrated that left hippocampal volume alone classified forgetters and retainers with 79% accuracy. These results indicate complex relationships between seizure focus or structural volume loss and rapid forgetting in TLE and implicate different mechanisms of forgetting for different types of material.

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Y.L. CHANG, E.C. LERITZ, K. McCOY, C.R. McDONALD, & R.M. BAUER. Use of the WMS-III in Surgical Epilepsy.

The main purpose of neuropsychological assessment in the treatment of surgical epilepsy is to provide data on lateralization and localization of seizure onset. The present study examined the ability of the Wechsler Memory Scale-Third Edition (WMS-III) to predict lateralization and localization of seizures in a population of patients with intractable epilepsy. Patients were classified using EEG and MRI data as having extratemporal or temporal lobe epilepsy (TLE). The TLE patients were further classified as having right or left seizure onset. The majority of the extratemporal cases had frontal lobe epilepsy. Univariate analyses of variance (ANOVA) using the various WMS-III indices as dependent measures were used to evaluate group differences. Results indicated that none of the WMS-III memory indices distinguished right vs. left seizure onsets, nor were there any group differences on individual subtest scores. However, extratemporal patients performed significantly worse than the TLE patients on the Working Memory Index. Three individual subtests distinguished temporal and extratemporal patients: Family Pictures, Digit Span, and Spatial Span. These results indicate that, while the WMS-III may not be effective in

differentiating left and right TLE patients, it appears to have some utility in determining temporal vs. extratemporal localization. Issues with regard to the use of the WMS-III in surgical epilepsy evaluations will be discussed. Correspondence: Yu-Ling Chang, Department of Clinical and Health Psychology, University of Florida, Health Science Center, P.O. Box 100165, Gainesville, FL 32610. E-mail: ychang@hp.ufl.edu

S.L. REMINGER, L.D. LITTRELL, B. DAVID, A.W. KASZNAK, L. RYAN, D.M. LABINER, & K. KAEMINGK. Hippocampal Sclerosis, Memory, and Patient Report of Function in Epilepsy.

The hippocampus is a temporal lobe structure thought to play an important role in episodic memory function. Neuropsychological research has demonstrated that hippocampal damage can cause decrements in memory performance. Patients suffering from complex partial seizures have been shown to have varying degrees of hippocampal sclerosis, which is thought to contribute to reported impairments in memory in this population. For the present study, 20 patients with complex partial epilepsy of presumed temporal lobe origin participated in structural magnetic resonance imaging. These images were used to quantify the volumes of the left and right hippocampus using manual morphometric measurement techniques. Patients also completed a series of standardized neuropsychological tests and a quality of life inventory. Multiple regression analyses demonstrated that left hippocampal volume predicted patients' retention of information from stories over a delay. Smaller volumes were associated with poorer recall. Left hippocampal volume also predicted performance on an auditory attention task, yet on this task smaller volumes were associated with superior performance. Multiple regression analyses were also conducted on subjective quality of life measures. Both left and right hippocampal volume predicted patients' subjective report of their cognitive functioning. Smaller left hippocampal volumes were associated with more positive reports of cognitive functioning, and smaller right hippocampal volumes were associated with more negative reports of cognitive functioning. These results will be discussed with regard to the potential influence of hippocampal sclerosis on neuropsychological performance and subjective report of cognitive function.

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E.C. LERITZ, R.M. BAUER, S. ROPER, R. GILMORE, & S. EISENSCHENK. Stereologic Measures of Hippocampal Cell Loss and Memory Function in Surgical Epilepsy.

Surgical resection of the medial temporal lobe, including the hippocampus, is a viable treatment option for the relief of intractable temporal lobe seizures. It is widely known that the hippocampus plays a critical role in the formation of new verbal and non-verbal memories. Specific subregions of the hippocampus, including cornu ammonis (CA) fields and the subiculum, have been implicated more strongly in certain aspects of memory. The present study investigated the relationship between neuropsychological functioning and specific subfield cell density counts in a group of patients with right ($N = 8$) or left ($N = 6$) temporal lobe epilepsy (TLE). Patients were evaluated with a broad range of neuropsychological measures pre and post anterior temporal lobectomy surgery. Quantitative cell counts were conducted on hippocampal specimens collected during surgery, including the subiculum, as well as CA regions 1, 2, 3, and 4 using a stereologic procedure. Correlational analyses were then conducted between subfield cell counts and surgery-induced memory change. Overall, the most consistent correlations were found between CA1 and CA3 and memory difference scores; smaller correlations were found with the subiculum, CA2 and CA4. In the left TLE patients, memory change scores were negatively correlated with subfield densities. This is consistent with previous investigations of macroscopic hippocampal cell counts and memory. In contrast, subfield densities from right TLE patients were more positively correlated with cognitive change following surgery. These results will be discussed in relation to functional adequacy versus functional

reserve models of hippocampal functioning to predict post-surgical memory performance in epilepsy patients.

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J. PINKSTON, C. KUBU, T.T. LINEWEAVER, R. NAUGLE, W. BINGAMAN, & I. NAJM. Do WMS–III Discrepancy Scores Predict Memory Outcome Following Temporal Lobectomy?

Likelihood ratios (LR) provide a powerful clinical tool for examining the utility of specific tests in identifying various patient groups at the individual patient level. We demonstrated the advantage of LR in predicting side of surgery in temporal lobe epilepsy patients using Auditory minus Visual Memory Index discrepancy scores from the WMS–III. The present study used LR to examine the utility of the same WMS–III Index discrepancy scores in identifying patients whose memory declined following surgery based on standardized regression-based change norms. Group analyses revealed significant discrepancy score differences in the expected directions between left and right anterior temporal lobectomy (ATL) patients prior to and following surgery. In addition, patients who underwent left ATL demonstrated clear declines on Auditory Memory Index scores following surgery. However, when the data were analyzed at an individual patient level using LR, the resulting LR approximated zero indicating that use of the discrepancy scores did not improve prediction of memory decline significantly greater than predictions based on base-rate information. These findings are contrary to those predicted by the functional adequacy model and are similar to other findings from our center which demonstrated that pre-operative WMS–III scores did not substantially improve prediction of post-operative memory change. These observations raise a number of provocative questions regarding potential differences between the WMS–R and WMS–III in evaluating changes in surgical epilepsy patients. In addition, the findings indicate that factors other than functional adequacy may play a role in identifying memory risk following ATL.

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J.S. HAUT, L.D. STANFORD, T.T. LINEWEAVER, R.L. DUCHOSLAV, E. WYLLIE, & P. KOTAGAL. Verbal and Visual Learning in Children and Adolescents With Epilepsy.

The memory performance of three groups of epilepsy patients (left hemisphere = 16, right hemisphere = 12, generalized = 10) was compared to that of 26 normal controls using the WRAML Verbal and Visual Learning subtests. Given that the factor structure of the WRAML has not been supported, individual subtests were chosen. Groups were matched on age with group averages ranging from 142.00 to 144.06 months. Raw scores for each learning trial and the delays were converted into proportion recalled. Results of a 2 (type) \times 4 (trial) \times 4 (group) MANOVA indicated significant main effects of type (less was recalled from the visual learning subtest) and trial (more was recalled over successive presentations). Also noted was a significant Trial \times Group interaction. *Post-hoc* analyses using Bonferroni corrections for multiple comparisons indicated that, collapsed across the learning tasks, children with generalized epilepsy recalled significantly less than controls on Trial 1. By the second and third trials, children with left focal epilepsy and those with generalized epilepsy recalled significantly less than controls. On the 4th trial, all epilepsy groups recalled significantly less (generalized = 40.7%, left = 50.8%, right = 51.4%) than controls (68.4%). Similar patterns were noted at the delay. These results indicate different learning curves depending on the location of seizure focus in children. Specifically, children with right hemisphere pathology initially learn at a rate similar to controls but do not keep up by the final trial, whereas those with generalized or left pathology show declines on earlier trials.

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J.S. HAUT, L.D. STANFORD, R.L. DUCHOSLAV, T.T. LINEWEAVER, E. WYLLIE, & P. KOTAGAL. Prose Memory in Older Children (9–14) With Epilepsy.

The Story Memory subtest of the WRAML presents a unique opportunity for assessing prose recall in older children. Stories B and C are differentially recalled, with less information recalled from Story C, even when the order of presentation is reversed. Thus, Story C can reasonably be considered to be more difficult. Immediate and delayed recall of these two stories was compared in three groups of epilepsy patients (left = 26, right = 26, generalized = 25) to 26 normal controls matched for age (group averages ranged from 140.77 to 147.69 months). Raw scores were converted into proportion recalled. Results of a 2 (story) \times 2 (time) \times 4 (group) MANOVA revealed significant main effects of Story (subjects recalled more of Story B than C) and Time (more information was recalled immediately than following a delay). Results also revealed significant Time by Group and Story by Time by Group interactions. *Post-hoc* analyses using Bonferroni corrections for indicated that children with right hemisphere pathology recalled less of Story B immediately than controls. By the delay, children with right hemisphere pathology and generalized epilepsy recalled less than controls. Note that the recall of children with left hemisphere pathology did not differ from controls. In contrast, for Story C, all epilepsy groups recalled less, immediately and at the delay, than controls. The same pattern was noted with Story C recognition. These results suggest that task difficulty affects prose recall and may be a more potent variable than task modality for differentiating side of seizure focus.

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C.H. VLAHOU, T.G. BURNS, & M.K. MORRIS. Performance Characteristics of Children With Epilepsy on the WISC–III and the CMS.

Previous researchers have stressed the need for availability of performance patterns in neuropathological populations on intelligence and memory batteries. Children with symptomatic epilepsy have consistently been found to score lower than normative samples on tests of intelligence. Evidence for memory impairments however is somewhat inconsistent, as some have failed to find support for such difficulties. We administered the WISC–III and the CMS to 44 and 47 children with epilepsy, respectively. Our total sample comprised 24 males and 26 females aged 5 to 16 year old ($M = 10.57$, $SD = 3.31$), 66% of which presented with complex-partial seizures. Our mean index scores for both batteries fell approximately 1 SD below the standardization sample mean. FSIQ, VIQ, and PIQ were all significantly higher than those reported by the WISC–III technical manual for an epilepsy sample. The manual reports VCI and PSI as the highest and lowest indexes respectively. We found both these indexes to be significantly higher than the ones reported in the manual, and none of the four WISC–III indexes differed from each other. On the CMS, only Immediate Verbal Memory was significantly lower than reported in the technical manual for an epilepsy sample. None of the CMS indexes differed from each other. The CMS General Memory Index did not fall significantly below WISC–III FSIQ. A 2 \times 2 repeated measures ANOVA showed visual memory to be significantly better than verbal; however there was no mean effect for delay interval and no Material \times Delay Interaction.

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C. KUBU, J.S. HAUT, L.D. STANFORD, M. NOCE, R.L. DUCHOSLAV, E. WYLLIE, P. KOTAGAL, K. HOLLAND, & W. BINGAMAN. The Role of Underlying Pathology in Memory and Naming in Children With Temporal Lobe Epilepsy.

Mesial temporal sclerosis (MTS) is frequently associated with intractable temporal lobe epilepsy (TLE). The literature documents a strong relationship between MTS and memory impairment. In contrast, relatively little is known regarding the memory performance in children with TLE related to other kinds of pathology. This study compared pre-operative memory performance in children with intractable epilepsy who underwent temporal lobe resection secondary to either MTS or tumor. A total of 18 patients

were examined (MTS = 8, tumor = 10). There were equal numbers of patients undergoing left and right temporal procedures in both groups. Group analyses indicated no differences between the 2 pathology groups in age or IQ measures. In contrast, significant group differences were apparent on the Childrens Memory Scale's Verbal Immediate, Verbal Delay, and Attention/Concentration Index scores and the Boston Naming Test raw score. The MTS group consistently performed significantly more poorly than the tumor group. The data were also analyzed at the individual patient level. These analyses revealed a clear pattern of poorer memory function and performance on confrontation naming measures in individual patients with MTS *versus* tumor. Due to small sample sizes, we were unable to compare left *versus* right temporal patients in each pathology group. These preliminary findings suggest that the underlying neuropathological substrate is related to memory and naming performance prior to surgery in children with TLE. Furthermore, these data are similar to those recently found in adults with TLE due to various pathologies at our center. Correspondence: *Cynthia S. Kubu, Ph.D., Department of Psychiatry and Psychology-P57, The Cleveland Clinic Foundation, 9500 Euclid Ave., Cleveland, OH 44195. E-mail: kubuc@ccf.org*

LANGUAGE INTERVENTION

L.M. MAHER, D. KENDALL, J.A. SWEARENGIN, K. PINGLE, A. HOLLAND, & L.J.G. ROTH. Constraint Induced Language Therapy for Chronic Aphasia: Preliminary Findings.

Pulvermuller et al. suggested that individuals with chronic aphasia benefited statistically and clinically from language therapy designed to include attributes of constraint induced movement treatment. The current intervention was designed to force the use of speech only for communication in high doses over a relatively short period of time (constraint induced language therapy or CILT). Key principles of CILT included (1) massed practice in an enriched environment, (2) constraint of other communication modalities, and (3) forced use of language through the application of visual barriers in a supported environment. We applied CILT to the rehabilitation of individuals with nonfluent aphasia greater than 2 years post stroke. Two dyads (i.e., 4 patients) were treated during speech interactions for 3 hr/day, 4 days/week for 2 consecutive weeks. Pre- and post-treatment testing and daily probe measures were obtained. Results suggested that all four subjects increased performance on at least 2 formal language measures administered, and continued to show improvement at one month post treatment. These findings support the notion that individuals with chronic non-fluent aphasia may make substantial, measurable change in language following the intensive CILT protocol.

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C. BREITENSTEIN, S. KAMPING, A. JANSEN, & S. KNECHT. Neuropsychological Correlates of Second Language Acquisition in Adults.

To obtain a more precise understanding of the mechanisms involved in language acquisition in healthy adults and the re-acquisition of language following brain damage, we trained 15 right-handed and left-hemispheric language dominant healthy subjects in an implicit pseudoword learning task and correlated the training success with standard neuropsychological measures of intelligence, attention, verbal and visual spatial short-term and long-term memory as well as personality scales. During a massed-practice 5-block training protocol, subjects improved from a chance level of 50% to a mean performance level of 73%. Learning remained stable at a one week retest interval. The best predictor of the training success, explaining a total of 74% of the variance, was the ability to form new verbal associations (subtest Verbal Paired Associates of the Wechsler Memory Scale-Revised). The total number of languages spoken fluently and a measure of verbal working memory (the ability to recall word lists) were also correlated with the training success. These findings demonstrate that

(1) massed practice is a crucial feature of language acquisition in adults; (b) therapeutic approaches using the principles of massed practice and learning without explicit memory strategies may yield more favorable outcome of aphasia therapy than purely linguistically oriented therapies; and (2) language acquisition does not depend on overall intellectual or long-term memory functions.

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A.B. MOORE, B. CROSSON, M. GAIEFSKY, C.E. WIERENGA, K.K. PECK, K. GOPINATH, K. WHITE, D. SOLTYSIK, L.J.G. ROTH, & R.W. BRIGGS. Right-Hemisphere Mobilization by Treatment of Intention in Aphasia: An fMRI Study.

Research in our laboratory has shown that a treatment designed to engage right-hemisphere intention mechanisms improves naming in nonfluent aphasia. However, there is a need to verify the putative mechanism of change. Two participants diagnosed with chronic, nonfluent aphasia due to left hemisphere CVA completed an overt, event-related fMRI study before and after the rehabilitative language treatment. A word generation task during which the subject heard a category and was asked to produce a single exemplar was employed. Gradient echo 1-short spiral scan images were acquired with a 3T GE Signa scanner (TE = 18 ms; TR = 1.66 s; FA = 60°; FOV = 20 cm). Five runs with 9 active events were conducted with inter-trial intervals of 21.9 s, 23.6 s, 25.2 s, and 26.9 s. ITIs were determined on the basis of optimal length of time required for the nonfluent aphasic patient to generate responses. Deconvolution analyses were conducted on correct responses. Pre-treatment images revealed activity in left-hemisphere regions including: perilesional areas, lateral frontal and medial frontal regions. Post-treatment fMRI data for both subjects, compared to pre-treatment images, revealed increased right hemisphere activity including medial frontal structures (SMA/pre-SMA), lateral frontal structures, temporal regions, and thalamic activity. Results suggest that, consistent with our hypothesis, the intention treatment is effective in engaging right-hemisphere mechanisms and that overt event-related fMRI provides an effective means of documenting neural substrates of rehabilitative change.

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K.S. RICHARDS, C. WIERENGA, F. SINGLETARY, R. FULLER, A. RODRIGUEZ, D. KENDALL, L.J. GONZALEZ ROTH, & B. CROSSON. Comparison of Intention and Attention Treatments in Nonfluent Aphasia.

This study examined the efficacy of 2 novel treatments in chronic nonfluent aphasia. Symptoms of aphasia can be influenced by intention or attention deficits. We hypothesized that for those with nonfluent aphasia, which can be characterized by difficulty initiating language, an intention treatment would be more effective than an attention treatment. 10 subjects with chronic, nonfluent aphasia received 2 treatments (39 sessions each) in which they performed, at the initiation of naming trials, either a complex movement with their left hand (intention treatment) or a head turn to the left (attention treatment). Both treatments were designed to engage intact right-hemisphere mechanisms. No significant differences were seen between the intention and attention baseline accuracies; although a trend for greater baseline scores for attention *vs.* intention in those who received the intention treatment first suggests that the intention treatment effects generalize to new baseline stimuli on the second treatment. Seven out of the 10 patients demonstrated an improvement in both treatments; 9 out of the 10 showed an increase in naming accuracy during the intention treatment. Although the intention treatment yielded more improvements in naming accuracy than the attention treatment, this difference was not statistically significant in group statistics. The improvements demonstrated in both treatments may be due to the relatedness of intention and attention processes.

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C.E. WIERENGA, K.S. RICHARDS, F. SINGLETARY, A. RODRIGUEZ, D. KENDALL, S. LEON, L.J. GONZALEZ ROTH, & B. CROSSON. Intention and Attention Treatments of High Functioning Nonfluent Aphasia.

The severity of anomia following stroke may influence response to rehabilitative treatment of aphasia. Naming deficits exhibited in nonfluent aphasia may be influenced by difficulty in language initiation, whereas naming deficits in fluent aphasia may be influenced by difficulty engaging attentional mechanisms. We developed 2 treatments designed to improve object naming through (1) engagement of intentional mechanisms and (2) engagement of attentional mechanisms in the right hemisphere. These treatments, previously found to be effective in participants with severe anomia, were modified for individuals who perform above criterion for enrollment in our original treatment study, by increasing the number of low frequency items of the stimulus set. Of the 5 participants with chronic, nonfluent aphasia who underwent the attention treatment prior to the intention treatment using the modified stimuli, 4 participants showed significant improvement in naming accuracy during the intention treatment. Four of the 5 participants made significant improvement in accuracy in the attention treatment. Group analysis of naming accuracy during treatment revealed no difference in performance on trained vs. untrained words in either the attention or intention treatments. Results suggest that treatment effects generalize to untrained items and support the hypothesis that these treatments affect the underlying mechanisms thought to be implicated in aphasia. In addition, these modified treatments appear to be effective for individuals with less severe anomia.

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A. RODRIGUEZ, A.M. RAYMER, & L.J.G. ROTH. Gesture and Semantic-Phonologic Treatments in an Individual With Anomia for Verbs.

Objective: Reports have suggested that semantic-phonologic and gestural treatments are effective in improving word retrieval in anomia. Most studies focus on noun production, with verb production less commonly reported. Thus, we report an individual with selective anomia for verbs in whom we studied the effectiveness of gesture and semantic-phonological treatments for verb retrieval. *Methods:* The subject was a 73-year-old, right-handed male, 8 months post left CVA, with aphasia and selective anomia for verbs. In the context of a single subject multiple baseline design, two treatments were initiated to improve word retrieval. The gesture treatment utilized representative pantomimes and the semantic-phonologic treatment utilized a series of yes/no questions about the meanings and sounds of the target word. After an extended stable baseline phase, gesture and semantic-phonologic treatments were applied sequentially for 10 one-hour sessions with a 1-month break between treatment phases. *Results:* Significantly positive treatment effects ($p < .05$) were noted for both treatments. Maintenance effects were also observed at 1-month follow up. In comparison, untrained items, probed throughout the treatment phases, showed no change. No significant differences were evident between treatments in this individual. *Conclusion:* Gesture and semantic-phonologic treatments were similarly effective in this individual, which suggests that verbs are amenable to the same types of treatments as nouns, despite their presumed different neural representations.

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J. PATTERSON. Integral Stimulation Treatment for Apraxia of Speech: Effectiveness and Generalization.

Integral stimulation is a commonly used technique to treat speech production disorders in persons with moderate to severe apraxia of speech. Integral stimulation has a theoretical foundation in learning theory and incorporates principles of motor learning, such as immediate repetition and cue fading. Published reports have shown its effectiveness in clinical

settings however few studies have addressed maintenance and generalization effects. Using a multiple baseline design across stimulus items, this study examined the effect of integral stimulation on intelligibility in verbal single word production and connected speech tasks in one patient with chronic moderate apraxia of speech and nonfluent aphasia. The pre and post treatment test battery included language tasks, single word production tasks, and narrative and conversational connected speech tasks. Stimulus items were single syllable words and three word phrases, and contained multiple sound targets to increase variability during treatment and maximize stabilization of learning. Twice weekly treatment sessions (43 total) began with a probe of untrained stimulus items. Integral stimulation was administered within the Eight Step Continuum of Rosenbek et al. Single word stimuli were scored on a binary system and phrase stimuli on a rating scale. Significant improvement from baseline was noted for 9 of 11 sound production targets in trained and untrained word and phrase stimuli; performance on labiodental targets did not change. Treatment gains were maintained at follow-up evaluation. Generalization to connected speech was inconsistent across speaking contexts. Findings are interpreted in terms of the influence of contextual requirements on motor learning.

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J. WAMBAUGH, R. CAMERON, & C. NESSLER. Retrieval of Action Names in Aphasia: A Comparison of Cueing Treatments.

The purpose of the present investigation was to examine the effects of 2 cueing treatments on the retrieval of action names with a speaker with chronic aphasia. The participant in this study was a 37-year-old male who was 19 months post-onset of a focal head injury that resulted in nonfluent aphasia. His verbal output consisted of single words and phrases that were predominantly nouns and social conventions. A single subject, combined multiple baseline and alternating treatments design was used to examine the effects of the treatments applied separately and concurrently. The treatments were semantic cueing treatment (SCT) and phonologic cueing treatment (PCT) and were considered to target the lexical-semantic and lexical-phonologic levels of processing, respectively. The participant's production of action names was measured for 4 lists of items during baseline sessions and continuously throughout the course of the study. SCT and PCT were applied separately and consecutively to 2 lists of items. Then, both treatments were applied concurrently to the remaining lists of items. Following the initial applications of SCT and PCT, correct naming of trained items increased rapidly to high levels of accuracy. Treatment effects were limited to trained items, with little change observed in untreated items. Positive changes in trained behaviors were observed for both SCT and PCT when the treatments were applied concurrently. Performance was similar with both treatments. Correct production of previously trained items was maintained at high levels. Pretreatment assessment results and stimulus generalization findings will be discussed relative to the primary data.

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B. JACOBS & C. GRAVLEY. Model-Based Lexical Comprehension Treatment Following Traumatic Brain Injury.

A partial replication of Grayson, Hilton, and Franklin's study was undertaken to examine the effects of semantically based training of spoken word comprehension for an individual with severe nonfluent transcortical mixed aphasia who is 20 years post-TBI. The *Psycholinguistic Assessments of Language Processing in Aphasia* (PALPA) was used to identify the locus of lexical processing deficits. PALPA results indicated a semantic system deficit, thus model-based treatment focused on semantic organization within categories was used to improve spoken word-to-picture matching. A single-subject multiple-baseline across behaviors design examined treatment and generalization effects. Experimental stimuli included 60 noun pictures (10 in each of 6 categories); 30 trained items measured treatment effect and 30 untrained items measured generalization effect. Prior to training, all stim-

uli were tested for spoken and written word-to-picture matching at levels that increased in number of stimuli (3 or 6) or complexity (semantically related or unrelated pictures) and oral and written naming. Training was initiated at Level 3 (stimulus field of 3 related pictures); incorrect pointing responses during training were prompted with semantic and visually distinctive cues and modeling of the correct response as necessary. The participant's Level 3 spoken word-to-picture matching improved for both trained and untrained pictures and cross-modal generalization to oral naming was evident. Training at Level 4 (stimulus field of 6 related pictures) has been initiated and is ongoing. The results of the second training phase will be discussed relative to evidence of change in the organization of the semantic system.

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Y. TANAKA, M. ALBERT, S. AKETA, K. HUIJITA, E. NODA, M. TAKASHIMA, C. NONAKA, Y. KOYAMA, T. OKA, & T. KUBO. Serotonergic Therapy for Aphasia.

Objective/Hypothesis: Treatment of non-fluent aphasia with SSRIs will simultaneously relieve depression and improve aphasia. *Background:* Convergence of four neurobehavioral observations provides the theoretical rationale of this study. (1) Lesions of the left frontal lobe can cause depression, (2) Lesions of the left frontal lobe can cause non-fluent aphasia. (3) Non-fluent aphasia is often associated with depression. (4) Depression due to left frontal lesions may be ameliorated by treatment with SSRIs. *Design/Methods:* 10 right-handed patients with either fluent or non-fluent aphasia syndromes were treated with SSRIs for 1 month. All patients were tested with language and other cognitive tests twice (pre- and post-treatment). *Results:* Overall, SSRIs significantly improved mood, reduced perseveration, and improved naming scores on the Boston Naming Test and Action Naming Test. Those aphasia patients whose depression was the most relieved by SSRIs and whose perseveration was the most reduced had the most improvement on naming scores. Contrary to expectation, however, no significant differences were found between fluent and non-fluent aphasics; and SSRIs were not more effective in patients with frontal lobe lesions than in those without. SSRIs were most effective in patients with non-severe aphasia. *Conclusions:* SSRIs can be a useful adjunctive therapy in patients with non-severe aphasia and depression, and seem to act by reducing perseveration and ameliorating depression.

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S. LEON, K.M. HEILMAN, R. FULLER, D. KENDALL, S.E. NADEAU, A.A. SPEVACK, & L.J.G. ROTH. Cognitive-Cholinergic Therapy of Anomia in 6 Cases of Alzheimer's Disease.

Introduction: Fuller et al. reported an AD patient who while being treated with a cholinesterase inhibitor remained anomic, but with errorless learning therapy, naming improved. The purpose of this study was to learn if this treatment is efficacious with other patients. *Methods:* Six subjects (including Fuller's) with probable AD receiving a cholinesterase inhibitor prior to being enrolled, were studied using a within-subject experimental design (multiple baselines across behaviors with generalization probes). Stable baselines were established while taking drug alone. This was followed by approximately 30 therapy sessions targeting lexical retrieval utilizing errorless learning. Daily probes of therapy effect were taken. *Results:* In each case, no effect on lexical retrieval performance was noted with repeated exposure to the task while on drug alone. In 3 cases significant behavioral effects were noted following initiation of therapy, while in the remaining 3 no effects were noted. Therapy effects when obtained ($n = 3$), were maintained at 1 and 3 months after cessation of therapy in all 3 subjects. Retrospective review of the three subjects that did not improve revealed that they either were taking drugs that might interfere with brain plasticity, were institutionalized, or both. *Conclusion:* Although we were able to replicate Fuller's findings that errorless learning together with cholinergic medication can improve naming, not all subjects improved.

Thus, further studies are needed to learn if failure to improve is related to medications, living conditions, or the neuropsychological basis of the anomia.

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M. PAGE, M. NICHOLAS, & N. HELM-ESTABROOKS. Cognitive Skills Predict Response to Alternative Communication Aphasia Treatment.

This study investigates communicative performance in people with severe restriction in verbal output due to non-fluent aphasia who are trained to use a specific alternative communication program known as C-Speak Aphasia, a picture-based computer program. Using C-Speak, patients learn to select icons from semantic-category groups and put them together to create novel messages that can be spoken aloud by the computer's speech synthesizer. This study tests the hypotheses that (1) functional communication can be improved significantly using the C-Speak Aphasia system, (2) nonverbal measures of cognitive abilities will predict response to C-Speak Aphasia training, and (3) verbal measures of semantic knowledge will have less value in predicting response to training. Using standard single-subject design methodology, each subject participated in extensive baseline testing and communication probes at selected points throughout a 6–9-month training period to evaluate response to treatment. We report findings from 4 subjects with similar severe non-fluent aphasia profiles and differing nonverbal cognitive profiles. Results from these subjects suggest that nonverbal cognitive abilities, in particular, executive function skills measured at baseline (design generation, trails, mazes, design memory, symbol cancellation), may be relevant to speed of progression through the training as well as to use of C-Speak Aphasia for spontaneous self-initiated messages. Analyses indicated that aphasia profiles and performance on semantic knowledge experiments were less effective predictors. We discuss findings in the context of the role of nonverbal cognitive abilities in non-fluent aphasia.

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P. PEDERSEN, K. VINTER, & T. OLSEN. A Randomized, Placebo-Controlled Study of Computer Rehabilitation of Aphasia.

A pilot study of non-supervised anomia therapy with a suite of adaptable computer programs designed to be used without therapist intervention had positive results in three single-case studies. That study was followed by a randomized, controlled study including stroke patients with any kind and severity of aphasia. Thirty patients were assigned to computer therapy, nonverbal computer programs (placebo) or no therapy. The primary outcome measure was PICA (Porch Index of Communicative Abilities). The testing also included WAB (Western Aphasia Battery) and functional communication with CETI (Communication Effectiveness Index). Single-case controls were also used. Two patients died in the study period and 4 dropped out. Pre-post testing data were available for 7 patients with aphasia therapy, 8 patients in the placebo group and 9 in the no-treatment group. No significant differences between the groups were found for the total PICA raw score or the WAB Aphasia Quotient. Functional communication (CETI) was significantly better for treatment compared with placebo, a similar but nonsignificant tendency was seen in relation to no treatment. The same pattern was seen for the reading part of the WAB. The improvement in functional communication may be seen as surprising as the therapy was nonsupervised computer therapy. The improvement in reading may be explained by a large number of tasks demanding reading and confirms the results of a study by Katz and Wertz. We will, additionally, also report results on the single cases.

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A.M. CIMINO-KNIGHT, A.L. HOLLINGSWORTH, S.E. MOSS, & L.J.G. ROTH. Computerized Treatment of a Case of Alexia Without Agraphia.

This presentation describes an efficacious treatment paradigm applied to a case of alexia without agraphia. The investigators sought to determine if (1) a brain-injured patient could utilize such a program, and (2) the computerized paradigm would effect qualitatively different patterns of improvement in reading function. The 70-year-old, right-handed male described in this presentation was diagnosed with phonological alexia; that is, having spared access to lexical-phonologic and semantic routes of reading. A treatment protocol was established based on theories of normal adult reading and presented via computer technology. The treatment consisted of a 5-week intensive program utilizing ABACA design where one set of tasks were developed for the spared semantic systems and another set of tasks were developed for the limited phonological systems. The results of this treatment program are described relative to an analysis of treatment task performance (lexical and phonological) and generalization measure performance (standardized reading battery).

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PROFESSIONAL ISSUES

J. DONDERS. A Survey of Former Clinical Neuropsychology Residents.

A survey pertaining to training experiences and current employment characteristics was sent to 219 persons who had completed, between 1996 and 2001, a 2-year postdoctoral residency that was associated with the Association for Postdoctoral Programs in Clinical Neuropsychology. A total of 108 usable surveys were returned (49%). Respondents described a broad range of settings (e.g., general medical, rehabilitation) and patient populations (e.g., adult, pediatric) as being characteristic of their residency. More than 70% of the respondents identified regular individual supervision as the most helpful during their residency, and more than 80% considered completion of a postdoctoral program to be essential for the training of clinical neuropsychologists. Almost 50% indicated that their residency had yielded at least 1 published article in a peer-reviewed journal. Current employment characteristics revealed significantly less involvement (compared to during residency training) with direct clinical neuropsychological services and a greater involvement with other (e.g., teaching, supervision) activities. In response to the request to identify one single thing that could have been improved about their residency, the most frequently reported issues pertained to a need for increased familiarization with billing and reimbursement issues (28%), and more protected time for research (16%). Specific implications for the postdoctoral training of aspiring clinical neuropsychologists will be discussed.

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Paper Session 3/10:45 a.m.–12:30 p.m.

fMRI: ATTENTION, MEMORY, AND SPACE

G. ALLEN, W. RINGE, R. MCCOLL, J. FLECKENSTEIN, & M. CULLUM. Cerebellar-Prefrontal Functional Connectivity in the Human Brain.

In recent years, studies of the cerebellum have indicated its surprising diversity of function. This includes a proliferation of functional neuroimaging studies showing cerebellar involvement in various cognitive tasks. In addition, analysis of nonhuman primate neuroanatomy has revealed connections between cerebellum and cerebral cortex that might support a cerebellar role in cognition. Foremost among these are projections from dentate nucleus to area 46 in dorsolateral prefrontal cortex, although such projections have yet to be demonstrated in humans. Functional connectivity MRI is a technique that allows the *in vivo* examination of connections

between brain regions in a steady (i.e., resting) state. We used this procedure to test for human cerebellar-prefrontal connectivity. Echo-planar (EP) and SPGR images of 12 normal volunteers (6 male, 6 female, age 24–42), were acquired at 1.5 T. After motion correction and spatial smoothing, a low-pass filter removed high-frequency noise from the EP data. Right and left dentate were identified, and within each, time series MR signal data were averaged across voxels. Averaged time courses were used as reference functions for correlation with all other brain voxels, and group-wise significance was considered achieved within a voxel if a significant correlation was observed in at least 10 of 12 subjects. Significant effects were observed in cerebellum, midbrain, putamen, parahippocampal gyrus, occipital cortex, and prominently in the middle frontal gyrus (area 46). These findings of functional connectivity between the dentate nucleus and area 46 of dorsolateral prefrontal cortex strongly support an anatomic substrate for cerebellar involvement in cognition.

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J. JONIDES, C.C. SYLVESTER, J.C. CHRISTENSEN, A.A. THOMAS, T.D. WAGER, J.K. KROGER, T.A. SALTHOUSE, D. BADRE, & E.E. SMITH. Neuroanatomy of the Trail Making Test Revealed by fMRI.

The Trail Making Test is among the most widely used instruments to diagnose frontal lobe dysfunction. In spite of its ubiquity, there is precious little information about which brain areas are recruited by the task. We constructed computerized versions of the instrument and tested normal participants during fMRI scanning at 3 Tesla. In one version of the task, participants viewed a series of screens on which there was a target number in the center, beginning with the number 1 and continuing consecutively. The number was surrounded by 4 alternatives. For each target, participants had to select one of the four alternatives to indicate the next consecutive number in the series. In the Trails B condition, the targets alternated between numbers and letters. Again, participants had to indicate the next item in the series, alternating between number and letter categories. As in the paper-and-pencil version, the Trails B condition resulted in slower responses than the Trails A condition. The brain activations that appeared when contrasting Trails B with Trails A were most robust in right dorsolateral and left frontopolar cortex as well as in bilateral superior parietal lobule and bilateral superior frontal gyrus. A second version of the task was also constructed to control for activations that may have been due to motor or visual search processes which are components of the standard task. The resulting activations implicate processes of attention allocation and switching in the Trail Making Test.

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A.R. MAYER, S.M. RAO, & M. SEIDENBERG. An Event-Related fMRI Study of Exogenous and Endogenous Visual-Spatial Attention.

The orienting of visual attention can be controlled by endogenous or exogenous mechanisms. Validly cued exogenous trials typically result in facilitation at short cue-target intervals and inhibition of return (IOR) at longer intervals. Early imaging studies reported similar areas of activation for endogenous *versus* exogenous orienting. However, these studies employed blocked designs that are incapable of separating neural responses to valid *versus* invalid trials, or facilitation *versus* inhibition effects. The current study used event-related fMRI to delineate the neuronal substrates involved in endogenous *versus* exogenous orienting and IOR. Endogenous cues (foveally presented unidirectional arrows) indicated the location of an upcoming target in 70% of trials. Exogenous cues (peripheral luminance changes) indicated the location of an upcoming target in 50% of trials (chance levels). Comparisons of valid endogenous *versus* exogenous trials yielded greater bilateral activation of the temporoparietal junction, right inferior parietal lobule, left posterior parietal lobes, superior temporal gyrus, hMT+, right FEF, and bilateral activation of visual cortex in the endogenous condition. No unique areas of activation were associated with exogenous orienting. In contrast, IOR compared to valid endogenous trials

resulted in a single focus of activation in the left superior temporal lobe. This experiment demonstrates that endogenous attention produces widespread activation of a large-scale cortical attention network relative to exogenous attention. The relative lack of difference between IOR and endogenous orienting conditions suggests the utilization of similar neuronal networks to prevent exogenous attention from dominating visual-spatial resources.

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S. MOSTOFSKY, J. SCHAFER, A. FLOWER, A. BOYCE, M. GOLDBERG, M. DENCKLA, & J. PEKAR. fMRI Evidence that the Neural Basis of Response Inhibition is Task-Dependent.

To investigate the hypothesis that neural activity involved in response inhibition depends upon the nature of the action being inhibited, event-related functional magnetic resonance imaging (fMRI) was used to examine activation associated with two different go–no-go tasks. A “simple” go–no-go task with minimal working memory load required subjects to push a button in response to green spaceships but not red spaceships. A “counting” go–no-go task with high working memory load required subjects to respond to green spaceships as well as to those red spaceships preceded by an even number of green spaceships. In both tasks stimuli were presented every 1.5 s with a 5:1 ratio of green-to-red spaceships. Twenty-four adults completed the “simple” go–no-go task; 12 completed the “counting” go–no-go task. fMRI group data for each task were analyzed using random effects models to determine signal change patterns associated with go events and no-go events (uncorrected $p \leq .001$). For both tasks, Go responses were associated with signal change in the left primary motor/sensory cortices, supplementary motor area (SMA) proper, and anterior cerebellum (right > left). No-go events were associated with activation in the pre-SMA and bilateral cerebellum for both tasks. The “counting” task elicited additional no-go activation in the dorsolateral prefrontal and posterior parietal cortices (right > left). The findings suggest that neural contributions to response inhibition may be task dependent, with the pre-SMA necessary for inhibition of unwanted movements, and dorsolateral prefrontal and posterior parietal cortices recruited for tasks involving increased working memory load.

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J.M. VONGHER, R.C. MULLIGAN, M. FISCHER, & S.M. RAO. Methylphenidate Modulates Neural Networks Involved in Verbal Working Memory.

The mechanisms by which dopamine modulates cognitive processes has received considerable attention in the animal literature. In contrast, relatively little is known regarding dopamine’s influence on neural systems activated in humans by executive function tasks. To address this issue, 13 healthy adults performed a verbal working memory task over three consecutive scanning sessions in a double-blind, placebo-controlled study. Forty-five minutes prior to task administration, participants ingested 0, 0.2, or 0.4 mg/kg of methylphenidate (MP). The verbal *N*-back task (1, 2, and 3-back) was presented alternately with a control condition (0-back) during whole-brain fMRI on a 1.5T scanner. There were no significant effects of MP on accuracy or reaction time. The left dorsolateral prefrontal cortex and the left thalamus demonstrated decreased signal intensity for the 2-back and 3-back as MP dosage increased. In addition, the left superior parietal lobule and the left BA6 demonstrated a decrease in signal intensity as MP dosage increased irrespective of *N*-back level. Signal intensity in the left inferior parietal lobule has a greater decrease for the low dose than the high dose compared to placebo. The left anterior cingulate had a similar pattern except the signal intensity was in the negative direction. Taken together, these results suggest that dopamine modulates executive system processes in humans via complex interactions between parietal, frontal, and subcortical networks. Overall, these results suggest that lowered levels of activation occur with increasing dopamine availability.

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Paper Session 4/10:45 a.m.–12:30 p.m.

EXECUTIVE SYSTEM IMPAIRMENTS IN NEUROPSYCHIATRIC POPULATIONS

E. GRANHOLM, J. McQUAID, F. McCLURE, P. PEDRELLI, & A. BECK. Neuropsychological Predictors of Improved Insight in CBT for Schizophrenia.

Many patients with schizophrenia lack insight into the cause of their symptoms and poor insight is associated with poor outcome. Specific neuropsychological impairments (e.g., frontal lobe deficits) are associated with poor insight and may interfere with interventions that attempt to improve insight. The present study examined neuropsychological predictors of improved insight in a cognitive-behavioral therapy (CBT) for schizophrenia. Fifty middle-age and older schizophrenia patients (M age = 55) were randomly assigned to either medication only or medication + CBT. With the aging of the US population, there is increased demand for modified treatments (e.g., add cognitive compensatory strategies) for these older patients. Following 12 weekly, 2-hr group sessions, patients showed improved insight on the Beck Insight Scale—a new scale taping thought challenging and insight targeted by CBT. Patients in CBT showed significantly greater improvement in insight than controls and greater improvement in insight was associated with greater reduction in positive symptoms. Moreover, patients with greater frontal lobe deficits (WCST) showed less improvement in insight. Interestingly, patients with greater memory (CVLT) and attention (span of apprehension) deficits showed greater improvement in insight in CBT. While abstract reasoning deficits may interfere with treatment, patients with attention and memory problems may be more likely to benefit from cognitive interventions targeting insight. CBT interventions tailored for older patients with schizophrenia can improve symptom outcome, but improvement may depend on changes in specific types of insight, which may be moderated by specific types of cognitive impairment.

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W.M. PERLSTEIN & N.K. DIXIT. Working Memory and Inhibition: Prefrontally Mediated Deficits in Schizophrenia.

Patients with schizophrenia (SZ) show deficits in working memory (WM) and inhibition of prepotent response tendencies, two processes that may reflect the operation of a single underlying mechanism. We acquired fMRI data while subjects performed tasks that placed demands on WM and response inhibition (RI) to test the hypotheses that (1) both tasks activate overlapping cortical networks; and (2) SZs show specific PFC activity alterations and task performance deficits reflecting WM and RI. Subjects (16 SZs, 15 controls) performed a version of the AX-CPT that required overriding a prepotent response tendency and the nback task that systematically varied WM load (0- to 2-back). fMRI data were analyzed, per task, following movement correction and cross-subject registration, using voxel-wise ANOVAs ($p < .005$, 8 contiguous voxels). Both tasks activated largely overlapping cortical networks typically engaged by verbal WM (i.e., bilateral dorsolateral PFC, Broca’s area, parietal cortex). Increased WM load was associated with monotonically increased activity, and RI with greater and more enduring activity. Focal group differences on each task emerged in an overlapping region of the right dorsolateral PFC: SZs showed lesser-magnitude activity increases under conditions of high WM and RI demands. Behaviorally, SZs performed more poorly than controls on measures of WM and RI, but not under control conditions. Results demonstrate that SZs exhibit PFC-mediated deficits in WM and in overriding prepotent response tendencies. Findings are consistent with the operation of a single underlying PFC-mediated cognitive control mechanism, and with physiological dysfunction of the dorsolateral PFC in schizophrenia patients.

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C. SIRA & C. MATEER. Aspects of Executive Dysfunction in Schizophrenia: Fractionating the WCST.

This preliminary report aims to identify the core deficits in executive function in individuals with schizophrenia. Previous research and clinical practice have often used the Wisconsin Card Sorting Test (WCST) as a gold standard of executive function. Although many individuals with schizophrenia fail the Wisconsin Card Sorting Test, the task is complex and can be failed for numerous reasons, making it unclear as to the particular nature of executive function compromised in schizophrenia. This study uses an experimental task, in which participants must choose among several stimuli, the one that has a unique feature based on color or shape. The correct selection principle changes seven times throughout 60 trials. Participants must select from competing information and demonstrate flexibility in changing response targets. This task is believed to reflect a simpler and more basic executive ability that is necessary for success on the WCST, and has been postulated to be dependent on the dorsolateral prefrontal cortex. Eight individuals with multiple episode schizophrenia (MES: M age 39.25; $SD = 9.54$) had significantly slower reaction times ($p < .05$) when shifting response sets (color or shape) than 7 individuals with 1st episode schizophrenia (FES: M age 22.86; $SD = 5.18$). There was no difference in reaction times on nonshift trials or in WCST performance between the 2 groups, and all participants fell below 1 standard deviation on at least one WCST variable. The results suggest that the experimental task is more sensitive to the set shifting difficulties in MES than the WCST.

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J. VASTERLING, N. LOWERY, M. McCLOSKEY, K. BRAILEY, & J. CONSTANS. Decision-Making in PTSD: Findings From the Iowa Gambling Task.

Neurobiological models of posttraumatic stress disorder (PTSD) implicate frontolimbic brain dysfunction. Although previous research has focused on the hippocampus, less is known about frontal lobe integrity in PTSD. Interconnected with the amygdala, the orbitofrontal (OF) cortex in particular is hypothesized as relevant to PTSD. The purpose of this study was to use a behavioral paradigm to examine OF integrity in PTSD. The Bechara et al. Gambling Task measures reinforcement-based decision-making, a function thought to be subserved by OF cortex. The Gambling Task and a brief neuropsychological battery were administered to 13 Vietnam veterans with PTSD and 19 veterans without mental disorders, who were equated for age, months in Vietnam, and WAIS-III Information scores. Findings revealed that PTSD-diagnosed veterans made more Gambling Task selections from disadvantageous card decks (i.e., those containing reinforcement contingencies of high pay-off but even higher losses) than did veterans without mental disorders [$F(1,30) = 5.38, p = .022$]. Performance on the Wisconsin Card Sorting Test, a task purported to show sensitivity to dorsolateral prefrontal (DLP) functioning, did not differ significantly between the 2 groups ($p = .69$). Number of disadvantageous Gambling Task choices did not correlate significantly with depression severity ($r = -.21, p = .26$), or working memory indices (Digit Span: $r = -.19, p = .31$; Visual Span: $r = -.21, p = .21$), suggesting that findings could not be explained on the basis of these variables. Results suggest that OF, but not necessarily DLP, functioning is impaired in PTSD.

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J.G. KEILP, H.A. SACKEIM, B.S. BRODSKY, M.A. OQUENDO, & J.J. MANN. Neuropsychological Correlates of Suicide Risk and Attempt Severity.

Neuropsychological dysfunction in depression may contribute to the risk for suicidal behavior. We recently reported that past suicide attempters making severe attempts were not only impaired in attention and memory, as is typical in depression, but also in executive functions. Associations between these neuropsychological dimensions and clinical measures of

both suicide risk and past attempt severity were examined here. Subjects were 48 adults with major depression; 28 with prior suicide attempt. Subjects received clinical ratings of depression severity, level of functioning, hopelessness, suicidal ideation, impulsiveness, hostility, and aggression history. Past attempts were rated for suicide intent and lethality (degree of medical damage). After medication washout, subjects received a battery of neuropsychological tests from which 2 independent multivariate performance dimensions were extracted: one related to attention/memory dysfunction, and one to executive dysfunction. Suicide risk indicators, including global assessment of functioning ($r = .31, p = .04$), suicidal ideation ($r = -.31, p = .03$), and past history of aggressive behavior ($r = -.32, p = .04$) were related to attention/memory dysfunction, but not to executive dysfunction. Past attempt severity indicators on the other hand, including past attempt lethality ($r = -.66, p < .001$) and suicide intent ($r = -.40, p = .04$), were related to executive dysfunction, but not to attention/memory deficits. Severity of typical depression-related attention/memory deficits are associated with risk factors for suicide attempt, but deficits in executive function may determine the ultimate severity of these attempts. Results suggest that there may be two neuropsychological factors contributing independently to the likelihood and outcome of suicidal acts.

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Symposium 7/10:45 a.m.–12:30 p.m.

TROUBLESHOOTING CONCERNS RAISED ABOUT THE WMS-III

Organizer and Chair: David S. Tulsky

Discussant: Robert K. Heaton

D.S. TULSKY. Troubleshooting Concerns Raised About the WMS-III.

The Wechsler Memory Scale-Third Edition (WMS-III) included significant changes as an attempt to represent the more recent research in the field of memory assessment. WMS-III subtest, index, and optional scores include several components of memory and learning (e.g., encoding/learning, storage retention, and retrieval). As a result, there are several new tasks and index scores, some that are unfamiliar to examiners and others that might have psychometric weaknesses in their design. Most notably, several of the WMS-III subtests have not been adequately validated nor tested in clinical samples. Other scores appear to have ceiling problems or lack parallelism with similar scores and could be recalculated. This symposium attempts to study and address some of the concerns that have been raised, and when appropriate, new index scores have been developed as an attempt to guide practice. Three of the talks focus on issues that have been raised within subtests. Collectively, these presentations address measurement issues concerning the clinical utility of Logical Memory, Visual Reproduction, Faces, and Letter Number Sequencing in patient groups that include epilepsy, multiple sclerosis, and other populations. Another talk focuses on new methods of interpreting discrepancy scores examining patterns that emerge between new index scores that have been developed. Finally, the fifth talk focuses on the lack of parallelism between the Immediate and General memory index and presents a new index that will allow direct comparisons between the immediate and delayed scores.

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L. LACRITZ, P. VAN NESS, M. AGOSTINI, R. DIAZ-ARRASTIA, & M. CULLUM. WMS-III Logical Memory and Visual Reproduction in Temporal Lobe Epilepsy.

In an effort to more fully explore the utility of Logical Memory (LM) and Visual Reproduction (VR) subtests from the WMS-III in patients with

lateralized epilepsy, we examined individual items from these subtests in subjects with either right ($n = 25$) or left ($n = 27$) temporal lobe epilepsy (TLE). The groups were of similar age and education and diagnoses were made by a multidisciplinary epilepsy surgery team. Similar to previously reported findings, LM immediate and delayed recall and percent retention were significantly lower in the left TLE group, while no differences were found between the groups on any of the VR scores. In examining details of LM performance, percent retention of Story B was significantly lower in the LTLE sample, while retention of Story A did not statistically differ between the groups. This may suggest that patients with LTLE benefit less from repetition of Story B than do patients with RTLE, although as expected (since it is presented twice) Story B retention was higher than Story A in both groups. Furthermore, a greater percentage of all subjects failed to recall any details from Story A (14%) compared with Story B (2%). Similarly, total forgetting of one or more of the VR figures was not uncommon, with 32% of subjects completely omitting at least one of the 5 items. These findings will additionally be compared to a group of subjects from the WMS-III standardization sample matched for age, education, and sex, to further assess recall patterns across LM and VR in the general population.

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D. BRYANT, D.S. TULSKY, N. CHIARAVALLI, J. DELUCA, & G. CHELUNE. Evaluating Speed Versus Working Memory in Persons With Multiple Sclerosis.

The objective of the current investigation was to examine the clinical utility of the Letter Number Sequencing (LNS) subtest of the Wechsler Adult Intelligence Scale-III (WAIS-III) and the Paced Auditory Serial Addition Test (PASAT) in persons with multiple sclerosis (MS). Subjects in Study 1 consisted of 30 adults with clinically definite MS. Using LNS *versus* PASAT performance as an indicator of WM impairment produced very different results, with 3% of the sample ($N = 1$) being classified as impaired on LNS *versus* 43% of the sample ($N = 13$) being classified as impaired according to PASAT. Hierarchical regression revealed that when depression and fatigue were taken into account, processing speed made a significant contribution to the amount of variance in PASAT performance accounted for independent of working memory ability. A second study examining LNS and PASAT in a larger sample ($N = 150$) found similar relationships. Ten percent of this larger study ($N = 15$) was classified as impaired on LNS *versus* 33% of the sample ($N = 49$) classified as impaired according to the PASAT. Results suggest that the PASAT was more sensitive than LNS as a measure of working memory impairment in persons with MS, due to the significant effect of processing speed on PASAT performance which is not observed on LNS.

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J. HOLDNACK. Response Patterns on WMS-III Face Memory Differ by Age and Clinical Groups.

The WMS-III includes a number of new subtests compared to predecessor versions. Face memory was included as a measure of visual memory functioning based upon clinical research demonstrating its sensitivity to right but not left temporal lobe functioning, history of use in neuropsychology. The face memory test consists of 24 targets and distracters using a "yes" or "no" forced choice, recognition format with immediate and delayed recognition conditions. Total scores for correct hits and rejections were calculated for all the cases in the WMS-III standardization sample. Analysis of these scores revealed low correlation at immediate ($r = .12$) and delayed ($r = -.04$) recognition; higher correlations of correct rejections with visual reproduction and family pictures compared to correct hits; and age-associated changes in the relationship between correct hits and rejections. Among young adults, correct rejections occur more fre-

quently than correct hits at immediate and delayed recall. For older adults, higher correct hits *versus* rejections occur more frequently. In patient groups Alzheimer's disease was characterized by global impairment with both hits and misses significantly below controls; while Korsakoff's patients displayed marked deficits in hits but not correct rejections ("no" saying) and Huntington's patients displayed impaired rejections but not correct hits ("yes" saying). These results indicate significant effects a response pattern on WMS-III face memory performance. The implications of these findings for research and clinical practice are discussed.

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K. HAWKINS. New Methods of Performing Discrepancy Analyses With the WMS-III.

Clinicians often tailor their expectations of WMS-III index scores through "discrepancy analysis" by using one of the current test scores to establish expectations for other scores in the same examination. Such analysis yields hypotheses about relative strengths and weaknesses and inferences regarding brain integrity. The clinical significance of a discrepancy depends upon the frequency (base rate) of the difference in the normal population. The difference between 2 scores may be statistically significant but clinically meaningless because the discrepancy is common in the normal population. Recent examinations of the frequency in which individuals have index scores that are discrepant from one another show that when 2 scores have low correlations, larger differences between the scores need to be obtained in order to interpret the differences as being "clinically meaningful." Such is the case when the Faces subtest is included as part of the Visual Memory Index as opposed to the new index scores developed by Tulskey, Ivnik, Price, and Wilkins that employ Visual Reproduction and Family Pictures. This presentation will examine patterns of discrepancy scores in the standardization (weighted $N = 1250$) and TPC collected clinical samples ($N = 145$) between the WMS-III index scores. Patterns will be examined for the overall sample (e.g., unadjusted scores), sample stratified by ability level (e.g., ability-adjusted scores), and demographically adjusted index scores.

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D.S. TULSKY, G. CHELUNE, & L.R. PRICE. Development of a "Delayed Memory Index" for the Wechsler Memory Scale-Third Edition.

The publication of the WMS-III yields two global memory scores: an Immediate Memory Index (IMI) and the General Memory Index (GMI), which are NOT directly comparable. The WMS-III IMI is comprised of the sum of the scaled scores on the 4 subtests that compose both the Auditory Immediate Index and the Visual Immediate Index scores. Like the IMI, the WMS-III GMI is comprised of the sum of the scaled scores on the 4 subtests that compose the Auditory Delayed Index, and the Visual Delayed Index. However, the Auditory Recognition Delayed Index score is also included in the WMS-III GMI, which makes direct comparison of immediate and delayed memory difficult. Thus, the GMI is confounded due to the fact that both recall and recognition are included in the score, which is only made more complicated because there is an artificial ceiling effect in the Auditory Recognition Delayed Index. To assist examiners with this comparison, a new "Delayed" Memory Index was derived from the WMS-III standardization sample using only the auditory and visual delayed recall subtests. This new index includes only the delayed components of the same 4 subtests found in the IMI. This presentation will describe the new index, describe its potential advantages, and show patterns of performance in the clinical group samples that were collected as part of the WMS-III standardization study.

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Symposium 8/10:45 a.m.–12:30 p.m.

**SPATIAL BIAS, SPATIAL REPRESENTATIONS,
AND UNILATERAL NEGLECT**

Organizer and Chair: Anna M. Barrett
Discussant: Anjan Chatterjee

A.M. BARRETT. Spatial Bias, Spatial Representations and Unilateral Neglect.

Classically, subjects with unilateral neglect after right hemisphere stroke are described as unaware of salient left-sided stimuli. However, patients with neglect may also exhibit other abnormalities such as asymmetric habituation and distractibility, asymmetric internal representations, and asymmetric motor bias. These symptoms are not fully explained by deficient stimulus detection. In this symposium, we will discuss how neglect symptoms not directly attributed to unawareness contribute to theories of this syndrome. Dr. John Adair will discuss data he and Dr. Duk Na collected on using stimuli with different internal characteristics to elucidate the mechanisms of “ipsilateral neglect.” Dr. Anna Barrett will compare and contrast syndromes of contralesional bias in brain-injured subjects (attentional grasp/distractibility, ipsilateral neglect, contralesional bias associated with visual field defects). Dr. Mark Mennemeier will discuss altered psychophysical perceptual continua in neglect and their implications for disordered internal representations in this syndrome. Dr. Anjan Chatterjee, the discussant, will lead question-and-answer sessions following each presentation, ending the symposium with summary, comments, and remarks on future research directions. Symposium attendees will improve their understanding of less emphasized, neglect-associated disorders. They will also become more familiar with current thinking about impairment of neuroanatomic–neuropsychological systems in unilateral neglect.

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J.C. ADAIR & D.L. NA. Spatial Bias as a Dynamic Function of Stimulus Attributes in Ipsilateral Neglect.

Individuals with hemispatial neglect may show differential bias on tasks that ostensibly tax similar aspects of spatial cognition, leading some to criticize neglect as “meaningless.” Patients with contralesional bias, termed “ipsilateral neglect” (IN), may provide insight into dissociations found in “conventional” neglect patients who fail to report or orient to stimuli in space contralateral to brain injury. Na et al. described right-brain-injured patients with significant line bisection bias to the left of center, thereby diagnosed as IN. Using stimuli composed of linear arrays of multiple elements (“character lines”) that subtend identical spatial coordinates (length, thickness, location in extrapersonal space), these patients’ bias shifted rightward when asked to mark the target character at line center. Data from 80 more consecutive patients with right hemisphere vascular lesions showed that those deviating leftward on standard line bisection either reversed bias to the right or made smaller leftward deviations on character line tasks. Such data complicate accounts of neglect that posit simple dichotomous attentional-sensory *versus* intentional–premotor processing defects. Task set (“top-down”) may interact with stimulus features (“bottom-up”) in a dynamic fashion to modify and manipulate spatial representations.

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A.M. BARRETT. Contralesional Bias After Brain Damage.

Spatial neglect is a failure to report, respond or orient to stimuli in the hemispace contralateral to a brain lesion. However, some brain-injured patients may demonstrate bias in the contralesional, rather than the ipsilesional, direction. When should contralesional bias after brain injury be

considered pathological? Is pathological contralesional bias equivalent to “ipsilateral neglect”? In this presentation, I will review clinical syndromes of contralesional bias, and discuss possible perceptual-representational and motor-intentional mechanisms of these errors. I will contrast (1) normal bias, (2) attentional grasp, (3) ipsilateral neglect, and (4) bias in subjects with visual field defects due to occipital brain lesions. I will present data I and my colleagues collected, and also data published by others. Like patients with spatial neglect, patients with visual field defects may demonstrate both contralesional and ipsilesional bias. These patients provide an opportunity for symptom-based outcomes research. However, systematic investigation of perceptual-representational and motor-intentional components of contralesional bias is needed in all the clinical contexts where it occurs.

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**M. MENNEMEIER, H. MURPHY, T. KRETZMER, G.R. JEWELL,
& T. NUNN. Altered Psychophysical Function in Neglect Across a Dozen Perceptual Continua.**

Though neglect is commonly understood either as a disorder of spatial attention, spatial movement, or mental representations of space (spatial deficits), neglect is also a disorder of magnitude estimation—judging stimulus intensity. Attentional deficits account for where stimuli are neglected in space, whereas deficits in magnitude estimation account for how much of a stimulus is neglected and sometimes exaggerated. We hypothesized that magnitude estimation depends on the formation of mental representations of stimulus intensity. Mental representations of stimulus intensity may be altered in neglect independent of spatial deficits. If so, then patients with neglect should demonstrate altered magnitude estimations across a wide variety of perceptual continua and not merely those related to spatial judgment. To test this hypothesis, normal control subjects and patients with neglect judged stimulus intensities across the following perceptual continua: area, length, number, loudness, light reflectance, tactile pressure (cuff and point), roughness, temperature, gustatory (salt and sucrose), and proprioception. A standard method of magnitude estimation was used. Data were summarized using power functions. Patients demonstrated altered power functions relative to controls in nearly all perceptual continua. Individual variation was present. Sensory impairment and executive function influence outcome. Spatial deficits cannot explain the fact that magnitude estimation is altered by neglect in nearly all perceptual continua tested. Rather, altered mental representations of stimulus intensity seem to represent an independent source of variance in neglect that is distinct from spatial deficits.

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Poster Session 4/11:30 a.m.–1:00 p.m.

DRUGS AND ALCOHOL

S.A. MALIK & K.K. ZAKZANIS. Ecstasy and Depression: Does Depression Exacerbate the Functional Deficits of Ecstasy Use?

Repeated recreational use of ecstasy, (+)–3, methylenedioxymethamphetamine (MDMA) leads to marked deficits in memory, psychological functioning, and higher-order cognition. Clinically depressed individuals suffer from many of these same deficits. The present investigation was undertaken to determine whether or not depression exacerbates functional deficits in ecstasy users. A short neuropsychological battery was used to measure differences in memory and executive functioning in depressed *versus* non-depressed ecstasy users. Both groups were matched for gender, age, education, and recreational drug history. Depressed ecstasy users showed greater deficits on CVLT-2 measures of short delay free recall ($p = .04$, $d = .72$) and ROCF measures of executive functioning ($p = .04$, $d = .72$). Nonsignificant between groups differences were found on measures of verbal, visual, and prospective memory, visuoconstructional abil-

ity, verbal fluency, and phonemic fluency. Hence, depression gives rise to selective functional deficits in ecstasy users.

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K.K. ZAKZANIS, D.A. YOUNG, & Z. CAMPBELL. Evidence That Abstinent Users of MDMA (“Ecstasy”) Demonstrate Impairment on Prospective Memory Tasks.

Quantitative evidence has begun to emerge where human studies suggest that repeated recreational use of \pm 3,4-methylenedioxyamphetamine (MDMA or “Ecstasy”) produces lasting impairments in explicit memory. The purpose of this investigation was to explore further the nature and pattern of component memory processes in abstinent MDMA users. Accordingly, 15 MDMA users and 17 matched normal controls completed a brief neuropsychological test battery composed mainly of the Rivermead Behavioral Memory Test (RBMT), a stem-completion task, and the Vocabulary subtest of the Wechsler Adult Intelligence Scale–III (WAIS–III). MDMA users were found impaired in terms of episodic prospective memory, as medium to large effects were observed between groups on time-based Appointment and event-based Message subtests of the RBMT. The results of this study also indicate that the ability to recall a future appointment may be related to the frequency of MDMA use and the absolute number of times MDMA was used. Direct evidence of this sort in MDMA users should address questions regarding the relation between neurotransmitter serotonin and component processes of memory.

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S. ROCK, A. LIN, J.C. STOUT, P. FINN, J. BUSEMEYER, R. SPIRES, & M.C. CAMPBELL. Impaired Decision-Making in Drug Abusers: Learning or Risk-Taking Deficiency?

Several studies have shown that drug abusers perform more poorly on the Bechara gambling task when compared to a non-drug abusing population by making relatively more disadvantageous than advantageous choices. It is unknown why this occurs, but one possibility is that drug abusers are slow to learn from previous choices or fail to learn the likelihood of a negative outcome. To test these possibilities, we altered the Bechara gambling task so that one version revealed the deck probabilities of winning or losing money throughout the task, thus eliminating the need to learn the contingencies. In addition, we explored the process of learning those contingencies through the use of cognitive models, which uses a theoretical basis to deconstruct complex tasks into separate processes, thus providing a theoretically based means for assessment of the hidden components (e.g., learning, risk-taking and sensitivity). We utilized the expectancy-valence learning with 3 and 4 parameters constraints and expectancy-utility models, specifically designed to integrate learning and decision-making processes into a unified model. We found that when the probability was stated individually, irrelevant of group, performed better. There was a significant interaction between gender and group for making more advantageous choices, thus control males did the best, followed by the drug abusing females, control females and drug abusing males, respectively.

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K.A. STRAITS-TRÖSTER, J. RIPPETH, L. ROMWALL, G. ROSENBAUM, K. BUSH, & A. SAXON. Cognitive Changes Among Methamphetamine Abusers in Early Recovery.

Neuroimaging studies have reported that methamphetamine users have reduced numbers of dopamine transporters and demonstrate cognitive deficits consistent with dopamine depletion. Cross-sectional studies suggest that these deficits may persist or even worsen with initial abstinence. This longitudinal study examined cognition among methamphetamine abusers during a 30-day residential program. Patients meeting DSM-IV criteria for methamphetamine dependence with no significant CNS medical history

were administered a neuropsychological test battery early in treatment (Day 3–10) and 3 weeks later (interim $M = 20.7$ days, $SD = .9$). Eligible patients were recruited consecutively ($N = 13$) and 11 were male (85%), white (85%), and unemployed (85%) with a mean age of 31.7 ($SD = 9.6$) years and 10.5 ($SD = 1.7$) years of education. Tests with standardized alternate forms were utilized to minimize practice effects. Cognitive functioning at baseline was impaired (mean T scores < 41) for information processing (PASAT: $M = 36.6$, $SD = 8.7$) and learning and delayed recall of both visuospatial and verbal information. Subjects performed more poorly on the verbal learning task compared to the visuospatial task at baseline (one-sample t test; $p < .001$). After 20 days of treatment, subjects ($N = 11$) remained impaired on learning and memory tasks. Paired t tests indicated improvement in percent of visuospatial information retained after a learning task ($p = .03$), but no improvement was noted for verbal memory. Improvements were noted for information processing (PASAT; $p = .002$), selective attention (Stroop C-W; $p = .04$) and psychomotor speed (Trails A; $p = .03$). Preliminary results support reports of cognitive impairment associated with methamphetamine-induced dopamine depletion and poor initial recovery of verbal memory.

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B.C. SCHWEINSBURG, R. GONZALEZ, M.J. TAYLOR, O.M. AL-HASSOON, M. CHERNER, G.G. BROWN, I. GRANT, & THE HNRC GROUP. Age-Related Cerebral Changes in Abstinent Methamphetamine Users.

Methamphetamine abuse has been associated with cognitive and neurochemical changes, but the impact of previous use on the aging brain is not well-understood. Aging may leave the brain vulnerable to substance-related injury, particularly in white matter. Based on this assumption, we hypothesized that recently abstinent methamphetamine users (METH) would display evidence of brain injury on spectroscopic examination, above and beyond what could be expected for normal aging. Decreased N-acetylaspartate (NAA: a marker of neuronal integrity) was expected to predict neuropsychological (NP) dysfunction in METH. Forty-eight METH (age = 37.1, education = 12.1, female = 31.3%, non-white = 16.7%) and 36 healthy control participants (CON: age = 34.8, education = 13.1, female = 30.6% non-white = 33.3%) received proton magnetic resonance spectroscopy and a comprehensive NP examination. T tests revealed METH and CON had similar concentrations of NAA in a frontal white matter (FWM) region of interest [$t(82) = .14$, $p = .89$]. However, age interacted with group status in a multiple regression [$F(3,83) = 3.16$, $p = .03$], and predicted a significant amount of variance in FWM NAA (partial $r = -.33$, $p = .003$). NAA declined with age in the METH group ($r = -.28$, $p = .05$), but increased with age in the CON ($r = .39$, $p = .02$). Quantities of methamphetamine use did not predict NAA. In addition, levels of NAA did not predict NP performance. The results suggest that white matter is sensitive to methamphetamine-related axonal injury, and this change is greater than can be explained by age alone. As the brain ages, axons may have a decreased ability to endure the toxic effects of substances.

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R. GONZALEZ, C. CAREY, L. NATARAJAN, T. WOLFSON, & I. GRANT. Non-Acute Effects of Cannabis on Cognitive Abilities: Comparing Methods of Research Synthesis.

Our research group recently completed a meta-analysis of the literature examining non-acute effects of cannabis on neuropsychological (NP) performance. A rigorous literature search and quality control process yielded 15 studies. For this abstract, these studies were used to compare the results obtained when employing different methods of data synthesis. First, a senior neuropsychologist classified each NP test administered in these studies to one of eight cognitive domains. Synthesis Method 1 simulated a qualitative review. For every domain examined in each study, we determined if authors’ concluded the presence or absence of group differences between cannabis users (CU) and their control group, primarily based on

information presented in their abstracts. Method 2 used the techniques of Hedges and Olkin to calculate an effective size (ES) and its variance for each test administered in a study. Then, for each study, ESs were combined across tests, within domains, to yield a new ES and its 95% confidence interval (CI). If the new ES and CI included zero, then a study was classified as finding no differences between CU and controls, for the respective domain. Method 1 & 2 showed poor agreement in establishing the presence or absence of between group differences ($\kappa = .33$), and differed statistically on their classifications [$\chi^2(1, N = 56) = 5.49, p = .02$]. Nevertheless, for each domain, the percent of studies finding group differences suggested an absence of a “cannabis effect,” regardless of method. In contrast, when meta-analysis was used to combine ESs within domains, across studies, we found small but statistically significant ESs for 2 cognitive domains. Our data illustrate how conclusions differ depending on the method of synthesis employed.

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L. THOMPSON, S. MIKULICH, & T. CROWLEY. Executive Function and Decision Making in Drug Abusing Delinquent Adolescents.

Executive function (EF) and decision making have been found to be deficient in adults with substance use disorders (SUD). Adolescents with SUD and or conduct disorder (CD) have shown deficits in aspects of EF, but adaptive decision making has not been studied. We examined the performances of adolescents in treatment for serious substance and behavior problems (CD/SUD group) in comparison to community controls, with the prediction that subjects in treatment would perform more poorly than controls. Twelve males and 10 females in treatment and 10 male and 9 female controls completed the Self-Ordered Pointing Task and the Cognitive Bias Task. We found a significant interaction between type of stimuli and group on Self-Ordered Pointing errors ($p < .01$), indicating that CD/SUD subjects made more errors than controls with verbal stimuli or abstract drawings, but not with concrete drawings. As with previous research using the Cognitive Bias Task, control males performed significantly differently than did control females ($p < .01$), so we analyzed group differences separately for the males and females. Males with CD/SUD performed significantly differently than did male controls ($p < .05$), showing a pattern similar to adult males with left frontal structural lesions. Female patients did not differ from female controls; group scores were not normally distributed, and control male data showed a bimodal distribution, complicating interpretation. Associations with measures of ADHD, aggression, and depression as well as implications for understanding EF and decision making in adolescents with CD/SUD will be discussed.

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P. CONNOR, H. BARR, & A. STREISSGUTH. Two Scoring Methods of the Rey-Osterrieth in Adults with Fetal Alcohol Damage.

Patients with Fetal Alcohol Syndrome (FAS) and Fetal Alcohol Effects (FAE) often display deficits in constructional praxis. The copy portion of the Rey-Osterrieth Complex Figure Test (RCFT) was administered to 90 adults (30 FAS, 30 FAE, 30 control, half female). Two scoring methods were compared: the standard scoring system and the Boston Qualitative Scoring System (BQSS). Both methods were sensitive to the effects of prenatal alcohol damage on presence and accuracy measures (standard scoring: 77% sensitivity, 67% specificity. BQSS: 45% sensitivity, 87% specificity). Because organization and planning abilities are particularly sensitive to the effects of prenatal alcohol damage, we also examined qualitative scores from the BQSS. The mean rank of all 19 subscores from the BQSS (both accuracy and qualitative) demonstrated a sensitivity of 75% and specificity of 87%. Organization (planning and neatness) from the BQSS demonstrated a sensitivity of 40% and specificity of 83%. Some BQSS subscales demonstrate a pathognomonic pattern in which very few controls make errors. These include the Planning, Vertical and Horizontal Expansion, Rotation, Perseveration, and Confabulation subtests. Altogether, these results demonstrate the need to assess qualitative organiza-

tion skills in evaluating fetal alcohol damage, confirming our earlier work with young children.

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R. GREENBAUM, I. NULMAN, E. FANTUS, D. SORBARA, G. KOREN, & J. ROVET. A Neuropsychological Approach for Diagnosing Fetal Alcohol Exposure.

The classic condition Fetal Alcohol Syndrome (FAS) involves a triad of features reflecting facial dysmorphism, growth retardation, and intellectual impairments. However, FAS encompasses only a small proportion of the children affected prenatally by alcohol, most of whom have non-discriminative facial features and lack a documented exposure history. While the latter are said to have Alcohol Related Neurodevelopmental Disorder (ARND), the diagnostic criteria for this condition have yet to be defined. We used a profile approach to examine neuropsychological assets and deficits in children with known or suspected alcohol exposure. Originally, we established a checklist of strengths and weaknesses from the available literature, parent descriptions, and our own experience with ARND, and we tested 52 children with known or suspected prenatal alcohol exposure using a battery of neuropsychological tests. Results were submitted to a discriminant function analysis to ascertain a hypothetical profile, which was further validated in samples with known exposures. Next, we refined our test battery and procedures in testing a further 55 children whose results were similarly analyzed and used to develop a diagnostic severity rating scale. Overall results indicated that attention, receptive language, verbal memory, social comprehension, and socioemotional functioning are the main areas of deficit while rote memory for numbers, visuospatial abilities, and gross motor skills are personal assets. Our developing iterative approach, which we found distinguishes alcohol from cocaine exposure, is unique in diagnosing fetal alcohol effects in the absence of discriminative facial features and well-documented history of exposure.

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R. GREENBAUM, G. KOREN, & J. ROVET. Behavior Profile in Prenatal Alcohol Exposure: Implications for Frontal Dysfunction.

Prenatal alcohol exposure (PAE) increases the risk of neuropsychological impairment as well as secondary socioemotional and behavioural disturbance. However, there are few detailed studies of socioemotional functioning in children exposed prenatally to alcohol. To better understand the challenges of PAE and direct treatment-oriented research, we compared 35 children aged 4–18 years diagnosed with Alcohol Related Neurodevelopmental Disorder (ARND) to 33 normal controls matched for age, gender, and SES on the Child Behaviour Checklist (CBCL), a standardized measure of socioemotional functioning. Results were analyzed both quantitatively and qualitatively to ascertain whether a distinct clinical profile of disturbed socioemotional functioning exists. Results indicated that children in the ARND group differed significantly from controls ($p < .001$) in their presentation of socioemotional and behavioral problems. The ARND group was more likely ($p < .001$) to exhibit clinically significant inter-class correlation coefficient profiles reflecting social problems, delinquent, and delinquent/aggressive behaviour clusters, supporting the hypothesis of frontal lobe dysfunction in children affected by PAE. Similarly, item analyses revealed a pattern of socioemotional disturbance reflecting inattention, disobedience, impulsivity, lack of guilt, lying/cheating, and poor interpersonal relations. Analyses of qualitative responses on the CBCL generated consistent and meaningful themes suggesting a characteristic profile comprised of self-regulatory problems, poor adaptive life skills, delinquent behaviour, as well as cognitive and socioemotional dysfunction. Overall, these findings are consistent with a distinct clinical profile suggestive of perturbed neurodevelopment of selective brain systems including frontal lobes.

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K.T. LEE, S.N. MATTSON, & E.P. RILEY. Classifying Children With Heavy Prenatal Alcohol Exposure With Attention Measures.

Deficits in attention are a hallmark of the effects of heavy prenatal alcohol exposure. However, a functional profile that discriminates alcohol-exposed children from nonexposed controls is not well defined. The current study attempted to distinguish children with heavy prenatal alcohol exposure from non-exposed controls using four measures of attentional functioning: the Freedom from Distractibility Index from the Wechsler Intelligence Scale for Children—Third Edition (WISC—III), the Attention Problems scale from the Children Behavior Checklist (CBCL), and omission and commission error scores from the Test of Variables of Attention (TOVA). Data from two groups of children were analyzed: children with heavy prenatal alcohol exposure and non-exposed controls. Children in the alcohol-exposed group matched on age, sex, handedness, ethnicity, and social status. Data were analyzed using logistic regression. This technique is useful for predicting the presence or absence of a characteristic (e.g., prenatal alcohol exposure) based on a set of predictor variables. The final model included the Freedom from Distractibility index from the WISC—III and the Attention Problems scale from the CBCL. The TOVA variables were not retained in the final model. Classification accuracy was 92.5% overall. Specifically, 95% of the alcohol exposed children and 90% of the control children were accurately classified. These data indicate that children with heavy prenatal alcohol exposure can be distinguished from non exposed controls with a high degree of accuracy using two commonly used measures.

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A. KANE, S.N. MATTSON, R. KLOPP, C.D. COLES, G. MARINTCHEVA, & E.P. RILEY. Relationship of IQ and WCST Performance in Children With Fetal Alcohol Syndrome.

Children prenatally exposed to heavy amounts of alcohol suffer from serious cognitive deficits. Neuropsychological studies have examined the relationship between overall intellectual ability and specific cognitive deficits in this population. We previously investigated the relationship between Full Scale IQ (FSIQ) score and Wisconsin Card Sorting Test (WCST) performance. The results suggested that although the alcohol-exposed group was impaired on the WCST relative to a nonexposed control group, their performance was greater than expected based on their FSIQ. The purpose of this study was to further investigate this relationship using a control group matched for FSIQ. Data were collected from 2 groups, children with fetal alcohol syndrome (FAS) and controls (CON) from 2 sites, the Institute of Psychiatry in Moscow, Russia and the Center for Behavioral Teratology in San Diego, CA. Groups were matched on age and sex. The FAS and CON groups from San Diego had significantly different FSIQ scores whereas the groups from Moscow were matched on this score. The results were interesting for 2 reasons. First, we replicated our previous findings: WCST scores were significantly higher than FSIQ scores in all groups. Second, when groups were matched on FSIQ, as with the Russian participants, WCST performances were also similar. Thus, although performance on the WCST is less impaired than suggested by overall intellectual ability, this relative strength is not specific to children with FAS.

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O.M. ALHASSOON, M.J. TAYLOR, B.C. SCHWEINSBURG, T.L. PATTERSON, G.G. BROWN, & I. GRANT. Neuropsychological and rCBF Differences Between Alcoholic Subtypes Identified Through MMPI Scale—4.

The MMPI Scale—4 is consistently found to be elevated among alcoholics. However, there is no published research examining the response patterns and associated neuropsychological (NP) and neurophysiological characteristics of different types of alcoholics using Scale—4. We examined NP and regional cerebral blood flow (rCBF) differences between subtypes of alcoholics identified through MMPI Scale—4 items. Utilizing a sample of

246 male recently detoxified alcoholics, latent class analysis was applied to items of Scale—4. Using the Akaike Information Criterion as a parsimony index, a 2-class model was found to best fit the data. One group (*antisocial group*) was found to endorse more antisocial items on the MMPI while the other group was found to endorse items related to anxiety and depression (*general psychopathology group*). Cases were assigned to their likely class using posterior probabilities. After matching the two classes on age, education, and ethnicity, they were compared on results of the Category Test, Trail Making Test, Tactile Performance Test, and California Verbal Learning Test—II. On the Category Test, the 2 classes differed significantly [$t(152) = 6.13, p < .001$] with the antisocial group (M T score = 39.6, $SD = 10.6$) performing worse than the general psychopathology group (M T score = 45.8, $SD = 11.9$). The two groups were not found to differ significantly on the other NP tests. The antisocial group also exhibited significantly lower rCBF in the left prefrontal region compared to the general psychopathology group [$t(16) = 2.23, p < .05$]. These results are consistent with alcoholic typologies that use antisocial characteristics as an integral component in classifying alcoholic patients.

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C. VICKERY, M. SHERER, T. NICK, R. NAKASE-THOMPSON, J. CORRIGAN, F. HAMMOND, S. MACCIOCCHI, D. RIPLEY, A. STRINGER, & A. SANDER. The Effect of Alcohol Abuse and Acute Intoxication on Early Functional Status After TBI.

The present study investigated the effects of acute intoxication and history of alcohol abuse on functional status at the time of acute rehabilitation admission in traumatically brain injured patients. Data from 1445 participants in the TBI Model Systems Project were analyzed with regression procedures intoxication at the time of injury (positive blood alcohol level; BAL, upon hospital admission) and history of alcohol abuse indicated by binge drinking (5 or more drinks on one or more occasions) in the month prior to injury as predictors of Disability Rating Scale (DRS) and Functional Independence Measure (FIM) scores at rehabilitation admission. Univariable regression analyses indicated that neither BAL nor alcohol abuse was a significant predictor of DRS or FIM. However, the substantial correlation between BAL and alcohol abuse (Spearman's coefficient = .54) indicated that these variables were confounded. Bivariable regression analysis indicated that both BAL and alcohol abuse were predictive of DRS and FIM once adjusted for each other. The same pattern obtained once the model was adjusted for other factors including sex, education, age, acute care length of stay, and initial Glasgow Coma Scale score. While higher levels of BAL were associated with poorer functional status, as expected, a history of alcohol abuse was unexpectedly associated with better functional status. The surprising association of alcohol abuse with better early functional status may be due to the specific definition of alcohol abuse used in this study. Future research should examine different methods of identifying subjects with a history of alcohol abuse.

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W. VANVOORST & R. SKEEL. The Predictive Role of Executive Functions in College Students' Drinking Patterns: Comparing Social and Formal Problem Solving in Young Adult Children of Alcoholics.

A variety of factors predict drinking patterns and alcohol-related problems in young adults, including a family history of alcoholism and measures of executive brain functioning. Other individual difference factors that elevate risk for developing problems related to drinking may include social problem solving. The role of social problem solving in predicting drinking patterns and alcohol-related problems in children of alcoholics has yet to be studied but it appears to be a vital area of investigation in terms of identifying at-risk individuals. The current project examined whether formal problem solving gauged by neuropsychological tests and self-reported social problem solving predicted alcohol-related problems in college students. Undergraduate students were screened for the presence

of a family history of alcoholism in their biological parents using the father and mother versions of the Short Michigan Alcohol Screening Test (F-SMAST, M-SMAST). Individuals with a positive family history of alcoholism ($n = 38$) and a sample without a family history of alcoholism ($n = 47$) were individually administered the Delis Kaplan Executive Function System (DKEFS) Tower Test and Sorting Test as measures of formal problem solving. Social problem solving was gauged using the Social Problem Solving Inventory-Revised (SPSI-R) and alcohol-related problems were measured using a version of MAST adapted for use with college students. Hierarchical regression analyses indicated that, after controlling for family history, social problem solving scores accounted for a significant amount of variance in alcohol problems ($\Delta R^2 = 6\%$). However, formal problem solving did not contribute a significant amount of unique variance to the prediction of alcohol problems. Results suggest that social problem solving may be useful in predicting which college students may experience alcohol related problems while formal solving abilities measured by neuropsychological measures appear weakly related to problem drinking.

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C.L. DIRKSEN, J.A. HOWARD, J. BASKIN, & M. OSCAR-BERMAN. Object Alternation in Abstinent Alcoholics With and Without Korsakoff's Syndrome.

We administered *object alternation* (OA) to 31 abstinent alcoholics, 9 patients with alcoholic Korsakoff's syndrome and 35 non-alcoholic controls. OA has been shown to be particularly sensitive to ventrolateral, ventromedial, and orbitofrontal dysfunction. Because frontal pathology has been well documented in Korsakoff and non-Korsakoff alcoholics, both groups were expected to be significantly impaired relative to non-alcoholic controls. Results were consistent with the predictions: Korsakoff and non-Korsakoff alcoholics committed significantly more errors on OA than did controls. The Korsakoff and non-Korsakoff alcoholic groups did not differ from each other. Regression analyses were performed to determine the effects of drinking variables, memory, and age on OA performance. Quantity Frequency Index (QFI), Length of Sobriety (LOS), number of years of drinking 21 or more drinks per week, General Memory Quotient (GM), and participant age were regressed, separately, on to OA error scores. None of the regressions was significant. Our findings suggest that (1) alcoholic participants show evidence of frontal-system dysfunction regardless of age, and (2) these deficits exist independently of global memory impairment.

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B. MONTAGNE, R.P.C. KESSELS, J. VAN HONK, A.J. WESTER, M.J.E. VAN ZANDVOORT, & E. DE HAAN. Cortical and Subcortical Emotional Processing in Korsakoff's Syndrome.

Satisfying interpersonal contacts depend a great deal on understanding emotional facial expressions of others. The recognition of emotional facial expression has been shown to be severely impaired in chronic alcoholics. That is, alcoholics are impaired in general in labeling emotional expressions. More specifically, they mislabel sad expressions, regarding them as more hostile (angry/disgusted). It was also found that patients with Korsakoff's syndrome show a normal emotional responsiveness. The current study looked at 22 patients diagnosed with Korsakoff's syndrome. Korsakoff's syndrome can develop in chronic alcoholics, and is characterized by severe cognitive dysfunction, which has been linked to frontal-lobe pathology, as well as to damage in the region of the diencephalon. This study is the first to make use of conscious (cortical) and unconscious (subcortical) measurements of emotional processing in Korsakoff patients. An emotional recognition task was used (anger, disgust, fear, happiness, sadness and surprise), as well as a masked and unmasked version of the emotional Stroop task (anger, neutral and happiness). The findings suggest that patients with Korsakoff's syndrome are less accurate at recognizing fearful and sad facial emotional expressions. Furthermore, there was a strong correlation ($r = .55, p < .01$) between attentional biases (interference or

facilitation) to masked and unmasked angry faces. This suggests that in contrast to healthy subjects, there is evidence that cortical emotional processing is impaired in Korsakoff patients, whereas subcortical emotional processing is relatively intact. This implicates that the diencephalic lesions in Korsakoff patients do not affect the subcortical emotional circuitry (i.e., the amygdala).

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**GENETIC DISORDERS:
COGNITIVE AND NEURAL CORRELATES**

D. CROCETTI, L.E. CUTTING, C.W. KOTH, D. DAVID, W. KATES, & M. DENCKLA. Relationship Between Parietal and Frontal Lobe Volumes and Cognitive Functioning in NF-1.

Studies have shown selective cognitive impairment and megalencephaly to be prominent characteristics of Neurofibromatosis Type 1 (NF-1); however, the relationship between brain tissue volume and cognition remains uncertain. In order to clarify this issue, we compared brain volumes and neuropsychological functioning in 18 males with NF-1 and 16 controls, aged 5–18 years. Using the Talairach parcellation technique, parietal and frontal lobe tissue volumes were measured. These volumes were then compared to performance on a visuospatial test traditionally assumed to reflect parietal lobe function (Judgment of Line Orientation; JLO). Consistent with previous findings, the NF-1 group scored significantly lower on the JLO ($p < .001$), and had larger total cerebral, parietal, and frontal lobe volumes as compared to controls (all $p < .050$). Multiple-regression analyses, controlling for age and total cerebral volume, were utilized to examine the *relationship* between brain volumes and neuropsychological performance. Results revealed that, regardless of group membership, there was a significant inverse relationship between frontal lobe volumes and JLO ($p = .008$) performance, whereas the specific relationship between JLO performance and parietal lobe volume was not significant. This suggests that in pediatric populations, JLO performance may be influenced by cognitive functions typically associated with the frontal lobe (i.e., executive functioning).

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L.E. CUTTING, C.W. KOTH, D. DAVID, & M. DENCKLA. Comparison of Neuropsychological Profiles of Children With NF-1 and RD.

It has been reported that children with Neurofibromatosis Type 1 (NF-1) have a high incidence of learning disabilities, particularly reading disabilities (RD). However, it is not fully understood whether there are differences in neuropsychological performance between children with NF-1 *versus* children with idiopathic RD, which might be important in determining the best instructional/intervention techniques for children with NF-1. Ten children with NF-1, 9 children with idiopathic RD, and 10 children without RD or NF-1 (Controls) were compared on reading and language measures using univariate and multivariate analyses of variance. Results indicated that the RD group showed lower scores than the NF-1 group on measures of single word reading and reading comprehension ($p < .001$); however, both groups' performance on these measures was below that of the control group's ($p < .001$). Both NF-1 and RD groups showed significantly lower scores than the control group on measures of phonological awareness and phonological memory (all $p < .01$); however, unlike the RD group, the NF-1 did not show impairment on Rapid Automatized Naming ($p > .05$), which tends to be predictive of single word reading fluency. On language measures, the RD and NF-1 groups showed significantly lower performance than the control group on receptive and expressive language, as well as inferential and figurative language, even when scores were adjusted for IQ (all $p < .05$). Overall, findings indicate that children with NF-1 show similar neuropsychological performance to that of children with idiopathic RD, suggesting that similar types of instructional/

intervention techniques known to be successful with children with RD may be beneficial for children with NF-1.

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G. SCHRIMSHER, R. BILLINGSLEY, J. SLOPIS, & B. MOORE. Visual-Spatial Performance and ADHD in Children With Neurofibromatosis Type-1.

Neurofibromatosis type 1 (NF-1) is a common genetic disorder associated with a variety of medical complications, cognitive impairments, and behavioral problems including a high incidence of Attention Deficit Hyperactivity Disorder (ADHD). The current study examined the hypotheses that deficits in visual-spatial/motor abilities (generally considered a feature of NF-1), would discriminate and classify children with a NF-1 diagnosis ($n = 101$) compared to control children ($n = 37$) beyond effects secondary to parent reported ADHD symptomology. Discriminant analysis showed a multivariate combination of visual-spatial/motor ability tests (Judgment of Line Orientation, Block Design subtest of the WISC-III, Recognition-Discrimination Test, Beery Visual-Motor Integration Test) to be a significant predictor of group membership ($p = .01$; canonical $R^2 = .23$). A significant increase in ADHD behavior was found in the NF-1 group and a discriminant analysis using ADHD residualized visual-spatial motor scores indicated that the combination of tests continued to be a significant predictor of group membership ($p = .01$ and a canonical $R^2 = .18$). This combination of tests proved to be a strong discriminator of NF-1 in that it correctly identified 90% of individuals with the diagnosis. Although this pattern of visual-spatial/motor deficits should not be considered a diagnostic criterion since it incorrectly classified 32% of controls as NF-1, it may help support the diagnosis of NF-1 in children who do not otherwise meet the formal diagnostic criteria.

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B. MILES, D. MINDEN, P.E. ANDERSON, B. FELDMAN, C. POND, S. REVEL-VILK, M. GOLOMB, M. McNEELY, A.M. STAIN, C. ACHONU, W. LOGAN, V. BLANCHETTE, & M. BARNES. The Effects of Hemophilia and Cerebral Bleeds on Behavioral, Socioemotional, and Adaptive Functioning.

Hemophilia is a congenital X-linked recessive disorder in which affected individuals are deficient in clotting factor VIII or factor IX, resulting in spontaneous, recurrent bleeding episodes, particularly in the extremities and joints. Cerebral hemorrhages can also occur though they are relatively less frequent and have not been well studied. We investigated the behavioral, socioemotional, and adaptive functioning of 48 boys with hemophilia (ages 3–18 years) using a standardized parent questionnaire (Child Behavior Checklist) and a measure of adaptive function (Vineland Scales of Adaptive Behaviour). Sixteen boys who had experienced cerebral bleeds were compared to other boys their age matched for severity of hemophilia. No significant differences were found between boys who experienced cerebral bleeds and those who did not on standard, composite scores on the parent questionnaire. Nor were there differences between the groups on the measure of adaptive function. Among boys with cerebral bleeds, parent ratings did not differ as a function of number of cerebral bleeds (single vs. multiple), bleed location (left vs. right), or age at bleed. This stands in contrast to differences found between the groups on selected neurocognitive measures such as intelligence and fine motor function. As a group, boys in our sample scored lower on adaptive functioning than the normal population. However, these boys did not differ in terms of clinical classifications on either measure. Boys with hemophilia, with or without cerebral bleeds, do not appear to be at increased risk for clinically significant behavioral, emotional, or adaptive problems according to parental report.

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G. MORALES, D. ZARABOZO, & E. MATUTE. Language Skills in Hemophilic Boys With Intracranial Hemorrhage.

It is well known that intracranial hemorrhage could affect language acquisition in children. Although plasticity of the Central Nervous System in children could reduce language sequelae other factors such as age, lesion size and locus, and number of hemorrhagic events may affect plasticity effects. Language skills of 9 HIV-negative hemophilic boys with cerebral hemorrhage (HG), aged from 6 to 15 years (M age = 11.6) and 9 control boys (CG) matched per age, sex, school grade and socioeconomic status were tested using four repetition tasks (repetition of syllables, words, non-words and sentences) a confrontation naming task, and 3 comprehension tests: a picture pointing task, an oral commands and an oral comprehension test. A Mann-Whitney U Test revealed no differences between both groups although a tendency of the HC to perform poorly was evident. However, a Scatterplot matrix showed one outlier when using the 8 language measures together. This boy presents a widespread parietal-occipital left hemispheric lesion produce by three hemorrhagic events. Results are discussed in terms of the characteristics of neurological impairment.

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P.E. ANDERSON, B. FELDMAN, B. MILES, M. GOLOMB, S. REVEL-VILK, M. McNEELY, C. POND, A.M. STAIN, C. ACHONU, D. MINDEN, W. LOGAN, V. BLANCHETTE, & M.A. BARNES. Impact of Intracranial Hemorrhage on Neurocognitive Functioning in Boys with Hemophilia.

Hemophilia is a blood clotting disorder that produces musculoskeletal complications, episodes of extreme pain, and disability. Intracranial hemorrhage (ICH) is a less common complication of hemophilia that has received little study, but which may place these children at risk for impairments in neurocognitive function. We investigated neurocognitive functioning of 48 boys with hemophilia. Sixteen boys with ICH were each matched to 2 controls for age and severity of illness. Comparison of the ICH and control groups on tests of intelligence, memory, fine motor skill, language, and academic function failed to reach significance although there were trends for the ICH group to have lower scores on Pattern Analysis, a timed measure of visual-organization/visual-motor construction, and on Purdue Pegs, a test of fine motor speed. In addition, there were significant effects for number of ICH events and age at ICH. Children with 2 or more ICH events were significantly poorer on Pattern Analysis and marginally poorer on memory and vocabulary measures than were children who had sustained 1 ICH. Children who experienced an ICH prior to 1 year of age had more difficulty on memory tasks and fine motor tasks than children who sustained an ICH after the 1st year of life. The results are discussed with reference to neurocognitive effects of brain bleeds in other populations such as childhood stroke. The results underline the need for further investigation of ICH in boys with hemophilia using larger samples and follow-up of these “at-risk” children as they develop into adolescence and adulthood.

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K. J. BJORAKER, M.C. GIBBS, R.S. ZIEGLER, L.R. CHARNAS, & E. SHAPIRO. Neuropsychological Function and Localization in Adrenoleukodystrophy.

Adrenoleukodystrophy (ALD) is an X-linked disease with several phenotypes. The most severe is the childhood form in boys resulting in rapid demyelination and death. Because the development of cerebral disease cannot be predicted, regular neuropsychological evaluation and MRI are conducted for early disease detection, important for bone marrow treatment outcome. The cognitive and behavioral presentation of ALD varies by the localization of demyelination. Posterior disease is the most common form. Of 110 children with ALD seen at the University of

Minnesota, 45 had scans with posterior localization and 15 had scans with anterior localization. The remaining subjects displayed no cerebral demyelination or had diffuse findings. Neuropsychological testing was done before BMT or at initial diagnosis. Results indicated significant age differences between the anterior (M age = 12.2) and posterior groups (M age = 9.6). WISC-III testing indicated no difference in mean Full Scale IQ, but the Posterior group demonstrated significantly greater Verbal-Performance IQ discrepancies ($t = 2.6, p < .02$). Tests were averaged to create neuropsychological domains. The anterior group did significantly better than the posterior group in the nonverbal domain ($t = -2.4, p < .01$) No significant differences were found in language, motor, and memory domains. The executive function domain was similarly nonsignificant, with trends suggesting we might detect compromised functioning in the anterior group with increased power. Behavior was assessed with PIC Adjustment T scores, with the anterior group having significantly higher T scores than the posterior group ($t = 2.4, p < .02$). Overall, the posterior group was characterized by early age of onset, poorer nonverbal skills, greater verbal-performance discrepancies, and better behavior.

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J.W. KIRK & R. LAJINESS-O'NEILL. Neuropsychological Findings in 2 Children Diagnosed with Sotos Syndrome: Contributions of Frontal/Executive Dysfunction in a NLD Profile.

Sotos syndrome (cerebral gigantism) is a genetic disorder characterized by rapid growth, characteristic facial features and cognitive impairment. Limited investigations have suggested a NLD profile, although possible heterogeneity. Comprehensive investigations of the cognitive phenotype have not been conducted. Neuropsychological findings in 2 boys (10 y/o and 7 y/o, respectively) with Sotos is presented to further elucidate the cognitive/behavioral phenotype. Expected Verbal/Performance discrepancies were evident despite overall variability in intellect (WISC VIQ=75, PIQ=59; KABC Sequential SS=102; Simultaneous SS=80, respectively). Visuo-motor integration was deficient or a relative weakness (VMI SS=60 and 81); however discrepant motor-free perceptual performance was evident (MVPT SS=60 and 93). Significant bilateral sensorimotor deficits and articulation difficulties were noted, in the presence of intact language. Significant deficits in abstraction and perseveration were evident (WCST Conceptual SS=72, 68; Perseveration SS=74, 58). Memory performance was marked by relatively intact story recall, facial memory, and visual selective reminding in the 10 y/o, but deficient verbal selective reminding secondary to poor organization and inefficient strategy. In the 7 y/o, impaired copy compromised the validity of visual memory results (Rey-O). Neurobehavioral features included ADHD, emotional dysregulation and somatization (stomach aches). The findings further support heterogeneity, but more importantly suggest that executive dysfunction is likely a strong contribution to the NLD profile as evidenced by impaired abstraction, planning and organization, attention/concentration, and emotional regulation in conjunction with inconsistent visual memory deficits and some preservation noted on motor-free perceptual task.

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E.J. MOES & D. RICCI. Noonan's Syndrome: A Neuropsychological Case Study.

Noonan's syndrome, also known as male- or pseudo-Turner syndrome (although it occurs in both sexes) is a common autosomal dominant genetic disorder (50% familial and 50% sporadic mutations) with an incidence of between 1/1000 and 1/2000 live births. NS is linked to chromosome 12q and is commonly associated with congenital heart defects (50–85%), characteristic facial anomalies (e.g., low set ears, widely spaced eyes), short stature (50–70%), webbed neck, coarse and/or curly hair and low hairline in the back, chest deformities and undescended testicles. However, since weight-height ratio is normal and phenotypic expression is variable and may change with age, these individuals may be

difficult to recognize. Nonetheless, individuals with NS have normal life spans, and often attend regular schools (65–85%), but may present with early developmental delays and learning difficulties. Research to date has emphasized the medical aspects of the syndrome, and very little information is available regarding cognitive aspects. A distinctive pattern of cognitive functioning (VIQ > PIQ) has been reported in more severe cases (diagnosis is done on clinical grounds, so physical appearance predicts the cognitive pattern in severe cases). We present a review of the literature and a detailed neuropsychological case study of a 26-year-old, college-educated woman diagnosed by Dr. Noonan. A clear advantage for verbal expression was found in contrast to significant difficulties with active manipulation of visuospatial material, non-verbal reasoning, organization, planning, and recall (but not recognition).

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A. FONARYOVA KEY, D. MOLFESE, C. MERVIS, & N. CUNNINGHAM. Hemisphere Asymmetry for Language Processing in 4-Year-Old Children With Williams Syndrome.

This project used event-related potentials (ERPs) to examine brain activity corresponding to language processing in eight children with Williams syndrome (WS) age 4; 0–4; 7 years. Williams syndrome is a genetic disorder characterized by mental retardation, diminished visuospatial ability but relatively preserved language skills. Previous studies indicated that microcephaly is common in WS but identified no specific brain lesions. The purpose of this research was to determine whether children with Williams syndrome process language in a way similar to that of normally developing children or in a unique way (e.g., show no hemisphere asymmetry). The children were presented with computer-synthesized syllables (/ba/, /ga/) presented in random order. ERPs were recorded using a 128-channel high-density array geodesic electrode net. The data were submitted to a PCA-MANOVA and a baseline-to-peak analyses as well as correlated with scores on the behavioral tests of language and IQ (i.e., Mullen Expressive and Receptive Language, Mullen IQ, KBIT Verbal, PPVT-III, CDI-IV). The results indicated that all children were able to discriminate between the 2 syllables and the amplitude of the ERP components for the second positive peak over the left but not right frontal area was strongly and inversely correlated with the children's behavioral language and IQ test scores ($r = -.718-.925$). The overall results provide evidence that children with WS exhibit hemisphere asymmetry for language processing, and the ERP components are related to the level of language ability.

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M. KRAL, R. BROWN, & G.W. HYND. Neurocognitive Functioning and Transcranial Doppler Ultrasonography in Children With Sickle Cell Disease.

The relationship between cerebral blood flow velocity, as measured by transcranial Doppler (TCD) ultrasonography, and neurocognitive functioning was examined for a sample of 60 children with sickle cell anemia (HbSS) who had no documented history of stroke. TCD studies were used to classify children according to STOP trial criteria (i.e., "normal" < 170 cm/s, $n = 25$; "conditional" = 170–200 cm/s, $n = 15$; and "abnormal" > 200 cm/s, $n = 20$). Participants' performance was compared on measures of intellectual abilities, academic achievement, sustained attention/concentration, executive function, and parent and teacher behavior ratings of executive function. Results revealed that children with "abnormal" TCD values performed more poorly than children with "conditional" TCD values on measures of verbal intelligence [$F(2,55) = 3.75, p < .05$] and behavior ratings of executive function [parent: $F(2,54) = 5.19, p < .01$; and teacher: $F(2,55) = 3.48, p < .05$]. In addition, children with "conditional" TCD values performed more poorly than children with "normal" TCD values on measures of sustained attention/concentration [$F(2,55) = 3.58, p < .05$; $F(2,55) = 3.16, p = .05$] and executive function

[$F(2,44) = 5.99, p < .01$]. TCD values also were a significant predictor of auditory working memory [$R_{\text{adj}}^2 = .15, F(4,38) = 2.78, p < .05$]. Findings support the hypothesis that neurocognitive functions subserved by the frontal systems (e.g., sustained attention/concentration and executive function) appear to be the most useful indices of progressive cerebrovasculopathy in children with HbSS disease.

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A. SCHATZ, A. BALLANTYNE, & D. TRAUNER. Visual and Verbal Learning and Memory in Cystinosis: Evidence for a Visual Processing Speed Deficit.

This study examined the hypothesized discrepancy between visual and verbal learning in individuals with cystinosis, a genetic metabolic disorder in which subtle visual-spatial impairments have been observed. Thirty-seven individuals with cystinosis and 37 matched controls were administered a visual learning and memory test that was developed in our laboratory (Visual Learning and Memory Test; VLMT) and the California Verbal Learning Test (CVLT). Individuals with cystinosis performed at a lower level than controls on almost all indices of visual learning and memory while no differences were found between the groups on the verbal measure. Examination of the results on the VLMT indicated that the visual learning impairment in cystinosis may result from a deficit in speeded visual information processing. We then aimed to remediate the observed visual learning and memory deficit by implementing an intervention that increased the processing time for visual stimuli. Fifteen individuals with cystinosis were administered a version of the VLMT in which the stimuli were exposed for 3 s rather than 1 s. Fifteen matched controls were administered the 1 s version of the VLMT. The results indicated that by increasing the exposure time for each visual stimulus, individuals with cystinosis were able to perform at the same level as control subjects. This is the first study to demonstrate impaired visual learning and spared verbal learning in individuals with cystinosis. These results may provide the foundation for designing cognitive interventions and have implications for a greater understanding of gene-behavior relationships.

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B. MENDELSON, R. HARRIS, S. WETTER, & C. MURPHY. Olfactory Event-Related Potentials in Young Children.

The current research on the function of smell in children is limited to studies that rely on behavioral or psychophysical methods. It would be extremely useful to have an objective measure to assess olfactory functioning, especially for populations such as young children, where obtaining valid responses to typical behavioral or psychophysical tests is challenging and often unreliable. The purpose of the present study is to investigate the usage of olfactory event-related potentials (OERP) to assess olfaction in young children and to compare the results to a normal adult population. OERPs provide real-time indices of the brain's response to the presentation of a stimulus odor by measuring the electrical activity of the brain with surface electrodes on the scalp. While OERPs have been used in studying olfaction in young and old adults, and other various clinical populations, it is not yet known whether they can be used to assess olfactory function in young children. In the current study, OERPs were recorded monopolarly from 3 midline scalp electrodes (Fz, Cz, Pz), amplified, filtered using a computer-based recording system, and averaged over trials. The odor stimulus was amyl acetate (banana odor), presented through an olfactometer. OERPs were successfully recorded showing the classical waveform components of NI, P2, N2, and P3. In comparison to a sample of young adults, the results indicate that the young children have larger amplitudes across all 3 electrode sites and shorter latencies for the Fz and Cz sites.

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MILD TBI IN SPORTS INJURIES

G. IVERSON, J. MOSELEY, M. COLLINS, & M. LOVELL. Outcome From Concussion in Amateur Soccer Players.

The purpose of this study was to evaluate the neuropsychological outcome of 20 amateur soccer players who sustained a concussion. The majority of athletes were in high school (80%), and the remaining were in college. Subjects were assessed with ImPACT (Immediate Post-Concussion Assessment and Cognitive Testing), a computerized neuropsychological test battery designed to measure attention, memory, reaction time, processing speed, and self-reported symptoms. Testing was administered at preseason to establish baseline scores and at one or more intervals following injury. Based on the American Academy of Neurology grading system, 85% had Grade 1 concussions, 5% Grade 2 concussions, and 10% Grade 3 concussions. The mechanisms of concussion were as follows: 35% head-to-head collisions, 35% head-to-ball collisions, 10% head-to-other collisions, 5% head-to-ground collision, and 15% cases with unrecorded mechanism of injury. The reliable change methodology was used to evaluate for changes in functioning attributable to the acute effects of concussion and to spontaneous recovery. Compared to baseline performance, 75% of the players had reduced neuropsychological ability and/or increased symptom reporting at 1–2 days post injury. A minority of athletes recovered quickly (25%). Athletes were assessed between one and four times in the first 3 weeks post injury. The majority demonstrated good outcome (75%), in that their neuropsychological performance and symptom reporting returned to baseline levels. Four subjects (20%) had poor short-term outcome, and then were lost to follow-up. One subject (5%) had poor outcome at 17 days post injury, and stopped playing competitively due to concerns about future injuries.

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M. MCCREA, T. HAMMEKE, & G. OLSEN. Acute Neurocognitive Effects and Early Recovery From Sports Concussion.

This study was designed to prospectively measure the immediate neurocognitive effects and early course of recovery from sports concussion. A total of 1,405 high school football players underwent preseason baseline testing on several concussion assessment measures. Thirty-eight subjects who sustained a Grade 1, 2, or 3 concussion were re-evaluated immediately, 3 hrs, and Days 1 through 6 and Day 45 post injury. A non-injured control subject matched to the injured player on demographics and baseline test performance was administered the same assessment protocol. Injured subjects exhibited significant post-concussive symptoms and cognitive impairment relative to pre-injury baseline and non-injured controls during the acute and subacute phase for a period of days following injury. Deficits in cognitive processing speed, verbal memory, and postural stability remained evident on Day 1, but significant differences subsided on Day 3 for cognitive abilities and Day 6 for postural stability and reported symptoms. Injured players with loss of consciousness (LOC) or post-traumatic amnesia (PTA) demonstrated greater deficits and slower rate of recovery than injured players not experiencing LOC or PTA. These findings demonstrate that there are a number of acute neurocognitive effects following MTBI with and without LOC and/or PTA, and that recovery occurs in a relatively rapid, gradual manner within days following uncomplicated concussion. A sports concussion research model is valuable to the study of the acute effects and recovery associated with other causes of MTBI often encountered by neuropsychologists.

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C. SCHRAMKE. Reliability of a Brief Baseline Concussion Evaluation for Adolescent Athletes.

Young athletes are at increased risk for concussion and athletic trainers are becoming increasingly aware of the need for better evaluation of concussion. Our screening battery was devised to be administered by athletic

trainers with minimal instruction and to be very brief and yet sensitive to the effects of concussion. Tests included the Hopkins Verbal Learning Test (HVLT), time to count from 1 to 20, time to say the alphabet, time to place 9 pegs, FAS, and time able to maintain unilateral postural stability with eyes open and closed on both a flat and foam surface. Twenty-two male 11th and 12th graders were tested during their routine physical evaluation during preseason training and again at the end of the football season. One sustained a concussion and had a good recovery. Tests were administered by athletic trainers who found the battery satisfied their need for brevity and ease of administration. There were significant within subject between trial correlations for HVLT second exposure (but not for other HVLT trials or total words), 9 hole peg test with both right and left hands and for 3 of the 8 postural stability measures ($p > .008$). Even with these relatively high correlations individual participants showed considerable variability between trials (e.g., HVLT second exposure differences ranged from 3 more to 3 fewer). Significant effects of time of test were found, with participants showing small but significant improvement in most cognitive measures. Implications and the utility of this battery for clinicians and trainers will be discussed.

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S.K. MILLER, J.L. WOODARD, & K.D. SHANNON. Retrieval Rather Than Storage Deficits Following Sports Concussions.

Deficits in list learning can often accompany mild sports-related concussion, although the specific cognitive processes underlying these deficits are often unclear. We applied a task-decomposition analysis to baseline and post-concussion performance on the Hopkins Verbal Learning Test-Revised (HVLT-R) using 2 novel measures of list learning, gained access (storage capacity) and lost access (retrieval ability), presumed to reflect two discrete cognitive processes. Gained access reflects the proportion of items recalled on Trial $N + 1$ that had not been recalled on Trial N , whereas lost access reflects the proportion of items recalled on Trial N that were not recalled on Trial $N + 1$. Athletes were administered the HVLT-R during preseason (baseline) and 1 to 11 days following concussion. When possible, control athletes were evaluated at the same intervals as the concussed players. Results indicated that the concussed players and controls had comparable gained and lost access at baseline. One to 3 days following concussion, gained access remained comparable between groups, while concussed players demonstrated more lost access than controls. Six to 11 days following concussion, neither gains nor losses approached significance. However, the effect size for losses remained large ($d = .71 SD$). Regression analyses indicated that time since injury predicted lost access but not gained access. These results suggest that list learning deficits after sports-related concussion are characterized by deficits in long term retrieval (lost access) rather than storage (gained access) and is consistent with the notion that executive-type memory deficits are more common than true amnesia in the days following sports concussion.

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A.A. PICA, J.L. WOODARD, E.S.W. DORSETT, S.K. MILLER, & C.D. MARKER. Influence of Postconcussive Symptom Dimensions on Cognitive Performance in Varsity High School Football Players.

Self-reported physical, emotional, and cognitive symptoms may potentially influence performance on neuropsychological measures. This study assessed the relationship between symptom severity ratings and performance on subtests from the computer-based Automated Neuropsychological Assessment Metrics (ANAM) in a sample of non-concussed varsity high school football players. A baseline principal components analysis of a 26-item postconcussive symptom inventory performed on 145 athletes revealed four components, accounting for 67% of the total variance. The component structure reflected a cognitive symptom component (e.g., difficulty concentrating), a negative affect component (e.g., irritability, feeling frustrated), an energy component (e.g., drowsiness, fatigue), and an

anxiety component (restlessness, difficulty sleeping). The negative affect component was significantly correlated with throughput scores (number of correct responses per minute) for mathematical processing and a 6-item memory search paradigm. The energy component correlated significantly with throughput scores for a speeded information processing task. Multiple regressions demonstrated that these significant correlations were maintained even when controlling for simple reaction time. However, total postconcussive symptom severity did not correlate significantly with any ANAM throughput scores. These results suggest that reliance on a global index of postconcussive symptoms may be relatively insensitive to affective or symptom related influences on cognitive functioning. Utilization of underlying symptom dimensions (e.g., component scores) are more effective in identifying those specific symptom-related clusters that can affect cognitive performance.

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E. FARACE, R.M. FERREE, J.A. HOLLIER, J.T. BARTH, & M.E. SHAFFREY. Trails A: Neurocognitive Effect of Previous Concussions in a Women's Rugby Sample.

The Center for Disease Control estimates > 300,000 sports-related concussions occur in the U.S. each year. Players of contact sports, such as football, rugby and boxing, generally sustain the highest rate of concussions, although surprisingly high numbers of injuries occur in non-contact sports such as soccer and basketball. Whereas a catastrophic event such as second impact syndrome is rare and controversial, repeat concussions can increase the risk of another concussion and lasting post-concussive symptoms. Yet long-term cognitive deficits from sport-related concussions are thought to be rare, and when they exist are ascribed to pre-morbid differences in intelligence or age. This assumption was directly tested in a homogenous population of collegiate women's rugby players, all of whom had average or above SAT scores and GPA. Participants were 54 women (M age 19.5, range 17–22) on a collegiate rugby team between 1999–2002. Players completed a demographic questionnaire including number of previous episodes of loss or alteration of consciousness, and then given a brief neuropsychological battery [Standardized Assessment of Concussion (SAC), Trails A and B, Paced Auditory Serial Attention Test (PASAT)]. Twenty-nine of the fifty-four players had previously experienced at least 1 incident of altered or lost consciousness. Although no differences were found on the PASAT or SAC between players with a concussion history and those without, players with a concussion history made significantly more errors on Trails A than their non-concussed counterparts on chi-square ($p < .05$). Results suggest possibility of long-term effects of concussion, which should be tested in a larger sample.

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M. McCREA, J. KELLY, & C. RANDOLPH. Standardized Assessment of Acute Mild Traumatic Brain Injury.

This study utilized the Standardized Assessment of Concussion-Emergency Room edition (SAC-ER) in the evaluation of acute mild traumatic brain injury at the accident scene or during emergency ambulance transport. A total of 27 head injured subjects with a Glasgow Coma Scale (GCS) score higher than 13 at the time of examination were administered the SAC-ER by emergency medical service (EMS) personnel within 15 min of injury. Three of the injured subjects were rendered unconscious, while 50% of subjects exhibited both posttraumatic and retrograde amnesia associated with their injury. Neuroimaging studies (head CT or brain MRI) were negative in all cases. Twenty-seven noninjured controls matched to injured subjects on age and education level were also administered the SAC-ER. Head injured individuals performed significantly worse than controls in SAC-ER total score and on all domains of cognitive functioning assessed on the SAC-ER, including measures of Orientation, Immediate Memory, Concentration, and Delayed Recall. Injured subjects also endorsed more items on a post-concussion symptom checklist than controls.

The SAC-ER was sensitive to subtle cognitive impairment as a marker of MTBI, despite a seemingly normal neurologic status and negative neuroimaging studies. The SAC-ER may be a useful clinical tool for emergency medical service personnel in measuring and characterizing cognitive dysfunction during the acute phase following mild traumatic brain injury. An objective measure such as the SAC-ER also provides an anchor point of acute impairment against which to track post-injury cognitive recovery.

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R. COLLINS, H. HANNAY, J. CASS, & A. VALADKA. Norm-Adjusted Test Scores Among Complicated Mild Head Injury Subtypes.

The term complicated mild head injury was introduced into the literature as a way to distinguish mild head injured patient (GCS 13–15) with radiologic abnormalities from those with abnormalities. Previously, we compared the global outcome (GOS and DRS) of complicated mild head injured patients with stable GCS scores (Group 1) to a group of complicated mild head injured patients, from the same setting, whose GCS transiently dropped below 13 during the first 48 hr in the Neurosurgery Intensive Care Unit of a level I trauma center (Group 2): It was demonstrated that Group 2 had a significantly worse outcome on the GOS at discharge and 1 month but were similar to Group 1 on both measures at 3 and 6 months. The groups were also compared on neuropsychological measures (i.e., attention, memory, executive and motor functioning) at 3 and 6 months post injury. Consistent with outcome measures at these time points, the groups did not differ. Since clinicians typically use normed test scores when making interpretations about patient functioning, the current study presents the standardized, normative neuropsychological test scores for both groups. The groups did not differ on the basis of age, education, gender, or ethnicity. Group 2 had a higher rate of alcohol on admission, cranial surgery, intubation, and sedation for agitation.

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B. SUFFIELD, S. LINDSTROM, B. LEE, J. ROSE, M. PHAN, R. LESSARD, J. BAER, & S. LONGMAN. Can Managed Care Help the Miserable Minority? Concussion Clinics and Return to Work After Mild Traumatic Brain Injury.

Purpose: Determine effectiveness of a pilot managed care model, including rapid referral to concussion clinics, in enhancing return-to-work rates amongst injured workers. *Subjects:* Of 112 head injured workers, 87 (78%) met ACRM criteria for Mild Traumatic Brain Injury as primary or secondary diagnoses. Of these, 47 (54%) missed work, and were included in the pilot. These subjects were contrasted with a group of 38 MTBI'd workers who had received treatment-as-usual 2 years before. *Procedure:* Workers were accepted into the pilot if they were referred within 8 weeks of injury. Initial intake included file review, the Ferguson & Mittenberg Concussion Symptom Checklist, the Recent Life Changes Questionnaire, and clinical interview. Workers were educated regarding diagnosis, and provided written information on concussion and its management. Referrals to psychologically based symptom management sessions and medical specialists were expedited. *Data Analysis and Results:* Persons involved in the pilot returned to work about twice as fast as treatment-as-usual controls (75% within 40 days, vs. 70 days for the controls). By 1 year, all but 2% of workers in the pilot had returned to work, whereas 10.5% of pre-pilot treatment-as-usual workers had failed to return to work by 1 year. Workers were highly satisfied with the intervention (4.3/5). Costs of the program were offset by outcomes. Factors influencing return to work included availability of a job, age at injury, and number and intensity of symptoms. *Conclusion:* Early intervention improved return-to-work rates in this preliminary sample, supporting its continued use, and expansion to other centers.

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U. SATISH, P. ESLINGER, S. STREUFERT, & S. VANDER VOORT. Mild Traumatic Brain Injury: Measurement of Residual Deficits.

Purpose: To assess residual deficits sustained by patients with mild traumatic brain injury. *Introduction:* While many head injury patients have a “good” recovery, between 15% and 27% continue to exhibit deficits, involving diminution of cognitive skills that are concomitant with social dysfunction and lost vocation productivity. Standard tests tend to be far removed from day-to-day task demands and fail to identify residual deficits. The use of more real-world-relevant techniques is needed. *Methods:* Standard tests and a simulation based assessment methodology were used. High levels of reliability and validity of the Strategic Management Simulations (SMS) have been demonstrated. Performance effectiveness is calculated on measures that range from response to simpler task demands (e.g., reaction time) to more complex functioning (e.g., planning, strategy). *Results:* Despite normal scores on standard tests patients’ performance produced dysfunctional patterns on simulation measurement categories. Scores in the domains of activity, initiative and breadth were dysfunctional. Contextual responsiveness was high with poor sequencing and goal direction. Performance differed sharply from the norm. *Conclusion:* The simulation technique is able to assess residual deficits in patients who continue to experience subtle difficulties.

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LEARNING DISABILITIES

L. JONES, W. LINDSTROM, C.J. MILLER, J. SANCHEZ, & G.W. HYND. Neuropsychiatric Diagnoses in Children With Learning Problems: Does the Incidence of Social–Emotional Problems Increase With the Number of Diagnoses?

Research suggests that the more diagnoses a person has, the more likely they are to be diagnosed with another disorder. In addition, children with neurodevelopmental learning problems are more likely than children without learning problems to receive additional social–emotional diagnoses. The present study seeks to determine from parental behavior ratings whether children with no diagnosis exhibit less psychopathology than children with developmental dyslexia, and if children with comorbid neuropsychiatric diagnoses of developmental dyslexia and ADHD display the most psychopathology of the 3 groups. Results of ANOVA data analysis indicate that the groups significantly differ in degrees of psychopathology as rated by their parents on the Behavior Assessment System for Children (BASC) Internalizing, Externalizing, and Behavioral Symptoms Index scales. In addition, *post-hoc* analysis revealed a significant difference in ratings of children with developmental dyslexia alone and children with comorbid diagnoses on the Externalizing scale. This finding is consistent with the fact that children with ADHD tend to exhibit hyperactivity and other externalizing behaviors. Although specific between-group differences were not identified for the Internalizing and Behavioral Symptoms Index Scales, there does appear to be an increase in T scores from group to group, which encourages future consideration of the hypothesis that children with comorbid diagnoses are more likely to exhibit social–emotional and behavioral problems. These findings highlight the relationship between developmental dyslexia, ADHD, and social–emotional problems.

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W. LINDSTROM, L. JONES, M. COHEN, J. WISENBAKER, & G.W. HYND. Verbal and Nonverbal Memory Deficits in Children with Developmental Dyslexia, Attention–Deficit Hyperactivity Disorder, and the Comorbid Condition.

Prior research has indicated the prevalence of information processing impairments in children with mental disorders. Due to inattention difficulties, children with ADHD often demonstrate encoding deficits that limit memory ability. Research has also implicated memory deficits as a contributing factor in reading difficulties. The purpose of the current study

was to compare verbal and nonverbal memory abilities in children (8–12 years old) with no diagnosis, developmental dyslexia, ADHD, or a combination of dyslexia and ADHD. Subjects' ability to encode and retrieve visual and verbal information, both immediately and after a delay, was assessed using subtests of the Children's Memory Scale. MANOVA results indicated significant differences for delayed visual memory and delayed verbal memory across groups, but failed to indicate significant findings for the immediate recall of the verbal and nonverbal information. *Post-hoc* analyses indicated the significant differences in visual delayed memory were due to the disparity between the performance of the ADHD group and the normal group. Although the overall differences in performance in delayed verbal memory were significant, *post-hoc* analyses were not able to specify which group differences were responsible for the overall significance level. Thus, findings suggest that children with ADHD are likely to experience impairments in delayed recall of visual information when compared to normals, while children with dyslexia were not found to be significantly impaired in either verbal or nonverbal memory at the $\alpha = .05$ level. Analyses of the comorbid condition across the verbal and nonverbal domains failed to indicate a synergistic effect.

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P.K. ISQUITH, G. GIOIA, & K. ESPY. Executive Signatures in Children With Developmental Disorders.

Executive function deficits are characteristic of many developmental syndromes including attentional (ADHD), language (LD), and Autistic Spectrum (ASD) disorders. One neuropsychological construct (i.e., executive function) underlying a variety of behavioral phenotypes, however, creates a discriminant validity problem. Multidimensional models of executive function offer some resolution, as different executive function profiles may characterize specific disorders. In order to explore these executive "signatures," parents of children previously diagnosed with LD ($N = 28$), ADHD ($N = 17$), ASD ($N = 31$) and low-risk preterm birth (PRE; $N = 34$) completed the Behavior Rating Inventory of Executive Function–Preschool Version (BRIEF-P) along with 110 age and gender matched controls. Scale scores were submitted to profile analysis via a mixed-model MANOVA. The omnibus levels (diagnostic group), flatness (BRIEF-P scale), and parallelism (interaction) tests were significant ($p < .001$). Overall, the ASD group was most elevated, followed by the ADHD group. The LD and PRE groups were least elevated but higher than controls across all scales. *Post-hoc* comparisons (Scheffé, $p < .05$) showed that only the ASD group was significantly elevated on the BRIEF-P Shift scale, and only the ADHD and ASD groups were elevated on the Inhibit, Plan/Organize, and Emotional Control scales. PRE and LD groups were elevated only on the Working Memory scale, but significantly less so than the ADHD and ASD groups. The analyses support unique executive signatures detectable in preschoolers with developmental disorders.

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C. SILVER, K. MACDONALD, & T. ROSVALL. Children's Problem-Solving: Test Performance Versus Parent Ratings.

It is important to know how well our test results predict children's functioning in the real world. For example, predictions about children's problem-solving in academic and social settings are made, based upon performance on tests such as the Category Test. However, the ecological validity of many neuropsychological tests is not well established. This study's purpose was to examine the relationship between children's CAT scores and parents' ratings of observed problem-solving behaviors. Twenty-seven children with LD/ADHD, ages 9 to 14, were tested, and parents rated their executive functioning on a questionnaire containing a specific item set concerning problem-solving. Mean CAT T score was 57 (12), suggesting that most children were unimpaired on this standardized test. Of a possible 198 points on the parent questionnaire, however, children's scores ranged from 23 to 142 ($M = 77$). No significant relationships were found between CAT T scores and overall parent ratings ($r = .07$) or ratings of problem-

solving ($r = .06$). No significant relationships were found between CAT errors representing perseveration and overall parent ratings ($r = .19$) or parent ratings of problem-solving ($r = .25$), although the coefficients were higher. Thus, significant variance in scores that reflect the children's problem-solving in the real world was not accounted for by standardized test scores. Factors other than brain-related abilities, such as environmental distractions and social/emotional influences, may affect real-world problem-solving to a great degree. In order to predict children's problem-solving in the real world, systematic investigation of the relative influence of test performance and external factors is needed.

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D. DEWEY, S. CRAWFORD, & B. KAPLAN. Clinical Importance of Parent Ratings of Children's Everyday Cognitive Abilities.

Objective: To determine if parents' reports of everyday cognitive functioning might be useful in distinguishing among children with Attention Deficit Hyperactivity Disorder (ADHD), children with reading disabilities (RD), and children with ADHD + RD. *Method:* Parents' reports on the Parent Ratings of Everyday Cognitive and Academic Abilities (PRECAA) were obtained for children with ADHD ($n = 49$; 44 males, 5 females), RD ($n = 60$; 39 males, 21 females), and ADHD + RD ($n = 50$; 38 males, 12 females). The PRECAA is composed of the following subscales: memory, language, higher cognitive abilities, coordination, learning behavior, and academic skills. Children were also assessed by testers blind to diagnosis, using the Woodcock-Johnson Psychoeducational Battery Revised, Bruininks-Oseretsky Test of Motor Proficiency, the Vocabulary and Block Design WISC-III subtests, and Developmental Test of Visual-Motor Integration. *Results:* The PRECAA was sensitive to differences among the three groups, and correctly classified more children (66%) than standard psychometric assessments (50%). Over 80% of children with ADHD were correctly classified using the PRECAA. Including the PRECAA resulted in a significant increase in the number of children correctly classified by psychometric measures alone. The PRECAA had moderate sensitivity, lower specificity, and good internal consistency (Cronbach's $\alpha = .91$). *Conclusion:* The PRECAA may aid clinicians in identifying children with learning and attention problems. It appears to assess aspects of everyday functioning not directly measured by psychometric tests.

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S.E. WEISMER, E. PLANTE, & M. JONES. Capacity Limits on Verbal Memory in Specific Language Impairment: An fMRI Study.

Capacity limitations on processing have been suggested to underlie the deficits of children with specific language impairment. This hypothesis was tested in a functional magnetic resonance imaging (fMRI) study of 8 children with specific language impairment (SLI) and 8 age and gender matched children with normal language (NL). Children were asked to encode and recognize stimuli under 2 conditions. Under the low demand condition, children answered, via button press, a series of yes/no questions. These questions were formulated to reflect syntactically simple sentences. Following this, children were asked to indicate, via button press whether a word presented to them had occurred in the sentences previously heard. The high demand condition was identical to the low capacity condition except that the yes/no questions were syntactically complex sentences. Encoding and recognition stimuli were presented in blocks, interleaved with a tone detection task for which children had to push a button when they heard a target tone among a train of pure tones. The order of high and low demand conditions were counterbalanced across subjects. Echo planar functional images and high resolution structural images were acquired with a 3T GE Signa magnet. Analysis focused on a set of regions associated with language processing (inferior frontal, superior temporal, supramarginal) and memory and attentional networks (precentral sulcus and parietal lobule). Task demands differentially affected language *versus* attention/memory ROIs. In addition, the SLI group showed

differences relative to the NL group in selected areas associated with language, attention, and memory.

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W. MATOS, J. SEIDEN, B.C. WILSON, & N. KOHN. Investigation of Auditory Stimulation on Cognition and Behavior in DLD Children.

Current treatment efforts for developmental disabilities especially communication disorders include intervention programs designed to address inefficiencies in auditory processing. Listening Training based upon the work of Tomatis and developed by P. Madaule is one such method that has provided clinical/anecdotal evidence as to its efficacy not only in addressing auditory processing but also other fundamental developmental issues such as those associated with autistic disorder. Recent research has attempted to quantify its effects but such studies have been criticized on methodological grounds such as small *Ns* and lack of control group. Designed to address these issues the present study assessed the effect of this auditory stimulation paradigm on communication disordered preschoolers (52 experimental and 52 control). Auditory processing, language functioning, speech production, fine motor planning, speed and coordination, gross motor skills, and behavior as rated by parents and teachers were measured in a pretest–posttest design. Raters were blind as to group membership. Present analysis showed nonsignificant treatment effects for all standardized test measures. Significant positive behavior changes reported by the mother via the BASC included decreases in hyperactivity, aggression, depression, somatization, and externalizing problems. Significant decreases in atypicality were noted by both parents. Significant behavioral changes were not reported by teachers. Differential effects by diagnostic subtype will be reviewed and alternative stimulation protocols will be investigated.

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D. DEWEY, S. CRAWFORD, B. KAPLAN, & B. WILSON. Memory Abilities of Children With Developmental Coordination Disorder.

Objective: To investigate the memory abilities of children with developmental coordination disorder (DCD). *Method:* Participants were placed into one of three groups, DCD ($N = 45$; average age = 11.8 years; 26 boys, 19 girls), suspect for DCD ($N = 51$; average age = 11.2 years; 33 boys, 18 girls), or normal comparison ($N = 78$; average age = 11.4 years; 59 boys, 19 girls), based on their performance on standardized measures of motor skills. All children had average IQs and were assessed using the Wide Range Assessment of Memory and Learning (WRAML). FSIQ was controlled for in all analyses. *Results:* Results indicated that the children with DCD displayed significantly poorer general memory than the children suspect for DCD and the normal comparison children [$F(2,164) = 8.82, p < .001$]. Examination of subtest performance indicated that the DCD and suspect groups scored significantly lower on Number/Letter Memory [$F(2,164) = 9.56, p < .001$], and Finger Windows [$F(2,164) = 8.22, p < .001$], than the normal comparison children. Significant group differences for Sound Symbol [$F(2,164) = 7.09, p < .01$], and Verbal Learning [$F(2,164) = 3.09, p < .05$], were also found: the DCD group scored significantly lower than the normal comparison group. On delayed recall, the DCD and suspect groups scored significantly lower than the normal comparison group on Story Memory [$F(2,161) = 9.58, p < .001$], and Sound Symbol [$F(2,161) = 4.44, p < .05$]. *Conclusion:* Children with DCD and children suspect for DCD had low scores on verbal and visual memory, particularly on tasks demanding attention/concentration and the retrieval of learned information. Thus, children with DCD appear to have difficulties in both encoding and retrieving information.

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D. DEWEY, S. CRAWFORD, B. KAPLAN, & B. WILSON. Developmental Coordination Disorder: Associated Problems in Attention and Learning.

Objective: To investigate problems of attention, learning and psychosocial adjustment in children with developmental coordination disorder (DCD). *Method:* Participants were placed into one of three groups, DCD ($N = 45$; average age = 11.8 years; 26 boys, 19 girls), suspect for DCD ($N = 51$; average age = 11.2 years; 33 boys, 18 girls), or normal comparison ($N = 78$; average age = 11.4 years; 59 boys, 19 girls), based on their performance on standardized measures of motor skills. All children had average IQs. The Woodcock Johnson Revised Psychoeducational Battery (WJ–R), Wide Range Achievement Test–Revised (WRAT–R) Spelling and the Child Behavior Checklist (CBCL) were administered. *Results:* Children with DCD and children suspect for DCD obtained poorer scores for attention [$F(2,68) = 27.21, p < .001$], and reading, written language and spelling ($p < .001$ for all subtests) compared to comparison children. On the CBCL, children with DCD and those suspect for DCD also evidenced more social problems [$F(2,68) = 21.98, p < .001$] withdrawn behavior [$F(2,123) = 12.33, p < .001$], somatic complaints [$F(2,123) = 5.45, p < .01$], anxiety [$F(2,123) = 6.06, p < .01$], and aggressive behavior [$F(2,123) = 6.57, p < .01$]. *Conclusion:* Children with DCD and children suspect for DCD are at risk for problems in attention, learning and psychosocial adjustment. Assessment of children with DCD should examine a wide range of neuropsychological and psychosocial functions, as this will assist in determining the types of interventions that would benefit these children.

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C. DRUMMOND, B.P. ROURKE, & S. AHMAD. Applying Rules for the Classification of NLD and BPPD to Younger Children.

Rules for the classification of Nonverbal Learning Disabilities (NLD) and Basic Phonological Processing Disabilities (BPPD) have already been generated and tested on older children (9–15). To follow up this newest addition to the Windsor series the next step was to evaluate the applicability of these classification rules on a younger population (ages 7–8) with NLD and BPPD, and make revisions if necessary. These rules were used to differentiate between the 2 learning disabilities (LD) using patterns from motor/psychomotor, tactile/perceptual, visual–spatial, auditory–perceptual, problem-solving, and language measures. An experienced neuropsychologist classified each child based on a full neuropsychological assessment. Children who received a classification of NLD or BPPD by the neuropsychologist and met criteria for definite or probable NLD and BPPD as defined by the rules were used in this study ($N = 124$; 114 BPPD and 10 NLD). Notably, the primary neuropsychological deficit of BPPD is auditory perception and the findings showed that the rule which relates to this applied to the highest percentage of children. One of the primary neuropsychological deficits of NLD is visual perception and the related rules applied to the highest percentage of children. The results also showed some surprising discrepancies between the age groups. Revisions were made to these rules for younger children that allow for their usage as a source of information to assist clinicians when deciding whether a comprehensive neuropsychological evaluation would be valuable. These rules can also serve as a guide when collecting LD samples for future research. Correspondence: *Christine Drummond, 3614 Wildwood Drive, Windsor, ON N8R 2C8, Canada. E-mail: pluckydrummond@hotmail.com*

A.F. SMITH, R.D. MORRIS, M.K. MORRIS, & R.A. SEVCIK. Arithmetic Subtypes Within a Sample of Children With Specific Reading Disability.

This study investigated the presence of the neuropsychological features of Arithmetic (AD)/Nonverbal LD, within an *a priori* defined sample of children with Reading Disability (RD), and attempted to differentiate their characteristics from those of other potential subtypes of children, which may exist in an RD sample. The participants included 206 children with RD who received a reading intervention program over the course of an

academic year. RD was defined utilizing low achievement and discrepancy criteria. The sample was divided into 4 groups based on their academic discrepancies: (1) reading/spelling lower than arithmetic ($n = 64$), arithmetic lower than reading/spelling ($n = 15$), reading/spelling and arithmetic below the 15th %ile and no discrepancy ($n = 35$), and at least 1 score above the 15th %ile and no discrepancy ($n = 92$). These groups were compared on 5 different neuropsychological domains: oral-motor praxis, core verbal, visual and verbal memory, simple and complex motor functioning, and visual and verbal attention. A significant difference emerged when means of each of the domains were compared using multivariate analysis of variance (MANOVA). Analyses of variance revealed that there was a significant difference among groups on measures of phonological processing, visual attention, expressive semantic skills, and naming fluency. There was no significant difference among the groups on measures of receptive verbal skills, visual memory, simple motor skills, complex motor skill, verbal attention, or visual attention.

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M. CORLETT, M. SEMRUD-CLIKEMAN, & N. NUSSBAUM. Visual Perceptual Dysfunction in Children With Nonverbal Learning Disabilities.

Extant literature suggests children with NLD possess intact or enhanced verbal processing abilities in the presence of significant deficits in visual memory, visual spatial skills and nonverbal reasoning. Many researchers and clinicians suggest that the most devastating aspect of the NLD presentation is impaired social skills. Children with NLD often misinterpret the actions and intentions of others leading them to distorted interpretations of social situations. Their misinterpretations appear to be so severe that they seem to have impaired reality testing, although they do not appear to suffer from psychosis or a true thought disorder. Rather, the nature of their deficiency is operational—that is, the processes by which children with NLD perceive and comprehend visual stimuli seem to be impaired. This research project uses the Rorschach Inkblot Test to explore the processes by which children with NLD translate visual stimuli into meaning. Specific scoring variables used included X -% (visual distortion), Z_f (visual synthesis and integration) and M (social attribution). Although the focus of this study is the investigation of cognitive processes associated with NLD, these children often present with co-existing diagnoses of Attention Deficit Hyperactivity Disorder, Predominately Inattentive Type (ADHD/PI). However, the potential role of inattention in the NVLD presentation has not been addressed in the current literature. This study compares Rorschach responses of children with NVLD+ADHD/PI, children with ADHD/PI, and children from a control group. Preliminary findings indicate children with NVLD+ADHD/PI show a significantly higher incidence of visual distortion and failures of integration and social attribution as compared to children with ADHD/PI and the control group.

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S. WARSCHAUSKY, J. ANGOBALDO, & J. KAY. Cognitive Correlates of Academic Achievement in Children With Craniofacial Anomalies.

Children with craniofacial anomalies are at significant risk for academic delays including high incidence of learning disabilities. This study examines the cognitive correlates of academic achievement in groups of children with and without craniofacial anomalies referred for evaluation of learning difficulties. From a consecutive series of neuropsychological evaluations that included WISC-III and WIAT, a sample of 26 children with craniofacial anomalies (CFA) was identified, mean age 129.4 months (32.4), 61.5% male, 64% with isolated cleft lip and/or palate and 36% with other non-cleft craniofacial conditions. A comparison group of children with learning difficulties (LD) without CFA or neurological history was assembled, matched on age, gender and Full Scale IQ. In the CFA group, there was greater incidence of hearing impairment (61.5% vs. 8.3%). There were no significant group differences in the WISC-III index scores. The CFA group had significantly lower written language scores than the LD

group. Hearing impairment was not a significant predictor of WIAT scores. Within-group multiple regression to predict WIAT scores from WISC-III index scores indicated that in the CFA group, WISC-III index scores were not significant predictors of written language scores. In the LD group, WISC-III VC and FD predicted Reading Comprehension. In the CFA group, Numerical Operations was predicted by VC and FD, whereas in the LD group, there were no significant predictors. Results suggest important differences in the neuropsychology of academic delays in children with CFA. Implications for future study of the role of specific neuropsychological variables including aspects of attention, speech and language are discussed.

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PARKINSON'S DISEASE

P.J. MOBERG, S.T. MOELTER, M. EISA, J.E. DUDA, & M.B. STERN. Relationship of Infrared Light Beam Finger and Foot Tapping to Unilateral UPDRS Motor Scores in Idiopathic Parkinson's Disease.

While deficits in upper and lower extremity movements have been described in idiopathic Parkinson's disease (IPD), there is a need for more detailed and reliable measurement of these functions. Sixty-four male patients with IPD were assessed using a light-beam interruption finger and foot-tapping device. Unimanual, alternating and synchronous movements were assessed for hands and feet. The motor subscale from the UPDRS was also administered and scores for dominant and nondominant sides calculated. Significant relationships between dominant UPDRS motor rating scores and dominant hand finger tapping ($r = -.27, p = .028$) as well as bimanual alternating ($r = -.30, p = .016$) and synchronous ($r = -.34, p = .007$) tapping scores were elicited. Nondominant tapping speed also showed a significant relationship with nondominant UPDRS motor scores ($r = -.25, p = .045$), but not with bimanual alternating or synchronous movements. With regard to foot tapping, significant correlations were observed between dominant and nondominant foot tapping speed and dominant and nondominant UPDRS motor ratings (all $ps < .03$), with reduced foot speed being generally related to greater disability. The light beam system showed sensitivity and appropriate laterality to UPDRS motor ratings, indicating good construct validity, supporting the use of infrared tapping technology in patient evaluation. The infrared technology allows for the reliable examination of multiple parameters of both upper and lower extremity movement and lends itself to outcome studies where precise measure of change is required.

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C.L. ELSINGER, S. DURGERIAN, J. VONGHER, S.A. CHEN, N. REYNOLDS, K. BLINDAUER, D. HARRINGTON, & S.M. RAO. Motor Timing in Patients With Parkinson's Disease: An fMRI Study.

A previous fMRI study in young healthy adults indicated that motor timing (paced finger tapping task) is dependent on three interrelated neural systems: (1) explicit timing (putamen, ventrolateral thalamus, SMA); (2) auditory sensory memory (inferior frontal gyrus, superior temporal gyrus) and (3) sensorimotor processing (dorsal dentate nucleus, sensorimotor cortex). Patients with Parkinson's disease (PD), whose primary pathology consists of a loss of dopaminergic neurons projecting to the dorsal putamen, demonstrate abnormal performance on motor timing tasks, characterized by decreased accuracy and nonscalar variability changes. Previous studies have shown motor timing deficits in PD, particularly when patients are withdrawn from dopaminergic replacement therapy. In this fMRI study, 10 PD patients were imaged while performing a motor timing task on and off dopamine supplementation to examine changes in functional neuroanatomy involved in timekeeping and working memory for temporal information. Patients tapped their index finger in synchrony with a series

of isochronous tones (synchronization phase), which was followed by tapping without the benefit of the auditory metronome (continuation phase). As expected, PD patients experienced more motor symptoms (measured by the Unified PD Rating Scale) off drug. Preliminary behavioral results suggest that patients are less accurate and show greater variability at slower tapping rates. Functional imaging data show increased activation within the sensorimotor cortex, SMA and basal ganglia in the on drug condition. Results indicate an overall dopaminergic drug enhancement effect on underlying neural systems mediating motor timing behavior in PD patients. Correspondence: Catherine Elsinger, Ph.D., Department of Neurology, Section of Neuropsychology, Medical College of Wisconsin, 9200 West Wisconsin Ave., Milwaukee, WI 53226. E-mail: celsinge@mcw.edu

O. PEDRAZA, S. BONGIOLATTI, W. BOSCH, D. GOKCAY, & D. BOWERS. Static Versus Dynamic Measures of Facial Expression in Parkinson's Disease.

Investigations of voluntary facial emotions in Parkinson's disease (PD) have primarily employed subjective ratings of "static" images. We have recently suggested that the use of objective computerized imaging techniques for quantifying "dynamic" facial expressions may provide a highly sensitive method to detect differences in emotional expressivity between PD patients and normal controls (NC). The present study complements and expands concurrent investigations by comparing the static-subjective and the dynamic-objective methodologies for studying facial expressions. *Methods:* Parkinson patients (Hohn-Yahr < 3), and age- and education-matched controls were videotaped while producing 6 voluntary facial emotions. Computerized imaging techniques were used to quantify dynamic facial expressions. An overall movement change value ("entropy") was obtained for each expression. Pictures of the peak facial expression for each emotion were shown to 25 raters who rated each static expression for intensity and valence. Thus, both objective movement values and subjective ratings were available. *Results:* As expected, PD patients were not rated as significantly worse than normal controls in terms of intensity or valence of the static facial expressions. Overall, the majority of subjective ratings of static images were not significantly correlated with the entropy or movement changes. *Conclusion:* The present study suggests that subjective ratings of static images may not be a highly sensitive method for detecting reduced facial expressivity in PD. Further, ratings of static facial expressions are not reliably associated with dynamic entropy values. These findings support the uniqueness of the dynamic-objective method as a sensitive indicator of reduced expressivity.

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D. BOWERS, W. BOSCH, C. PEDEN, W. TRIGGS, & D. GOKCAY. Faces of Emotion in Parkinson's Disease: Micro-Expressivity and Bradykinesia During Voluntary Emotions.

Previous investigators have argued that the "masked facies" of Parkinson's disease (PD) involves spontaneous but not voluntarily expressed emotions. This distinction may reflect the contribution of unique neural systems for spontaneous (subcortical, limbic) versus voluntary emotions (frontal, pyramidal). We present an alternative view and hypothesize that even voluntary expressions are reduced in PD due to decreased dopaminergic innervation of frontal motor systems. *Methods:* We used sophisticated computer imaging techniques to quantify dynamic facial expressions (fear, sad, anger, disgust, surprise, happy) that were voluntarily produced by 8 PD patients (Hohn-Yahr < 3) and 8 normal controls. The 2 groups were age, sex, and education-matched. No patient was demented (MMSE > 28) or depressed. All PD patients were tested on medication during their "on period." Dynamic facial expressions were videotaped, digitized, and analyzed for movement changes using custom software developed by Gokcay. This software automatically computed overall movement change (entropy) during the temporal course of the expression and the time to reach a peak expression. *Results:* Relative to controls, PD patients displayed: (1) significantly less facial movement (*micro-expressivity*) over time for all

facial emotions; and (2) took significantly longer to reach peak expressions (*bradykinesia*). *Conclusion:* Our findings indicate that the "masked facies" of PD is not limited to spontaneous expressions, but also involves voluntary or posed facial expressions. The use of Parkinson's disease as a model system for the neuroanatomic dissociation between voluntary and spontaneous expressions is unjustified. Both systems appear detrimentally influenced by depleted dopaminergic innervation of the brain.

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X.E. CAGIGAS, J.V. FILOTEO, & D.L. STRAYER. Object-Based Negative Priming Is Not Impaired in Patients With Parkinson's Disease.

Negative priming (NP) is the phenomenon in which target identification is slowed when the target had been a distractor on the previous trial. Recently we found that non-demented Parkinson's disease (PD) patients displayed reduced NP relative to controls on a task in which targets appeared in different spatial locations. These findings suggest that PD impairs inhibitory attentional processes (the mechanism believed to underlie NP). However, other studies have identified hyper NP in these patients. These discrepancies may be due to differences in the specific cognitive processes required by various NP tasks. In order to further evaluate NP in patients with PD, 12 PD patients and 12 controls were administered an object-based negative priming task. The experiment consisted of 3 conditions: the NP condition in which the target object on a given trial was the distractor on the previous trial; the positive priming condition in which the target object on a given trial was the exact same target object on the previous trial; and a neutral condition in which the target and distractor objects were different across trials. Results indicated that PD patients did not differ from controls in the magnitude of positive priming and, importantly, the 2 groups did not differ in the magnitude of negative priming. These findings suggest that PD patients may not demonstrate abnormal NP with certain tasks. Further, differences in performance on spatially-based and object-based NP tasks may be related to previously observed dissociations in spatial and object working memory in PD.

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L. GRANDE, R.M. BAUER, B. CROSSON, D. DEDE, J. ALGINA, & K.M. HEILMAN. Attentional Inhibition in Parkinson's Disease.

Individuals with Parkinson's disease (PD) are better able to act when movement is evoked by some external stimulus (exogenously evoked) than when movement is based on an internal idea or motivation (endogenously evoked). In addition to characteristic motor impairment, patients with PD also have cognitive deficits, including compromised attention. The cognitive deficits associated with PD appear to parallel the exogenous-endogenous distinction. The current study investigated the possibility that endogenously evoked attentional inhibition (driven by goal directed behavior) is disrupted in PD while exogenously evoked attentional inhibition (driven by sensory information) is spared. An inhibition of return (IOR) paradigm was employed to investigate exogenously evoked inhibition for spatial location, and a negative priming (NP) paradigm was employed to investigate endogenously evoked inhibition for spatial location. Participants completed these tasks on two occasions, and PD patients completed each measure both on and off dopamine replacement therapy. On the IOR task, PD patients and controls demonstrated a similar degree of attentional inhibition. On the NP task, PD patients and controls demonstrated a pattern of inhibition, although the magnitude of inhibition was significantly reduced in the PD group. The current study proposes the involvement of a corticostriatopallidothalamic circuit in understanding the disruption of inhibitory attention in PD.

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V. ZIZAK, K. POSSIN, D.C. DELIS, M. JACOBSON, S. JERKINS, D.P. SALMON, & J.V. FILOTEO. Performance of Parkinson's Disease Patients on the CVLT-II.

Nondemented Parkinson's disease (PD) patients and a group of age- and education-matched normal controls were administered the revised version of the California Verbal Learning Test (CVLT-II). Overall, the two groups did not differ in their ability to learn, recall, and recognize verbal list items, a finding that is consistent with other studies of non-demented PD patients. However, an examination of the qualitative indices obtained on the CVLT-II revealed that PD patients tended to use a semantic clustering strategy to a lesser degree than normal controls, despite relatively normal learning and recall of the word list. Impaired semantic clustering in the PD patients was not associated with performances on tests of novel problem solving or verbal fluency, but was related to performance on a general measure of cognitive functioning (Dementia Rating Scale). In the normal controls, greater use of a semantic clustering strategy was related to better retention of the word list at the long delay, suggesting that semantic encoding of verbal information during learning will result in a more durable memory trace. In contrast, there was not a significant relationship between semantic clustering and delayed recall of the word list in the PD patients. These latter findings indicate that the normal relationship between semantic clustering and delayed recall may be disrupted in patients with PD. Possible explanations of decreased semantic clustering in PD patients will be presented.

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B. PATRY & E. MOHR. Temporal Memory and Executive Skills in High-Functioning Parkinsonian Patients.

Research has suggested that frontal-subcortical circuit disruption may compromise the functional integrity of the frontal lobes, thereby contributing to the cognitive deficits experienced by people with Parkinson's disease (PD) who have no evidence of dementia. This study sought to investigate frontal lobe functioning by evaluating executive ability and temporal memory in a group of high-functioning patients with PD. This subpopulation of PD patients was selected because they were deemed least likely to exhibit executive impairments. A secondary goal was to explore the potential relationship between temporal memory and working memory. Twenty nondemented outpatients with PD and 20 matched controls (ages 50–78), with a university degree, a professional occupational history, or both, completed measures of executive function (WCST, Backward Digit Span, Digit Ordering Test and Picture Arrangement), and temporal memory (Temporal Ordering Task, Word Sequencing Test). The patient group completed significantly fewer categories on the WCST and differed significantly from controls on three measures derived from the Temporal Ordering Task. The patient group also displayed a trend of lower scores on the Word Sequencing Test. No group differences emerged on the working memory tasks, which did not correlate significantly with the temporal memory tasks. Furthermore, there were no group differences with respect to set shifting (WCST perseverative errors), set-formation (WCST trials to the first category), and sequencing (Picture Arrangement). These results are interpreted in the context of frontal-subcortical circuitry.

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C. HOLLNAGEL & J. MINK. Working Memory and Inhibition in Mild Parkinson's Disease.

Working memory, inhibition, and other impairments have been described in mild Parkinson's disease. Although one cognitive model suggests inhibition is important in working memory and aging, this has not been explored in Parkinson's disease. Deficits in inhibition of irrelevant motor and sensory information have been described in Parkinson's disease. Similarly, failure to inhibit competing visual information has been suggested

as the basis of visuo-perceptual deficits in mild Parkinson's disease. The purpose of this study was to better understand the cognitive changes associated with mild Parkinson's disease, and contribute to a more unitary view of inhibitory deficits across multiple systems in Parkinson's disease, i.e., motor, sensory, and cognition. We hypothesized that deficits would be found in working memory and inhibition, but not in primary memory or long-term memory. We further hypothesized that after statistically controlling for inhibition, working memory deficits would become nonsignificant. The performance of 30 participants with mild Parkinson's disease and 30 age- and education-matched controls was compared. All participants were screened for dementia and depression and were tested off anti-Parkinson medication. As expected, those with mild Parkinson's disease demonstrated significant impairments in working memory and inhibition with no significant differences in primary memory or long-term memory. In contrast to prediction, controlling for inhibition did not account result in a non-significant working memory difference between the groups.

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C.L. DIRKSEN, E.K. DONOVAN, A. CRONIN-GOLOMB, & M. OSCAR-BERMAN. Hemi-Parkinson's Disease and Verbal Memory as Assessed by the CVLT.

Past studies have found that adults with Parkinson's disease (PD) with right-side motor onset (RPD: greater left-hemisphere dysfunction) perform worse than those with left-side onset (LPD: greater right-hemisphere dysfunction) on several verbally based cognitive tasks. Although PD patients are impaired on the widely used California Verbal Learning Test (CVLT), it is not known if their impairment is a function of side of symptom onset. We administered the CVLT to 9 nondemented RPD, 7 nondemented LPD, and 15 healthy adults matched for age and education. We hypothesized that because the CVLT is a verbal memory task, RPD would be impaired relative to LPD and control participants. PD patients, as a group, recalled significantly fewer words than the control group on Trial 5 of immediate recall, and this result was driven completely by impairment of the RPD subgroup. RPD also recalled significantly fewer words than the control group on Short Delay Free Recall, Long Delay Free Recall, and Long Delay Cued Recall. No significant differences were found between LPD and control participants. The results indicate that what appears as a general PD impairment in recalling verbal material may be driven by patients with right-side onset. Taken together with studies of visuospatial impairments in LPD, our findings support the view that the neuropsychological profiles of PD patients are a function of side-of-symptom onset. These data underscore the importance of considering side of onset in clinical evaluations and research studies.

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M.-S. HUA, Y.L. CHANG, R.-M. WU, Y.-R. WU, & S.-T. CHEN. Automatic-Controlled Processing Function in Patients with Parkinson's Disease.

Neuropsychological interest in automatic-controlled processing abilities in patients with Parkinson's disease (PD) is primarily based on studies of their explicit and implicit memory function. Most of the recent researchers, however, have already realized that most of the conventional explicit and implicit memory tasks can't purely measure either controlled or automatic processes. In fact, normal performance on either implicit or explicit memory tasks demands various levels of awareness. In the present study, we examined cognitive domains of attention and memory in a sample of nondemented patients with idiopathic PD to make an attempt to explore the issue of automatic-controlled processing abilities in these patients with varying degree of motor disabilities. The results revealed that our patients with Hoehn and Yahr's Stage I were impaired in divided attention.

The patients with Stage II were defective in divided attention, verbal free recall, and borderline in incidental memory. The patients with Stage III were impaired in selective and divide attention, verbal free recall, and executive function, and borderline in incidental memory. Since our free recall and divided attention measures require more expenditure of cognitive resources, and strategic processes, we thus suggest that our non-demented patients with idiopathic PD were defective in controlled processing functioning.

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N. PERACHIO, K. RYDER, J. WETMORE, R. ADAMS, W. BEATTY, & J.G. SCOTT. Differential Impact of Anxiety on Cognition Between Clinical Groups.

Level of anxiety, rather than depression, has been shown to be associated with cognitive impairment in Parkinson's disease (PD) patients. This previously reported finding was based on a limited patient sample from the VAMC, leaving in question generalizability to more diverse patient groups with neurodegenerative conditions. The present study evaluated the impact of anxiety on cognitive performance in 90 subjects, including PD patients with possible dementia (PDD) as well as Alzheimer's disease (AD) patients. Subjects were drawn from patients of the VAMC and OUHSC clinics and were administered the State-Trait Anxiety Inventory (STAI), the Mini-Mental State Exam (MMSE), and the Repeatable Battery for the Assessment of Neuropsychological Status (RBANS). Correlation and regression analysis revealed that MMSE alone accounted for 31% of the variance in RBANS Total for the PD group, 36% of the variance in the PDD group, and 52% of the variance in the AD group. Combining MMSE with STAI-State and Trait accounted for 60% of the variance in the PD group, 61% of the variance in the PDD group, and 81% of the variance in the AD group. The negative impact of anxiety on cognitive performance was found across 3 clinical groups. Measures of Anxiety were most effective in improving the predictive power of the MMSE for RBANS Total in the AD group, with slightly smaller increases in predictive power for the PD and PDD groups. These findings support the need to assess levels of anxiety in conjunction with cognitive performance in neurodegenerative patient groups.

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S. McPHERSON, D. MASTERMAN, & P. INTEMANN. Apathy and Depression in Parkinson's Disease: Impact on Cognition and ADLs.

Prior research has shown that Parkinson's disease (PD) patients with apathy and depression perform worse than patients with apathy alone on measures of verbal memory and on time dependent tasks. Few studies to date have examined the relationship between activities of daily living (ADL) and apathy and depression in PD. We compared the performance of PD patients with and without apathy ($N = 33$) and with and without depression ($N = 35$) on a battery of cognitive tests and on the Schwab and England ADL scale. A one-way ANOVA revealed significant differences for patients with and without apathy for category fluency (animals; $p < .02$), two measures of verbal processing speed [Stroop color naming ($p < .007$) and word reading; ($p < .05$)], and for ADL's in both "on" ($p < .004$) and "off" ($p < .02$) periods. No significant differences were found for depression alone for any cognitive measure or ADL's in either the "on" or "off" periods. Although patient's with apathy had higher scores on the Beck Depression Inventory ($p < .05$), significant interactions for apathy and depression were present only for category fluency and for ADLs, but only in the "off" period. These results add to the growing body of literature as evidence that although apathy and depression may co-exist, they are distinct entities and that the presence of apathy alone has a negative impact on ADLs.

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L. MESSINIS & G. ANTONIADIS. Neuropsychological Performance and Depression in Parkinson's Disease Patients.

The present study evaluated the neuropsychological performance of Parkinson's disease (PD) patients with depression (PDD) and without depression (PDND) and assessed the possible effects of depression on cognitive tasks. Neuropsychological measures included RPM, WCST, WMS-R, COWAT and BDAE Boston and Animal Naming Tests. A cross-sectional comparisons design was utilized among a PDD, PDND and NC group. Participants were recruited from the outpatient neurology departments of the University Hospitals of Patras and Larissa in Greece. The groups consisted of 18 PDD and 18 PDND patients. These groups were matched for age, education, gender, disease duration and severity. Eighteen NC patients matched for age, education and gender, were also assessed. PD was diagnosed by clinical neurological examination and PDSBB criteria. Assignment of participants into PDD and PDND groups was based on BDI scores, psychiatric interviews and DSM-IV-TR diagnostic criteria. Patients were excluded if demented, or had any other disorder that could have an impact on neuropsychological performance. PD patients were being treated with standard antiparkinsonian medications. The PDD and PDND groups showed significant impairments in semantic category fluency, verbal fluency, delayed verbal recall and category naming compared to the NC group. The PDD group showed significant impairments in visual confrontation naming and lexical-semantic fluency compared to the NC group. When comparing PDD and PDND groups, PDD patients showed deteriorated performance on memory and language subtests. Depression appears to exacerbate memory and language impairments in PD patients, although depression probably affects the severity rather than the pattern of cognitive impairments.

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M. SINDEN, J.S. MARTZKE, J.A.R. CARR, & C.R. HONEY. Comparison of Cognition and Mood in Patients with Essential Tremor and Parkinson's Disease.

Essential tremor (ET) is thought to be a benign condition. Few studies have examined neuropsychological functioning in ET or compared cognition in ET to other movement disorders. We administered a neuropsychological battery (DRS, RAVLT, Corsi Blocks, Digit Span, COWA, Stroop, Trails A & B, HVOT, JLO, POMS) to 29 ET and 19 Parkinson's disease (PD) patients. All patients had treatment resistant tremor and were referred for thalamic surgical intervention. The groups did not differ in age, education, gender, handedness, hemisphere indicated for surgical intervention or total DRS score. Relative to published norms, ET and PD patients had decreased performance on DRS initiation/perseveration and conceptualization subscales, BVRT-R, Digit Span, Stroop (all trials), Trails A and Trails B ($ps < .05$). Level of impairment on these measures did not differ between groups, except for the DRS initiation/perseveration subscale and the BVRT-R (PD worse than ET, $p < .05$). In addition, PD patients showed poorer performance on the RAVLT compared to ET patients ($p < .05$). Relative to published norms, ET patients reported significant tension/anxiety while PD patients reported significant fatigue/inertia, confusion/bewilderment and tension/anxiety ($ps < .05$). Patient groups differed only in terms of fatigue/inertia (PD more fatigued than ET, $p < .05$). Patients with ET show cognitive impairment that is primarily executive and frontostriatal in nature. This impairment did not differ from that found in our sample of PD patients, with the exception that PD patients had poorer memory performance.

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J.A. FIELDS, S.P. WOODS, & A.I. TRÖSTER. Predictors of Daily Functioning in Essential Tremor.

Emerging research indicates that a proportion of patients with essential tremor (ET) display deficits in one or more domains of complex attention,

verbal learning, verbal fluency, visuoperception, and select executive functions. Whether, as in Parkinson's disease, these cognitive deficits negatively impact patients' activities of daily living is unknown. In the present study, 54 patients with ET underwent comprehensive neurologic and neuropsychological assessment as part of a surgical candidacy evaluation. In addition, participants completed self-report questionnaires assessing emotional adjustment and quality of life, including the Profile of Mood States (POMS) and the Sickness Impact Profile (SIP). The Home Management scale from the SIP contains 10 items designed to measure participants' ability to manage their household affairs, for example shopping and paying bills. A stepwise multiple regression analysis was conducted to predict SIP Home Management scores from demographic and disease variables, mood state, and measures of attention, visuoperception, verbal learning, and executive functions. Contrary to our initial hypothesis, no measure of cognitive functioning was associated with the SIP Home Management scale. Rather, tremor severity and fatigue (POMS) significantly predicted SIP Home Management scores, together accounting for approximately 36% of the variance. Findings suggest that the cognitive deficits in ET may not be of a sufficient magnitude to disrupt home management activities beyond that which can be explained by tremor and fatigue.

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S.P. WOODS, J.A. FIELDS & A.I. TRÖSTER. Predictors of Neuropsychological Decline After Thalamic DBS for Essential Tremor.

Initial studies generally support the cognitive and neurobehavioral safety of thalamic deep brain stimulation (DBS) in patients with essential tremor (ET). Analyses of individual change scores, however, suggest that some patients with ET experience mild postsurgical neuropsychological decrements. The aim of the present study was to determine the predictors of postsurgical neuropsychological decline in ET. Forty-nine patients with ET underwent neuropsychological evaluation at baseline and 3 months after unilateral thalamic DBS. Twenty-seven patients (55%) demonstrated mild postsurgical neuropsychological decrements (ET-D) as defined by at least a 1 standard deviation decline on cognitive tests in 2 or more domains of functioning. A total of 22 patients (45%) did not meet criteria for ET-D and were classified as neuropsychologically stable (ET-S). The ET-D and ET-S groups were comparable in terms of baseline demographic, disease, and neuropsychological characteristics, as well as postsurgical motor outcomes. However, a greater proportion of ET-D patients underwent left thalamic stimulation. In addition, the ET-D group had significantly higher pulse width (PW) stimulator settings than ET-S participants. Discriminant function analysis revealed that PW settings significantly predicted postsurgical group membership. Patients with PW settings > 120 ms were greater than 10 times as likely to exhibit subtle postsurgical neuropsychological decrements than patients with lower PW. Although higher PW may be required for optimal tremor control in certain patients, consideration must also be given to the potential risks of subtle cognitive morbidity.

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L.M. RILLING, J.A. LUCAS, R.E. WHAREN, M.F. TURK, J.D. PUTZKE, & R. J. UITTL. Predictors of Health-Related Quality of Life After Vim DBS Surgery for Tremor Control.

Deep brain stimulation (DBS) of the thalamic ventral intermediate nucleus (Vim) has emerged as an effective treatment for essential tremor (ET) and tremor associated with Parkinson's disease (PD). Improvements in motor functioning and health-related quality of life (HRQOL) following surgery have been well documented; however, the contribution of pre-operative factors to post-operative HRQOL remains unclear. This study sought to determine pre-operative cognitive, mood, and psychosocial pre-

dictors for post-operative HRQOL. Participants included 38 patients with PD ($n = 18$) or ET ($n = 20$) with a mean age of 66.8 years (range = 42–88) and a mean education of 12.8 years. Patients were administered the Dementia Rating Scale, Profile of Mood States (POMS), and self-report measures of perceived social support and HRQOL prior to unilateral Vim DBS surgery. Mood and HRQOL were also assessed 3 months following surgery. Data were analyzed using hierarchical multiple regression with pre-operative HRQOL entered into the model first to control for baseline quality of life. Remaining predictors were then allowed into the model in a stepwise fashion. Pre-operative HRQOL accounted for 40% of the variance ($p < .001$). Pre-operative scores from the POMS Tension/Anxiety and Vigor scales accounted for an additional 10% variance ($p < .05$) beyond baseline HRQOL. In contrast, pre-operative cognitive functioning, depression, and social support were not significant contributors. Post-operative improvement of tremor also was not predictive of HRQOL. Findings suggest that pre-operative stamina and potential reductions in anxiety consequent to post-operative tremor reduction may, in part, account for post-operative improvements in HRQOL in PD and ET patients. Correspondence: Laurie Rilling, Mayo Clinic, Department of Psychiatry & Psychology, 4500 San Pablo Rd., Jacksonville, FL 32224. E-mail: rilling.laurie@mayo.edu

K. RYDER, J. WETMORE, W. BEATTY, A. STEVENS, P. FRANCEL, K. BHARUCHA, & J.G. SCOTT. Cognitive Changes From Surgical Versus Medical Treatment of Parkinson's Disease.

Clinical research on the impact of Deep Brain Stimulation (DBS) has produced conflicting findings of improvements, declines, and no change in cognitive performance. The absence of control or comparison groups in the majority of studies has contributed to the current debate regarding interpretation of performance change. No change in performance is often interpreted as no impact, but it may indicate a mild form of impairment if practice effects are normally observed in PD patients. Medically treated Parkinson's patients (PD-MED, $N = 10$), surgically treated Parkinson's patients (PD-DBS, $N = 8$), and control subjects ($N = 6$) were administered the Mini-Mental State Exam, California Card Sort Task (CCST), and the Repeatable Battery for Neuropsychological Status (RBANS) at two time points, approximately 4 months apart. *T*-test analysis was performed on baseline, follow-up, and performance change scores. Several significant differences were found between the PD-MED control groups at baseline and follow-up. The lower scores of the PD-MED group were consistent with disease-related changes in cognitive functioning. No significant difference in change scores were observed between the PD-MED group and controls, or between the PD-DBS group and the PD-MED group. The PD-MED group scored significantly lower than the PD-DBS group on the RBANS Delayed Memory Index at baseline and the follow-up figure copy subscore. PD-DBS group cognitive performance changes following DBS surgery are similar to changes observed in medically treated PD patients. Practice effects were not observed in the PD-MED group, indicating practice effects should not be expected in PD-DBS patient groups.

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G. VINGERHOETS, S. VERLEDEN, M. MIATTON, & P. SANTENS. Predictors of Cognitive Impairment in Patients With Parkinson's Disease.

One-hundred patients with idiopathic PD underwent 7 motor-free neuropsychological tests out of which 9 cognitive measures were selected. To determine a global impairment score we evaluated each test performance against the performance of a demographically matched normal peer group to determine an impairment score for that test. The impairment scores are based on standard deviations from the mean and range between zero (normal performance) and 4 (a performance that falls below minus 4 standard

deviations of the normative mean). The impairment scores for each test were added to determine the global impairment score for that patient. A stepwise linear regression analysis revealed that age ($B = .26$, Standard Error $B = .06$, $t = 4.75$, $p < .001$) and type of onset PD symptom ($B = -2.36$, Standard Error $B = 1.0$, $t = -2.36$, $p = .02$) were significant variables that explained 23% of the variance of the global impairment score. We performed two multivariate analyses of variance with age (<60 vs. >60) and type of onset clinical symptom (tremor vs. akinesia/rigidity) as between-subjects factor respectively. Age has a significant effect on the (already age-corrected) cognitive impairment profile [Hotelling's T^2 (10,89) = 3.73, $p < .001$]. Older PD patients (>60 years) perform worse on almost every cognitive measure. Type of onset clinical symptom also had a significant effect on the cognitive impairment profile [Hotelling's T^2 (10,79) = 1.93, $p = .05$]. Patients showing tremor as onset clinical symptom were more likely to suffer cognitive impairment in the more advanced stages of the disease than patients with akinesia and/or rigidity onset symptoms.

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G. VINGERHOETS, S. VERLEDEN, M. MIATTON, & P. SANTENS. Cognitive Profile in Demented and Non-Demented Patients With Parkinson's Disease.

One-hundred patients with idiopathic PD underwent 8 neuropsychological tests out of which 10 cognitive measures were selected. We evaluated each test performance against adequate normative data to determine its impairment score. The impairment scores are based on standard deviations and range between zero (normal) and 4 (a performance below minus 4 standard deviations of the normative mean). Twenty-eight patients (28%) showed age-controlled cognitive impairment in 8 or more (out of 10) cognitive variables and were considered to suffer general cognitive impairment and probable dementia. In the nondemented group fine motor control appeared to be the most severely impaired cognitive function. Mental flexibility, selective attention, verbal learning, and verbal fluency showed moderate impairment, whereas visual recognition, spatial localization, and delayed verbal recall was mildly impaired. Left/right orientation in space and spatial reasoning appeared, on average, normal. In the group of patients with probable dementia the severely impaired fine motor control was supplemented with severely impaired memory and, to a lesser extent, visuospatial difficulties. These observations are confirmed by multivariate analysis of variance using group (demented vs. nondemented) as a between-subjects factor [Hotelling's T^2 (10,80) = 8.78, $p < .001$] *Post-hoc* tests revealed that this difference was highly significant for memory and attention variables (always $p \leq .001$), moderately significant for spatial localization and mental flexibility ($p < .05$), and not significant for left/right orientation and fine motor control. This differential pattern of cognitive decline in PD suggests the contribution of different underlying

neurodegenerative mechanisms each responsible for specific impairments in the cognitive profile.

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D. J. ZGALJARDIC, J. C. BOROD, N. S. FOLDI, & P. MATTIS. Parkinson's Disease: Neuropathology and Cognitive/Behavioral Sequelae.

Parkinson's disease (PD) is a neurodegenerative movement disorder affecting striatal structures, primarily characterized by voluntary motor deficits. However, as frequently reported in the neuropsychological literature, PD patients can also exhibit cognitive and behavioral impairments. In recent years, considerable attention has been paid to the circuits connecting the striatum and prefrontal cortex (e.g., dorsolateral, orbitofrontal, and anterior cingulate) and how they might mediate cognition and behavior in humans. It has been suggested that these same circuits are disrupted in PD and may be responsible for the frontal/executive deficits predominantly reported in this patient population. A review of studies involving non-human subjects, healthy normals (using neuroimaging), and brain-damaged individuals is conducted here in order to better understand and categorize the cognitive sequelae concomitant to specific frontostriatal circuit dysfunction and to ascertain how they might provide the substrate for neuropsychological impairments exhibited in PD. This survey of the current literature provides a critique and analysis of the cognitive and behavioral impairments afflicting PD patients in terms of (1) functional neuroanatomy, (2) neurochemical and cellular disruption, (3) depression, and (4) emotional processing deficits. Furthermore, despite a considerable focus on the dysfunctional dopaminergic system in PD, a special feature of this paper is to highlight how disruption to the cholinergic system may also play an important role in the cognitive impairments reported in this patient population.

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Birch Lecture/5:00–6:00 p.m.

TRANSLATING THE BIOLOGY OF STEM CELLS TO REGENERATION MEDICINE

Dennis Steindler

FRIDAY MORNING, FEBRUARY 7, 2003

Poster Session 5/8:00–9:15 a.m.

DEVELOPMENTAL DYSLEXIA

H. VAN DER VEER & A. BOUMA. Dyslexia in South-African Children: A Cross-Cultural Approach.

The aim of this study was to compare the nature of dyslexia between 2 ethnic groups of South-African reading-disabled children. It was hypoth-

esized that dyslexics' word recognition difficulties would be affected by phonological awareness deficiencies on one hand, and sequential information processing deficiencies on the other hand. Word recognition was tested by reading aloud different types of words (regular, irregular, pseudo-words). Phonological awareness skills were measured by tasks relying on phonological analysis of pseudo-words. The Kaufman Assessment Battery for Children (K-ABC) was administered to assess different types of information processing strategies (sequential vs. simultaneous). We observed that Black dyslexics performed more poorly on word recognition tasks than White dyslexics, whereas such a performance difference was not obtained between Black and White controls. Compared to controls, both

groups of dyslexics made more errors on word-reading tasks and they showed stronger word-type effects as well as stronger word-length effects. Moreover, they performed significantly weaker on phonological tasks, and they scored lower on the simultaneous and the sequential processing scales of the K-ABC. In contrast to our expectation, the Black reading-disabled children performed significantly lower on the simultaneous processing scale than the White reading-disabled children. Although the White and Black dyslexics showed similar patterns of word-reading difficulties, regression analyses revealed that phonological and simultaneous processing deficiencies seem to be more crucial indicators of dyslexia in Black than in White reading-disabled South-African children. The theoretical implications of these findings will be discussed.

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A. LÓPEZ ANGEL, D. ZARABOZO, & E. MATUTE. Could Dyslexic Spanish Speaking Children Reach a Normal Reading Level?

The aim of this work was to investigate whether Spanish-speaking, reading-disabled children could reach the reading level of normal children after two years of regular and compensatory instruction. Sixty reading disabled children (RDG), 39 boys and 21 girls, from 2nd to 6th school grades, 12 of each group, aged from 7 to 15 years old and 60 normal children (CG) matched by gender and school grade, were asked to read aloud a short story and immediately after, each child was asked to reproduce the story orally. Two years later the same task was asked to 102 of these children, 51 of each group. Reading speed, number of misreading words, and number of omitted words were recorded. Text production was analyzed in terms of number and type of narrative units recovered as well as the number of words employed by each child. Factorial ANOVA Group (RDG, CG) × Evaluation (initial, 2 years later) was performed. Results show that at the initial level, the RDG obtained significantly lower scores than the CG on each one of the 6 measures being analyzed. Two years later, although both groups showed increased scores, the RDG level was still significantly lower than the CG in every measure so investigated. The findings suggest that reading-disabled children have difficulties reaching the reading level of their schoolmates even in a transparent orthography language, such as Spanish. The results are discussed in terms of the similar sequence hypothesis.

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K. CORRIVEAU, E. FESTA-MARTINO, J. WINER, J. GITEN, & W. HEINDEL. Dissociation Between Two Types of Word-Form Priming in Developmental Dyslexia.

Priming refers to the enhanced processing of a stimulus due to previous presentation of that stimulus. Although the neuropsychological mechanisms underlying priming remain unresolved, recent studies suggest that different types of word-form priming may be mediated by distinct processes. Specifically, word-stem completion (WSC) priming may involve the modification of preexisting lexical representations whereas perceptual identification (PI) priming may involve enhanced prelexical perceptual processing. If WSC and PI priming do differ in their reliance on lexical representations, then they may be dissociable in children with developmental dyslexia. In the present study, WSC and PI priming were assessed in 10 children with dyslexia (ages 8–16) and 10 normal control children. In the WSC task, subjects read aloud 15 words and were asked to complete 30 (15 studied, 15 unstudied) 3-letter stems with the first word that came to mind. In the PI task, subjects read aloud 15 words and were asked to read 30 (15 studied, 15 unstudied) tachistoscopically presented words. Relative to controls, the children with dyslexia exhibited impaired performance on the WSC task but enhanced performance on the PI task. Moreover, a measure of visual persistence was found to be positively correlated with PI but not WSC priming in the dyslexic children, suggesting that their

enhanced PI priming may be due to slowed visual processing. Taken together, these findings support the notion that two distinct priming mechanisms mediate performance on WSC and PI tasks, with WSC but not PI priming critically dependent on the modification of lexical representations. Correspondence: *William Heindel, Department of Psychology, Brown University, 89 Waterman St., Box 1853, Providence, RI 02912. E-mail: William_Heindel@Brown.Edu*

T. HELLAND. Factor Analyses of Cognitive Functions in Dyslexia.

This study focused on cognitive functions in dyslexia. Dyslexia is traditionally associated with language impairment related to the left temporal lobe. However, the definition by the British Dyslexia Association points to other cognitive impairments in dyslexia, affecting numeracy and organizational skills. This calls for a wider range of cognitive assessments besides tasks of phonological awareness typically given to dyslexic subjects. The present study analyzed results of tasks of brain asymmetry for language, attention, working memory, executive functions, basic calculation and language comprehension administered 43 dyslexic children 12.67 (*SD* 1.68). Our earlier studies showed that these variables distinguished between controls and dyslexics, and between dyslexic subgroups. It was assumed that factor analyses would load not only on tasks of left hemisphere functions (language), but also on right hemisphere functions (numeracy) and frontal functions (organization). Factor analyses using eight selected variables loaded on three orthogonal factors. Factor 1 was loaded by results from dichotic listening, digit span and Stroop interference. Factor 2 was loaded by basic calculation and the Rey-Osterrieth Complex Figure Test. Factor 3 was loaded by a task of language comprehension and the Wisconsin Card Sorting Test. Factor 1 was classified as “phonological processing” related to left hemisphere and frontal functions. Factor 2 was classified as “visuospatial processing” related to the parietal lobes, while Factor 3 was classified as “semantic” associated with the frontal lobes. The findings are discussed in relation to sample size, empirical research and clinical implications.

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B. HALLOWELL. Eye Tracking for the Study of Reading Comprehension in Children and Adults.

Patients with neurological impairments present challenges for the assessment of reading comprehension. During traditional assessment, failures can be falsely attributed to comprehension deficits as opposed to response problems (e.g., verbal apraxia, limb apraxia, or paralysis), or problems involving understanding of assessment tasks. Spontaneous eye movements provide a non-verbal, non-volitional response mode while patients look at test stimuli, and thus may help to improve the validity of reading test results. The eye movements investigated here are saccades, abrupt high-velocity eye rotations that bring images into the eye’s point of greatest visual acuity. Saccades do not require conscious planning and execution, so are differentiated from volitional, intentionally directed eye movements, such as those used for augmentative communication. This is an important distinction, given potential deficits that may affect oculomotor programming of intentional fixations. Eye movement recording yields an on-line processing measure. Numerous studies across diverse disciplines have correlated spontaneous, non-volitional eye movement data with other measures of cognitive and linguistic processing. A rich body of literature addresses how the eyes move to gain information from text during the reading process, but few studies have addressed the effect of reading comprehension on how viewers view text or scenes. Previous studies have supported the effectiveness of eye tracking to assess auditory linguistic comprehension in children and adults. Data are presented from a series of 3 experiments, two with adults and one with children. Results support the feasibility of using eye movements to index reading comprehension. Potential applications for clinical practice and research are discussed.

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K. CORRIVEAU, E. FESTA-MARTINO, J. WINER, J. GITTEN, & W. HEINDEL. Increased Visual Persistence in Children and Adults With Developmental Dyslexia.

Numerous studies have addressed the auditory temporal processing deficit in Developmental Dyslexia (DD); however, it is unclear whether this deficit is strictly auditory, or whether it generalizes to other temporal processing deficits. This study addressed this question by examining visual temporal processing in students with DD in a visual persistence task. Visual persistence was measured by using a 5×5 dot matrix consisting of 2 slides of 12 dots each such that, when superimposed, displayed 24 out of 25 possible dots. Subjects were asked to click on the position of the missing dot. The gap length between presentations of the 2 slides was varied using a double-staircase method based on subjects' accuracy at detecting the missing dot; the average gap duration across the last 5 staircase reversals was used as the measure of visual persistence. Twenty young (10 dyslexic, 10 control) and 17 college-age (7 dyslexic, 10 control) students participated. Both young and college-age dyslexic students were able to accurately detect the position of the missing dot at significantly longer gaps than their age-matched controls. Moreover, there was no overlap in the range of individual visual persistence thresholds obtained by the dyslexic and control participants in each age group. This increased visual persistence, manifested as an enhancement in task performance, may reflect slowed visual processing in children with DD. This increased persistence that is also present in adult dyslexics indicates that compensatory mechanisms being used by college-age students do not eradicate lower-level visual processing deficits.

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B.T. SCHMIDT & L.K. OBLER. Visual Processing Speed and Reading in Adults.

The developmental literature reports a correlation between reading comprehension and fluency. However, it has been noted that in some cases there is a dissociation between skilled reading comprehension and oral reading fluency in skilled adult readers. Currently, persistent oral-reading fluency deficits are generally attributed to poor phonological awareness or temporal processing differences, which is hypothesized to inhibit automaticity, and evidence suggests that these phonological deficits underlying dyslexia persist into adulthood. Recently, some hypothesize that there is a relation between fluency and processing speed. In order to determine the extent to which processing speed is linked to reading fluency, 20 native English speakers ranging in age from 16–36 ($M = 21$), with normal speech, language and hearing, no known neurological deficits and corrected or normal vision participated in this study. Speed of oral reading, reading comprehension and nonlinguistic visual processing speed were each assessed. Correlation was evident between oral reading rate and reading comprehension ($r = .444, p = .05$) as well as a correlation between oral reading rate and nonlinguistic visual processing speed ($r = .477, p = .033$). However, the correlation between reading comprehension and visual processing speed was not significant in this sample ($r = .167, p = .482$). Thus visual processing speed differences are linked to fluency of reading, but less directly to comprehension.

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S.D. MARION, D. BADARUDDIN, D. CHARLTON, B. SIMON, L. HUMPHREY, & W.S. BROWN. Bimanual Coordination Deficits in Children With Reading Disabilities.

The cerebral commissures connecting the 2 sides of the brain, including the corpus callosum (CC), have been increasingly recognized as an important functional component in the neurocognitive systems responsible for reading disability or dyslexia. A particularly informative area of study with respect to interhemispheric interactions in reading disability has been motor control and bimanual coordination. In this study, 30 children with dyslexia and 30 matched controls were tested on the computerized version of the Bimanual Coordination Test (cBCT) and various reading measures.

Results confirm an association between reading disability and those aspects of cBCT performance previously shown to relate to interhemispheric functioning. The dyslexic group performed more slowly ($R = 11.48, p < .01$) and less accurately ($F = 9.04, p < .01$) than controls on bimanual angles in which the hands were required to turn the knobs of the cBCT response box at asymmetric hand speeds. Poor performance on interhemispheric aspects of the task was related to deficits on the Gray Oral Reading Test ($F = 9.90, p < .01$), 2 reading subtests of the Woodcock-Johnson Tests of Achievement (Letter-Word, $F = 9.90, p < .01$; Word Attack, $F = 9.90, p < .01$), and the Rapid Automatized Naming Test ($F = 9.90, p < .01$), independent of cBCT measures of pure motor speed and general visuomotor control. These findings are consistent with the idea that timing of information-sharing between the 2 sides of the brain through the CC may contribute to developmental dyslexia.

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G.K. DEUTSCH, R. DOUGHERTY, W.T. SIOK, R. BAMMER, J.D.E. GABRIELI, & B. WANDELL. Correlations Between White Matter Structure and Reading Performance in Children.

Developmental dyslexia is a neurocognitive deficit that is specifically related to reading and spelling processes. Both structural and functional neuroimaging studies have shown significant differences between dyslexics, operationally defined by comparing performance on simple reading tasks with other cognitive tasks, and normal controls. For example, diffusion tensor imaging (DTI) in adults has revealed a correlation between white matter structure (measured by fractional anisotropy, FA) and reading performance. The FA values in a region of the left temporal lobe of adult dyslexics were correlated with reading difficulties measured behaviorally. The current study used whole-brain DTI (1.5T GE Scanner) to measure FA in both dyslexic and control children, ages 8–13. Our goal was to determine whether white matter disruption correlated with reading ability is present in children of the age range at which reading problems are first identified. Significant group differences in FA were found in a small left temporal-parietal region, and these differences significantly correlated with reading performance. These FA differences may be caused by disruption of white matter microstructure in the dyslexic subjects; we are also exploring the hypothesis that these FA differences arise as a consequence of gross structural differences in this brain region that perturb the normal location of white matter fiber tracks.

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J.B. FANCHER, R. MARKANEN, A. LEWANDOWSKI, M.Y. KIBBY, & G.W. HYND. The Cerebellar Vermis and Dyslexia.

Current cerebellum literature has implicated vermal structures in a variety of psychological disorders. More specifically, studies have identified a relationship between the anterior vermis lobe (I-V) and schizophrenia, the combined VI-VII vermis lobules and autistic-like behaviors and autism, and the posterior vermis lobe (VIII-X) and ADHD and disturbances of attention. Fawcett and Nicholson have argued that the primary locus of problems observed in dyslexia is in the cerebellum. To date, limited research has examined the relationship of cerebellum vermis morphology and dyslexia. Thus, the purpose of this study was to explore the relationship between the sizes of the three vermis lobes and dyslexia. Anatomical MRIs were collected and the vermis was measured on 33 children ages 8 to 11. Neuropsychological measures also were collected to determine group membership. Preliminary results demonstrated significant group differences in VIQ and mid-sagittal supratentorium area. Thus, VIQ and supratentorium size were used as covariates in subsequent analyses. Further analysis indicated that the posterior vermis lobe (VIII-X) is significantly smaller in children with dyslexia compared to controls. Thus, the posterior lobe previously identified with attention difficulties also appears to be related to problems with reading. This finding supports the Nicholson and

Fawcett argument that children with dyslexia show abnormalities in the cerebellum.

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R. MARKANEN, J.B. FANCHER, A. LEWANDOWSKI, M.Y. KIBBY, & G.W. HYND. Cerebellum Hemisphere Morphology in Dyslexia.

Controversy continues to exist about the role of the cerebellum in cognition. Some studies have demonstrated a relationship between the cerebellum and cognitive functions important to reading. Nicholson and Fawcett expanded this notion, suggesting that the cerebellum may be the primary locus for deficits in dyslexia. Thus, the focus of this study is to see if differences exist in cerebellar hemisphere morphology between children with and without dyslexia. Cerebral morphological studies in dyslexia have demonstrated symmetry or reversed asymmetry in children with dyslexia for specific regions of interest. In contrast, cerebellar morphology has not been well studied in the field of dyslexia to date. Structural MRIs were collected and measured on 33 children ages 8 to 11. Relevant neuropsychological variables were measured to determine group membership (with or without dyslexia). Results of our study complement previous research. Initial results demonstrated that absolute size of either hemisphere is not significantly different between groups. However, when asymmetry was analyzed, significant between group differences were observed. Specifically, we found that children without dyslexia demonstrate cerebellar hemisphere volume asymmetry. Conversely, children with dyslexia showed cerebellar hemispheric symmetry. This pattern of results is consistent with asymmetry research on the cerebral hemispheres in dyslexia. This finding also supports the argument that cerebellar morphology is related to the deficits observed in children with dyslexia.

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M.Y. KIBBY, J.B. FANCHER, R. MARKANEN, A. LEWANDOWSKI, & G.W. HYND. A Test of the Cerebellar Deficit Hypothesis of Dyslexia.

The role of the cerebellum in cognition has been a topic of much debate over the past decade. Many continue to believe that the cerebellum is primarily involved with motor functioning, including procedural learning and movement programming and execution. However, research suggests that the role of the cerebellum may go beyond motor functioning to include language and visual-spatial processing and shifting of attention, through its connections with various cortical and subcortical structures. Recent work by Nicholson and Fawcett suggests the primary source of deficits in dyslexia may be the cerebellum. According to their model, reduced cerebellar functioning at birth is related to difficulties in acquisition and "automatization" of articulatory skills, phonological processing skills, eye movement control, and motor skills. These deficits (except motor incoordination) lead to children's inability to learn how to read. In order to test the cerebellar deficit hypothesis, our laboratory has begun a research program focused on the relationship between cerebellar volume and cognitive functioning in children with and without dyslexia. To date, 40 children, ages 8–11, have been assessed with structural MRI and neuropsychological testing. Our findings will be reviewed, highlighting the relationships between group membership (children with and without dyslexia) and morphology of the cerebellar vermis and hemispheres. Differences amongst groups in the relationships between cerebellar volumes and various cognitive functions will be covered more extensively. Our conclusion on the validity of the cerebellar deficit hypothesis of dyslexia will be discussed in light of these findings.

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D. MOLFESE, A. FONARYOVA KEY, V. MOLFESE, S. KELLY, N. CUNNINGHAM, C. RUMAGE, S. TERRELL, & M. FERGUSON. Brain Response Differences Between Dyslexic, Average, and Advanced Readers.

Few event-related potential (ERP) studies compare brain responses of advanced readers with average and poor readers. Such studies, however,

are important in determining whether a continuum exists across different levels of reading skills. The present paper addresses this paucity of data by studying 3 groups of children between 9.25 and 12.1 years differing in reading levels: 8 *advanced readers* (4 females) reading 2 years above grade level, 9 *average readers* (5 females) reading at grade level, and 10 *poor readers* (5 females) reading 2 years below their grade level. The Slossen Reading Test assessed reading levels. High density array 128-electrode nets recorded ERPs to 3-letter consonant-vowel-consonant (CVC) word trigrams, pronounceable nonsense syllables, and misspelled words. ERPs were digitized at 4 ms intervals for 1.5 s. Following artifact rejection, baseline correction and averaging for each electrode site and condition, ERPs were submitted to amplitude/latency measurements and multivariate analysis procedures. P2 amplitude and latency discriminated between the 3 groups. Poor readers generated a large yet slow (latency = 300 ms) P2 response over the left hemisphere. Average readers produced a 50% smaller but earlier (latency = 275 ms) P2 while P2 amplitude in the Advanced Readers decreased again by 50%, occurring still earlier (220 ms). Interpretations suggest that advanced readers process reading information more efficiently than average and poor readers. The latter groups appear to devote more cortex and effort to decoding text material.

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R. TUNICK, R. BOADA, N. RAITANO, & B. PENNINGTON. Co-Familiarity of Speech and Reading Disorders.

There are indications that two disorders, dyslexia or reading disability (RD) and phonological disorder (PD), which involves disordered speech production, overlap at symptomatic, cognitive, and possibly genetic levels. The present study investigated the rates of both speech and reading disorders in the parents of 5–7-year-old children with and without PD. Eighty-three children with PD and twenty-seven controls were selected, and the 218 parents completed self-report speech and reading history questionnaires. Parents of children with PD self-reported significantly higher rates of PD history relative to parents of controls (27.5% vs. 10.0%; $p < .05$). Using a research-validated diagnostic cut-point on the Adult Reading History Questionnaire (ARHQ), 24% of parents of children with PD and 11.1% of the parents of controls were identified as having RD. These rates were significantly different ($p < .05$), supporting the co-familiarity of these disorders. Next, PD probands were subtyped according to the persistence of their articulatory deficit, and the presence or absence of symptoms of comorbid language impairment (LI). Relative to the parents of children with PD alone, parents of those with PD + LI exhibited higher rates of past symptoms of RD ($p < .05$), and parents of children with persistent PD + LI exhibited higher rates of symptoms of PD ($p < .05$). Several competing hypotheses regarding the etiology of this co-familiarity of PD and RD, including cross-assortment and co-transmission of these disorders, will be examined.

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N. RAITANO, R. TUNICK, R. BOADA, & B. PENNINGTON. The Relation Between Speech Disorder Symptomatology and Pre-Literacy Skills.

Over the past several decades, research has demonstrated a strong relationship between developmental dyslexia or reading disability (RD) and developmental speech/language disorders (DSLSDs). This research has demonstrated that children with RD have deficits in speech/language skills and children with DSLSDs have elevated rates of RD. Despite this research, the exact nature of the relationship between DSLSDs and RD remains unclear, partly because of the heterogeneity of DSLSDs. The current study examined how two dimensions of DSLSD symptomatology, the persistence of articulation difficulties and the presence of a language impairment (LI), relate to pre-literacy skills, including phonological awareness (PA), rapid serial naming (RSN), and letter knowledge (LETTER), in a sample of 5- to 6-year-old children with DSLSDs ($N = 73$). Results revealed a somewhat different pattern results for these dimensions of DSLD

symptomatology. Specifically, there was a main effect of persistence for PA tasks [$F(1,68) = 5.37, p < .05$], such that children with persistent articulation difficulties had lower PA scores. In contrast, there were main effects of LI status for all pre-literacy skills [PA: $F(1,68) = 8.96, p < .01$; RSN: $F(1,68) = 5.74, p < .01$; LETTER: $F(1,68) = 16.92, p < .001$], such that children with LI had lower scores on all pre-literacy tasks. These results suggest that the persistence of articulation difficulties and the presence of LI may have somewhat differential relations to pre-literacy and possibly literacy skills. These findings will be discussed within the context of research on the literacy outcome of children with DSLDs.

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C.R. MONTGOMERY, C.M. ZETTLER, R.D. MORRIS, R.A. SEVCIK, & M.G. CLARKSON. Auditory Processing in Children With Reading Disabilities: Temporal Order Judgments.

Previous research suggests that children with reading disabilities may have an auditory temporal processing deficit. To evaluate this possibility, fifty-eight 7- to 9-year-old children (34 diagnosed with a reading disability and 24 controls) were tested in an auditory localization task requiring echo suppression and temporal order judgments (TOJ's). Children diagnosed with a reading disability attained (1) an IQ > 70 and a reading-achievement scaled score of 85 or below, or (2) an IQ > 70 and a reading regression-corrected discrepancy 1 SE or greater of the estimate. On each trial, 14-ms duration clicks were presented at a rate of 1.5/s for up to 20 presentations from loudspeakers located 90° to either side of the child's midline. Clicks came from a single loudspeaker (SL) or from both loudspeakers (BL) with the sounds from one delayed relative to the other to assess echo suppression (5 or 10 ms), or TOJ's (200 or 400 ms). Other delays included 20, 50, and 100 ms. Ten trials for each stimulus condition were presented in random order. The child indicated the leading click's location (BL) or the single click's location (SL). Hierarchical regression analyses indicated that reading disability status did not predict performance at the 5-ms delay with all children suppressing echoes to localize the sound. Reading disability status did predict performance at the 400-ms delay with the children diagnosed with a reading disability performing more poorly than did control children suggesting that a TOJ deficit exists in children with reading disabilities.

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J. BREIER, J. FLETCHER, B. FOORMAN, & L. GRAY. Perceptual Maps of a Voice Onset Time Series in Children at Risk for Dyslexia.

Children (ages 5 to 6 years) determined to be at risk ($n = 25$) or not at risk ($n = 15$) for dyslexia using standard tests of phonological processing listened to tokens from a voice onset time (/ga-/ka/) or tone series played in a continuous unbroken rhythm. Changes between tokens occurred at random intervals and children were asked to press a button as soon as they detected a change. For phonemic stimuli, at-risk children were less sensitive to changes between tokens that crossed the phonetic boundary (>30 ms) than not-at-risk children [$F(1,38) = 13.26, p < .0008$], but not within the boundary ($p > .25$). Maps of group stimulus space for phonemes produced using multidimensional scaling of latencies indicated that at-risk children attended less to the phonological information available in the speech stimuli (x-axis) and more to subtle acoustic differences between phonetically similar stimuli (y-axis). There were no group differences in d' or perceptual maps for the control, tone series. Findings suggest a possible mechanism for deficits in phoneme perception observed in children with poor phonological processing skills.

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E. PARRISH & R. GRAVES. Visual and Auditory Localization, Attention and Perception in Developmental Dyslexics.

Previous research has examined the role of the visual magnocellular pathway and the visual dorsal stream in the visual deficits found in dyslexic

individuals. Auditory deficits in dyslexia have also been found. Dyslexia has also been associated with abnormal hemispheric specialization and with positive schizotypal traits. This study attempted to integrate these areas of research by examining these constructs within a set of subjects. The participants were 11 previously diagnosed dyslexic individuals and 20 control subjects, all of whom were undergraduate students. Participants completed a reading task, 2 schizotypy scales, a visual localization task and a dichotic listening task. The visual and auditory tasks were completed under both divided attention and left-directed attention instructions. Results showed that the dyslexic individuals had lower auditory detection sensitivity, lower ability to shift visual attention left when instructed, and higher positive schizotypal traits. A discussion of the theoretical implications of these results and the growing body of research regarding dyslexia is given.

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M.H. KOSMIDIS, V. FOLIA, C.H. VLAHOU, & G. KIOSSEOGLU. Semantic and Phonological Strategies in Illiteracy: A Dichotomous or Continuous Process?

Previous studies have proposed that the acquisition of literacy modifies the functional organization of the brain. Researchers have suggested that while illiterates have access only to semantic processing skills, those who have learned grapheme-phoneme correspondence have several mechanisms available to them through which to process oral language. We examined the putative dichotic nature of language processing, and the differences between literate and illiterate individuals in the cognitive strategies used to process oral language. We studied 19 illiterate women (zero years of schooling), 20 women with a basic education (1-9 years), and 19 women with more than a basic education (10-16 years). We administered semantic and phonological verbal fluency tests, a word/pseudoword repetition and judgment test, and a dichotic listening test (consisting of semantically and phonologically related, as well as unrelated, word pairs). While word production on semantic and phonological fluency increased with increased education, clustering strategies suggested that the ability to produce words was dichotomous in nature. Illiterate individuals repeated real words accurately, but mispronounced pseudowords to sound like real words. Finally, the most highly educated, and not the illiterate, group benefited the greatest from the semantic pairs on dichotic listening. Our findings suggested that semantic processing is continuous in nature and is augmented by increased education. Instead, conscious phonological processing appears to be dichotomous in nature and is improved through literacy, regardless of level of education. Therefore, differences in neuropsychological performance between literate and illiterate individuals may be confounded by factors other than language processing skills.

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E. MATUTE, T. MONTIEL, M. ROSSELLI, A. ARDILA, & D. ZARABOZO. Reading, Writing, Spelling and Phonemic Skills Across Ages in Spanish-Speaking Children.

It is well known that reading, writing, spelling and phonemic awareness acquisition are related to each other. Nonetheless, development may occur at different rates throughout childhood. In this study the effect of age on reading, writing, oral spelling, and phonemic skills across 5 age groups (6-7, 8-9, 10-11, 12-13, and 14-15 years) were analyzed. One hundred and eighty-two Mexican children (87 boys, 95 girls) were tested using 2 reading tasks (reading words and non-words), 2 writing tasks (writing to dictation words and non-words), oral spelling, 2 phonemic awareness tasks (phoneme blending and phoneme counting) and a phonemic perception task. A Kruskal-Wallis Test revealed a significant age effect over 3 tasks: word writing, phoneme blending, and oral spelling. Even though older participants performed better than younger groups, scores near to maximum are present in the younger group on reading and writing non-words tasks. Mann-Whitney *post-hoc* U tests revealed that accentuated changes

occurred for the phonemic blending test at ages 10–11 to 14–15, in the oral spelling task ages 10–11 to 12–13, and in the words-dictation writing between 10–11 and 14–15 years. Results show that reading words and non-words for Spanish speaking children is an easy task. However, performance on spelling and phonemic awareness tasks needs many years to be mastered. Results are consistent with previous research findings and demonstrated that it is easier to learn how to read than how to write in Spanish.

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T. MONTIEL, D. ZARABOZO, & E. MATUTE. Phonemic Awareness as Discriminant Tool of Spanish-Speaking Poor Readers.

Reading speed and misreadings are used to classify good or poor children readers. On the other hand, previous research has shown that achievement in phonemic tasks is related to early reading. The aim of this study was to identify good and poor readers using phonemic awareness tasks. Twenty-nine good readers (GR) and 27 poor readers (PR), Spanish-speaking 6th grade children, selected by their teacher and aged 10 to 11 years, were asked to read a short narrative (289 words). Results showed that the PR obtained significantly lower scores on reading speed ($t = -2.769, p < .008$) and misreadings ($t = 3.32, p < .002$). Also, we assessed children's performance in 6 phonemic tasks: phoneme deletion, word phonemic decoding, non-word phonemic decoding, phoneme substitution, word phonemic blending, non-word phonemic blending. A discriminant analysis shows that "word phonemic blending" and "phonemic substitution" classified 78.6% of children, whereas for the reading measures, "misreadings" classified 67.9% of children. These findings suggest that phonemic awareness skills are useful when assessing reading achievement of 6th grade Spanish-speaking children.

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GENDER DIFFERENCES ACROSS COGNITIVE DOMAINS

J.C. PENDERGRASS, R. ERWIN, T.J. ROSS H. GARAVAN, E.A. STEIN, & R.C. RISINGER. Gender-Related Differences in Amygdala Responses to Emotional Stimuli.

Animal, human lesion, and functional neuroimaging research has established that the amygdala has a central role in emotion. Though data have confirmed the involvement of the amygdala in processing negative, fearful stimuli, the amygdala's function in processing other types of affective stimuli, such as positive stimuli, remains unclear. Insufficient control of the arousal and valence qualities of stimuli and of the gender of subjects may explain mixed findings in previous studies. The present study examined gender differences in the subjective evaluation of and amygdala response to visual stimuli that varied in emotional content (positive vs. negative valence) and arousal level (high vs. low) in matched male and female volunteers who underwent functional magnetic resonance imaging. Overall, males rated the stimuli and, more specifically, highly arousing, positive stimuli as more arousing compared to females. Females rated the highly arousing stimuli as more negative compared to males. Highly arousing stimuli produced a greater amygdala response than low arousing stimuli in both males and females. Males demonstrated stronger amygdala responses overall, after collapsing across all 4 conditions, and to low arousing, negative stimuli compared to females. There were no laterality effects. The results of the present study suggest that the perceived arousal level of affective stimuli may mediate amygdala response and that gender differences in amygdala response may be mediated by gender differences in subjective evaluations of the affective stimuli. The present study highlights the importance of including gender as a potential influence in subjective evaluations of and amygdala response to affective stimuli.

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D. KATZ & D.A. YURGELUN-TODD. Gender Differences in Memory for Emotionally Laden Words in a Negative Story.

Evidence from neuropsychological and neuroimaging research has suggested gender differences in cerebral lateralization of higher cognitive functions as well as emotional responsiveness. The neuropsychological examination of emotional memory as a memory measure is relatively new. No research to date has investigated neuropsychological aspects of emotional memory in women and men. The present study investigated recall of neutral and emotional information using a newly developed test of emotional memory. Fifty healthy women (25 young and 25 elderly), and 45 healthy men (25 young and 20 elderly) were administered the Emotional Memory Test (EMT) and the Symptom Checklist-90-Revised (SCL-90-R). The EMT included two stories (negative and positive). Three scores were calculated for each story: neutral content, emotional behavior (e.g., scream), and emotional word content (e.g., frightened). ANOVAs were calculated and a Bonferroni correction was done to control for multiple comparisons. A significant difference by gender group and emotional word content score for the negative emotional story was found ($p = .007$). A significant interaction effect of all independent variables (age, gender, and emotional distress) and the emotional word content score of the negative story ($p = .004$) was found. Females scored significantly higher than males, the younger group scored significantly higher than the older group, and the participants with low emotional distress scored higher than those with higher emotional distress. Similar analyses did not produce significant results for the positive story. Findings suggest that gender differences in emotional processing may influence memory of negatively emotionally laden material as well as emotional responsiveness.

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K. MORDECAI & P. MAKI. Sex Differences in Implicit and Explicit Verbal Memory.

Estrogen is known to exert effects on sexually dimorphic cognitive tasks. In a previous study, we found that conceptual implicit memory (CIM) was enhanced during the high estrogen phase of the menstrual cycle. Given this finding, we investigated the possible sex differences in CIM within the context of our longitudinal study of IM. Seventy-three Baltimore Longitudinal Study of Aging participants (44 men and 29 women) were tested twice approximately 7.9 years apart (Time 2 age range = 29–89 years). IM tasks included perceptual skill learning (identification of newly presented fragmented objects), perceptual priming (faster identification of repeated objects relative to new ones), and conceptual priming (above-chance generation of previously studied, uncommon category exemplars in response to a category cue). A verbal recall task measured explicit memory. We hypothesized that women would perform better on verbal tasks (CIM, verbal recall, verbal fluency tasks) and men would perform better on perceptual tasks (Hidden Patterns Test). Women performed better on both CIM and verbal recall at Time 1 and Time 2 ($p < .05$), and on letter fluency at Time 2 ($p < .05$). There were no sex differences among other tasks. Verbal recall and CIM were correlated for women at Time 2 ($r = .43$). Both letter and rhyme fluency correlated with CIM ($r = .39$ and $.37$, respectively) for women only. Findings suggest that females have an advantage in accessing verbal representations in memory that extends to CIM.

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F. GOULD, J.L. WOODARD, S.T. GRAFTON, J.R. VOTAW, R.C. GREEN, M.E. DOBRASKI, K.D. SHANNON, & J.M. HOFFMAN. Gender Differences in PET Activation in Healthy Older Adults on a Working Memory Task.

This study explored functional neuroanatomical differences between eight healthy older men and women on a working memory task using PET imaging of cerebral blood flow. Participants performed within normal limits on a battery of neuropsychological measures and were negative for

the apolipoprotein E $\epsilon 4$ allele. The participants ranged from 56 to 82 years of age. During the rehearsal conditions, individual list words from either a 5- or 10-word list were presented at the rate of 4 s per word on a computer monitor. As each word was presented, participants were asked to rehearse the word on the screen aloud, in addition to other words that were previously presented. In the reading (control) condition, participants were asked to repeatedly read the word on the screen aloud without rehearsing previously presented words. Regional cerebral blood flow images were acquired using a modified autoradiographic method. The images were then realigned, normalized, and smoothed using SPM99 before being subjected to pixel-by-pixel statistical analysis. Both men and women displayed greater activation of bilateral dorsolateral prefrontal cortex and bilateral premotor cortex during the memory conditions *versus* the reading condition, consistent with prior imaging studies of working memory. However, women displayed greater activation in anterior cingulate gyrus while men displayed greater activation in cerebellum bilaterally, possibly reflecting different attentional networks engaged during the task. Future research may serve to establish the neurobiological substrates of attention and memory that differ between the sexes.

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C. FRANCE, J. STEWART, L. FOX, S. CLOUSE, J. FRANCE, & J. SUHR. Pulsatile Changes in Blood Pressure Are Related to Performance on Simple Cognitive Tests.

Previous research has shown that baroreceptor stimulation is associated with inhibition of somatosensory pathways, reduced cortical excitability, and impaired psychomotor speed. The present study examined the relationship between endogenous baroreceptor stimulation, as indexed by blood pressure pulse amplitude, and performance on simple cognitive tests. Forty-three healthy young adults completed computerized tests of simple reaction time (SRT), judgment of line orientation (JLO), facial recognition (FR), and mental reorientation (MR). A Finapres 2300 finger arterial pressure monitor was used to obtain continuous blood pressure readings throughout the protocol. Mean pulse pressure amplitude was computed by calculating the difference between systolic and diastolic blood pressure for each heartbeat. For each test, the relationship between mean pulse pressure and performance time was positive for women (SRT = .41; JLO = .28; FR = .29; MR = .46) and negative for men (SRT = -.34; JLO = -.45; FR = -.36; MR = -.29). A comparison of these correlational relationships revealed significant or marginally significant sex differences for SRT ($z = 2.19, p < .05$), JLO ($z = 2.15, p < .05$), MR ($z = 2.21, p < .05$), and FR ($z = 1.87, p = .06$). These results suggest that higher pulse pressure was associated with poorer performance on each of these tests for women and better performance for men. These findings provide novel evidence that endogenous baroreceptor stimulation may be associated with differential effects on central nervous system activity in women *versus* men.

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B. CHOLERTON, L.D. BAKER, G.S. WATSON, M. REGER, C.W. WILKINSON, S. ASTHANA, S. PLYMATE, C. HALE, & S. CRAFT. Cortisol, Somatostatin, and Cognition: Sex Differences in Healthy Older Adults.

Sex differences in the hypothalamic–pituitary–adrenal system have been widely reported in both animal and human models, although the pattern in humans remains unclear. Equally tentative is the current understanding of glucocorticoid actions in the aging central nervous system, which have been reported to both enhance and reduce performance on cognitive tasks. To evaluate the effects of cortisol on cognition, we administered two conditions, cortisol (0.12 mg/kg/h) or saline, on separate days to 18 healthy older men and women. Results suggest a significant interaction effect for delayed verbal memory, such that recall was suppressed in females but enhanced in males after receiving cortisol ($p < .05$). Conversely, cortisol improved time to complete a task of simple attention in

females only, while both males and females demonstrated fewer errors on a task of visual working memory (p values $< .05$). These findings provide further support for sex differences in response to cortisol administration, and suggest that acute cortisol may differentially affect various aspects of cognition. A number of potential mechanisms may be responsible for these results. Cortisol is reported to augment the release of the neuropeptide somatostatin, an effect that may be dependent upon gender. We have previously shown that somatostatin can improve recall; thus the observed enhanced recall noted with cortisol infusion for males may be in part due to increased somatostatin levels. To further explore potential sex differences, we are currently investigating the effects of somatostatin infusion on healthy older men and women, and these results will also be reported. Correspondence: Brenna Cholerton, 16820 121st Avenue Court East, Puyallup, WA 98374. E-mail: bchol@u.washington.edu

M. HIRT, K. MATHEWS, & M. GEISLER. Gender Differences in Children's EEG Activity in a Music-Related Learning Task.

The purpose of this study was to differentiate learning abilities in a music-related learning task between boys and girls using frontal brainwave activity and behavioral responses. These children were defined as being between 8 and 16 years of age ($M = 12.5$ years of age, $SD = 1.70$). Equal numbers of boys and girls participated in both *music* and *no music* trials. Each trial involved two conditions. The first condition involved learning a beat (steady .75 beats/s) and the second condition involved learning a rhythm (variable .25–1 beats/s). The behavioral response was a button press along to the beat or rhythm while seated in front of a computer screen that presented corresponding visual cues to the beat and rhythm. Behavioral responses and frontal electroencephalographic (EEG) activity were recorded during all trials. Ten seconds of raw EEG activity were quantified in order to yield Alpha power (8–13 Hz). Alpha power is often indicative of level of concentration, such that low alpha power indicates high level concentration. Preliminary analysis of the frontal EEG activity from the left and right hemispheres revealed that boys had higher alpha activity compared to girls across most tasks. Behavioral data corroborated these effects showing that the boys had more incorrect responses than the girls on most tasks. These results suggest that boys had lower levels of concentration on most tasks when compared to girls. These electrophysiological and behavioral data support previous findings on gender differences in concentration levels.

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D. HIGGINS & D. HARRISON. Interaction of Sex and Hostility on Verbal Fluency Performance.

One hundred twenty-six right-handed undergraduate men ($N = 63$) and women ($N = 63$) were classified, using the Cook-Medley Hostility Inventory, into 6 groups of 21 (high-, mid-, and low-hostile) and administered a verbal fluency task (a modified COWAT). Group and sex differences were predicted for this executive language task. Hostility has traditionally been linked to a system of right frontal regulation of right temporal areas, and men usually report higher levels of hostility than women. Verbal fluency, both letter and category, is produced more exclusively by left than right frontal areas. However, recent research suggests that left frontal lobe patients tend to generate unusual word profiles (diversification thought to be mediated by preserved right frontal lobe functioning); whereas, right frontal lobe patients tend to generate highly typical word profiles (responses thought to be constrained by preserved left frontal lobe functioning). Data were analyzed for overall sex and group effects. No main effects of sex or group were found for verbal fluency scores. However, a Sex \times Group interaction effect was found for Trial 1 of verbal fluency [$F(2, 120) = 3.82, p < .0247$]. Men classifying themselves as more hostile performed better on the first trial of the verbal fluency test compared to men classifying themselves as less hostile, while women classifying themselves as more hostile performed worse on the 1st trial of the verbal fluency test, compared to women classifying themselves as less hostile. Reasons for this finding, that hostile men and women performed in opposite ways on

this task, are discussed in terms of sex differences in dynamic functional cerebral laterality.

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D. HIGGINS & D. HARRISON. Sex Differences in Verbal and Figural Perseveration Across Trials.

One hundred twenty-six right-handed undergraduate men ($N = 63$) and women ($N = 63$) were administered a verbal (COWAT) and figural (RFFT) fluency task. Sex differences were predicted in perseveration on these executive tasks, as sex differences in frontal systems are more directly related to higher cortical/executive functions. Verbal fluency is produced more exclusively by left than right frontal areas, while figural fluency is produced more by right than left frontal areas. However, perseveration on these tasks is thought to be mediated more by right than left frontal systems. An analysis of verbal perseveration scores (repeated words: words generated) found no main effects of sex or trial; however, a Sex \times Trial interaction effect was found [$F(2,240) = 3.19, p < .0429$]. Men perseverated more on repeated trials of the verbal fluency test, while women perseverated less on repeated trials; i.e., in men, sequent trials produced more perseverative errors; however, in women, the same produced less perseverative errors. An analysis of figural perseveration scores (repeated designs: unique designs) found a main effect of trial [$F(2,240) = 5.81, p < .0034$], wherein Trial 3 ($M = 6.7\%$) was significantly different from Trials 1 and 2 ($M = 3.8\%$ and 4.0% , respectively). No other main effects or interactions were found. In addition, a main effect of task was found, as both men and women perseverated more on the figural fluency task than the verbal fluency task. This finding is framed in arousal theory, with both priming and interference effects discussed, including sex differences in the dynamic interplay of frontal systems.

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K. CHIPMAN & E. HAMPSON. Rapid Production of Novel Gestures: Further Support for a Female Advantage in Motor Selection.

Research on ideomotor apraxia has suggested that sex differences may exist in the neuroanatomical organization and function of the limb praxis system. Until recently, no study had systematically tested for a corresponding sex difference in *normal* praxic function. To address this issue, Chipman and Hampson compared healthy men and women on a timed gesture sequencing task modeled after those used in apraxia research. Women passed the task at significantly faster speeds than men, consistent with a female advantage in rapid movement selection. However, several "non-praxic" factors were not controlled that may have contributed to speeded performance on the task. The present study determined more precisely the source of the female advantage. Normal participants were taught to perform nine novel hand and arm postures in response to computer-generated color cues. Following acquisition, the cues were presented in randomized sequences at progressively faster speeds. As expected, women achieved a significantly faster mean speed than did men. Analyses of covariance showed that this finding could *not* be accounted for by speed of motor execution, color detection, color discrimination, or associative retrieval. The most parsimonious explanation for the female advantage seems to be that women are faster than men at selecting the motor programs. These findings provide the clearest evidence to date for a sex difference in normal praxic function and are consistent with patient reports of a more anteriorly organized praxis system in women.

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L. SYKES TOTTENHAM, L. ELIAS, & D. SAUCIER. Males Outperform Females on Targeting in Both Intrapersonal and Extrapersonal Space.

Males excel at motor tasks directed to extrapersonal space (more than 5 feet from the body), such as extrapersonal targeting with a ball. Conversely, females excel at motor tasks directed to intrapersonal space (within

arm's reach of the body), such as performance on the Purdue Pegboard—a fine motor task in which pegs must be placed into holes. This study examined whether the male advantage for targeting in extrapersonal space would be observed in 2 novel tasks requiring targeting in intrapersonal space. Eighteen males and 20 females, all right handed, performed the following tasks: extrapersonal targeting with a ball, extrapersonal targeting with a laser, intrapersonal targeting with a laser, intrapersonal computerized targeting, and the Purdue Pegboard. In all instances, performance with the right hand outperformed the left hand. As predicted, males significantly outperformed females on extrapersonal targeting with a ball [$F(1,36) = 3.620, p = .035$], and females significantly outperformed males on the Purdue Pegboard [$F(1,36) = 19.980, p < .001$]. The intrapersonal and extrapersonal laser targeting tasks also exhibited a significant male advantage [$F(1,36) = 5.646, p = .023$; and $F(1,36) = 9.055, p = .005$, respectively]. Finally the computerized targeting task exhibited a significant Sex \times Hand interaction [$F(1,36) = 6.241, p = .017$]. *Post-hocs* (Tukey's) of the interaction indicated that the only significant difference was a simple main effect of sex favoring males for computerized targeting with the left hand. Collectively, these results suggest that males are superior at targeting, regardless of the type of space in which the task is performed.

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C.A. PIERCE & M. MENNEMEIER. Age and Gender Effects on Attentional Bias and Estimation Error Indexed by the Crossover Effect.

The crossover effect is a phenomenon in which subjects perceive the center of short lines to be on 1 side of true center and the center of long lines to be on the other. This effect can be understood as a function of directional biases in attention and systematic errors in magnitude estimation. This study investigated the effects of age, gender, and menstrual cycle on attentional bias and magnitude estimation, using the crossover effect as a model. Fifty-eight normal subjects participated in the study: 15 elderly males, 15 elderly females, 15 young males, and 13 young females. Subjects participated in a standard line bisection task and line bisection tasks with left and right cues; each task encompassing 10 different line lengths. The results indicated that all subjects, regardless of age or gender, exhibited a rightward bias in attention. Consequently, the theory of differential age-related right hemisphere decline was not supported. There was no effect of menstrual phase in young females. Differences in magnitude estimation were observed across gender and age. Males showed a more consistent pattern of magnitude estimation errors than females regardless of age. Specifically, whereas men overestimate the shortest lines and underestimate the longest, women only overestimate the shortest lines. The effect of gender on magnitude estimation might reflect an influence of testosterone on lateralized brain function. Young men were the most consistent in both attentional orientation and bias in magnitude estimation (i.e., the crossover effect), whereas older men were less consistent and women were inconsistent.

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T.D. PARSONS, A. RIZZO, J. MCGEE, & J.G. BUCKWALTER. Gender Differences and Cross-Uncrossed Differences in a Virtual Environment.

Introduction: Gender differences and hemispheric differences in visuospatial processing is a widely studied, and controversial, topic. Some studies suggest that women have a greater degree of bilateral processing for spatial tasks, perhaps using left hemisphere processing to solve both verbal and nonverbal tasks. Contrariwise, men may have more specialized hemispheric lateralization. The lateralization theories would then suggest that men might solve a visuospatial task using mainly right hemisphere processing, whereas women would employ a more bilateral approach using the left hemisphere as well. The purpose of this study was to compare performance of males and females on a cross-uncrossed difference task

(CUD), which measures the differences in reaction time between responses that must be transferred across the corpus callosum *versus* responses that are not transferred. *Method:* Thirty individuals between the ages of 64 and 86 (M age = 73.6; M years education = 15.4%; % women = 50) participated in a study designed to validate a new test of spatial ability administered in virtual reality. As part of this project a CUD was administered. The difference between males and females in reaction time between 2 crossed and 2 uncrossed conditions, as well as IHTT were not significant. *Conclusions:* Current results suggest that men may not solve a visuospatial task using mainly right hemisphere processing. Further, women may not employ a more bilateral approach using both the right and left hemispheres.

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S.H. OFTE & K. HUGDAHL. Right–Left Discrimination: Effects of Sex and Age.

Right–left discrimination involves visuospatial abilities, language functions, integration of stimuli, and requires an understanding of the relativistic aspect of right–left discrimination. Females tend to perform better on verbal tasks than males, thus it was hypothesized that females would perform better than males on a verbal right–left discrimination test. Even though theories on right–left discrimination states that the ability is fully developed from the age of 11–12 years, recent research indicates that the ability has a different life span development. It was therefore hypothesized that the younger subjects would perform better than the older. A verbal version of a right–left discrimination test was used. The test consisted of logical deduction tasks, with 2 premises and 1 conclusion. *Example:* Peter is standing to the right of me, facing the same way. Left of me is a car. *It's to the right of Peter.* The subjects' task was to evaluate whether the stated conclusion was correct or false. The sample consisted of 62 subjects. The results showed that males solved more items correctly than females. The younger females solved more items correctly than older females. There was no difference between the younger and older males for correct scores. There was no difference between the error scores for any of the groups. All groups solved more items correctly than incorrectly, except for the older females, for whom there were no difference between correctly and erroneously solved items. The results are discussed in relation to theories on right–left discrimination, lateralization, and cognitive processing.

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MILD COGNITIVE IMPAIRMENT

R.C. PETERSEN, G.E. SMITH, R.J. IVNIK, J.E. PARISI, & D.W. DICKSON. Neuropathological Heterogeneity of Mild Cognitive Impairment.

A great deal of research has been conducted in recent years on the topic of mild cognitive impairment (MCI), and while there is agreement on many of the clinical features of subjects with MCI, there is no consensus regarding the underlying neuropsychological substrate for these subjects. We evaluated 15 subjects (10 women, 5 men) from the Mayo Alzheimer's Disease Research Center/Alzheimer's Disease Patient Registry who died while their clinical classification was MCI. The mean age of these subjects was 89 years and their mean Mini-Mental State Exam score was 26 with a Dementia Rating Scale of 126. Autopsies were performed in the Neuropathology Core of the Alzheimer's Disease Research Center and the cases were characterized according to the following criteria: NIA/Reagan criteria for the likelihood of Alzheimer's disease (AD): *high 1, intermediate 3, and low 11*. When CERAD neuropathological criteria were used, 3 had probable AD, 3 had possible AD and 9 had insufficient criteria to diagnose as AD. Taken together, these data indicated that only a few (3) cases met neuropathological criteria for AD while an additional 3 were felt to repre-

sent pathological aging with frequent neurofibrillary tangles but only diffuse amyloid deposition in the neocortex. Additional neuropathological conditions included argyrophilic grains and hippocampal sclerosis. From these data, we concluded that all subjects with the clinical diagnosis of MCI had some pathology of medial temporal lobe structures accounting for their memory deficit but only a minority fulfilled criteria for AD at that time of the clinical diagnosis of MCI.

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A. NORDLUND, M. SJÖGREN, P. HELLSTRÖM, & A. WALLIN. The Goteborg MCI Study: Neuropsychological Assessment.

The objective of the Goteborg MCI study is to investigate the predictive value of various neuropsychological, biochemical and brain imaging parameters for the development of dementia, such as Alzheimer's disease (AD) and vascular dementia (VaD), in patients with clinically defined (CDR = .5, GDS = 2–3) mild cognitive impairment, i.e., before dementia can clearly be diagnosed. At present 225 subjects have been enrolled and 175 patients (cognitive impairment without dementia 60%, mild AD 20%, mild VaD 15%, other 5%) have been included in the study, together with 40 healthy controls. In the neuropsychological part of the study a well balanced battery of tests, considered to be sensitive for cognitive change, is administered. The battery measures various aspects of function within each cognitive domain: it comprises both verbal and nonverbal tests of *episodic memory and learning*, several tests of *speed and attention*, tests of aspects of *visual spatial function*, a battery of language tests and several tests of *executive function*. A few instruments, e.g., Benton's Judgment of Line Orientation, a tactile perception test and a test of perception of emotion, were omitted due to ceiling effects. The importance, in this population, of examining various aspects of cognition, is illustrated by the preliminary results, indicating a large variation of performance within the visual spatial (perception, organization, construction) and executive (judgment, divided attention, planning) domains.

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I. REINVANG, L. GJERSTAD, B. STANDNES, A.K. SOLBAKK. Neuropsychological Profiles in MCI Patients With Different Genetic Risk Factors.

Mild cognitive impairment (MCI) is a significant neuropsychological risk factor for dementia. MCI is usually defined by selective memory impairment, but Petersen et al. speculate that there are several cognitive subtypes of MCI, related to different etiological factors and with different implications for prognosis. Carriers of the apolipoprotein E $\epsilon 4$ allele have increased risk for AD. The incidence of one or more $\epsilon 4$ alleles in the general population is 14%. We test the hypothesis that carriers of $\epsilon 4$ alleles are overrepresented in middle aged persons seeking assessment for cognitive impairment, and that they have a different profile of cognitive impairment from non-carriers. Patients ($N = 53$) are admitted to an ongoing study if they have no known dementia or serious disease, and age between 50 and 75. The study includes neuropsychological testing (expanded CERAD protocol), genetic testing for ApoE, MRI scanning and informant interview (CERAD-BRSD). Patients with MMSE score of 25 or higher are included as MCIs in this study. We identified 27 MCI cases, and found that 13 (48%) had 1 or more ApoE $\epsilon 4$ alleles, supporting our first hypothesis. The genetic groups ($\epsilon 4+$ and $\epsilon 4-$) did not differ in age (61 years) or in mean MMSE score. We found no differences between genetic groups in test performance for fluency (animal, FAS), memory (CVLT, Rey figure), attention (TMT, Stroop), vocabulary or matrices. Neuropsychological test profiles identified 7 persons with an amnesic type of MCI and 5 of them (71%) had 1 or more $\epsilon 4$ alleles.

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R. ZEC & G. PYO. A Case Study of the Transition From Normal Memory and Cognition to MCI to DAT.

We administered a comprehensive cognitive test battery for dementia on a yearly basis over a 7-year period to a woman who transitioned from clearly intact memory and cognition to mild cognitive impairment of the amnesic type to very early dementia of the Alzheimer type. The woman was 74 years old at the first evaluation and 80 years old at the most recent assessment. She has 18 years of education. The test battery includes the extended Alzheimer Disease Assessment Scale, MMSE, a detailed orientation test, RAVLT, Rey-Osterrieth CFT with memory trials, a story recall test, WAIS-R similarities, block design, picture completion, and symbol digit, HVOT, Raven's Colored Matrices, Stroop test, Trails A and B, phonemic word fluency, semantic word fluency, alternating word fluency, Boston Naming Test, and the Beck Depression Inventory. The patient displayed average or better memory and cognition on all test measures using age norms at her first assessment at age 74. She subsequently displayed a gradually progressive decline on measures of episodic memory over the next 7 years beginning with small declines on sensitive memory measures (e.g., 30 min delayed recall on the RAVLT) and culminating in severe impairment in episodic memory by age 78. During this long period of memory decline, there has been no decline on the vast majority of the non-memory measures. This case demonstrates that impairment in episodic memory in DAT begins insidiously and progresses gradually and that the progressive memory decline can occur over many years before there is impairment in non-memory cognitive functions.

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J. TSCHANZ, K.A. WELSH-BOHMER, M. NORTON, C. CORCORAN, & J. BREITNER. Progression to Dementia in Diverse Types of Mild Cognitive Impairments of Aging.

Background: Elderly individuals with mild symptoms of cognitive impairment are at increased risk for dementia. Identifying risk factors that predict progression to dementia is therefore a priority. We examined this issue in an elderly population of varying risk. **Methods:** In 4,475 individuals, categorized into baseline risk groups of probable Prodromal AD (mild ambiguous AD—"MA"), cognitive impairment from other causes (Other Cognitive Impairment—"OCI"—e.g., stroke, psychiatric disorders), and Non-Case ("NC"), we compared 3-year conversion rates to dementia and the influence of genetic and environmental factors. **Results:** Conversion rates to dementia for MA and OCI were 42.5% and 35.4%, respectively (cf. 3.4% for NC). Hierarchical logistic regression models showed that baseline cognitive score (OR = .817, $p < .001$), three-year decline (OR = 1.32, $p < .001$), and self-perception of memory (OR = 1.45, $p = .008$) increased later dementia risk. Interestingly, *APOE* genotype interacted with risk group such that OCI individuals with an E4 allele were at increased risk (OR = 4.36, $p < .021$) vs. those without the allele. *APOE* genotype had no differential effect in the other risk groups. These findings, as well as the increased risk associated with older age (OR = 1.11, $p < .001$), were eliminated when memory rating and cognitive scores were entered. Neither family history of dementia/AD, nor worsening ADLs/IADLs independently increased dementia risk. **Conclusions:** Elderly individuals with cognitive impairment (self-report or testing) regardless of etiology are at increased risk for dementia. *APOE* genotype may further identify at-risk individuals with impairments from various causes.

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F.W. UNVERZAGT, S. GAO, K.A. LANE, B.S. MUSICK, S.L. HUI, K.S. HALL, & H.C. HENDRIE. Incidence of Cognitive Impairment No Dementia: Data From the Indianapolis Study of Health and Aging.

Background: Cognitive impairment no dementia (CIND) is a heterogeneous condition with variable clinical outcome. It is up to 5 times more prevalent than dementia; however, population-based incidence rates are unknown. **Method:** The Indianapolis Study of Health and Aging is a lon-

gitudinal, population-based study of African Americans, aged 65 and older, who were seen for baseline survey and 2- and 5-year follow-up. Each assessment used a 2-stage design with in-home screening followed by full diagnostic evaluation of a subsample of participants based on screening performance with sampling for false negatives. **Results:** The inception cohort numbered 2212 persons. A total of 1698 participants completed the follow-up (144 were demented or CIND at baseline, 217 died before follow-up, and 153 were lost to follow-up). The group completing follow-up averaged 73.3 ± 6.7 years of age and 9.9 ± 6.7 years of education. There were 26 incident cases of CIND at 2-years and 62 incident cases at 5-year follow-up. The age-standardized annual incidence rates were: 3.39% (95% confidence interval [CI] 1.05, 5.72) for age 65–74, 6.11% (95% CI 3.76, 8.45) for age 75–84, and 9.12% (95% CI 4.82, 13.42) for age 85 and older. **Conclusions:** Among elderly African Americans, the incidence rate of CIND increases with increasing age. This rate is higher than published incidence rates for Alzheimer disease (especially in the 65–74 and 75–84 age groups). The rate increase over Alzheimer disease is likely due to the presence of multiple causes and variable clinical outcomes in CIND.

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L. LACRITZ, D. GONZALEZ, A. LIPTON, R. ROSENBERG, K. MARTIN-COOK, L. HYNAN, F. BONTE, & M. CULLUM. A Nonverbal Subtype of Mild Cognitive Impairment.

Current criteria for mild cognitive impairment (MCI) require subjective memory complaints and objective memory deficits in individuals who do not meet criteria for dementia. As a greater emphasis is often placed on verbal memory assessment in dementia, individuals who present with primary nonverbal memory problems may be overlooked. This study examined verbal and nonverbal test results of 76 patients evaluated through the Alzheimer's Disease Center who presented with memory complaints, but were not diagnosed with dementia or any other neurological or psychiatric condition. Subjects were classified as having nonverbal or verbal MCI if they met general MCI criteria and demonstrated asymmetric memory scores (>1 SD discrepancy between scores on comparable verbal and nonverbal tests, with either verbal or nonverbal memory scores being average and the other being impaired). Forty-seven (62%) of the initial 76 subjects met general MCI criteria, and of these, 23% ($n = 11$) met criteria for nonverbal MCI. By comparison, only 4% ($n = 2$) met criteria for Verbal MCI, and the remaining 72% were characterized as mixed MCI, with more global memory deficits. These data provide support for the heterogeneity of MCI, and suggest the existence of a nonverbal subtype requiring further study and definition.

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S. MACDONALD, D. GARRETT, D. HULTSCH, & R. DIXON. Is Intraindividual Variability Associated With Mild Cognitive Impairment?

Intraindividual variability refers to transient within-person inconsistency in performance. Several underlying factors have been hypothesized to influence inconsistency, including atrophy of CNS functioning. That inconsistency may be a behavioral indicator of neural integrity is supported by recent findings linking increased inconsistency to probable Alzheimer's (AD) disease. The present study extended these results by examining whether older adults classified with cognitive impairment but no dementia (CIND) also exhibited increased performance inconsistency relative to those not cognitively impaired (NCI). We used 6-year data (3 waves) from the Victoria Longitudinal Study ($N = 446$, Wave 1 age = 54–89). Individuals classified as CIND ($N = 109$, $M_{MMSE} = 27.7$) were between 1 and 2 standard deviations below their group mean in episodic memory performance, whereas NCI individuals ($N = 337$, $M_{MMSE} = 28.7$) scored normally. To index inconsistency, intraindividual standard deviations (ISDs) were calculated across reaction time (RT) trials for 4 cognitive measures. Results indicated greater inconsistency for the CIND group

on 3 of 4 RT measures: choice RT (CRT: $M_{ISD} = 6.88$ vs. 6.36), lexical decision (LEX: $M_{ISD} = 7.91$ vs. 6.91), and semantic verification (SEM: $M_{ISD} = 7.84$ vs. 6.86). Significant Status \times Age interactions for LEX and SEM demonstrated that these group differences were magnified with increasing age. Theoretically, CIND may fall on a continuum between healthy aging and dementia. Presently, we are examining 6-year change in inconsistency in relation to CIND status. We expect the CIND group to exhibit increased inconsistency across longitudinal waves. We discuss implications for inconsistency as a predictor of impairment, aging decline, and impending dementia.

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T. LENTZ, E. STRAUSS, D. HULTSCH, & M. HUNTER. Intraindividual Variability and Severity of Cognitive Impairment.

Older adults and individuals with compromised neurological systems, due to disorders such as Alzheimer's, Parkinson's or traumatic brain injury, show greater short-term inconsistency on cognitive tasks in comparison to younger adults and healthy controls. Such inconsistency is thought to reflect irregularities in neurobiological systems due to aging, trauma or disease. The present study investigated whether intraindividual inconsistency is related to the severity of cognitive impairment in community dwelling older adults. Healthy volunteers ($N = 91$) with no evidence of dementia were administered 5 benchmark cognitive tasks and these results were used to create 3 groups; healthy adults, adults down 1.0+ SD on one task and adults down 1.0+ SD on 2 or 3 tasks. Participants were tested over 5 biweekly sessions on a battery that included 3 reaction time tasks: simple reaction time task (SRT), choice reaction time task (CRT) and 1-back choice reaction time task (CRTB). The findings indicate that (1) severity of cognitive impairment was positively related to degree of inconsistency: individuals with more extensive cognitive impairment were more variable on the RT tasks than those with mild cognitive impairment and individuals with mild cognitive impairment were more variable than healthy controls; and (2) the complexity of the task was positively related to the degree of inconsistency: greater inconsistency was found for all groups on the CRT tasks than on the SRT task. These results suggest that any irregularity, even mild, in the neurological system increases the amount of variability in cognitive functioning.

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C.C. PERSAD, B. GIORDANI, N.A. ALEXANDER, J. ASHTON-MILLER, K. GUIRE, & J. KEMP. Cognition and Motor Performance in Healthy Old and Cognitively Impaired Subjects.

To look at the effects of increasing cognitive demands on mobility performance in both healthy and cognitively impaired older adults, a walking version of the Trail-Making Test was developed. In this task, participants were asked to walk along pathways of instrumented markers that showed either numbers (as in Trails A) or numbers and letters (as in Trails B) amongst other distracters. Subjects were required to walk along the pathways by stepping on the numbers and/or letters in order, just as done in the standard Trails task. Time to complete the task was recorded. In addition, all participants were administered a short battery of neuropsychological tests. To date, 7 healthy older adults and 7 cognitively impaired with diagnoses of Mild Cognitive Impairment have been tested. Results demonstrated that overall the cognitively impaired group had more difficulty on the Trails B version of the walking trails task in comparison to the healthy group. In addition, several neuropsychological measures were significantly correlated with performance in both groups of individuals. Measures of both spatial and visual memory as well as performance on the paper-and-pencil version of trails were significantly associated with performance on both versions of the Walking Trails task (range of Spearman $r_s = .72$ – $.96$). In addition, simple attention was an important variable for the healthy old but not the cognitively impaired group. Consistent with

earlier findings by our lab, these results demonstrate the importance of cognitive functioning to successful mobility performance.

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J. HOLDNACK. Mild Cognitive Impairment and the WMS–III: Identification and Implications.

Research studies indicate that a substantial number of older adults suffer from symptoms of cognitive impairment (MCI: Mild Cognitive Impairment), particularly memory impairment, yet do not meet criteria for a diagnosis of dementia. Diagnostic standards and procedures for identifying cases of MCI continue to evolve and some guidelines have been established for clinicians working with geriatric patients. Data collection for the WMS–III began prior to establishment of criteria for identifying individuals with MCI and exclusionary criteria necessarily required a diagnosis of a dementia. This study examines the WMS–III standardization data to identify markers of cognitive impairment and possible MCI among subjects aged 65–89. Several markers suggestive of a functional impairment in delayed memory, orientation and general cognitive status were developed in analyzing statistically rare findings (1% or less of cases) among healthy young and middle-aged adults. Four models were compared with each model identifying 94% of the Alzheimer's and 90% of the Korsakoff's patients collected as part of the WMS–III validity studies. The least complex model identified cases of functional impairment in 1% of 65–69-year-olds and increasing by age to 26.6% for ages 85–89. The most complex model identified functional impairment in 4% of 65–69-year-olds increasing by age to 42.7% for ages 85–89. Additional data and recommendations for applying these results in clinical practice and test standardization are discussed.

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M.E. O'CONNELL & H. TUOKKO. A Comparison of the 3MS and MMSE in Detecting Cognitive Decline Over 5 Years.

Screening measures sensitive to cognitive decline are important for identifying older adults who require neuropsychological assessment. Data from the Canadian Study of Health and Aging (CSHA) were used to compare Modified Mini-Mental State Exam (3MS) and Mini-Mental State Exam (MMSE) scores for detecting cognitive decline in normal older adults over a 5-year period. Of the 580 English-speaking older adults who had undergone neuropsychological assessments at CSHA-1 and CSHA-2, a subsample of 258 participants who were diagnosed with no cognitive impairment (NCI) at CSHA-1 was selected. Reliable change scores for the 3MS and MMSE that account for practice effects were computed for each participant, using reliability data provided. The sensitivity and specificity of the 3MS and MMSE reliable change scores for discriminating between participants who did and did not show cognitive decline at CSHA-2 were compared using area under the curve (AUC) analyses and a modified z test that accounted for correlation between the scores. Results indicated that changes in 3MS and MMSE scores were equally accurate for identifying participants with and without cognitive impairment at CSHA-2 (3MS AUC = .6951, SE = .0371; MMSE AUC = .6533, SE = .03799; $z = 1.46$, $p = .07$). These data suggest that changes of more than 12 points on the 3MS and 6 points on the MMSE are reliable indicators of cognitive decline. Correspondence: *Megan O'Connell, Department of Psychology, University of Victoria, Victoria, BC V8W 3P5, Canada. E-mail: mocommel@uvic.ca*

R. READY, B. OTT, & J. GRACE. Quality of Life in MCI and AD.

This study investigated differences between patient- and caregiver-reported quality of life (QOL) in elderly patients with memory impairment. Factors hypothesized to be associated with QOL ratings from patients and caregivers were analyzed and compared. Participants ($n = 48$) were outpatients from a university-affiliated memory disorder clinic and were diagnosed with Mild Cognitive Impairment or Alzheimer's disease. Two global ratings of QOL were collected separately from patients and caregivers, using the Cornell-Brown Scale for Quality of Life and the Demen-

tia Quality of Life instrument. Patients and caregivers also completed questionnaires about patients' memory, IADLs, and the Neuropsychiatric Inventory Questionnaire (NPI-Q). Patients were administered a memory test and patient insight was rated. Caregivers provided self-ratings on the Geriatric Depression Scale-Short version (GDS-S). Multiple regression analyses indicated that patient-rated QOL was significantly ($p < .05$) predicted only by self- and caregiver-ratings on the NPI-Q. Caregiver ratings of patients' QOL were predicted by self- and caregiver-rated NPI-Q, caregiver ratings of patients' memory, and caregiver GDS-S scores. Thus, there is consensus between caregivers and patients that greater severity of neuropsychiatric symptoms is associated with lower patient QOL. However, there is disagreement as to the impact of memory impairment, with caregivers reporting a stronger association between QOL and memory impairment than patients. This finding may partially account for the common finding that caregiver ratings of patient QOL are lower than patient self-ratings. Investigators and clinicians also should be aware that caregiver depression may bias their perceptions of patient QOL.

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R. READY, J. GRACE, & D. CAHN-WEINER. Learning and Memory in Elderly Memory Disorder Patients.

Accurate and thorough assessment of learning and memory in elderly individuals is essential for accurate diagnosis. The differential contributions of executive functions, attention, and language abilities to different tests of learning and memory were investigated in elderly memory disorder patients diagnosed with either mild cognitive impairment or dementia ($N = 90$). Patients were administered a comprehensive neuropsychological battery that included tests of learning and memory that differed in content (verbal vs. nonverbal) and structure (structured vs. unstructured). Results indicated that learning and memory scores on the tests were significantly correlated but were not equivalent. The most important differences were predictors of learning scores. Whereas learning scores on all three tests were significantly correlated with measures of attention, executive functions, and language, regression analyses indicated that only learning scores on unstructured tests were significantly predicted by language or executive function measures. In contrast to learning scores, savings and recognition scores were less overlapping with other cognitive measures. Thus, results indicate that learning is a complex, higher-order cognitive process that likely is difficult to isolate from abilities of attention and executive functions, especially for unstructured tests. In contrast, savings and recognition scores appear to be more "pure" measures of memory. In sum, results indicate that scores from different memory tests are not interchangeable. To obtain a reliable and valid assessment of elderly patients' learning and memory abilities, our findings support the common practice of administering several different tests that vary in content and structure.

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MULTIPLE SCLEROSIS

N. CHIARAVALLI, J. DeLUCA, N.B. MOORE, & J.H. RICKER. The Efficacy of Cognitive Remediation in MS Subjects With New Learning Deficits.

This study tested the effectiveness of a method to improve new learning in Multiple Sclerosis (MS), the Story Memory Technique (SMT), through a double-blind, randomized clinical trial. Twenty-one participants with clinically definite MS and moderately to severely impaired new learning abilities (as defined by performance 2 or more standard deviations below normative data on a list learning task) were randomly assigned to the experimental or control groups. There were no significant differences between the groups in demographic characteristics, cognitive or emotional functioning. Participants underwent baseline neuropsychological assessment, 8 sessions of treatment, and 2 follow-up neuropsychological assess-

ments (immediate follow-up, long-term follow-up). To evaluate changes in learning and memory following treatment, change scores were computed for the Hopkins Verbal Learning Test (HVLT-R), Memory Assessment Scales: Prose Memory (MAS), and Rivermead Behavioral Memory Test (RBMT). The experimental group showed a significant improvement in HVLT-R performance, while the control group showed a decline. This effect was significant from baseline to immediate follow-up ($p < .01$), as well as baseline to long-term follow-up ($p < .05$). No changes were noted on the MAS or the RBMT. In addition, no significant changes were noted in depression or anxiety following treatment. Results indicate the SMT to be helpful in treating learning and memory deficits in persons with MS with moderate to severe impairment in new learning abilities.

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M.R. BASSO, C. GHORMLEY, N. LOWERY, & J. JOHNSON. Self-Generated Encoding Enhances Memory of Amnesic MS Patients.

Memory dysfunction commonly occurs in multiple sclerosis (MS), but few effective interventions exist to treat this difficulty. One method which may ameliorate forgetfulness in MS is self-generated encoding. Relative to didactic learning, self-generated encoding results in enhanced recall, retrieval, and retention in neurologically normal individuals. Yet, little is known concerning self-generated learning in clinical samples, especially MS. In this study, participants were administered the CVLT-II, and level of memory function was classified according to total recall score. This yielded 22 members of the control group (CTRL), 71 unimpaired patients with MS (MS-UN), 10 mildly impaired patients with MS (MS-MILD) and 12 moderately-severely impaired patients with MS (MS-MOD). Participants were then administered a series of learning tasks during which half of the material was self-generated, and half was didactically presented. The material reflected that encountered during daily activities, and included memory for names, object locations, and appointments. Generally, the impaired MS groups recalled less information than the MS-UN and CTRL groups. Nonetheless, all groups remembered more information that was self-generated than didactically presented. Notably, in several instances involving self-generated encoding, the MS-MOD and MS-MILD groups remembered as much information as the CTRL and MS-UN groups. These effects were observed on recall and recognition memory measures. Thus, self-generated learning enhanced recall of amnesic MS patients inasmuch as it did controls, suggesting potential efficacy in rehabilitation settings. Moreover, these data have implications for the controversy concerning acquisition vs. retrieval deficits in MS, implying that impaired acquisition may be the most salient factor.

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H.A. WISHART, A.J. SAYKIN, B.C. McDONALD, K.R. SCHUSCHU, J.S. RAMIREZ, L.A. FLASHMAN, R.M. ROTH, K.A. RYAN, C.E. FADUL, & L.H. KASPER. Mechanisms of Compensatory Neural Processing in MS: Role of the Corpus Callosum.

Recent functional magnetic resonance imaging (fMRI) research shows reallocation of neural processing resources in multiple sclerosis. On motor tasks, expanded, displaced, and bihemispheric activation occurs. These alterations in brain activation may play a compensatory role. The aims of the present study were to replicate prior findings regarding motor activation patterns in MS, and to determine whether integrity of the corpus callosum is related to extent of bihemispheric motor cortex activation. Participants were 11 right-handed individuals with mild to moderate relapsing remitting MS (MDN EDSS = 1.5) and 11 healthy demographically-matched controls. Administered on a 1.5T GE scanner, the fMRI task involved paced finger-to-thumb opposition in a simple fixed sequence. fMRI analyses included statistical parametric mapping on a voxel by voxel basis using the general linear model and random effects procedures in SPM99. Midsagittal callosal area was measured on 3D SPGR T1-weighted volumetric scans. Both patients and controls showed predomi-

nantly contralateral motor cortex activation for each hand; patients showed significant additional ipsilateral frontal activation ($p < .01$, $k = 3$). Callosal area was smaller in patients than controls ($p < .01$). In the patient group, callosal area was positively related to the extent of activation in and near motor circuitry bilaterally. Callosal area was negatively related to activation outside motor circuitry (all $p < .01$, $k = 3$). This study provides evidence that interhemispheric spread of brain activation associated with movement in MS is in part related to integrity of the corpus callosum. Further research is warranted on cortical functional reorganization in MS. Correspondence: Heather Wishart, Department of Psychiatry, Dartmouth Hitchcock Medical Center, Lebanon, NH 03756-0001. E-mail: wishart@dartmouth.edu

B.C. McDONALD, H.A. WISHART, A.J. SAYKIN, K.R. SCHUSCHU, J.S. RAMIREZ, A.C. MAMOURIAN, K.A. RYAN, C.E. FADUL, L.H. KASPER, & T.W. McALLISTER. Gray Matter Reduction on Voxel-Based Morphometry in Multiple Sclerosis.

Previous research has demonstrated brain volume loss in patients with multiple sclerosis (MS), and has used amount of decrease in cortical volume as a surrogate marker for disease progression. Decreased volume of cortical white matter has long been attributed to the primary disease process in MS, however, recent studies using various structural brain imaging methods have shown that cortical gray matter (GM) is not spared in MS, and that GM changes correlate to some degree with disease severity. No published research has yet examined GM density changes in MS using voxel-based morphometry (VBM). This study used VBM to replicate previous findings of GM changes in MS using other imaging techniques, and to identify affected brain regions. Participants were 20 patients with mild to moderate relapsing-remitting MS (*MDN* EDSS = 2.0) and 20 healthy demographically-matched controls. Structural MRI scans were acquired on a GE 1.5T LX scanner and included a T1 SPGR 1.5 mm coronal volume and axial T2 and FLAIR series for lesion identification. VBM procedures were conducted as discussed in Ashburner and Friston. SPGR volumes were spatially normalized, segmented, smoothed (FWHM = 10), and contrasted using SPM99. Results showed significantly decreased GM density in MS patients relative to controls in the thalamus and basal ganglia structure bilaterally. These findings support previous evidence of GM change in MS, and demonstrate that changes are detectable by VBM even in patients with relatively mild disease. Future research will be needed to correlate GM changes with MS disease progression and related cognitive and emotional symptoms.

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C. CHRISTODOULOU, L. KRUPP, Z. LIANG, W. HUANG, P. MELVILLE, W.F. SCHERL, T. MORGAN, T.W. MACALLISTER, L. LI, L.A. TUDORICA, X. LI, R. PEYSTER, C. ROQUE, & P. ROCHE. Neuroimaging Markers of Cerebral Injury and Neuropsychological Performance in Cognitively Impaired Multiple Sclerosis Patients.

Objective: To examine the association between neuropsychological performance and magnetic resonance (MR) measures of cerebral injury in multiple sclerosis (MS) patients with cognitive impairment. *Methods:* Participants were 33 individuals with definite MS, with a mean age of 45.0 years ($SD = 7.8$) and 15.3 ($SD = 2.5$) years of education. They were tested at baseline as part of a clinical trial to enhance cognition with an acetylcholinesterase inhibitor. The majority were women (78.8%). Their disease course was relapsing remitting (57.6%) or secondary progressive. Inclusion criteria included at least mild cognitive impairment on the Rey Auditory Verbal Learning Test. A modified Brief Repeatable Battery (BRB) formed the core of the neuropsychological protocol. Neuroimaging measures of cerebral injury were: central (ventricular) cerebral atrophy, and ratios of N-acetyl aspartate (NAA) over both creatine and choline. *Results:* A clear and consistent relation was found between cognitive and MR measures, using partial correlations controlling for age and education. The correlation of overall neuropsychological performance and central atrophy accounted for approximately half the shared variance ($r^2 = .487$).

Almost all cognitive tasks correlated significantly with MR measures, with the strongest findings for the Symbol Digit Modalities Test, a measure of sustained concentration and information processing speed/efficiency. Among MR measures, central cerebral atrophy displayed the strongest correlations. Only NAA ratios in the right hemisphere sites displayed significant correlations. *Conclusions:* Establishing a strong and stable association between neuropsychological and MR features in appropriate subsets of MS patients could aid in the investigation of potential interventions to enhance cognition.

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M. SHAWARYN, J. DeLUCA, E. GAUDINO, N.B. MOORE, T. FLINCHBAUGH, & J. HALPER. Cognitive Impairment and Everyday Functioning in MS.

The present study examined how cognitive ability is related to everyday functioning in persons with multiple sclerosis (MS). Participants, including 28 persons with MS and 15 healthy controls (HC), completed a standardized neuropsychological battery, and objective (Executive Function Performance Test; EFPT) and subjective [Functional Behavior Profile (FBP) and Functional Assessment of Multiple Sclerosis (FAMS)] measures of everyday functioning. Correlational analyses revealed that cognitive functioning was significantly related to overall objective everyday functioning on the EFPT, including the tasks of making a telephone call, paying bills, and complex cooking. Cognitive functioning was not related to subjective everyday functioning. There was no significant relationship between objective and subjective measures of everyday functioning. Multiple regression analyses were conducted to assess the relationship between a model comprised of demographic (age and education), and physical and cognitive functioning variables and the dependent variables of objective and subjective everyday functioning. Overall, the model significantly predicted 40% of the variance for actual performance of everyday tasks, with cognitive functioning and education emerging as the significant predictors. Regarding subjective everyday functioning, the model was not related to a self-report, but it did significantly predict a family report; however, cognitive functioning did not emerge as a significant predictor of subjective everyday functioning. The findings suggest that cognitive functioning predicted actual performance of everyday tasks, not subjective reports of everyday functioning. In order to more accurately capture the impact of cognitive impairment on everyday functioning, it is important to assess actual performance and not rely solely on reports from either the individual or a family member.

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T.W. MACALLISTER, C. CHRISTODOULOU, C. McILREE, T. MORGAN, W.F. SCHERL, P. MELVILLE, & L. KRUPP. Cognition, Physical Disability, and Employment in MS Patients With Cognitive Impairment.

Prior research indicates that cognitive impairment affects daily functioning and employment in persons with multiple sclerosis (MS). We examined this issue in an MS sample selected for cognitive impairment. Participants were 68 individuals with clinically definite MS: 55.9% relapsing-remitting MS, 41.2% secondary progressing MS, and 2.9% primary progressive. The sample was predominantly female (69.1%) with a mean age of 44.38 ($SD = 8.45$). The mean educational level was 14.63 years ($SD = 2.34$). Inclusion criteria included at least mild impairment on a test of verbal memory. Cognition was assessed with a modified version of the Brief Repeatable Battery and physical disability with the Expanded Disability Status Scale (M score = 3.69, $SD = 1.79$). Partial correlations were computed controlling for the effects of age and education. Results indicate that physical disability significantly correlated with employment ($r = .312$), as did one of the neuropsychological tests: Symbol Digits Modalities Test ($r = -.25$). After controlling for cognitive impairment, physical disability continued to significantly predict employment ($r =$

.28). However, after correcting for physical disability, the relations between cognitive dysfunction and employment became nonsignificant. Results indicate that physical disability was a better predictor of employability than is cognitive impairment in this sample. However, observed relations between cognitive variables and employment status may have been attenuated by restricted range due to selection criteria. Results from the present study were limited by the dichotomous nature of the employment variable. Future research should consider a more differentiated set of employment related variables.

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I. FISHMAN & R. BENEDICT. Behavioral Syndrome Associated With Multiple Sclerosis.

The nature and prevalence of a characteristic behavioral syndrome associated with multiple sclerosis (MS) was studied in a random sample of 75 patients. Behavioral changes since the disease onset were examined using the Neuropsychiatric Inventory, a valid and reliable informant-based rating scale. In addition, data on personality traits, mood and neurologic disease-related factors were collected, in an attempt to examine associations between the maladaptive behaviors and other psychological factors. Exploratory factor analysis identified two distinct clusters of behavioral symptoms, associated with euphoria, disinhibition and lack of emotional control on one hand, and dysphoria-spectrum behaviors on the other. Content analysis revealed that the first factor was reminiscent of the behavioral syndrome described in the literature, and as such, it was identified as a measure of the MS-associated behavioral syndrome. A factor score reflecting significant levels of behavior defined the presence of the syndrome, which was found in 9% ($n = 7$) of the present sample. The presence of the behavioral syndrome was found to be significantly predicted by the NEO Compliance facet of Agreeableness and estimated neuropsychological impairment as measured by the informant-based MSNQ. Implications for understanding of the behavioral syndrome in MS and importance of its early identification are discussed. These findings contribute substantially to the growing body of literature on the nature and incidence of the behavioral syndrome in individuals with MS.

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E.J. ANDERSON, J.M. KATZENSTEIN, J.A. JORDAN, R.G. BURRIGHT, & P.J. DONOVICK. Analysis of Psychomotor Inefficiencies in Multiple Sclerosis Patients.

Multiple sclerosis affects both physical and cognitive abilities. This present study examined deficits in rudimentary motor tests and their influence on speeded cognitive (verbal) output tests. Four tests were utilized to examine psychomotor output impairments in a multiple sclerosis population. The Purdue Pegboard and a letter cancellation test were used to measure execution of physical motor speed. COWA and PASAT tests were used to examine cognitive output speed on 2 levels: generation and manipulation of information. It was our hypothesis that MS persons showing poor motor performance on the physical tasks will perform more poorly on the speeded cognitive tasks. After controlling for age, education, and IQ levels, results suggest MS persons showing a physical deficit on the letter cancellation test and the Purdue Pegboard performed more poorly on the PASAT test, but not the verbal fluency test. MS persons not showing a deficit on the physical speeded tasks did not perform as poorly on the PASAT. Analyses confirm a relationship found between PASAT performance and the number of pegs on the Purdue Pegboard ($p = .05$). Hence, within the MS population, a physical motor deficit may actually inflate deficits on the speeded working memory tasks that involve manipulation of newly input information as opposed to generation of information alone.

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K. FOLLESØ & A. SCHLOSSER. Letter and Category Fluency Performance in Patients With Multiple Sclerosis.

Letter fluency (LF) and category fluency (CF) tasks have become a regular part of neuropsychological assessment. The literature indicates that these tasks are sensitive to organic brain pathology, and the LF task is described as specifically sensitive to frontal lobe dysfunction. Several studies have investigated the utility of discrepancies in LF and CF scores to differentiate between brain pathologies, but results have been mixed. This poster presents the verbal fluency data for a group of 29 multiple sclerosis (MS) patients with verified cognitive deficits. All results were transformed to age and education corrected T scores. The average T scores on the LF task (35.8) fell below the average T scores on the CF tasks (41), and this difference is statistically significant at the .05 level. Further analysis revealed that 35% of the MS patients showed depressed scores on LF task exclusively, 10% showed depressed scores on the CF tasks exclusively, whereas 31% showed depressed scores on both tasks. Thirty-eight percent of the patients revealed the expected pattern of LF scores falling significantly below scores on CF. Seventeen percent showed the reversed relationship. The data shows that although 75% of the patients demonstrated difficulties on one or both fluency tasks, making verbal fluency difficulties a frequent problem in MS, test performance was not characterized by a systematic pattern of LF and CF scores.

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J. RANDOLPH, P. ARNETT, & P. FRESKE. MS Patient and Significant Other Metamemory Ratings: Relationship With Tested Memory Functioning.

Despite a growing literature examining metacognition (i.e., self-reported cognitive functioning) in multiple sclerosis (MS), it remains unclear whether MS patients are more or less accurate at rating their cognitive abilities than significant others. This study examined the relationship between MS patients' and informants' ratings of patients' memory as compared to patients' tested memory functioning. Thirty-nine MS patients and their significant others endorsed the Memory Functioning Questionnaire (MFQ); patients were administered tests of working memory, verbal memory, visual memory, and depressed mood as part of a larger study. Zero-order correlations were calculated between memory indices and a composite of all MFQ items related to daily memory functioning and perceptions of memory change. Informants' ratings of MS patients' memory functioning were correlated with patients' performance on working memory, verbal recall, and verbal recognition memory tasks. Patients' own MFQ ratings correlated with verbal recognition memory but no other memory indices. Hierarchical regression analyses revealed that spouse and patient memory reports remained associated with memory performance after accounting for patients' physical disability [Expanded Disability Status Scale (EDSS) ratings] and depressed mood. Metamemory difference scores (calculated by subtracting patient MFQ reports from spouse reports) were associated with verbal learning, again suggesting that significant other ratings are more robustly related to patients' memory performance than patients' own reports. These findings suggest that (1) MS patients' significant others may be more accurate at rating patients' memory abilities than patients themselves, and (2) informant reports are not necessarily biased by patients' depressed mood or physical disability.

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D. BRYANT, B. DIAMOND, & J. DeLUCA. Processing Speed Interacts With Working Memory Efficiency in Multiple Sclerosis.

Information processing speed was assessed using the visual threshold serial addition test (VT-SAT), a working memory (WM) test designed to control for performance accuracy. Two trials of the VT-SAT varied WM load (test difficulty). On the VT-SAT trial with lower WM load (the less difficult 1-back trial), results showed that after controlling for performance accuracy, participants with MS had significantly slower processing

speed than healthy controls (HCs). Performance accuracy on this less difficult trial was equivalent between the MS and HC groups, indicating that when given additional time to perform this less difficult WM test, participants with MS were able to perform as well as HCs. On the VT-SAT trial with higher WM load (the more difficult 2-back trial), results showed that not all participants with MS were able to achieve a performance level similar to HCs when given additional time to perform this more difficult trial. About two-thirds of participants with MS were able to perform the more difficult trial as well as HCs when given additional time. However, a subset of approximately one-third of participants with MS were unable to perform the more difficult VT-SAT trial even when given additional time. This result suggests that persons with MS differ in the extent to which slowed processing speed accounts for the WM impairments demonstrated. The current results are discussed within the context of the interaction of processing speed with WM efficiency, and the implications of this interaction for the rehabilitation of WM impairments associated with MS.

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S. GRIFFITHS, A. YAMAMOTO, E. KOZORA, L. ROSS, V. BOUTREAU, & A. THORNTON. Memory Impairment in Multiple Sclerosis: Proactive and Retroactive Interference Effects.

To further elucidate the nature of memory dysfunction in multiple sclerosis (MS), we compared interference effects in these patients with systemic lupus erythematosus (SLE) and healthy controls. California Verbal Learning Test indices of proactive interference and retroactive interference were calculated and compared across samples of 60 MS patients, 51 SLE patients, and equal numbers of healthy controls matched on age and education. Multiple sclerosis patients' performance reflected normal accumulation, but attenuated release from proactive interference compared with controls ($F = 4.6, p < .05$), but no reliable differences in buildup and release from proactive interference were observed between MS and SLE patients, or between SLE patients and controls. Furthermore, there were no group differences in susceptibility to retroactive interference. These findings suggest that the sensitivity of MS patients to the semantic properties of the stimuli apparently differs from that of normal controls. It may be more difficult for MS patients to automatically utilize semantic properties of information during memory operations.

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C. GHORMLEY, M.R. BASSO, N. LOWERY, & J. JOHNSON. Neuropsychological Impairment and Informed Consent in Multiple Sclerosis.

In order to advance medical science, clinical trials often involve individuals with neurologic illness. These investigations frequently include patients with significant cognitive impairment. Owing to neurobehavioral deficits, patients may be unable to provide competent consent to research participation. In particular, studies involving individuals with Alzheimer's disease have revealed that neuropsychological impairment renders patients unable to provide informed consent. Specifically, deficits in executive function, attention, and memory seem to contribute to such incapacity. Because these functions are commonly impaired in multiple sclerosis (MS), patients with MS may be incapable of providing informed consent. In the present study, 19 individuals with MS and 12 control subjects were given the digit span subtest, CVLT-II, and WCST. Participants' ability to understand information contained in informed consent protocols was measured using the Understanding Treatment Disclosure Scale (UTD). The UTD is a standardized instrument that assesses decisional capacity to provide informed consent. Compared to controls and unimpaired patients, impaired MS patients were less able to understand the fictional informed consent vignette. Nonetheless, understanding of the fictional vignettes was enhanced with recognition cueing. These data indicate that neurobehavioral deficits can diminish the ability of MS patients to provide valid informed consent, but their ability to do so may be remediated with recognition cueing. Furthermore, consistent with Dymek et al. and Holzer et al., ex-

ecutive functioning was determined to be the best predictor of the ability to provide valid informed consent.

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NEUROPSYCHOLOGICAL ASSESSMENT IN TBI

A. BARTFAI, J. ARQUIST, M. ÖSTLUND, D. KARLSTEDT, S. EVANS, L. BOLIN-HELLBLUM, N. LORENZEN, & G. EDMAN. Differences in Neuropsychological Profile Between Stroke and TBI Patients Presenting With Similar Clinical Symptoms.

Mild persistent cognitive disability following head trauma, a vascular accident or some other type of CNS insult is not uncommon in adults. However, the incidence is unknown. Subjective complaints include a wide range of persistent emotional, cognitive, behavioral and physical symptoms, alone or in combination. In the present study 16 patients with cerebrovascular infarcts (CVI: M age: 50.8 range 35–61 years) and 34 with mild traumatic brain injury (mTBI: M age: 48.1 range 35–65 years) were included. The distribution of patients according to length of education did not differ significantly ($\chi^2 = .85, n.s.$). Clinical status was assessed during a semi-structured interview focusing on 4 clusters of symptoms: affective, cognitive, somatic and pain. Comparisons between the groups indicated a dissociation in the test profiles with mTBI patients having significantly lower performance on WAIS-R Information ($p < .05$) and the DVI patients having significantly lower performance on WAIS-R Block design ($p < .05$). Logistic regression based on age-corrected WP's classified 73% of the subjects correctly. The results indicate: (1) that despite similar clinical symptoms, there are distinct differences between the groups; (2) patients, referred with a "mild" stroke diagnosis have an underlying focal visuospatial disability, but no motor disturbances, (3) patients with mTBI showed increased difficulties in retrieving semantic knowledge. The results also indicate the risk that subtle visuospatial disturbances might remain undetected in CVI, leading to adjustment difficulties. A follow-up indicated that only 11% of the stroke patients returned to full-time work as opposed to 36% in the mTBI group.

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S. BREED, K. DAHLMAN, W. GORDON, & J. BREEZE. A Comparison of Cognitive Functioning Among Individuals With TBI, AD, and No Disability.

Objective: To test the hypothesis that patterns of mnemonic functioning differentiate between individuals with TBI and AD. *Participants:* Individuals aged 55 or older with mild/moderate TBI ($n = 57$), probable AD ($n = 65$), and no cognitive disability ($n = 50$). *Measures:* Age-adjusted scaled scores or percentiles on a brief battery of neuropsychological tests: WMS Logical Memory I and II, Visual Reproduction I and II, WAIS Vocabulary and Digit Span, Trails A and B, and the COWAT. *Results:* ANOVAs were used to compare mean scores. Significant differences existed among the three groups for all tests ($p < .01$). Using $\alpha = .05$, Bonferroni-adjusted between-group comparisons showed that individuals with AD scored lower than controls on each measure, while individuals with TBI scored lower than controls on Logical Memory I and II, Trails A and B, and the COWAT. Individuals with AD scored lower than individuals with TBI on tests of memory (Logical Memory I, II, Visual Reproduction I, II), processing speed (Trails A) and fluency (COWAT). To compare retention between immediate and delayed recall for the Logical Memory and Visual Reproduction subtests, change scores were computed from the age-scaled scores. On both tests, individuals with TBI were not different from controls; both showed improved scores between immediate and delayed recall. In contrast, individuals with AD were different from both the TBI and ND groups (Logical Memory, Visual Reproduction), as their age-scaled scores declined between immediate and delayed recall. *Conclusion:* Retention of

learned information discriminates between individuals with AD and TBI, suggesting that a different mnemonic process underlies the two disorders. Correspondence: Sabrina Breed, Mount Sinai School of Medicine, Department of Rehabilitation, Box 1240, One Gustave Levy Place, New York, NY 10029. E-mail: sabrina.breed@msnyuhealth.org

K. NESBIT-GREENE, S. WARSCHAUSKY, & J. DONDERS. Executive Dysfunction and Social Integration Following Traumatic Head Injury.

This study examined which factors are predictive of long-term social integration after traumatic head injury (THI). The sample included 47 young adults with a history of THI (ages 17–21, 62% male, median coma duration 1 day) who were assessed 1–3 years post injury. Neuropsychological measures included the Trail Making Test, Benton Visual Retention Test, Buschke Selective Reminding Test and Dysexecutive Questionnaire (DEX). Social integration was assessed with the Community Integration Questionnaire (CIQ). Hierarchical multiple regression analyses were used to evaluate the influence of injury severity and dysexecutive problems on self-perceptions of social integration. General neuropsychological status as assessed by the Trail Making Test–Form B, and dysexecutive problems as assessed by the DEX, were significant predictors of social integration. Injury severity alone did not predict social integration, but had a mediating effect via performance on the Trail Making Test. Specific questionnaires pertaining to day-to-day dysexecutive functions appear to predict social integration above and beyond what can be accounted for by traditional neuropsychological tests. Implications for clinical assessment and future research on ecological assessment of executive functions are discussed. Correspondence: *Jacobus Donders, Psychology Service, Mary Free Bed Hospital, 235 Wealthy S.E., Grand Rapids, MI 49503. E-mail: jdonders@mfbr.com*

N. KIRSCH, J. KAY, & S. WARSCHAUSKY. Hierarchical Linear Modeling of Verbal Learning Characteristics After Traumatic Brain Injury.

The California Verbal Learning Test (CVLT) has been found to be sensitive to the effects of traumatic brain injury (TBI), including differentiating between various subtypes of memory dysfunction. The present study used hierarchical linear modeling (HLM) to investigate neuropsychological correlates of the rate of word acquisition over the five learning trials of the CVLT. The sample included 73 adults, mean age 35.3 (14.1) years, 69.9% male, with a history of moderate or severe TBI who underwent neuropsychological evaluation in a TBI treatment program. Goodness-of-fit analysis indicated that a decelerating quadratic function fit the CVLT learning curves significantly better than a linear function. Older participants had a slower rate of acquisition over the learning trials. Neuropsychological variables predicted rate of acquisition, including scores on the Trail Making Test B, verbal fluency, and WAIS–III Digit Span Backward and Digit Symbol/Coding; higher scores were predictive of more rapid acquisition. When all neuropsychological variables were entered into the model simultaneously, only WAIS–III Digit Symbol/Coding was a significant predictor of learning rate, while there was a trend level association between Trails B score and rate of acquisition. Together, all variables explained 48% of the variance in rate of acquisition beyond that explained by participant age. Results indicate important associations between executive functioning and verbal learning abilities. Findings also demonstrate that verbal learning as measured by the CVLT is not a linear function. Correspondence: *Seth Warschausky, Ph.D., University of Michigan, D4 100 MPB, Ann Arbor, MI 48109-0718. E-mail: sethaw@umich.edu*

R. SKELTON & S. ROSS. Deficits in Spatial Cognition After TBI Revealed by Virtual Morris Water Maze.

Animal research has established the Morris Water Maze as one of the best paradigms for studying cognitive deficits resulting from aging and brain injury, largely due to its ability to assess spatial cognition (learning, memory, navigation) and its sensitivity to dysfunction of the hippocampus and frontal lobes. Since these are areas commonly damaged in traumatic brain injury (TBI), and since anterograde episodic amnesia is a common conse-

quence of both hippocampal damage and TBI, we previously adapted the paradigm for use with humans, using a virtual environment. We found that even when survivors of moderate and severe TBI showed considerable recovery in other areas, clear deficits in spatial cognition remained. However, this earlier work relied on a relatively primitive 3-D rendering of the water maze and its lack of realism could have confounded our findings. Accordingly, we replicated the finding with a virtual environment built with a sophisticated 3-D engine (Unreal®) using 10 community-living and 4 institutionalized TBI survivors and 15 non-brain-injured comparison participants. We found clear differences between the groups, with effect sizes on traditional dependent variables (latency, distance, quadrant preference) ranging from 1.4 to 2.2. Comparison of several other dependent variables, including a linear combination of the previous three, revealed effect sizes up to 2.6. Given the use of a new, heterogeneous sample population, and an improved virtual environment, these results confirm and extend previous findings and further verify the usefulness of the virtual water maze for revealing spatial cognition deficits after TBI.

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F. CONSTANTINIDOU & L. KREIMER. Feature Description and Categorization of Common Objects Following Traumatic Brain Injury.

A common sequel of traumatic brain injury (TBI) is the reduced ability to cognitively perceive the relationship between objects and their properties. This study investigated the ability to categorize common objects following brain injury. Thirteen subjects with moderate-severe TBI (ages 17–50 years, $M = 30.92$, $SD = 13.23$) and 13 matched normal subjects (ages 19–47, $M = 29.27$, $SD = 12.06$) participated. Groups were matched in age, gender, and education. Subjects with TBI were tested at a median 4 months post injury ($M = 6.9$, $SD = 7.31$). Initially subjects were asked to describe common objects, followed by a training session to learn 8 perceptual features, and culminated in an application where subjects were asked to apply all 8 features to describe additional objects. MANOVA ($\alpha = .05$) results indicated that normal subjects provided significantly more features when asked to describe 10 common objects spontaneously compared to the group with TBI ($p < .033$). The session designed to teach subjects 8 perceptual features implemented a multitrial verbal learning paradigm. MANOVA ($\alpha = .05$) results indicated that TBI subjects learned significantly fewer words than normal subjects across the 5 trials ($p < .012$). Both groups benefited from the repeated learning trials ($p < .0001$). Furthermore, the rate of learning was similar between the 2 groups ($p = .806$). The above training session was effective in teaching subjects the 8 features to enhance categorization as both groups performed significantly better during the application condition compared to the spontaneous description of objects (MANOVA, $\alpha = .05$, $p < .0001$). The results of the present study provide support for the use of repeated training trials to enhance transfer of learning in patients with brain injury.

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G.M. CUESTA, L. WENNERHOLM, V. McVEY, S. BERTHOD, J. HERON, A. MAULUCCI, C. PEASE, J. SPENCER, & B.D. JORDAN. Concurrent Validity of the Brief Test of Head Injury With the MMSE and the FIM.

The Brief Test of Head Injury (BTHI) has shown good concurrent validity with the Glasgow Coma Scale and the Rachos Los Amigos Scale scores. However, the relationship between the BTHI and other measures commonly used with brain-injured persons has not yet been established. Forty-four patients with both traumatic and non-traumatic brain injuries were evaluated at an acute rehabilitation hospital. All were administered the Mini Mental State Examination (MMSE), BTHI, and the Functional Independence Measure (FIM) within seven days of admission to acute rehabilitation. Mean MMSE score was 16, standard deviation (SD) = 9, range = 0–30. Mean BTHI total standard score was 96, $SD = 20$, range = 8–127. Mean Admission Total FIM (AT FIM) score was 56, $SD = 22$,

range = 20–109. The total MMSE score was significantly correlated with the Total Standard Score, TSS, (.759**) and all seven subtests of the BTHI: Orientation/Attention, O/A, (.752**), Following Commands, FC, (.768**), Linguistic Organization, LO, (.873**), Reading Comprehension, RC, (.407**), NAMING, N, (.663**), Memory, M, (.768**), and Visual Spatial Skills, VSS, (.541**). There were modest correlations between AT FIM scores and the BTHI Total Standard Score (.381**) and 5 of the BTHI subtest scores: FC, (.467**), LO, (.486**), RC, (.411**), M, (.398**), and VSS, (.445**). The study findings suggested that the BTHI has modest to good concurrent validity with the AT FIM and the MMSE, respectively. ** $p < .0001$; * $p < .01$.

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S. McCauley, C. Boake, H. Levin, S. Brown, & C. Contant. Lack of Differential Utility of the DSM–IV and ICD–10 Criteria for Postconcussional Disorder.

Little research has been conducted comparing the differential utility of the DSM–IV and ICD–10 diagnostic criteria for Postconcussional Disorder (PCD). This study prospectively recruited a consecutive series of patients with mild to moderate TBI from the ER or hospital wards of a Level-1 trauma center. Outcome was measured at 3 months post injury. The diagnosis of PCD was made using a semi-structured interview based on the ICD–10 clinical and DSM–IV criteria for PCD. Outcome was measured using the SF-36, Community Integration Questionnaire (CIQ), Centers for Epidemiological Studies-Depression scale (CESD), and the Visual Analog for Depression scale (VASFD). Of the 178 TBI patients (146 mild/32 moderate), 39 met DSM–IV criteria for PCD, and 114 met ICD–10 criteria. Separate analyses were performed comparing patients meeting DSM–IV PCD vs. no-PCD and patients meeting ICD–10 PCD vs. no-PCD. Significant differences were found between patients with PCD vs. no-PCD using either diagnostic criteria for all composite and subscales of the SF-36 (all $p < .006$), CESD (both $p < .0001$), and VASFD (both $p < .0001$). The CIQ Total score was poorer for patients with DSM–IV PCD whereas the CIQ Productivity score was poorer for patients with ICD–10 PCD. These results suggest little if any differential utility of 1 set of diagnostic criteria over the other. In spite of significant differences in criteria and timeframes for symptom duration, there appears to be no difference in outcome between the 2 diagnostic systems.

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N. J. Pastorek, H. J. Hannay, & C. Contant. Alternative Handling of Missing Data When Predicting Outcome from Acute Testing.

Missing data is a perennial problem in neuropsychological studies, especially when attempting to assess patients in the acute stages of recovery from severe traumatic head injury. Medical problems and confusional states can prevent a considerable proportion of patients from completing neuropsychological testing. Attempting to include these non-completers in analyses by assigning them artificial scores can produce skewed distributions that preclude the use of parametric statistical methods. Conversely, excluding these non-completers from analyses can produce non-representative samples of patients with predominantly favorable outcomes. In the current study, the ability or inability of 105 head-injured patients to complete four tests of language comprehension and attention at one-month post-injury was used to create a dichotomous test completion status variable for each individual test. It was hypothesized that test completion status would be better than raw test scores at predicting Disability Rating Scale (DRS) and Glasgow Outcome Scale (GOS) scores at 6 months post injury. As expected, test completion status on each of the 4 neuropsychological tests accounted for a significant amount of variance in the DRS above that accounted for by age, education, Glasgow Coma Scale score, and pupil response, and significantly improved prediction of GOS scores. However, raw scores on only 1 test of language comprehension improved prediction of DRS after controlling for the aforementioned covariates. The

use of test completion status, rather than raw scores, effectively increases sample size, reduces range restriction on outcome measures, and increases the generalizability of results.

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R. Jones, K. Manzel, & D. Tranel. Reliable Neuropsychological Performances After Traumatic Brain Injury.

Test-retest reliability of several common neuropsychological measures was examined in a brain damaged sample. Although statistical reliability is usually derived from normal subjects, such estimates may be of limited use in determining true change in a clinical patient. It is possible, for example, that in addition to lower mean performances on tests, clinical samples also show greater or lesser variability on such tests. Differences in variability have direct impact on the extent to which “change” in a clinical patient can be established. Twenty-four subjects (18 males, 4 females, education 12.9 ± 2.3 years, age 33.6 ± 9.3 years) with traumatic brain injury (TBI) were assessed at two points in time more than one year after the initial injury. Average interval between tests was 2.2 years. All had confirmed injuries including loss of consciousness, and none had other neurologic history, psychiatric disease, or developmental disabilities. Measures included tests of orientation, selected WAIS subtests, AVLT, Complex Figure Test, Visual Retention Test, COWA, Facial Discrimination, and the Trail Making Test. Test-retest reliability coefficients ranged from .65 (Facial Discrimination) to .93 (WAIS Information), and most coefficients were in the .7 to .8 range. Paired t tests indicated no significant difference between performances at the two time points for any of the 16 dependent variables, reflecting stable mean performances in this sample. The results demonstrate test-retest reliabilities that are similar to those obtained in normal populations, and mean performances that are stable over time. These findings have implications for interpretation of change in performance in TBI patients.

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R. Green, L. Mainwaring, S. Bisschop, M. Antoniazzi, P. Comper, V. Kristman, & D. Richards. Interpreting Neuropsychological Test Performance Following Mild TBI.

Background: One objective of research in mild traumatic brain injury in sports has been to develop tools to detect mild cognitive deficits. Conventional neuropsychological (NP) tests and methods are typically inadequate. To increase sensitivity, some studies have employed baseline NP assessments (obtained at the start of the sports season) to serve as a comparator. We will illustrate that caution must be used with this approach, particularly if a control group is not employed. **Method:** Patient group ($N = 30$); age and education matched controls ($N = 20$). Test battery, with alternate forms, included timed tests (Digit Symbol, DS; SART reaction time, Silly Sentences, Trails A & B) and pre-morbid IQ (Spot-the-Word). Repeated measures, prospective design: pre-injury and immediately post-injury assessments (patients) or separated by at least 1 week (controls). **Results:** Group \times Session ANOVA for each task revealed no interaction. Planned contrasts assessed sensitivity to deficits in patients, and practice effects in controls. On Session 1 vs. Session 2 pairwise comparisons, patients were unchanged but for a decline on DS. Controls showed significant improvement on all timed-tests (except DS), despite alternate forms. **Conclusions:** On average, time between sessions was shorter in the control group, and this may partially explain practice effects. Nevertheless, the null findings in patients (on all but 1 task) may not reflect an absence of cognitive decline; instead, the absence of practice effects may itself reflect cognitive decline. Caution is warranted in interpreting an apparent absence of decline following injury; early return to play due to Type II error could have a deleterious outcome.

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P. VAN DER HEIJDEN & J. DONDERS. Construct Validity of the WAIS-III After Traumatic Brain Injury.

A sample of 166 patients with traumatic brain injury (TBI) was selected from a 4-year series of consecutive rehabilitation referrals. Persons with premorbid (e.g., psychiatric history) or comorbid (e.g., financial compensation-seeking) confounding factors were excluded. Confirmatory factor analysis was used to test a variety of competing hypothetical WAIS-III models for fit and parsimony. Kaiser's measure of overall sampling adequacy was .89, which is considered good by conventional standards. On the basis of *a priori* specified criteria, including comparative fit index $> .90$, parsimonious normed fit index $> .60$, and root mean squared error of approximation $< .08$, it was determined that a four-factor model fit the data relatively best. This model, composed of Verbal Comprehension, Perceptual Organization, Working Memory, and Processing Speed, had a very acceptable ratio of χ^2 to degrees of freedom (1.76) and also provided statistically significant improvement ($p < .001$) over the next best competing model. The results suggest that the latent structure of the WAIS-III in this clinical sample is very similar to that reported in the standardization sample of the instrument. These findings support the construct validity of the 4-factor structure in patients with TBI. We conclude that interpretation of the WAIS-III along those 4 dimensions may result in more accurate diagnostic impressions than relying on a general intelligence index or on a Verbal-Performance dichotomy.

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P. VAN DER HEIJDEN & J. DONDERS. WAIS-III Factor Index Subtypes After Traumatic Brain Injury.

Profile subtypes, based on WAIS-III factor index scores (Verbal Comprehension, Perceptual Organization, Working Memory, and Processing Speed) were examined in a sample of 166 patients with traumatic brain injury (TBI) who had been referred for rehabilitation over a 4-year period. Persons with premorbid (e.g., psychiatric history) or comorbid (e.g., financial compensation-seeking) confounding factors were excluded. The same 2-stage clustering procedure that had been applied previously with the WAIS-III standardization sample was used to identify clinical subtypes. Three reliable clusters were found that were differentiated primarily by level of performance across all factor index scores. However, profile subtypes were not flat because the Processing Speed index was a relative weakness in each of the three clusters. Clusters differed meaningfully in both length of coma ($\eta^2 = .09$) and level of education ($\eta^2 = .11$), suggesting that both neurological and demographic variables affected WAIS-III results in this clinical sample. The clusters also demonstrated predicted differences on Part B of the Trail Making Test (corrected for age and education; $\eta^2 = .39$), confirming their external validity. We conclude that TBI affects overall level of performance on the WAIS-III, with a more specific effect on the Processing Speed index, and that an educational correction to the norms is desirable.

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K.L. TELMET, R. HANKS, L.J. RAPPORT, & J. MALEC. Reliability and Validity of a Modified Galveston Orientation and Amnesia Test.

The Modified Galveston Orientation and Amnesia Test (MGOAT) was developed to measure posttraumatic amnesia (PTA) in those individuals who cannot verbally respond to the free recall format of the Galveston Orientation and Amnesia Test (GOAT). This nonverbally mediated multiple-choice format lacks empirical research on its reliability and validity. Thirty-four rehabilitation inpatients with TBI and 49 rehabilitation controls were administered the GOAT and MGOAT to assess reliability and validity, as well as to obtain base-rate data for clinical comparison. Among the TBI participants, reliability of the GOAT was acceptable ($\alpha = .81$); however, the reliability of the MGOAT was low ($\alpha = .70$). As would be expected, among the controls, the majority of the items were invariant

(i.e., correct) and therefore reliability was poor ($\alpha < .40$). Correlations between the 2 versions were low to moderate for the initial administration of the measure on inpatient rehabilitation admission ($r_s = .37$ and $.46$). Upon resolution of PTA, the correlation between the versions weakened ($r = .28$), most likely due to increased restriction of range. Strong specificity but modest sensitivity for the two versions was demonstrated. Within the TBI group, there was no significant difference in the classification of PTA resolution across the two versions indicating good concurrent validity. Although the GOAT appears to be a reliable measure of PTA among persons with TBI, the MGOAT lacks adequate psychometric characteristics required for a modified version.

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M. RIES & S. TIMMONS. Impaired Memory Retrieval Following Severe Closed Head Injury: The Role of Reconstructive Processes.

Impaired memory retrieval is a widely cited consequence of severe closed head injury (CHI). Performance on standardized memory tests indicates retrieval deficits not only by low recall and recognition scores, but also by high numbers of intrusion and confabulation errors. High rates of intrusion errors are a ubiquitous finding in the memory literature pertaining to severe CHI. This high rate of intrusion errors may be due to a high reliance on reconstructive memorial processes. Memory research on healthy adults suggests that memories are not stored as facsimiles of the past, but instead depend on constructive processes that are sometimes prone to distortion. The experimental research on processes of memory reconstruction (or "false" memories) in healthy adults has found that people are easily lead to recall events that never occurred or items/words that were never seen. The present investigation used the Deese/Roediger-McDermott paradigm to study reconstructive memorial processes following severe CHI. Within this paradigm, participants were told to remember lists of words that are semantically-related to a nonpresented "theme" word. Participants were also instructed to rate the confidence of their memory for each reported word. Results for recall and recognition tests indicated that CHI participants remembered fewer items from the lists, and they made more semantically related false positive responses than did Control participants. Both CHI and Control participants rated their confidence for semantically-related false positive responses as highly as they rated confidence for correct responses.

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M. RIES & W. MARKS. Integrity of Inhibitory Processes Involved in Spatial Attention Following Severe Closed Head Injury.

Attentional difficulties are commonly observed in long-term survivors of severe closed head injury (CHI). The mechanisms underlying difficulties with attention are not well understood. However, a recent research endeavor using the negative priming paradigm indicates that selective attention deficits following CHI result from an impaired ability to inhibit task-irrelevant stimuli. The present study investigates the integrity of inhibitory processes involved in exogenous orienting of spatial attention following severe CHI. Posner's inhibition of return (IOR) task was employed to meet this objective. Within trials of this task, participants are exposed to an exogenous cue at one location on the computer screen and then respond to a stimulus at a cued or uncued location. Healthy adult control subjects typically demonstrate delayed reaction times to stimuli presented at the previously cued location relative to reaction times at an uncued location. This phenomenon is termed the IOR effect. Both control and CHI participants demonstrated the IOR effect. Therefore, inhibitory processes involved in exogenous attentional orienting appear to be intact following severe CHI. The IOR task is thought to measure functioning of neural structures that compose a "posterior attentional network" (e.g., superior colliculus, posterior parietal cortex). Therefore, results suggest functional integrity of these neural structures in long-term survivors of CHI.

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Paper Session 5/8:45–10:30 a.m.

TBI STUDIES: WHERE AND WHEN

R.O. HOPKINS, A. McCOURT, H. CLEAVINGER, R.B. PARKINSON, J. VICTOROFF, & E.D. BIGLER. White Matter Hyperintensities and Neuropsychological Outcome Following Traumatic Brain Injury.

Background: Traumatic brain injury (TBI) results in white matter changes, affective and neuropsychological sequelae. This study assessed matter hyperintensities (WMH) following TBI and their relationship to affective symptoms and neuropsychological function. *Methods:* Forty-five TBI subjects, 29 males and 15 females were included in the study. The mean age was 25.6 + 12.4 years and mean education level 11.8 + 1.9 years. MR scans, measures of affect, and neuropsychological tests were administered. Age and gender matched controls were obtained from a normative database. Magnetic resonance scans were rated for WMH in the periventricular and centrum semiovale regions using a 4-point rating scale. *Results:* There was a significant difference in WMH for the TBI subjects (36%) and control subjects (1%). The TBI subjects had a higher incidence of PVWMH compared to controls (odds ratio = 7.17, 95%, $p \leq .05$). The TBI subjects had a higher incidence of combined WMH compared to controls (odds ratio = 7.72, 95%, $p \leq .05$). There were no differences for WMH in the centrum semiovale. WMH did not correlate with symptoms of depression or anxiety. The combined WMH and PVWMH correlated with impaired memory and executive functioning. Duration of posttraumatic amnesia and Glasgow Coma Scale scores were significantly correlated with the combined WMH in the TBI subjects. *Conclusion:* Traumatic brain injury can result in white matter changes in the centrum semiovale and periventricular regions. WMH were not related to symptoms of depression and anxiety, but were related to measures of memory, executive function, and markers of injury severity.

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M. SCHMITTER-EDGEcombe, W. MARKS, M. WRIGHT, & M. VENTURA. Retrieval Inhibition in Directed Forgetting Following Severe Closed-Head Injury.

This study used a within-subjects variant of the list method directed forgetting procedure to examine the role of inhibition in memory performance following severe closed-head injury (CHI). Twenty-four severe CHI participants and 24 matched controls studied visually presented picture and word stimuli in both forget and remember conditions. In the forget condition, after the first half of the list was presented, participants were told that all previously presented items should be forgotten and that only the subsequently presented items should be remembered for a later recall test. In the remember condition, which was administered at least 1 week later, participants were told to learn all list items. Participants' memory for the to-be-forgotten and to-be-remembered items was assessed with a free recall test followed by a source-monitoring task. We found that despite poorer recall performance, the CHI participants exhibited a directed forgetting effect similar to controls. That is, like controls, they recalled significantly fewer to-be-forgotten items than to-be-remembered items in the forget condition. The source-monitoring data further illustrated that the inhibited items were not forgotten but rather their activation was suppressed. For both groups, when the studied items were presented as cues in the source-monitoring task, item recognition scores did not differ across the lists in either the forget condition or the remember condition. Both groups also exhibited a consistent picture superiority effect. These findings suggest that severe CHI patients' residual memory deficits are unlikely to reflect inefficient retrieval inhibition and that visual therapy methods may prove useful in remediation.

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S. RASKIN. Time Estimation and Memory for Intentions in Individuals With Brain Injury.

In previous studies of the neuropsychological basis of memory for intentions, the ability to estimate time appeared as a significant contributing factor. In this study, individuals with traumatic brain injury (TBI) who demonstrated an ability to remember a planned intention of less than 2 min ($N = 15$) and matched normal control (NC) subjects ($N = 15$) were administered the Memory for Intentions Screening Test (MIST) and a computerized test of time estimation. On the MIST, individuals with TBI were significantly impaired on all variables compared to the NC group ($p < .01$). Significant interactions indicated that the TBI group was more effected by an increase in time delay and by the requirement of a time-based cue rather than an event-based cue, than were the controls. On the test of time estimation, the group with TBI was significantly impaired compared to the control group on both the prospective and retrospective components at all time periods except 2 min ($p < .01$). Interestingly, whereas the control subjects made errors that reflected a continuum of time, the individuals with TBI seemed to collapse time so that all of their estimates were one of two possible numbers (e.g., all estimates for one subject were either 2 min or 10 min). Whether this is a deficit in time estimation per se, or a perseverative error requires further investigation. Overall score on the MIST was not significantly correlated with time estimation score, nor was prospective memory errors for either group. However, prospective time estimation was significantly correlated with time-based cue performance for both groups ($p < .01$).

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D.L. ROBINS, P.J. SEIGNOUREL, J.A. DEMERY, M.A. COLE, & W.M. PERLSTEIN. Exploring Stroop Interference in TBI: Errors Versus Reaction Time.

Stroop interference is frequently used to assess inhibitory function in individuals with traumatic brain injury (TBI). However, clinical versions of the Stroop rely on reaction time (RT), even though it is commonly reported that TBI patients show generalized slowing rather than disproportionate RT interference. We hypothesized that deficits in top-down mediated control of inhibitory processes would be reflected in disproportionate error-rate interference, rather than interference reflected in RT. Nineteen TBI patients (4 mild, 8 moderate, 7 severe) and 11 demographically-matched neurologically-normal controls performed the Golden "card" and computer-administered single-trial cued versions of the Stroop task. The single-trial design incorporated both task-switching (color naming, word reading) and delay (short, long) manipulations between task instruction and imperative stimulus on a trial-wise basis. Consistent with predictions regarding RT, TBI patients showed generalized slowing across color-naming conditions compared to controls on both versions [Golden $F(1,29) = 17.38, p < .001$; single-trial $F(1,28) = 10.88, p < .003$], but no disproportionate RT interference. Analysis of errors on the single-trial version indicated that TBI patients were *selectively* impaired in the long-delay incongruent color-naming condition [$t(29) = 2.23, p < .034$]. Results suggest that (1) analysis of errors may be more sensitive than RTs to impaired inhibitory function in TBI, and (2) TBI patients are impaired in their ability to strategically engage top-down mechanisms for inhibition of prepotent response tendencies. Results also suggest a reconsideration of methods for assessing Stroop interference in the clinical context.

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D.H.K. SHUM, J.R. TUNSTALL, J.G. O'GORMAN, & A. MAUJEAN. Effects of Traumatic Brain Injury on Planning Ability.

The Tower of London (TOL) was developed to assess ability to plan. The test has aroused considerable interest in the literature because of its strong theoretical base and sensitivity to prefrontal lobe damage. Individuals with traumatic brain injury (TBI), however, have not been found to be impaired on the TOL, even when the injury is severe. This could be due to

a ceiling effect associated with the number of moves required. The present study aimed to clarify the effects of TBI on TOL performance by increasing the number of disks from 3 to 4 and by extending the maximum number of moves required from 5 to 9. Twenty individuals with moderate to severe TBI and 19 matched controls were administered this new TOL, the Controlled Oral Word Association Test, and the Letter-Number Sequencing Test. Individuals with TBI performed at a similar level to controls on the 5 simple TOL items (2–5 moves) but significantly more poorly than controls on the 5 complex items (6–9 moves). These results suggest that TBI does affect performance on the TOL and hence the ability to plan and highlight the importance of using a test with appropriate level of difficulty. Correlations between the 3 tests suggest that the TOL measures a different aspect of executive functions to the other tests. Psychometric properties and norms of this new version of TOL will also be presented to support its clinical utility.

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Symposium 9/8:45–10:30 a.m.

THE NEUROPSYCHOLOGY OF DRIVING ASSESSMENT

**Organizers: J. Lengenfelder and J. Himmelstein.
Chair and Discussant: M.T. Schultheis.**

J. LENGENFELDER & J. HIMELSTEIN. The Neuropsychology of Driving Assessment.

The ability to drive an automobile is a complex behavior that comprises visual, physical, and cognitive abilities. Determination of driving capacity following neurological compromise, often completed by rehabilitation professionals, typically does not require a neuropsychological evaluation. Given the fact that cognition has been demonstrated to be an integral component of driving, the assessment of cognition is essential in driving evaluations. As such, neuropsychologists can play a fundamental role in the evaluation of determining the impact of cognitive impairment on driving ability. This symposium will focus on neuropsychological evaluation of the cognitive components of driving as well as the assessment of driving related ability in various clinical populations. The first part of the symposium will focus on visual scanning and attention in driving. Dr. Brouwer will present on visual scanning in hemianopsia and driving and Dr. Rizzo will present on vision and driving in dementia populations. Dr. Novak will discuss the application of a new measure in screening for readiness to return to driving. The second part of the symposium will focus on evaluating driving using more traditional cognitive measures in addition to applying a new technique of virtual reality. Dr. Lengenfelder will focus on assessing divided attention using a new technique while the last presentation will focus on traditional neuropsychological measures with a virtual reality approach in traumatic brain injury. The application of neuropsychology to the assessment of cognition in driving is emphasized and the results of neuropsychological studies using new measures and new technologies will be presented.

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W. BROUWER, M. VANIER, M. TANT, & P. LAZURE. Hemianopia and Driving: Testing the Limits of Practical Fitness to Drive.

In many countries homonymous hemianopia (HH), a visual field defect caused by postchiasmatic brain-damage is legally defined as a case of unfitness to drive. In some countries, however, an escape clause is formulated, allowing a non-professional driving license if safe and fluent driv-

ing is demonstrated in an official on-road test ("practical fitness to drive"). Safe and fluent driving after HH requires effective compensatory scanning. We discuss the critical role of neuropsychological functional limitations additional to HH in understanding and predicting effective visual scanning and practical fitness to drive. In the driving simulator-study, conducted in Montreal, a comparison was made between performance of 15 subjects with pure left-sided HH (L-HH), 7 subjects with left-sided hemianopia and hemi-neglect (L-HHN), and 5 subjects with pure right-sided hemianopia (R-HH). Simulator performance was related to tests of visual attention with and without opportunities to compensate. Driving performance in pure HH was found sufficient if the driving task provided opportunities and time for tactical compensation. Hemi-neglect patients did not profit from opportunities for compensation both in the visual attention and simulator task. In the on-road study conducted in Groningen, visual performance in a driving test of HH patients without hemi-neglect before ($n = 28$) and after ($n = 16$) visual scanning training (maximally 18 hr, including maximally 6 hr on-road training) was analyzed in relation to visual attentional tests. Measures of visual speed appeared to be particularly important. Training also improved the slower group but not enough to meet official requirements. Implications for assessment and rehabilitation are discussed.

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M. RIZZO. Vision and Driving in Dementia.

Neurodegenerative disorders cause impairments in a range of cognitive abilities that are critical to safe driving, including vision, attention, working memory, and executive function (decision-making and implementation, and self-monitoring). Neurologists are often asked for an opinion on whether affected patients should continue to drive. What do we know about driving risk in cognitive disorders? Can we predict fairly and accurately which patients pose an unacceptable crash risk? This seminar will review localization of cognitive impairments in the driving task in patients with Alzheimer's disease and associated disorders. Faculty will review state-of-the-art studies using driving simulation, instrumented vehicles, road tests, and epidemiologic studies of crash records and injuries in at-risk drivers with cerebral lesions. It will also review (1) taxonomies of human error applied to driving, (2) pragmatic application of cognitive testing with neuropsychological probes, and (3) the role of driver retraining and recertification from cognitive rehabilitation and public policy perspectives. Participants who attend this talk will better understand (1) the relative value and drawbacks of different sources of information on driver safety including driving simulators, instrumented vehicles, road tests, and state, and (2) which standard neuropsychological tests and visual tests best predict driver safety and crash risk. The seminar participants will be able to generate more fair and accurate opinions and make better referrals to specialists who evaluate at-risk drivers with cognitive disorders.

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T. NOVACK, J. SCHNEIDER, W. WEED, J. BLANKENSHIP, & J. BAÑOS. Screening for Driving Readiness Using the Useful Field of View Test.

Methods of screening for readiness to return to driving after traumatic brain injury (TBI) are needed. The present study examines the use of the Useful Field of View (UFOV) test with a traumatically brain injured population. Sixty-one individuals with TBI were evaluated with the UFOV procedure just prior to participating in an assessment of driving readiness that included on-the-road evaluation. The mean age of the sample was 33 and elapsed time since the injury ranged from 2 months to 19 years. Each subject was scored regarding adherence to good driving habits during the test and a global rating of whether the person was capable of driving was generated. Risk level for driving based on the UFOV was measured as *very low* for 74% of the subjects, while 23% were rated as *low risk*. In the

opinion of the driving evaluator, 61% of the subjects were capable of driving with little or no restriction. Even with the limited range of risk identified by the UFOV, based on *t* tests there was a significant difference in UFOV raw score on each of the three subtests for the very low *versus* low or greater risk groups. Logistic regression, however, revealed that days since injury and standard score on the Trail Making Test Part B were stronger predictors of driving approval than UFOV scores. The UFOV test appears to hold great promise as a screening device regarding readiness to drive, but the contribution of simpler tests, such as TMT-B, should not be discounted.

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J. LENGENFELDER, T. AL-SHIHABI, T. FLINCHBAUGH, R. MOURANT, J. DELUCA, & M. SCHULTHEIS. Divided Attention and Virtual Reality Driving Assessment in TBI.

Cognitive impairment following traumatic brain injury (TBI) can have a significant impact on the ability to drive an automobile. One cognitive component commonly deemed as relevant to driving capacity is divided attention, which requires the ability to process/respond to information while simultaneously conducting more than one task at a time. This study examines the impact of divided attention on driving behaviors such as speed control and lane position using a virtual reality (VR)-based driving environment. Individuals with TBI and healthy controls (HC) are compared on a VR driving divided attention task which includes driving as a primary task (i.e., speed, lane position) and a 4-digit number recognition as a secondary task. Neuropsychological measures of divided attention were also administered. Results indicate the although individuals with TBI produce more errors on the number recognition task while driving, their actual driving performance of speed and lane positioning does not differ from HC. Results will be discussed in the context of the divided attention literature and the implication of impairments in divided attention and driving behaviors will be presented. Discussion comparing the VR task to traditional neuropsychological measures of divided attention and the innovative assets offered through VR for driving assessment will be presented. Understanding the relationship between specific cognitive impairments and performance on measures of driving skills and abilities is emphasized.

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J. HIMELSTEIN, C. RACASI, R. MOURANT, T. AL-SHIHABI, J. DELUCA, & M.T. SCHULTHEIS. Virtual Reality and Neuropsychological Indices of Driving Skills.

A virtual reality driving system (VRDS) was developed to provide an objective and ecologically valid driving assessment protocol. This pilot study begins to examine the validity of the VRDS via comparison of VRDS performance and cognitive measures shown in the literature to be associated with driving. *Methods:* Participants were 6 individuals with traumatic brain injury and 6 healthy controls. Assessment included 7 measures of cognition, a self-report measure of impulsivity, and completion of a residential driving course delivered via the VRDS using a head mounted display. Driving measures including speed management, lane deviation, and head tracking (mean and standard deviation of head rotation) were calculated from VRDS performance. Correlational analysis was conducted using the indices of cognition, impulsivity and VRDS performance. *Results:* Average speed, speed variation, and time to complete the course were not significantly related to measures of cognition or behavior. Lane deviation measures were directly related to cognitive indices of simple attention and planning and trends were revealed for positive correlations with measures of working memory. Head tracking measures were significantly related to level of impulsivity and cognitive measures targeting planning and simple attention. *Conclusions:* Pilot data support the validity of VRDS measures of lane deviation and head tracking, as they

were associated with cognitive indices previously linked to driving skills and a measure of impulsivity. Conversely, pilot data did not support the validity of VRDS indices of speed management. Preliminary results suggest the VRDS may provide a valid method for quantifying driving skills. Correspondence: Jessica Himelstein, Kessler Medical Rehabilitation Research & Education Corporation, 1199 Pleasant Valley Way, West Orange, NJ 07052. E-mail: jhimelstein@kmrrec.org

Symposium 10/8:45–10:30 a.m.

IMAGING AND NEUROPSYCHOLOGICAL FUNCTION IN VASCULAR COGNITIVE IMPAIRMENT

Organizer and Chair: D.L. Nyenhuis

Discussant: Paul Malloy

D.L. NYENHUIS, P.A. BOYLE, K.D. GARRETT, J.H. KRAMER, G.T. STEBBINS, & P.E. MALLOY. Imaging and Neuropsychological Function in Vascular Cognitive Impairment.

Neuroimaging provides a window into the presence, extent and course of cerebrovascular disease in cognitively compromised patients. This symposium focuses on relationships between neuroimaging and neuropsychological function. Speakers will introduce imaging methods as part of their presentation. Dr. Stebbins introduces diffusion tensor imaging (DTI), a structural MRI measure of the directional flow (anisotropy) of water molecules through brain. He demonstrates the relationship of DTI fractional anisotropy (FA) to cognition in stroke patients with vascular cognitive impairment, no dementia (VCIND). Dr. Nyenhuis provides structural validation for VCIND by demonstrating differences in FA in VCIND and stroke patients without cognitive impairment, and examines the neuropsychological deficit pattern in VCIND. Dr. Garrett compares qualitative and quantitative measurement of white matter hyperintensities in vascular dementia (VaD) patients. She finds a computer-mediated thresholding technique to be more reliable and more highly correlated to cognitive impairment than visual rating methods. Dr. Boyle, in a longitudinal design, demonstrates the utility of combining neuropsychological measures and quantitative imaging techniques when predicting the course of VaD functional impairment. Dr. Kramer also shows the utility of combining imaging and neuropsychological tools when making clinical decisions. He finds that volumetric measurement of hippocampal atrophy distinguishes AD patients from subcortical ischemic vascular disease (SIVD) patients who do not show rapid forgetting. He posits that SIVD patients with hippocampal atrophy may have concomitant AD. Finally, Dr. Paul Malloy discusses the symposium findings and integrates them into the larger context of imaging and vascular cognitive impairment.

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D.L. NYENHUIS, G.T. STEBBINS, F. URRESTA, S. FREELS, L. DE TOLEDO-MORRELL, E. GENCHEVA, M.E. MOSLEY, & P.B. GORELICK. Neuropsychological Deficits and White Matter Integrity in Post-Stroke VCIND.

Vascular cognitive impairment, no dementia (VCIND) refers to patients with CVD-related cognitive deficits not meeting VaD criteria. Little has been done to describe the VCIND neuropsychological deficit pattern or to examine clinicopathological relationships. To this end we completed two studies. First, we compared post-ischemic stroke patients with VCIND ($n = 27$) to stroke patients without cognitive impairment (NCI, $n = 37$) on neuropsychological tests, grouped *a priori* into domains (e.g., working memory), then transformed into standardized, weighted principal component scores (PCS). Education corrected regression models showed group

differences in Visuospatial, Working Memory, Encoding, Delayed Recall, Delayed Recognition, Language and Psychomotor domains. Stepwise multivariate regression analysis retained Encoding and Delayed Recall, suggesting that the groups differed most on memory domains. Second, we compared diffusion tensor imaging (DTI) fractional anisotropy (FA), masked to all but white matter in VCIND ($n = 27$) and NCI ($n = 27$) subjects, matched for age and education. The groups' white matter FA scores differed significantly [$t(49) = 3.06, p < .005$], while normalized white matter volumes derived from DTI were equivalent ($p > .50$). Visual inspection showed the greatest differences in frontal, deep subcortical (vs. periventricular) areas. In the VCIND group, FA correlated with the Visuospatial PCS score ($r = .38, p < .01$). In summary, our findings suggest that (1) memory (both encoding and delayed recall) is the most vulnerable neuropsychological function in post-stroke VCIND; (2) deep, frontal white matter dysfunction is key to the development of post-stroke cognitive deficits; and (3) visuospatial functions rely, at least in part, on intact white matter integrity.

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G.T. STEBBINS, D.L. NYENHUIS, F. URRESTA, S. FREELS, L. DE TOLEDO-MORRELL, E. GENCHEVA, M.E. MOSLEY, D.A. TURNER, J.D.E. GABRIELI, & P.B. GORELICK. White-Matter Integrity in Ischemic Stroke: A DTI Study with Behavior Correlates.

Post-ischemic stroke patients often present with cognitive deficits in processing speed and executive components of working memory (e.g., reasoning). Disruption of white matter has been suggested as a primary cause of these cognitive impairments, however standard MRI techniques often fail to document such a relationship. Advances in MRI methods allow for the assessment of microstructural integrity of cerebral white matter using diffusion tensor imaging (DTI). Intact cerebral white matter increases anisotropic diffusion (FA). We investigated whole-brain white matter integrity (FA) in 51 nondemented patients with recent post-ischemic strokes and assessed the relationship between FA and psychomotor processing speed and reasoning performance. Patients were scanned using echo-planar DTI and tested for psychomotor processing speed (Symbol Digit Modalities Test—oral version: SDMT) and reasoning ability (Raven's Progressive Matrices Test: RPMT). DTI data were processed to provide a measure of white matter anisotropy (FA) excluding lesion sites. Total white matter FA was significantly correlated with processing speed (SDMT:FA $r = .43, p < .002$) and reasoning performance (RPMT:FA $r = .45, p < .001$). Regressions of behavioral scores on white matter FA demonstrated significant regional relationships: processing speed performance was significantly related to frontal FA and reasoning performance was significantly related to frontal and parietal FA. These results demonstrate that decreased integrity of nonlesion white matter in recent post-ischemic stroke is associated with decreased cognitive function, and supports the theory that white matter disruption is a primary cause of these cognitive impairments.

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K.D. GARRETT, R.A. COHEN, R.H. PAUL, D.J. MOSER, & P.F. MALLOY. Methods to Measure White Matter Hyperintensities in Vascular Dementia.

White matter hyperintensities (WMHs) are ubiquitous on MRI studies of vascular dementia (VaD) patients. As several studies have demonstrated that WMHs are often associated with severity of illness, cognitive impairment, and functional decline, the accurate and reliable measurement of WMHs on MRI is an important, yet often overlooked, prerequisite for accurate interpretation of neuroimaging studies. The advantages and pitfalls of using two types of commonly used methods are discussed: visual ratings with ordinal scales and computer-mediated techniques. Using a sample of 36 VaD patients, we evaluated the reliability and validity of a visual ordinal rating scale and a computer-mediated thresholding technique to evaluate WMHs. Results indicated the computer-mediated technique had stronger inter-rater reliability than the visual ordinal rating scale. Furthermore, the computer-mediated thresholding technique was correlated to several measures of neuropsychological functioning believed to be compromised in VaD (i.e., psychomotor speed, executive functioning) while the visual rating scale was not. Results suggest that this computer-mediated thresholding technique is superior to visual ratings of WMHs.

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P.A. BOYLE, R.H. PAUL, D.J. MOSER, & R.A. COHEN. Predicting Functional Declines in Vascular Dementia.

This presentation will focus on the use of neuropsychological measures of executive functioning and quantitative neuroimaging techniques for predicting functional declines among patients with vascular dementia (VaD). Data from a longitudinal study investigating the course and determinants of functional impairment in VaD will be presented. VaD patients were evaluated at 2 time points: baseline and 1 year follow-up. Baseline executive test performance and quantitative MR-based estimates of subcortical neuropathology were used to predict functional declines at follow-up. We hypothesized that (1) instrumental activities of daily living (IADLs) would decline significantly over the course of 1 year; and (2) baseline executive test performance and subcortical neuropathology would predict functional impairment at 1-year follow-up. A paired-samples t test demonstrated that IADLs declined significantly over the course of 1 year. Regression analysis revealed that baseline executive test performance accounted for 52% of the variance in IADLs after 1 year; this model was significant even after controlling for baseline functional impairment. Contrary to our expectation, subcortical neuropathology did not explain unique variance in IADLs. These findings demonstrate that executive dysfunction is a strong and unique predictor of functional declines in individuals with VaD.

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J.H. KRAMER, D.M. MUNGAS, B.R. REED, N. SCHUFF, M. WEINER, B.L. MILLER, & H.C. CHUI. Forgetting in Dementia With and Without Subcortical Lacunes.

Alzheimer's disease (AD) and subcortical ischemic vascular disease (SIVD) are common causes of dementia, often co-occur, and can present quite similarly, making differential diagnosis clinically challenging. Because hippocampal pathology and rapid forgetting of new information are thought to be cardinal features of AD, we tested the hypothesis that patients with SIVD would retain information better than AD patients. Participants were 35 dementia patients with subcortical lacunes (SIVD group), 27 dementia patients without lacunar infarction (AD group), and 56 normal controls. Subjects were administered the Memory Assessment Scale list learning task, which is a 12-item list administered over 6 learning trials, followed by a 30-min delayed recall trial. Results indicated that despite comparable levels of initial acquisition, AD patients showed more rapid forgetting. Further analysis, however, indicated that memory patterns within the SIVD group were heterogeneous, with some participants exhibiting forgetting and some exhibiting good retention. The AD group had smaller hippocampal volumes than the SIVD group with good retention, with the SIVD group with rapid forgetting falling between the other 2 groups. SIVD participants with good retention showed a trend for greater executive impairments relative to SIVD participants with rapid forgetting and AD participants. Results suggest that rapid forgetting in SIVD may imply concomitant AD, whereas the dementia in patients with good retention may be purely vascular in origin. Three SIVD patients with rapid forgetting followed to autopsy all had AD pathology, further supporting the link between memory patterns and AD.

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Symposium 11/8:45–10:30 a.m.

**APHASIA IN THE 21ST CENTURY:
THE INFLUENCE OF HAROLD GOODGLASS**

Organizers: S. Weintraub and N. Helm-Estabrooks

Chair: E.F. Kaplan

Discussant: L. Gonzalez Rothi and K. Heilman

S. WEINTRAUB & N. HELM-ESTABROOKS. Aphasia in the 21st Century: The Influence of Harold Goodglass.

Harold Goodglass was a leading thinker in neuropsychology in the latter half of the 20th century. His influence derives from studies of aphasia and the neurological foundations of language. His ideas and work have had an impact on theory, research, and clinical practice in disciplines as diverse as linguistics, cognitive neuroscience, speech pathology, behavioral neurology, and developmental psychology. His now classic studies of agrammatism and of naming promoted the melding of cognitive psychology and behavioral neuroscience and informed current theory and experimentation, including the work of numerous colleagues in the international community. This symposium gathers researchers and clinicians from several different disciplines, representative of the scope of his influence. Arthur Wingfield will present data from recent collaborations with Dr. Goodglass on object-naming in aphasic patients. His special focus will be on the role of word stress in naming and the importance of word-onset phonology as a trigger for the correct response following initial naming failure. Cynthia Thompson will discuss syntactic processing deficits in aphasic patients and patterns of recovery. Nancy Helm-Estabrooks will review studies of the impact of non-aphasic cognitive deficits on the treatment of aphasia. Sandra Weintraub will focus on the study of aphasia in patients with dementia, discussing the syndrome of *primary progressive aphasia* and some of the insights it offers for the classification of dementia and for the cerebral organization of language. Dr. Edith Kaplan will introduce the symposium and Drs. Leslie Gonzalez-Rothi and Kenneth Heilman will be the discussants.

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C.K. THOMPSON. Syntactic Deficits and Patterns of Recovery in Agrammatic Aphasia.

This presentation will highlight recent research examining syntactic deficits, i.e., verb and sentence deficits, as well as patterns of syntactic recovery in agrammatic aphasia. Findings from a series of studies examining verb comprehension and production will be presented in which we have shown that, while verb comprehension is relatively spared in agrammatism, production deficits appear to be related to the argument structure properties (participant roles) of verbs. Verbs with greater complexity in terms of either the number or type of arguments entailed within the verb's lexical entry are more difficult for agrammatics to produce than those with lesser complexity. Findings from studies of sentence deficits in agrammatism also will be presented. These studies show that agrammatic aphasic patients have difficulty with both comprehension and production of syntactically complex sentences in which verb arguments and adjuncts have been moved out of their canonical (S–V–O in English) position. In addition, recovery from these deficits, when provided with treatment controlling both the lexical and syntactic properties of sentences, follows predictions articulated by linguistic theory. Recovery of related structures also is enhanced by training more, rather than less, complex structures. These studies support Goodglass's notion that recovery follows a path of previous linguistic knowledge. Results from functional magnetic resonance imaging (fMRI) studies examining the neural correlates of recovery from sentence deficits also will be presented.

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A. WINGFIELD. Object Naming in Aphasia: Insights From Clinical and Experimental Studies.

A difficulty in word-finding is present in virtually all persons with aphasia and it often remains as a residual problem even after other symptoms have shown relief. This difficulty is especially highlighted by the task of visual confrontation naming. Harold Goodglass was early to see the importance of object naming to the understanding of aphasic language, both at the clinical level and as a test of theory. One of Goodglass' goals was to take inferences drawn from observations of brain damaged patients, experimental observations of normal speakers and studies of functional brain imaging to develop a coherent framework for the understanding of normal and aphasic naming. This presentation describes analyses of naming errors in aphasic word production and the evidence these analyses offer for the importance of word stress and word-initial phonology in the naming process. Data will then be presented from both normal and aphasic subjects using the technique of word-onset "gating" in which listeners attempt to identify words from just their onsets. One of the goals of these studies is to explore the mechanisms by which word onsets can elicit the correct response when naming has failed. Of special interest in these studies is the role of prosody (stress pattern of the target word) in word retrieval and word identification. The presentation concludes with a description of new studies currently underway that examine prosody in the successful and unsuccessful production of object names by normal and aphasic subjects. Correspondence: *Arthur Wingfield, Volen National Center for Complex Systems, Brandeis University, Waltham, MA 02454-9110. E-mail: wingfield@volen.ccs.brandeis.edu*

N. HELM-ESTABROOKS. Cognition and Aphasia: Implications for Rehabilitation.

The status of nonlinguistic cognitive skills in individuals with aphasia has long been a subject of controversy. It was Carl Wernicke's opinion that any intellectual disturbances that might accompany aphasia should not be considered part of the disease. In contrast, Pierre Marie stated that a decrease in intelligence should be highlighted in any definition of aphasia. The issue of cognitive status in individuals with aphasia is of particular importance for their response to treatment programs where skills such as attention and memory are critical to learning, and to their ability to communicate in everyday settings which have unpredictable demands and fluctuating conditions thus requiring good executive functions. The formal first study of aphasia and "intelligence" employing standardized test measures was published by Weisenburg and McBride, who found that some aphasic people had deficits of visuospatial and spatial abilities. Subsequent studies have shown that nonlinguistic cognitive test performance is not related to aphasia severity. Glosser and Goodglass focused on executive control functions of aphasic individuals and found that such impairments were independent of linguistic and visuospatial deficits but, instead, were linked to lesions in left frontal and prefrontal regions. In this presentation, the issue of cognition and aphasia will be discussed and the evidence reviewed. In addition, data from emerging studies will be presented demonstrating that overall cognitive status of equally aphasic individuals is critical to response to specific treatment protocols and to their ability to generate and communicate unique messages.

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S. WEINTRAUB. Primary Progressive Aphasia: Large-Scale Neural Networks and Dementia.

The study of patients with acute aphasia from cerebrovascular lesions over the past 150 years has defined our understanding of the neural correlates of language. In contrast, the study of patients with neurodegenerative brain disease for this purpose has been relatively late to develop. The increasing interest in studying dementia to inform cognitive theory parallels the growth over the past 25 years in research on neurodegenerative brain diseases associated with aging, and an emphasis on early detection of clinical symptoms of dementia. The investigation of patients with neurodegenerative dementia early in the course of their illness has led to the

discovery that deficits can be quite clinically focal, residing in one domain, such as language, for many years before symptoms appear in other cognitive domains. The clinical syndrome of *primary progressive aphasia* (PPA) is characterized by the slow erosion of language, in relative isolation from other cognitive deficits, for many years. The diagnosis is based on the absence of amnesia and primary impairments in other non-language-related neurobehavioral domains within the first 2 years of observable symptoms. The early symptoms have been correlated with structural and functional neuroimaging and with post mortem neuropathological findings. The left perisylvian anatomical predilection pattern of these features is consistent with the early clinical profile. This presentation will review current concepts of PPA and will outline the questions it has raised with respect to nomenclature for dementia and our concepts of language localization and its reorganization in the face of gradual, progressive neurological damage.

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Poster Session 6/9:30–10:45 a.m.

ASSESSMENT BATTERIES: FOCUS ON INTELLIGENCE

R. GRAVES & L. CARSWELL. Prediction of Premorbid Boston Naming and California Verbal Learning Test Scores.

Many studies have developed regression equations to estimate Wechsler IQ scores on the basis of measures that are less susceptible to general cognitive decline. When the actual current IQ score is abnormally lower than the estimated (predicted premorbid) IQ, evidence of cognitive decline is obtained. Few studies have applied this approach to predicting ability measures other than IQ, however. The current study involved 98 normal elderly Canadians (*M* age = 71.9). Boston Naming Test scores were predicted by scores on the Spot-The-Word subtest of the Speed and Capacity of Language Processing test ($r = .61$, standard error of estimate = 2.72 items). California Verbal Learning Test (CVLT) Long Delay Free Recall scores were predicted by CVLT Immediate Free Recall Recency scores ($r = .53$, *SEe* = 2.45 words). Regression equations and percentile tables of actual minus predicted discrepancy scores are provided. Use of discrepancy norms can potentially improve detection of decline in naming and memory function, especially for high premorbid ability clients. Correspondence: *Roger Graves, Department of Psychology, University of Victoria, P.O. Box 3050, Victoria, BC V8W 3P5, Canada. E-mail: rgraves@uvic.ca*

R. LANGE, G. HOPP, & G. CHELUNE. Challenging the Clinical Applicability of Group Mean Methodology for Profile Analyses.

Despite recognition of the cognitive heterogeneity within diagnostic groups, the research literature continues to provide examples of 'prototypical' cognitive profiles by averaging scores across various cognitive measures within a clearly defined diagnostic sample. However, this method assumes that individuals within a sample are homogenous in nature and will exhibit similar cognitive functioning. The purpose of this investigation is to illustrate the limitations of 'group mean methodology' in profile analyses, and to present a more suitable method for identifying and presenting cognitive profiles. Participants were 200 (71.5% female) patients with multiple sclerosis who were administered the WAIS-III and WMS-III. Based on a 2-step cluster analysis procedure, 3 sub-profiles were identified within the sample. Significant differences ($p < .001$) across the 3 sub-profiles were found on the majority of WMS-III and WAIS-III measures. To determine which method of profile analysis would best characterize the patients in the sample, individual patient profiles were compared to the group mean profile and the 3 subprofiles using Pearson correlation as a proximity measure. Results indicated that a higher number of patients were more

appropriately characterized by 1 of the 3 subprofiles ($r \geq 0.3 = 91.0\%$; $r \geq 0.5 = 69.5\%$; $r \geq 0.7 = 33.0\%$) compared to the overall group mean profile alone ($r \geq 0.3 = 64.0\%$; $r \geq 0.5 = 42.5\%$; $r \geq 0.7 = 13.5\%$). These results highlight the necessity for researchers to discontinue using statistical procedures that rely on group mean methodology, and to adopt more appropriate techniques.

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M.R. SCHOENBERG, J.G. SCOTT, K. DUFF, & R.L. ADAMS. Clinical Utility of the OPIE-3 as an Estimate of Premorbid Intelligence.

The WAIS-III standardization clinical sample was used to evaluate the clinical utility of the OPIE-3 formulas in predicting IQ scores. The OPIE-3 is a procedure that combines current performance on the WAIS-III Matrix Reasoning (MR), Information (Info), Picture Completion (PC), and Vocabulary (Voc) subtests with premorbid demographic variables of age, education, gender, region of the country, and ethnicity in estimating FSIQ scores. The results are presented for clinical populations including those with mild to moderate dementia of the Alzheimer's type, traumatic brain injury, left lobectomies, right lobectomies, Parkinson's disease, Korsakoff's disease, and Schizophrenia. Results indicated that the algorithm that combined Voc and demographic variables (OPIE-3V) yielded the largest mean differences between predicted and obtained IQ scores across the clinical samples. The OPIE-3(2ST), a formula that combined MR and Voc with demographic variables, also yielded significant differences. The OPIE-3 formula that combined Voc, Info, MR, and PC [OPIE-3(4ST)] yielded the smallest difference between predicted and obtained scores. A model that used MR and PC (OPIE-3P) provided FSIQ estimates that were significantly different for left lobectomy patients while the OPIE-3V yielded the greatest differences between predicted and obtained in a small sample of right temporal lobectomy patients. These data indicate that the OPIE-3V, OPIE-3(2ST) and OPIE-3P have utility as estimates of premorbid WAIS-III FSIQ for patients with diffuse as well as lateralized brain dysfunction.

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D.E. PATTON, M.R. SCHOENBERG, J.G. SCOTT, K. DUFF, & R.L. ADAMS. Does Age Affect Estimates of WAIS-III FSIQ? Prediction Errors With the OPIE-3.

Data from the WAIS-III were used to evaluate prediction errors of a combined current performance and demographics regression algorithm in estimating FSIQ scores. The sample ($n = 2450$) was randomly divided into two groups. The first group ($n = 1222$) was used to develop the formulas and the 2nd ($n = 1225$) to validate the algorithms. The OPIE-3 combines WAIS-III subtest raw scores (Vocabulary, Information, Matrix Reasoning, and Picture Completion) and demographic data (i.e., age, education, gender, region, and ethnicity). Estimated FSIQ scores derived from the OPIE-3 were evaluated across 13 age groups. Differences between predicted and actual FSIQs indicated that the frequency of estimation errors varied as a function of age ($p < .01$). The OPIE-3 FSIQ 4-subtest formula systematically overestimated FSIQ for individuals aged 16–17 years (3.18 points) and 80–89 years (4.41 points). However, meaningful differences were not found between age groups regarding the percentage of individuals whose predicted FSIQ fell within the same qualitative IQ category as their actual FSIQ. Agreement rates between predicted and actual FSIQ category ranged from 62 to 71%. Similarly, the percentage of individuals misclassified by more than 10 FSIQ points by age group was relatively small (1–11%). These results suggest that the OPIE-3 provided a robust estimate of FSIQ across age groups in a neurologically intact sample. Limitations, particularly with individuals aged 16–17, are discussed. Correspondence: *Mike Schoenberg, Department of Psychiatry and Behavioral Sciences, University of Oklahoma Health Sciences Center, P.O. Box 26901, Oklahoma City, OK 73190. E-mail: mike-schoenberg@ouhsc.edu*

K.M. DORFMAN, M.R. SCHOENBERG, J.G. SCOTT, K. DUFF, & R.L. ADAMS. Estimates of WAIS–III VIQ and PIQ: Developing the OPIE–3(VIQ) and OPIE–3(PIQ).

Data from the WAIS–III standardization sample were used to generate formula to estimate VIQ and PIQ scores using demographic variables and current WAIS–III subtest performances. The sample ($N = 2,450$) was randomly divided into two groups, the first ($N = 1,222$) was used to develop formulas and the second ($N = 1,225$) to validate the regression algorithms. Age, education, ethnicity, gender, region of the country as well as Vocabulary (Voc), Information (Info), Matrix Reasoning (MR), and Picture Completion (PC) subtests raw scores were used as predictor variables. The VIQ algorithm combined Voc raw subtest scores with education, gender, and ethnicity. The OPIE–3(PIQ) combined MR and PC with age, education, and ethnicity. The formulas were highly significant and accurate in predicting VIQ and PIQ. Comparisons between obtained VIQ–PIQ differences and the differences between estimated VIQ–PIQ scores indicated that 78% of the sample ($N = 2,450$) was within 15 points of their actual VIQ–PIQ difference. Furthermore, of the 430 individuals with VIQ–PIQ differences greater than 15 points, 68.4% predicted VIQ–PIQ difference was within 10 points of their actual VIQ–PIQ scores. Data suggests that good estimates of VIQ and PIQ is possible and prediction of VIQ and PIQ may highlight differences in premorbid abilities better than an estimate of FSIQ alone.

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M.R. SCHOENBERG, J.G. SCOTT, K. DUFF, & R.L. ADAMS. Estimating WAIS–III FSIQ Using Combined Performance and Demographic Variables: The OPIE–3.

Data from the WAIS–III standardization sample were used to generate FSIQ estimation formula using demographic variables and current WAIS–III subtest performances. The sample ($N = 2,450$) randomly divided into 2 groups, the 1st ($N = 1,222$) was used to develop the formula and the 2nd ($N = 1,225$) to validate the regression equations. Age, education, ethnicity, gender, region of the country as well as Vocabulary, Information, Matrix Reasoning, and Picture Completion subtests raw scores were used as predictor variables. Prediction formulas were generated using 4 subtest, 2 subtest, single verbal, and 2 performance subtest algorithms. The 4-subtest model [OPIE–3(4ST)] combined Information, Vocabulary, Matrix Reasoning, Picture Completion raw scores with demographic variables. The two subtest algorithm [OPIE–3(2ST)] used Vocabulary and Matrix Reasoning raw scores with demographic variables. The formulas for estimating FSIQ were highly significant and accurate in predicting FSIQ. The OPIE–3(4ST) model accounted for 86.1% of variance [OPIE–3(2ST) = 83.8%] in the original sample and 85.4% [OPIE–3(2ST) = 80.3%] in the validation sample. Additionally, 93.5% of OPIE–3(4ST) and 88.7% of OPIE–3(2ST) estimated IQs fell within 10 points of obtained IQ. When evaluated in terms of IQ category, the OPIE–3(4ST) nor OPIE–3(2ST) misclassified any subjects by more than 2 categories.

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G. IVERSON & J. BERNARDO. Comparing the Canadian and American WAIS–III Normative Systems in Inpatient Neuropsychiatry.

The Canadian Normative Supplement for the Wechsler Adult Intelligence Scale–Third Edition was published and distributed in 2001. Normative data for 1,105 Canadians between the ages of 16 and 89 are provided. The normative data are stratified by age group. Continuous norming was the statistical method used for generating the Canadian norms. This method is considerably different than the method employed for the original American norms. The purpose of this study is to compare the WAIS–III normative scores derived from the Canadian and American norms in a sample of 33 neuropsychiatric inpatients, most of whom had serious brain injuries or diseases. The correlations between the 2 normative systems were $r = .99$ for all the IQs and Index scores, except the Processing Speed Index ($r =$

.92). The correlations for the subtests ranged from .97 to .99. Paired sample t tests revealed that the Canadian norms yielded lower scores on all IQs, Indexes, and subtests, with the exception of Symbol Search. The effect sizes for the differences between the IQ and Index scores ranged from trivial to medium. The biggest differences were for the Performance IQ, Perceptual Organization Index, and Processing Speed Index. The effect sizes for the subtests ranged from trivial to small, with the exception of Matrix Reasoning, which was a small-medium effect ($d = .39$). The clinical implications of using the Canadian *versus* the American normative data will be discussed.

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C. WELLS, R.M. STUTZ, M. MEYER, & R.P. STUTZ. Predictors of Intellectual Ability in Disability Applicants.

Recent research suggests that clinicians need to consider the impact of demographic and clinical variables when interpreting IQ scores. The present study examined the impact of sex, race, education, disability (physical, psychiatric, or both), and substance abuse history on IQ scores obtained from the Wechsler Abbreviated Scale of Intelligence (WASI). Regression analyses were performed to develop predictor models for Verbal, Performance, and Full Scale IQ scores in a sample comprised of individuals in a vocational rehabilitation program. Only race and education were found to be significant predictors of Verbal, Performance, and Full Scale IQ. Two-way interactions resulted in a significant Race \times Physical Disability interaction. However, this interaction did not significantly contribute to the proportion of variance accounted for by the main effects model. This study suggests a need for a demographic adjustment of race and education when interpreting individual WASI IQ scores in disability applicants.

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J. REDFIELD. The WAIS–III as a Five-Factor Test.

New factor models for the WAIS–III were developed and evaluated within the test's standardization sample, and validated in clinical samples. Every other age group out of the 13 in the WAIS–III standardization sample was assigned to either a derivation or a validation subsample. To investigate the possibility of age-specific factor structures, the 2 subsamples were further subdivided into 3 age groups (below 30, 30–64, 65 and up), within which parallel analyses were performed. Exploratory factor analyses suggested tentative factor structures that, along with other theoretical and empirical models, were further tested and refined using structural equation modeling. Cross-validation and multiple-group analyses best supported a 5-factor model consisting of the 4 traditional WAIS–III factors (Verbal Comprehension, Perceptual Organization, Working Memory, Processing Speed), plus a Fluid Reasoning factor defined by Arithmetic and Matrix Reasoning. The 5-factor model's fit in the full standardization sample was compared to that of competing theoretical and empirical models using confirmatory factor analysis, and the 5-factor model was superior to alternatives. Measurement invariance of factor loadings across the age range was established for the 5-factor model, but not for the traditional 4-factor model. Residual subtest variances were correlated with reliabilities, and factor intercorrelations varied with age in theoretically meaningful ways. The 5-factor model had better cross-validity than the traditional 4-factor model in 2 moderately large clinical samples ($Ns > 500$) composed of individuals with a mixture of neurological, psychiatric, and substance abuse disorders.

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X. SALAZAR, K. BOONE, M. PONTON, J. SHERKE, D. SCHROCK, N. NELSON, C. EDWARDS, & J. RAZANI. Validation of the Satz-Mogel Short-Form for the WAIS–III in a Clinical Sample.

The Wechsler Adult Intelligence Scales have become one of the most widely used instruments for the estimation of intelligence. However, the length of these measures, approximately 90 min, makes their use difficult

or impractical in certain situations (e.g., research protocols, bedside administrations, patients with compromised stamina, etc.). In an attempt to compensate for this drawback, various short forms of these instruments have been developed. One of the more popular of these abbreviated administrations has been the Satz-Mogel short-form procedure, which reduces the administration time by approximately 50%. The present study attempts to validate this procedure for the 3rd edition of the Wechsler scale, the WAIS-III. One hundred protocols from a referred neuropsychological and psychiatric population were rescored using the Satz-Mogel procedure. Correlations between the two forms were significant for all 11 subtests ($r > .88$), as well as for the three IQ scores ($r > .96$). Short-form estimates for the Verbal, Performance, and Full Scale IQ scores were within ± 5 points of the standard protocol in 82%, 77%, 83% of the cases, respectively. A change in diagnostic classification occurred in only 7% of the sample for FSIQ, and in 11% and 15% of the sample for VIQ and PIQ, respectively. The short form detected reliable WAIS-III Verbal-Performance IQ discrepancies in 72% of the cases, with a 12% false-positive rate. The above results suggest that the Satz-Mogel procedure is a viable method of IQ estimate. Its utility rivals that of other short-form methods including the Wechsler Abbreviated Scale of Intelligence (WASI).

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B.A. STEINBERG, L.A. BIELIAUSKAS, G.E. SMITH, & R.J. IVNIK. IQ-Adjusted Normative Data: Empirical Findings and Theoretical Considerations.

Although education-adjusted normative data have become increasingly popular in neuropsychologic practice, there are both empirical and theoretical reasons for suspecting that such norms may yield less accurate diagnostic conclusions than IQ-adjusted norms. After briefly reviewing the results of 4 previous investigations of the relative merits of education- and IQ-based adjustments on 9 common neuropsychometric instruments (Boston Naming Test, MAE Token Test, and Judgment of Line Orientation Test; Trail-Making Test, Stroop Color-Word Test, and Controlled Oral Word Association Test; Wechsler Memory Scale-Revised; and Rey Auditory Verbal Learning Test and Visual Spatial Learning Test) in subsamples of neurologically intact elderly participants (ages 56–99) from the Mayo Older Americans Normative Studies (MOANS) database, we identify critical conceptual issues that pertain to the interpretation of demographically modified test data and summarize interdisciplinary findings that relate to the assessment of older examinees (including information about genetic contributions to cognition, age-associated changes in neuroanatomy and neurophysiology, and influences of processing speed, working memory, and fluid intelligence on everyday neurocognitive functioning and on performances on neuropsychologic tests). We conclude by offering specific recommendations for practice.

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A. NAGRA, W. VANVOORST, E. OLSEN, & R. SKEEL. The Impact of Visual Acuity on Neuropsychological Performance.

Although a variety of sources suggest that measures such as Trails A & B, Digit Symbol from the WAIS-III, and cancellation tasks related to attention require visual scanning ability, little research has been performed examining the impact of visual acuity on these measures. In order to determine what measures are susceptible to reduced visual acuity, and examine what level of visual acuity is sufficient to complete tasks without reduced performance, individuals with varying visual ability were compared on several tasks hypothesized to be highly dependent on visual acuity (Trails A & B, Digit Symbol from the WAIS-III, d2 Test of Attention, Grooved Pegboard, Stroop) and several control tasks. The sample included 76 participants ranging in age from 17 to 44 ($M = 20.83$, $SD = 4.73$). Participants' uncorrected measured acuity ranged from 20/20 to 20/400. Initial correlational analyses revealed the only measures significantly correlated with near acuity were Digit Symbol [$r(76) = -.298$, $p <$

.01] and Trails B [$r(76) = .269$, $p < .05$]. In an effort to examine where decreased vision began to impact performance, participants were categorized as having perfect vision (20/20), mild impairment (20/25), moderate impairment (20/30–20/50), or severe impairment (<20/70). Groups classified with moderate and severe impairment were significantly worse than the other 2 groups on Digit Symbol [$F(3,72) = 5.23$, $p < .02$] and Trails B [$F(3,72) = 4.95$, $p < .01$]. No other comparisons reached significance. Clinical guidelines for acuity screening are discussed.

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W.F. SCHERL, L. KRUPP, C. CHRISTODOULOU, T. MORGAN, P. COYLE, L.E. ELKINS, W.S. MACALLISTER, & C. MCILREE. Neuropsychological Profile of Healthy Controls recruited by Random Digit Dialing: Normative Data and Alternate Forms Reliability.

Background: Much normative data on neuropsychological tests is derived from convenience samples (e.g., college students or hospital employees) and subject to a variety of sampling biases. *Goal:* We used random digit dialing methodology to reduce such biases and provide clinicians and researchers with normative data on standard neuropsychological tests commonly used to measure cognitive impairment in neurological populations (e.g., Lyme disease, multiple sclerosis). *Methods:* Ninety-seven healthy controls (59 women, ages 19–65) recruited using the Mitofsky-Waksberg random digit dialing sampling methodology served as a comparison group for a study of cognitive functioning in early and chronic Lyme disease. Participants were administered a battery of standard neuropsychological tests including: Wechsler Adult Intelligence Scale-Revised Vocabulary and Block Design; Wide Range Achievement Test-3 Reading; Bushke Selective Reminding Test; Controlled Oral Word Association (phonemic association); Digit Symbol Modalities Test; Stroop; Wechsler Memory Scale-Revised Logical Memory; Benton Visual Retention Test; Trails A & B; Paced Auditory Serial Addition Test; Finger Tapping and Grooved Pegboard. Alternate forms were administered when available, and counter-balanced across participants. *Results and Conclusions:* Normative data for each of the tasks will be presented, stratified by age, average education and IQ. No differences were identified in the difficulty of alternate forms administered.

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R. STERN, A. VAN METER, K. LANG, H. WESTERVELT, C. LEITEN, A. HETHCOX, & T. WHITE. The NAB Judgment Test: Description and Interrater Reliability.

The Neuropsychological Assessment Battery (NAB) is a newly developed comprehensive adult test battery which consists of approximately 44 tests grouped into 6 "modules," including Screening, Attention, Language, Memory, Spatial, and Executive Functions. The entire NAB takes up to three hours to administer, though it is designed to allow for briefer, more focused examinations when appropriate, based on the results of a 30–45-min Screening Module. The NAB has 2 equivalent forms in order to allow for repeated administrations over time. The NAB is normed on an extensive nationwide standardization sample. One of the Executive Functions Module tasks, the 10-item Judgment test, is designed to assess key aspects of judgment in daily living, including items pertaining to home safety (e.g., "Why should you not unplug electrical appliances while your hands are wet?"), hygiene (e.g., Why is it important for people to brush their teeth?), and medical safety (e.g., "What should you do if you take too much of a prescription medication?"). Each question is rated on a 0–2 point scale. The interrater reliability of Form 1 of the Judgment Test was examined by having 2 bachelor's level research assistants independently rate the responses provided by 54 healthy subjects participating in the standardization study. The resulting Single Measure Intraclass Correlation Coefficient (ICC) was .87. These results indicate that the NAB Judgment Test has excellent interrater reliability.

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R. STERN, J. RUFFOLO, A. VAN METER, C. LEITTEN, & T. WHITE. The NAB Figure Drawing Test: Description and Interrater Reliability. Neuropsychological evaluations typically include a drawing task as a measure of visuocognition. One of the most commonly employed tests is the Rey-Osterrieth Complex Figure (ROCF). Some authors have argued, however, that the ROCF is too complex for elderly dementia patients, and the available scoring systems for the ROCF either lack in ratings of relevant qualitative features or provide more qualitative information than many users require. The Neuropsychological Assessment Battery (NAB) is a newly developed comprehensive instrument which consists of approximately 44 tests grouped into 6 “modules,” including Screening, Attention, Language, Memory, Spatial, and Executive Functions. The NAB has two equivalent forms in order to allow for repeated administrations over time, and it is normed on an extensive national adult standardization sample. The Spatial Module includes an 11-element Figure Drawing task which has less detail and complexity than the ROCF, though still requires intact organizational skills to complete. There are both Copy and Immediate Recall conditions, each receiving 2 ratings: (1) a Presence, Accuracy, and Placement score; and (2) an Organization score (a combination of Fragmentation and Planning ratings). Interrater reliability of these scores was examined by having two research assistants independently rate 48 productions drawn by a combination of healthy controls, and patients with either MS or ADHD. Each production required only 2–3 min to score and the resulting Intraclass Correlation Coefficients (ICC) were excellent (Presence, Accuracy and Placement = .94; Organization = .95). Correspondence: Robert A. Stern, Neuropsychology Program, Rhode Island Hospital, 110 Lockwood St., Suite 430, Providence, RI 02903. E-mail: rstern@lifespain.org

R. STERN, N. HELM-ESTABROOKS, J. RUFFOLO, C. LEITTEN, & T. WHITE. The NAB Narrative Writing Test: Description and Interrater Reliability. Narrative writing is commonly used to assess written language skills in neuropsychological evaluations. Most writing samples, however, are evaluated only qualitatively due to the lack of adequate or reliable quantitative scoring procedures. The Neuropsychological Assessment Battery (NAB) is a newly developed comprehensive adult instrument which consists of approximately 44 tests grouped into 6 “modules,” including Screening, Attention, Language, Memory, Spatial, and Executive Functions. The NAB has 2 equivalent forms in order to allow for repeated administrations over time, and is normed on an extensive nationwide standardization sample. The Language Module includes Oral Production and narrative Writing tests, both relying on the same colorful family scene stimulus. The Writing test includes 5 scores, including: Legibility, Spelling, Syntax, and Conveyance, as well as a Total Score. The interrater reliability of the scoring system was assessed by having a class of 17 speech and language graduate students independently rate each of 10 writing samples (using the Form 1 stimulus) produced by a group of patients with a variety of disorders and expressive language impairments (e.g., AD, VaD, TBI, CVA). The resulting Intraclass Correlation Coefficients (ICC) ranged from .55–.94, with a Total Score ICC of .83. These ratings were made without training and without reliance upon exemplar writing samples (to be included in the *NAB Professional Manual*), suggesting that these ICCs may be lower than what would be obtained with scorers who have more experience with the NAB and guidance from scoring exemplars. Correspondence: Robert A. Stern, Neuropsychology Program, Rhode Island Hospital, 110 Lockwood St., Suite 430, Providence, RI 02903. E-mail: rstern@lifespain.org

P.S. FASTENAU. Five Alternate Forms for 5 Neuropsychological Tests: Test–Retest Reliability. Rationale: Five alternate forms were designed for WAIS–III Digit Span, Digit Symbol, Letter–Number Sequencing, Trail Making Test; Paced Auditory Serial Addition Test (PASAT); and Rey Auditory–Verbal Learning Test (RAVLT). Content validity and criterion-related validity have been described previously. Test–retest reliability was examined here. Method: Participants were 102 non-clinical adults (79% female, 88% right-handed;

78% White, 14% African American, 8% Other/Multiracial) diverse in age (18–60 years, $M = 36.9$, $SD = 12.5$), education (10–21 years, $M = 15.3$, $SD = 2.7$), and estimated IQ (WRAT–3 Reading SS 53–123, $M = 1–4.5$, $SD = 12.0$). Participants completed 2 test sessions separated by a brief break at Week 1 (T1 and T2) and 2 more test sessions at Week 2 (T3 and T4). By random assignment, half completed the original test at T1 followed by an alternate form at T2; for the others, form order was reversed. One week later, half of the participants completed the same alternate form again (T3) followed by a novel alternate form (T4); for the others, form order was reversed. Scores on the alternate form administered at Week 1 were correlated with scores on that same form at Week 2. Results: T2 and T4 scores were most comparable (each followed 1 practice trial); correlations ($n = 8$) ranged from .83–.96 ($M = .91$, $Mdn = .93$, $p < .0005$). Correlations among the other three pairs of trials (T2–T3, T1–T4, and T1–T3) were confounded by inequitable amounts of practice preceding the trials being compared, resulting in lower retest coefficients. Discussion: Temporal stability of the alternate forms was supported for all 5 tests.

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L. BEGLINGER, D. KAREKEN, O. TANGPHAO-DANIELS, M. DERBY, P.S. FASTENAU, B. GAYDOS, J. CRAWFORD-MILLER, & E. SIEMERS. Practice Effects and Alternate Forms in Serial Testing: Drug Trials Methodology. Detecting cognitive enhancement from novel pharmacologic agents in phase I clinical trials requires frequent serial assessment and is complicated by practice effects. Alternate forms can correct declarative memory practice effects over two sessions, but only attenuate procedural learning (Fastenau et al., 2002). Further, many instruments for dementia trials are too simple for healthy volunteers. We examined practice effects in 28 healthy adults [71% female; 79% White; age = 37.2 ($SD = 7.6$); education = 14.5 ($SD = 2.1$); WRAT–3 reading = 95.5 ($SD = 14.7$)]. Participants completed tests in a fixed order weekly for 3 consecutive weeks: Finger Tapping (FT), letter fluency, AVL T, Digit Symbol, Trail Making Test (TMT), Letter–Number Sequencing, Stroop, and Paced Auditory Serial Addition Test (PASAT). Nineteen completed 3 additional weeks without treatment ($n = 9$ enrolled in drug arm). To minimize variability, examiner, time of day, caffeine, tobacco, and medications were held constant. Six alternate forms (5 plus original) were used for each test except FT, fluency (3 forms), and Stroop. Form order was counterbalanced; ANOVAs for each test revealed evidence of form effects for TMT A & B. ANOVA across 6 sessions revealed significant changes in at least 1 session, despite alternate forms, on all tests except LNS and TMT B. Learning occurred principally in the first 3–4 sessions ($p < .001–.046$), in part from ceiling effects. PASAT ($p < .001$) and Stroop interference ($p = .001$) showed greatest learning. Most tests had adequate interform reliability ($r > .6$); TMT was particularly unreliable. Conclusions: Serial assessment with alternate forms can attenuate retest effects, but “learning-to-learn” still occurs.

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C.A. BRENNER, J.L. GODFREY, C.A. SANDMAN, J.P. O’HAL-LORAN, & W.P. HETRICK. Comparability of Traditional and Computerized Administration of 12 Common Neurocognitive Assessment Tests. Neuropsychological tests are administered to investigate the performance of individuals in relation to an established normative sample. Computerized administration of these tests can increase standardization, reduce cost, time, and potential human error introduced during paper/pencil formats. However, computerized testing has been limited to subjects who can perform unattended and do not allow verbal responses. A novel computer platform that has multimodal response input capability and a “dual-interactive” display architecture enables the examiner to monitor, guide, and interact with a patient during testing, was evaluated. With this system

the examiner is able to: control the pace of testing; pause, repeat instructions; and receive information regarding patient performance and test progress. Using the Computerized Memory and Interactive Neuropsychological Diagnostic System (CMINDS), we administered computerized versions of Letter Number Sequencing, Symbol Digit Modalities (oral version), Category Fluency, Letter Fluency, Boston Naming, Digit Span, Auditory Verbal Learning, Card Sort Test, Continuous Performance Task (distractive version), Finger Tapping, and Trails A and B to 44 healthy subjects to establish the reliability of computerized administration. Independent samples *t* tests revealed no significant differences between CMINDS performance and published normative data for any tests under investigation. Furthermore, administration and scoring time was substantially reduced by the CMINDS system (approximately 75 min). This study provides preliminary confirmation of the operational validity and time efficiency of the dual-monitor computer interface for the administration and scoring of neuropsychological tests with CMINDS.

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J.G. BUCKWALTER, V.C. CROOKS, S.B. ROBINS, & D.B. PETITTI. Associations Between a Cognitive Screening Test and a Battery of Neuropsychological Tests.

Screening tests of cognitive function are an integral part of the clinical care of patients, multistage diagnostic procedures and, in large-scale studies, often serve as the sole measure of cognitive performance. Few screening tests have been developed in accordance with established psychometric criteria. While measures are described as assessing "global" cognitive functioning, few screening tests have been validated against neuropsychological batteries to confirm they are associated with multiple cognitive domains. Given increasing reliance on screening measures administered over the telephone, we determined to evaluate the associations between the Telephone Interview of Cognitive Status modified (TICS_m) and a standard battery of neuropsychological tests. All participants (*n* = 3,681) were enrolled in an ongoing study of the association of estrogen use with the prevalence and incidence of dementia and had received the TICS_m. Two hundred ten women were randomly selected to receive an in-person neuropsychological battery and 105 consented to complete the battery. The battery included tests of verbal and nonverbal memory, attention, working memory and executive functioning. Factor analysis (principal components, roots ≥ 1 , varimax rotation) of the neuropsychological test scores yielded 5 factors labeled (1) Wordlist Memory; (2) Contextual Memory; (3) Working Memory/Executive Functioning; (4) Nonverbal Memory; (5) Processing Speed. The TICS_m was significantly correlated with contextual memory only ($r = .39$) an effect that was independent of age and education. The association of the TICS_m with the other factors did not approach significance. We conclude that global screening tests evaluate cognitive domains similar to those evaluated by the Logical Memory test.

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MEDICAL ILLNESS AND NEUROPSYCHOLOGICAL DYSFUNCTION

K. WILDER-WILLIS, R. RIGGS, J.T. ARNETT, J. LINN, & M. ALOIA. Cognitive Dysfunction and Compliance in Obstructive Sleep Apnea (OSA).

OSA is associated with cognitive dysfunction which may improve with Continuous Positive Airway Pressure (CPAP). However, previous research has suggested that adequate CPAP compliance is as low as 28%. The goals of the current study were (1) to determine the prevalence of cognitive dysfunction in OSA, (2) compare cognitive functioning in compliant and non-compliant individuals, (3) whether baseline cognitive functioning was predictive of compliance with CPAP at 3-month follow-up. Thirty-six individuals with polysomnography confirmed diagnosis of OSA

(*M* age = 58.2, *SD* = 12.07), mean RDI of 48.98 (*SD* = 23.9) participated in the study and were administered tests of attention and reaction time (Continuous Performance Test, Trail Making Test, Part A), psychomotor speed (Grooved Pegboard Test), verbal memory (Hopkins Verbal Learning Test), nonverbal memory (Brief Visual Memory Test–Revised), and executive functioning (Trail Making Test, Part B, Controlled Oral Word Association). Participants' performance were compared to published norms and impairments (>1 *SD*) were evident in psychomotor speed (50%), verbal memory (44% impaired), and verbal fluency (38% impaired). Preliminary follow-up data (*n* = 12) results indicated that compliant participants (*M* = 85 hr) performed better than noncompliant participants (*M* = 3.9 hr) in reaction time ($t = 2.1, p < .05$), psychomotor speed ($t = 2.2, p < .05$), verbal fluency ($t = 2.8, p < .05$), executive functioning ($t = 1.8, p < .05$), and nonverbal memory ($t = -1.9, p < .05$). Baseline CPT ($r = -.61$) and HVLIT ($r = -.60$) performance were correlated with CPAP compliance at follow-up, suggesting that cognitive impairments predict CPAP compliance. It is anticipated that follow-up data will be available for an additional 11 participants over the next 8 months.

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G.G. POTTER, B.L. PLASSMAN, M.J. HELMS, K.A. WELSH-BOHMER, D.C. STEFFENS, & J. BREITNER. The Effects of Coronary Artery Bypass Graft on Cognitive Status Change Among Elderly Male Twins.

Previous findings regarding the long-term cognitive effects of coronary artery bypass graft (CABG) are inconsistent, which may be due in part to differential genetic risk within most study samples. We examined the effect of CABG on cognitive status change scores in members of the NAS-NRC Twins Registry of World War II veterans. The veterans were administered the modified Telephone Interview for Cognitive Status (TICS-*m*) at approximately 3-year intervals between 1990–2002 as part of an epidemiological study of dementia. Using an analysis dependent on pairing of monozygotic and dizygotic twins discordant for CABG (*N* = 466 individuals), we found at follow-up that men who had CABG between age 62–72 showed an increase in TICS-*m* scores and performed significantly better than their co-twin who did not have the procedure. Individuals who had CABG from age 73–82 showed a slight decline in TICS-*m* performance at follow-up, but were not significantly different from their non-CABG co-twin. This pattern of performance was also replicated on a factor of TICS-*m* related to memory. Based on this study of twin pairs who share genetic and environmental risks for cardiovascular problems, our results suggest that timing of the CABG procedure may be important to positive outcome in the areas of memory and general cognition. The age at which CABG surgery is performed may help explain inconsistent results in the literature regarding the adverse neuropsychological consequences of CABG.

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K.D. GARRETT, J. TSCHANZ, I. SKOOG, A. KHACHATURIAN, K. WELSH-BOHMER, P. ZANDI, J. BREITNER. The Relationship Between Cardiovascular Risk Factors and Cognitive Decline.

Background: Recent studies suggest a role for cardiovascular risk factors (CRFs) in cognitive decline in the elderly. Limited longitudinal data exist, however, from population-based samples. In the present study, we examined the cognitive performance of a population of elderly individuals screened for dementia, stroke, and other neurodegenerative diseases over a three-year interval. *Methods:* 4,023 elderly individuals with self-report information on CRFs were assessed with the Modified Mini-Mental Status Exam (3MS) at baseline and three years later. *Results:* Multiple regression analyses (adjusted for age, gender, education, and *APOE* genotype) showed the medically treated diabetes $\beta = -.71, p < .02$ and years of hypertension ($\beta = -.02, p = .03$) were associated with poorer baseline 3MS performance (Model $R^2 = .289$). Surprisingly, years of hypercholesterol-

emia were associated with better baseline 3MS performance ($\beta = .05, p < .01$). Multiple regression (adjusted for demographic variables and APOE genotype) with 3MS change scores revealed greater decline with diabetes ($\beta = .82, p < .04$) and heart attack ($\beta = .83, p < .02$, Model $R^2 = .084$). Years of hypertension and hypercholesterolemia did not significantly affect cognitive decline. *Conclusions:* The present data support the notion that chronicity of some CRFs are associated with poorer cognitive status, and that decline is associated with more severe conditions. Surprisingly, years of hypercholesterolemia were associated with better cognitive performance. To the extent that hypercholesterolemia was treated, this result is consistent with preliminary data linking lipid-lowering agents with reduced risk for Alzheimer's disease. Additional data are needed to explore this issue, to specify the neuropsychological profiles associated with CRFs, and to examine their long-term risks for dementia.

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P. POFF, B. KAMROWSKI-POPPEN, L. RIEMENSCHNEIDER, & G. SOUTHWELL. Computerized Test Performance in a Normotensive Sample at Risk for Hypertension.

The cognitive effects of hypertension in individuals with chronic, established elevations in blood pressure are well documented. Fewer reports involve relatively healthy, normotensive individuals who are at risk for hypertension, with many reporting no relationship between blood pressure and cognitive performance. This may be partly due to the insensitivity of traditional, clinician-administered neuropsychological instruments as well as the nature of the samples studied (e.g., older adults, comorbid medical conditions). The purpose of the present study was to assess the relationship between blood pressure and cognitive test performance utilizing a well-validated, computerized neuropsychological test battery (i.e., ANAM 2001) in a younger sample of normotensive individuals at risk for hypertension. The sample was comprised of 46 active duty military and family members enrolled in a lifestyle modification/weight loss program. Data on systolic and diastolic blood pressure, aerobic fitness level, and percent body fat were collected during this time period. The mean age of the participants was 35.50 years ($SD = 10.58$ years) with a mean of 13.68 years of education ($SD = 1.83$ years). Mean systolic and diastolic blood pressure was 123.32 mmHg ($SD = 17.19$) and 79.00 mmHg ($SD = 7.66$), respectively. Stepwise multiple regression analyses revealed that systolic blood pressure, along with aerobic fitness level, was a significant predictor of performance on a matching-to-sample reaction time task. Age, gender, and ethnicity were also significant predictors on other subtests of the battery.

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N. STROOBANT & G. VINGERHOETS. The Definition of Neuropsychological Dysfunction After Cardiac Surgery.

Introduction: A considerable lack of agreement exists between studies in reported rates of cognitive impairment in patients after cardiac surgery. One of the most important causes is the variability in how cognitive deficits are defined. We compared 2 frequently used definition criteria. *Methods:* Seventy-one patients (M age: 59.9 years, 63 men) were assessed using 7 neuropsychological tests one day before, 6 days and 6 months after ($n = 41$) the surgery. We classified our patients as having cognitive decline with (1) a decline of more than 1 standard deviation from the baseline distribution of scores on that test; and (2) a decrease on test scores by at least 20% from the baseline. *Results:* The 20% change criterion consistently identified the largest proportion of patients with cognitive deficits: 69% resp. 36.6% of the patients exhibited cognitive deficits on ≥ 2 tests at 6 days resp. 6 months. According to the 1 SD criterion 23.9% resp. 9.8% of the patients had significant cognitive decline on ≥ 2 tests at 6 days and 6 months. Twenty-three point nine percent of the sample (at 6 days) and 7.3% (at 6 months) was rated as impaired by the 2 criteria. *Discussion:* The 20% change criteria appears to be the most sensitive method to identify impaired patients. Unlike the 1 SD criterion it can identify patients

with low baseline scores. Being not referenced to an unique sample mean and SD , it is generalizable to other studies and populations. Future research on cognitive outcome after cardiac surgery would benefit from standard definition criteria.

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J.G. KEILP, K. CORBERRA, & B.A. FALLON. Intellectual and Memory Impairment in Chronic Lyme Disease.

There is substantial uncertainty about the nature of cognitive deficits in chronic Lyme (CL) disease. In this ongoing study, 43 patients with a history of Lyme disease (meet CDC clinical criteria, prior positive serology, at least 3 weeks of IV antibiotic therapy, current cognitive complaints, and a current positive IgG Western blot), and 26 nonpatient controls were administered the WAIS-III and WMS-III. All scores were converted to age, sex, education, and ethnicity adjusted T scores for statistical analyses. MANOVAs on the 4 WAIS-III index scores [Wilks $\lambda = .79, F(4, 60) = 4.02, p = .006$] and 8 WMS-III index scores [Wilks $\lambda = .73, F(8, 60) = 2.83, p = .010$] were significant. Patients performed more poorly on the Verbal Comprehension, Working Memory, and Processing Speed indices of the WAIS-III, and on the Auditory Immediate, Immediate Memory, Auditory Delayed, Auditory Delayed Recognition, General Memory, and Working Memory indices of the WMS-III. Standard scores for CL patients on the WAIS-III and WMS-III, however, typically fell within an average range, and deficits relative to normative values were only evident after T-score conversion. CL patients have intellectual and memory deficits that are, on average, mild. Clinical evaluation of individual patients may not reveal impairment on the WAIS-III and WMS-III unless adjustments are made for demographic factors that provide more appropriate expectations for performance. Other, specialized neuropsychological instruments may have greater sensitivity to these deficits.

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R.F. KAPLAN, R.P. TREVINO, G.M. JOHNSON, L. LEVY, R. DORN-BUSH, L.T. HU, J. EVANS, A. WEINSTEIN, C.H. SCHMID, & M.S. KLEMPNER. Cognitive Functioning in Patients With Persistent Symptoms and a History of Lyme Disease: A Placebo-Controlled Antibiotic Treatment Study.

It is controversial whether additional antibiotic treatment will improve cognitive functioning in post-treatment chronic Lyme disease (PTCLD) patients. To determine whether antibiotic therapy improves cognitive functioning PTCLD patients were randomized to intravenous ceftriaxone 2 g daily for 30 days followed by oral doxycycline 200 mg daily for 60 days or matching intravenous and oral placebos in a double blind study. All 129 patients had a physician documented history of Lyme disease. Seventy-eight were seropositive for IgG antibodies against *B. burgdorferi*, and the other 51 were seronegative. Assessments were made at baseline and 90 and 180 days post treatment. Symptom severity was measured from the pain, cognitive functioning and role functioning scales of the Medical Outcomes Study (MOS). Memory, attention and executive functioning were assessed using Rey Auditory Verbal Learning Test, Benton Visual Retention Test, California Computerized Assessment Package and Controlled Oral Word Association Test. Mood was assessed using the Beck Depression Inventory and MMPI-2. There were no significant baseline differences between seropositive and seronegative groups. Both groups reported a high frequency of MOS cognitive symptoms, depression and somatic complaints, but had normal baseline neuropsychological test scores. There were significant decreases in MOS symptoms, higher objective test scores, and improved mood between baseline and 90 days. However, there were no significant differences between groups receiving antibiotics and placebo. PTCLD patients with symptoms, but without other evidence of an active Lyme infection, do not show objective evidence of cognitive impairment. Additional antibiotic therapy was not more beneficial than administering placebo.

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K. WATERLOO, R. OMDAL, S.I. MELLGREN, W. KILDINGSNES, & G. HUSBY. Fatigue in Patients With Systemic Lupus Erythematosus II: Psychosocial Aspects.

Objective. Studies examining the relationship between fatigue and immunological, inflammatory, or other disease characteristics of SLE have shown no consistent findings. To further elucidate the basis for fatigue in SLE, we therefore examined affective states, personality traits, and quality of life (QOL) in an unselected group of patients with SLE. *Methods.* Fifty-seven White SLE patients were examined. Fatigue was measured by the Fatigue Severity Scale (FSS). Personality traits and psychological function were evaluated by the Minnesota Multiphasic Personality Inventory–2 (MMPI–2), affective states by Beck Depression Inventory (BDI), and mental health status and QOL by the General Health Questionnaire version 30 (GHO-30). *Results.* Fatigue was closely associated (simple or stepwise regression) with high scores on subscales D-2 and Hy-3 in MMPI–2 ($R^2 = .31$; $p = .0002$), as well as with high scores on BDI ($R^2 = .22$; $p = .0006$) and GHQ ($R^2 = .33$; $p < .0001$). *Conclusion.* Fatigue seems not to be caused by any easily recognizable single or multiple of inflammatory or immunological factors. Rather, our results point to fatigue being a multifaceted phenomenon where several psychosocial factors are strongly related, and indicate that fatigue is part of a complex response to chronic disease.

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S. WATSON, W. FUJIMOTO, A. PETROVA, S. LATENDRESSE, M. MCNEELY, S. KAHN, & S. CRAFT. Basal Insulin Influences Memory in Persons With Impaired Glucose Tolerance.

Many investigators have reported an increased prevalence of cognitive deficits in patients with 2 diabetes mellitus (T2DM) or impaired glucose tolerance (IGT). Hyperglycemia may contribute to these deficits. However, reduced insulin effectiveness and hyperinsulinemia, which are essential features of T2DM and IGT, may also influence cognition. Exercise and diet, which improve insulin effectiveness, have been associated with improved cognition. The present study examined the effect of exercise and diet on adults with IGT: 13 treated with rigorous exercise and a low fat diet, and 8 treated with stretching and a less strict diet. Neuroendocrine and cognitive measures, including story recall, were obtained at baseline and month 12. As expected, groups did not differ at baseline on story recall or morning fasting plasma insulin levels. When groups were examined together, story recall improved with treatment ($p < .01$). Interestingly, lower baseline plasma insulin was associated with greater improvement in recall ($r = -.46$, $p < .04$). As predicted, the exercise group, but not the stretching group, showed significantly improved recall ($p < .01$). These findings suggest that lower basal insulin levels may characterize a subset of subjects who show the greatest cognitive improvements in response to exercise and dietary modification.

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M. HUGHES & P. DOWLING. Early Cognitive Decline in Type 2 Diabetes: Memory or Information Processing?

Some studies of cognitive functioning in Type 2 Diabetes have reported changes in memory function but methodological limitations and age-related confounding factors have made it difficult to attribute the memory decline solely to diabetes. To investigate the specific effects of diabetes on cognitive function, a study was conducted with a relatively young group of persons with diabetes ($n = 30$, age < 69 years), who had minimal comorbid illness and no history of stroke. Areas of cognitive function investigated included attention, information processing, memory and learning. Statistical analyses were based on a core set of measures from these domains to ensure adequate power. Comparison of the performance of the diabetic group with a matched control group on this core set of measures revealed a significant difference ($p < .000$) on the information processing measure (WAIS–III Symbol Search) but not on memory or learning measures (WMS–R Logical Memory II and Visual Reproduction II, RAVLT

Delayed Recall). Further analysis of all memory measures revealed very few significant differences and these differences were better interpreted as reflecting attentional factors (e.g., RAVLT Trial I) rather than memory *per se*. Hence this study suggests that the initial cognitive effect of diabetes is a slowing of information processing. Moreover reduced speed of processing was not confined to the diabetic subgroup that had greater disease severity, based on typical illness variables such as glycemic control, duration of illness, and the presence of treated hypertension. This finding lends support to the view that diabetes contributes directly to cognitive decline.

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C. FLAHERTY-CRAIG & M. MIGUELEZ-PAN. Chronic Pain Syndrome in a Group of Patients With Localized Lesions in the Region of the Cingulate Gyrus.

Current models of pain perception stipulate that sensory and emotional components of pain are processed by parallel and distinct structures. They posit the secondary somatosensory cortex (SSSC) to be highly involved in pain processing. A lateral pain system has been defined by the contralateral SSSC and bilateral primary SSC, characterized by stimulus specificity and stimulus response dependency. A medial system has also been identified, associated with the motivational–affective component of pain, represented in the anterior cingulate gyrus (ACG). More recently, the role of a posterior CG (PCG)—parietotemporal cortex network has been recognized in focusing attention toward a stimulus event and evaluating its significance. We evaluated a group of 5 subjects with deficiencies in visuospatial perception. Four reported chronic pain syndromes (CPS) of gradual onset and moderate intensity. All were administered a modified version of the Parietal Lobe Battery of Goodglass and Kaplan and the NEO Personality Inventory. Findings included deficiencies in drawing from copy, multiplication/division, clock setting and hidden finger recognition. NEO profiles evidenced anxiety ($T = 62$) and depression ($T = 73$). Radiology findings for the CPS patients converged in the CG: (1) right ACG (area 14); (2) bilateral ACG (area 24); (3) left PCG (area 31); (4) left ACG (area 24). The patient free of CPS demonstrated bilateral subcortical lesions in area 19 (occipital) adjacent to area 31. Findings support the thesis that focal lesions affecting the integrity of the CG may represent 1 etiology of CPS, resulting from dysregulation of the networks subserving pain intensity perception.

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C. BACK-MADRUGA, R. FONTANA, L.A. BIELIAUSKAS, M. BURTON-WILLIAMS, E. WRIGHT, L. PADMANABHAN, H. SLEEPER, Z. KRONFOL, K. LINDSAY, & THE HALT-C TRIAL STUDY GROUP. Predictors of Cognitive Impairment in Chronic Hepatitis C Patients Entering the HALT-C Trial.

The purpose of our study was to identify predictors of cognitive impairment in a large cohort of chronic hepatitis C patients who have not responded to prior antiviral therapy and are entering the NIH-NIDDK sponsored HALT-C Trial. One hundred and thirty-nine subjects with chronic hepatitis C were administered a battery of neuropsychological tests, the CIDI modules for alcohol, drug abuse, depression, and anxiety, the BDI–II, and the Shipley. Cognitive impairment was defined as T scores more than 1 standard deviation below normative means on at least 4 of the 12 neuropsychological tests. Fifty-four subjects (39%) were identified as cognitively impaired (M age = 49.78 ± 7.12 ; 85% high school graduates) and 85 subjects (61%) were identified as cognitively intact (M age = 49.61 ± 8.61 ; 98% completed high school). Multiple Logistic regression analysis with forward selection was used to identify factors associated with cognitive impairment. Estimated pre-morbid intelligence (i.e., Shipley IQ; $p < .0001$) and use of antidepressant medication ($p = .03$) were the only baseline factors associated with cognitive impairment. Cognitive impairment was unrelated to hepatic fibrosis score, HCV RNA viral level, platelet count, duration of infection, age, level of education, IV drug use, cocaine use, CIDI diagnosis, BDI–II score, and medications for anxiety,

diabetes, hypertension. Our results suggest that lower levels of intellectual functioning and antidepressant medication use are independently associated with cognitive impairment in chronic hepatitis C patients. The findings are discussed in relation to the cognitive reserve theory.

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M.J. TAYLOR, S.L. LETENDRE, B.C. SCHWEINSBURG, O.M. ALHASSOON, I. GRANT, & THE HNRC GROUP. Reduced N-Acetylaspartate Related to Hepatitis C Virus Infection in Abstinent Methamphetamine Users.

Hepatitis C virus (HCV) infection and methamphetamine dependence commonly occur together and have individually been associated with neurochemical changes in the brain assessed by magnetic resonance spectroscopy (MRS). This study was designed to evaluate the hypothesis that reductions in N-acetylaspartate (NAA: a marker of neuronal integrity) would be evidenced in individuals with both HCV and methamphetamine dependence, compared to methamphetamine abusers without HCV, and controls. Six abstinent methamphetamine abusers with HCV infection, ten abstinent methamphetamine abusers without HCV infection, and 10 controls were compared on results from proton MRS in frontal white matter, frontal gray matter, and the caudate nucleus. Groups were equated on mean age (40.7 years) and education (12.8 years). *Results:* In the frontal white matter, HCV infected methamphetamine abusers had significantly reduced NAA compared to HCV uninfected methamphetamine abusers and controls [$F(2,23) = 3.52, p < .05$]. In frontal gray matter NAA was significantly reduced in both groups of methamphetamine abusers, and HCV status was not a significant predictor [$F(2,23) = 3.86, p < .05$]. No significant differences were found in the caudate nucleus region. Our findings on the effects of methamphetamine abuse on cortical NAA replicate those noted earlier by Taylor et al. The novel finding in the present study is the possibility that HCV infection independently is associated with reduced NAA concentration in white matter, possibly indicating axonal injury in HCV infected persons who are also methamphetamine abusers. Because our study did not contain an HCV infected group who were not substance abusers, it is unclear if the HCV effect we observed requires prior experience with stimulant drugs.

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R. COLLINS, S. LIPPMAN, & C. MEYERS. The Effects of IFN- α + 13-CRA on Patients With Squamous Cell Carcinoma.

Combination treatment with interferon- α (IFN- α) and 13-cis-retinoic acid (13-CRA) has shown promise in reducing the recurrence of primary skin cancers; however, the IFN- α component of the treatment is associated with depression and cognitive dysfunction. The present study assessed differences in BDI-II (BDI) scores, quality of life (QOL), and verbal fluency in patients diagnosed with squamous cell carcinoma. Patients were assessed prior to randomization to IFN- α and 13-CRA treatment, or surveillance, and again following 3 months on treatment, or surveillance. The initial sample was screened for outliers, and missing data, and all multivariate assumptions were met. The final sample ($n = 36$) was predominantly male, with an average age of 63 and 12 years of education (no groups differences, $p > .05$). A doubly multivariate analysis, with age and education as covariates, revealed a treatment by time interaction. Both groups were similar across all 3 measures at the first assessment. At 3 months, patients treated with IFN- α and 3-CRA evidenced an increase in BDI scores and a decrease in QOL, whereas patients under surveillance evidenced a decrease in BDI scores and an increase in QOL. Only BDI scores were significant in the stepdown analysis of the Treatment \times Time interaction ($p < .05$). Treatment with IFN- α and 13-CRA appeared to have little effect on verbal fluency.

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D.D. CORREA, L.E. ABREY, H. THALER, & L.M. DeANGELIS. Cognitive Outcome in Survivors of Primary CNS Lymphoma (PCNSL).

Combined modality therapy for PCNSL with methotrexate-based chemotherapy (MTX) and whole-brain radiation (WBRT) has been shown to improve patient survival, but may increase the risk for delayed neurotoxicity. Sequelae may include progressive cognitive impairment of sufficient severity to diminish the quality of life in long-term survivors. However, few studies have examined neurocognitive functioning in this population. Twenty-eight patients diagnosed with PCNSL and treated with either combined or single modality therapy, and who were in disease remission participated in the study. The mean age was 60.32 years ($SD = 12.25$), and mean education was 14.75 years ($SD = 3.65$). Median time since diagnosis = 60 months; median time since treatment completion = 37.5 months; 12 patients received WBRT + pre- and post-WBRT chemotherapy; 4 patients received WBRT + pre- or post-WBRT chemotherapy; 11 patients received single modality treatment; 6 patients relapsed and received additional treatment. Preliminary neuropsychological findings showed impaired performance (z score < -1.5) on tests of complex attention, psychomotor speed, cognitive flexibility, memory, and naming. Correlational analyses revealed significant correlations ($p < .01$) between number of brain lesions and memory and naming test scores, and between treatment history and tests of complex attention and executive functions. Planned data analysis will focus on the contribution of treatment modality (combined vs. single agent), disease duration, relapse history, and other relevant variables to both cognitive performance and quality of life. Eight-month follow-up cognitive evaluations are in progress, and the results will be compared to baseline testing to assess progression of cognitive impairment.

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A.J. SAYKIN, T.A. AHLES, J.D. SCHOENFELD, H.A. WISHART, C.G. PIETRAS, C.T. FURSTENBERG, B.C. McDONALD, T.W. McALLISTER, & A.C. MAMOURIAN. Gray Matter Reduction on Voxel-Based Morphometry in Chemotherapy-Treated Cancer Survivors.

Systemic cancer chemotherapy may be associated with neuropsychological deficits in adults. These are often mild but may persist, and memory and executive systems are particularly implicated. We recently reported neuropsychological findings in a cohort of long-time survivors (>5 years) treated for breast cancer and lymphoma. Despite the prevalence of systemic chemotherapy, there has been little attention to cognitive consequences and especially to the neural mechanisms that could account for these changes. Brain imaging has the potential to clarify the neural substrates of these changes. In a preliminary structural neuroimaging study, we recruited long-term survivors of breast cancer treated with chemotherapy ($n = 12$) or local therapy only ($n = 9$) and healthy controls ($n = 12$). Structural MRI scans were acquired on a GE 1.5T LX scanner and included a T1 SPGR 1.5 mm coronal volume and an axial T2 series for lesion identification. We assessed gray matter (GM) density using voxel-based morphometry. SPGR volumes were spatially normalized, segmented, smoothed (FWHM = 10), and contrasted using SPM99. Women treated with chemotherapy showed local bilateral reduction of neocortical GM density in several regions compared to controls. These results provide preliminary evidence of GM changes after chemotherapy. White-matter and brain-activation changes also require assessment. Prospective neuroimaging studies are needed controlling for the range of factors that can influence brain structure, physiology and cognitive function in cancer patients.

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MEMORY

S. COOK, P. DAVIDSON, M. VERFAELLIE, S. RAPCSAK, & E. GLISKY. Memory for September 11th in Brain-Injured Patients.

Flashbulb memories are vivid, enduring memories for the circumstances surrounding learning about surprising or shocking events. It thus involves memory for the source of event information as opposed to memory for the event itself. The brain regions involved in flashbulb memories, however, are uncertain. Although medial temporal lobe/diencephalic (MTL/D) damage impairs content memory, frontal lobe (FL) damage has been associated with impaired source memory. One would therefore expect that flashbulb memories should depend on the FLs. However, in an unpublished study by Kapur, FL patients exhibited normal flashbulb memories for Princess Diana's death, whereas amnesic patients with MTL/D damage, although aware that Princess Diana had died, did not know how they acquired this information. Davidson and Glisky also found no relationship between FL performance and flashbulb memories of Princess Diana's death in older adults. In the current study, we examined memory for the events of, and circumstances surrounding learning about, September 11th in amnesic patients with MTL/D damage, FL patients, and a control group. The results indicated that although the MTL/D patients were impaired in memory for the event itself, those patients who did recall the event were relatively unimpaired in memory for the source of that information. Conversely, the FL patients showed relatively preserved memory for the 9-11 events, but memory for the source of that knowledge was impaired.

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D. WEGESIN, J. REAM, R. BASNER, & Y. STERN. Effects of Sustained Sleep Deprivation on Source Memory.

Neuropsychological testing and brain imaging have revealed preferential impairment of prefrontal cortical function after sleep deprivation. The current study examined the effects of sleep deprivation on source memory, a mnemonic function thought to rely on prefrontal areas. Sixteen young participants (age 20–30 years) completed an item/source memory task, after zero, 24 and 36 hr of sustained sleep deprivation. For the task, participants studied 2 lists of sentences (List 1 and List 2 in sequence). During the test phase, a series of nouns (half seen during study; have new) were sequentially presented. For words judged old, participants were asked to name the source of the word, i.e., List 1 or List 2. Results revealed that recognition of old items was relatively unaffected by sleep deprivation, whereas remembering the source of the studied items was impaired after 36 hr of sleep deprivation. Further, though response latency was unaffected by sleep deprivation, intraindividual variability in reaction time measures increased linearly with increasing sleep deprivation. Intraindividual variability reflects transient fluctuations in performance within a task and has been reported in patients with frontal lobe damage. Together, these data provide evidence suggesting that processes subserved by the frontal lobes may be particularly vulnerable to the effects of sleep deprivation.

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M. COATES & R. LAFORCE. Strength of Interference in the Brown-Peterson Paradigm.

The Brown-Peterson Paradigm (BP) is a widely used measure of working memory which requires subjects to count backwards by intervals of threes, while retaining a consonant trigram. It has not been determined whether strength of interference affects a participant's score on this task. Previous studies of dual task paradigms have found that this may modulate performance. The goal of this research was therefore to examine the strength of interference in the BP by correlating performance with arithmetic ability and by manipulating the level of complexity of the task. Fifty participants (*M* age: 20.8 years) were given a test of arithmetic and 2 versions of the

BP (the standard version and a modified version, MBP, requiring more complex computations). Results of the comparison between BP and MBP scores indicated a significant difference only for the most demanding attentional condition (i.e., the longest delay, 18 s). Mathematical abilities were significantly correlated with performance on the MBP, but not on the BP. Because most subjects had relatively high mathematical ability, it was decided to divide them into groups of low and high mathematical ability to explore whether arithmetic ability facilitates performance on this task. As expected, a significant difference emerged on both the BP and MBP. Speed of information processing was not a contributory factor. Altogether, these results suggest that strength of interference plays a role in the BP paradigm. Future studies should involve populations with a greater range of mathematical ability to further examine this relationship. Correspondence: *Mark Coates, School of Psychology, University of Ottawa, Lamoureux Hall, 145 Jean-Jacques-Lussier Street, PO Box 450, Station A, Ottawa, ON K1N 6N5, Canada. E-mail: markc7@hotmail.com*

R. TEMPLE, A. McBRIDE, R. TAYLOR, & M. HORNER. The Role of Attention and Executive Functioning in CVLT–II Performance.

Research has demonstrated relationships between measures of executive functioning (EF) and the California Verbal Learning Test (CVLT). The research is unclear, however, as to whether these relationships reflect the specific influence of EF's, or basic cognitive competency. In the present study, multiple regression analyses were used to clarify the contributions of EF and attention (a non-executive domain) to CVLT–II performance. Participants were 86 veterans (69 male, 7 female) who completed a clinical neuropsychological evaluation that included the CVLT–II, Wisconsin Card Sorting Test (WCST), and WMS–III Digit Span (DS). It was predicted that EF's (operationalized as WCST performance), and attention (operationalized as DS performance) would contribute independently to CVLT–II performance. The predictors tested in the first model were WCST categories completed, total errors, percent perseverative errors, and failures to maintain set. The outcome variables (each tested in a separate equation) were CVLT–II List A Total, short- and long-delayed free and cued recall (SDFR, LDFR, SDCR, LDCR), percent recall consistency, and semantic clustering. WCST total errors significantly predicted CVLT–II List A Total, SDFR, and LDCR (all *F*s > 4.9, *p*s < .04). The second model was identical to the first, with the addition of DS as a predictor. In this model, WCST total errors predicted List A Total, SDFR, SDCR, LDFR, LDCR, semantic clustering, and percent recall consistency (all *F*s > 4.0, *p*s < .05). DS predicted semantic clustering and percent recall consistency. These results support the hypothesis that EF's uniquely contribute to CVLT–II performance, and this contribution is not simply attributable to attentional processes.

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J. GAINES, A. SHAPIRO, M. ALT, & R. BENEDICT. Semantic Clustering Indices for the Hopkins Verbal Learning Test–Revised.

The revised version of the Hopkins Verbal Learning Test is a brief test of verbal learning and memory with 6 alternate forms. This study examined the validity of newly developed semantic clustering indices for the HVLt–R. Participants were normal elderly persons drawn from the HVLt–R standardization sample, and demographically matched patients diagnosed with Dementia of the Alzheimer's type (DAT), vascular dementia (VaD), and major depressive disorder (MDD). Raw clustering scores were calculated as the number of times a correct word was followed by another correct word from the same category. Ratio clustering scores were then calculated by dividing raw clustering scores by the number of correct words recalled during a trial. Comparison of group means revealed that DAT, VaD and MDD groups all had consistently lower ratio clustering scores than healthy controls. In addition, DAT and VaD groups had lower clustering scores than MDD patients, and DAT patients had lower clustering scores on the delayed recall trial than VaD patients. Principal components factor analysis including a range of neuropsychological test indices revealed a seman-

tic clustering factor distinct from verbal learning and recall, nonverbal learning and recall, generative/semantic fluency and naming, and executive function factors. The results suggest that semantic clustering indices are a useful and sensitive measure of verbal learning that can discriminate these diagnostic groups.

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A. LUNDERVOLD, H. NORDBY, T. ØDELIEN, I. REINVANG, K. SUNDET, A.-K. SOLBAKK, & S. ANDERSSON. Verbal Memory Function and Brain Activity.

The aim of the present study was to examine the relationship between neuropsychological measures of verbal memory function and electrophysiological measures of brain activity associated with early stages of auditory information processing. Brain activity was assessed by recording event-related potentials (ERPs) to composite sounds of two different durations (75 and 25 ms) that occurred with different probabilities (.9 and .1). A total of 2000 stimuli were presented at 250 ms intervals in a randomized sequence. The deviant stimulus, having the shorter duration and lower probability, elicited a negative ERP wave indicative of the mismatch negativity (MMN). The MMN component indexes the efficiency of immediate auditory processing. Verbal memory function was assessed by Digit Span from WAIS-R and California Verbal Learning Test (CVLT). Eighty-six normal controls (M age = 28.76 years, M education = 14.44 years) were included in a study of the relation between aspects of verbal memory function and the MMN. We found a statistically significant correlation between the MMN amplitude and measures of immediate memory: Digit Span and the first presentation of List A in CVLT. Our results indicate that the efficiency of early information processing is critical when immediate verbal memory is called for. In general, we suggest that the relation between different “stages” of information processing, as assessed by the ERP “profile” of individual subjects, should be included in a neuropsychological evaluation of patients with diffuse verbal memory complaints. Further analyses of the relation between different ERP components and different aspects of memory function are in progress.

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L.C. BAXTER, L.S. SUSSKIND-WILDER, D.J. CONNOR, M.N. SAB-BAGH, & S.C. JOHNSON. Hippocampal Activation to Familiar Information Is Related to Memory Ability.

Successful retrieval of previously learned (familiar) information is compromised in Alzheimer’s disease, likely due to the degeneration of the hippocampal region. Discrimination of familiarity and novelty is a useful way to study the neural activity associated with retrieval. We compared the fMRI neural response to familiar items in a group of elderly participants with and without retrieval deficits. We hypothesized that those with better recall would show greater hippocampal activity when recognizing familiar items. *Methods:* Participants: Eleven right-handed, healthy volunteers: mean age = 78.7, SD = 6.9; mean MMSE = 27.5, SD = 1.9. Long Delayed Free Recall (LDFR) on the California Verbal Learning Test-II was used to estimate retrieval ability. Participants were grouped based on LDFR scores: ≥ 9 words (n = 6); < 9 words (n = 5). Prior to scanning, participants learned 5 line drawings which were then randomly presented intermixed with novel ones during scanning. Participants decided if each item was familiar (F) or novel (N). fMRI images were processed using SPM99. Individual maps reflecting activation during the familiar condition ($F > N$) were entered in a random effects t test analysis comparing high and low LDFR scorers. *Results:* Bilateral hippocampal activity was observed for high vs. low scorers (*left:* Talairach coordinates -18, -28, -16; T = 4.58, p < .001; *right:* Talairach coordinates 20, -20, -14, T = 4.55; p < .001). *Conclusion:* This preliminary study found that people with better CVLT recall showed better hippocampal activity when recognizing familiar items. Further studies will investigate hippocampal contribution to both encoding and retrieval processes.

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A. BERARDI & N. GAUVRIT. Short-Term Memory Recall With Semantic Versus Lexical and Explicit Versus Implicit Categories.

Semantic categories are known to improve short-term memory (STM) recall. The objective of this study was to compare the effect of semantic vs. lexical categories and of explicit vs. implicit categories on STM recall. A total of 103 healthy young subjects (age range: 18–22 years) were administered a 16-word STM task. Words were presented for 1 min on a sheet of paper either in random order on a column, or in 4 columns with words grouped by semantic category (cloths, foods, buildings, actions) or by lexical category (current, popular, sustained, unusual words). Words were also presented according to implicit or explicit categories. In the explicit condition, categories were explicitly named; in the implicit condition they were not. Subjects in the different groups were matched on vocabulary test scores. After the STM learning phase, subjects were administered a 1-min interference task. They then recalled as many words as possible from the STM list. Results were analyzed using ANOVAs with 2 factors: type of category (random, semantic, lexical), and type of presentation (explicit, implicit). Results indicated that semantic categories improved STM recall (p = .0001) compared to both lexical categories and random order (which in turn did not differ from each other). Implicit categories lead to better STM recall than explicit categories (p = .02), presumably because they did not interfere with STM learning. The results suggest that semantic and implicit categories are more effective than lexical and explicit categories in improving STM recall.

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J. KIXMILLER, R. FITZSIMMONS, E. HEEREY, & C. RANDALL-WALKER. Investigation of a Prospective Memory Task to Assess Prospective Memory Performance.

Prospective memory (PM) refers to remembering to perform an intention in the future at a certain time or under certain circumstances. This type of memory has obvious implications for day-to-day functioning yet is understudied. The Rivermead Behavioral Memory Test does include prospective memory tasks which correspond to real world functioning in patients with brain-damage and AD. A disadvantage of this test is that it is not appropriate for use in clinical settings (i.e., limited time and space). In an attempt to remedy this, a simple, single-item PM question was asked of patients prior to administering the Mini Mental Status Examination (MMSE). The item requested patients to first provide the examiner a personal item and then remember to ask for it back at the end of the test. If patients failed to request the item spontaneously, they were given a verbal cue, (“Wasn’t there something you were going to ask me at the end of the test?”) to see if they could then recall the PM task with a prompt. Correlations were computed between those patients who did and did not recall the PM item with select subtest MMSE scores. For patients who did freely recall the PM item, PM correlated with age and performance on the total MMSE score, orientation, 3-step command, and 3-item recall, and 3-item cued recall subtasks of the MMSE. For patients who did not pass, PM failure correlated significantly with total MMSE score orientation, 3-step command, and 3-item cued recall but did not with 3-item free recall or age. Results are discussed with regard to PM assessment and future research directions.

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W.A. LAW, R.L. KANE, J.R. ASHBURN, S. KIM, R. COLL, & P.A. DEUSTER. Cognitive Inefficiency After Exercise Stress: Resistance to Tyrosine Enhancement.

Individuals can be classified as high or low physiological stress responders based on an exercise-induced glucocorticoid reaction that corresponds with increased striatal dopamine (DA) turnover. Under nonstress conditions, enhanced working memory performance has been demonstrated following administration of supplemental tyrosine, a precursor of DA metabolism in the brain. Based on known relationships between exercise and

DA turnover, DA and prefrontal functioning, and exercise effects on cognition, we hypothesized that exercise stress would impact processing efficiency, the central executive component of working memory. Cognitive processing efficiency pre- and post-treadmill exercise was evaluated under tyrosine supplement and placebo conditions in physiological high and low stress responders. After establishing stable responding (minimum of 5 practice trials) on the NASA-1 Spaceflight Cognitive Assessment Tool (Version 2.2), cognitive processing efficiency changes associated with exercise and supplemental tyrosine were evaluated in 14 healthy males (ages 20–45, education 16–20 years; 6 high stress responders). A combined between groups (high/low stress reactors) and within subjects (exercise and tyrosine supplement conditions) repeated measures ANOVA yielded a significant cubic trend across the 4 treatment trials (pre-exercise/tyrosine, post-exercise/tyrosine, pre-exercise/placebo and post-exercise/placebo: [$F(1,13) = 6.82, p < .05$], reflecting a significant effect of exercise [pre- post-exercise: $F(1,13) = 8.53, p < .05$]. Tyrosine supplementation did not improve performance [tyrosine vs. placebo: $F(1,13) = .026, p > .10$] and there was no significant group effect [high vs. low reactors: $F(1,12) = 1.21, p > .1$].

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S. CAVACO, S.W. ANDERSON, & A. CASTRO-CALDAS. Parameters of Procedural Memory in Amnesia.

To explore the scope and duration of preserved procedural memory in amnesia and its possible application in cognitive rehabilitation, the performances of 9 amnesics (3 HSE, 5 anoxics, and 1 thalamic stroke) were compared to those of 40 matched normal controls on 6 new perceptual-motor skill tasks based on real world activities. The 1st task consisted of pressing a sequence of 5 buttons, without visual contact with the hand. The 2nd and 3rd tasks consisted of tracking constant series of 8 target locations using respectively a joystick and a steering wheel in the reverse mode (i.e., the cursor move in the opposite direction as the device). The 4th task consisted of weaving fabric with an actual loom, by performing a recurrent 5-step routine. The 5th consisted of tracing geometric figures with a stylus on a touch screen monitor. The 6th consisted of pouring water from a small watering can into graduated containers, from a point at 20 cm distance. These tasks were repeated 24 hr and 2 months following initial training. The amnesics were able to acquire all skills at a level comparable to controls, and demonstrated similar pattern of retention over 24 hr and 2 months. Preserved procedural learning of complex perceptual-motor skills in individuals with severe amnesia for declarative information was shown to be a robust phenomenon, demonstrated across a variety of stimulus conditions and perceptual-motor demands. These findings introduce new possibilities in the rehabilitation of patients with moderate to severe declarative memory impairment.

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C.B. FORTIER, J.F. DISTERHOFT, S. CAPOZZI, & R. McGLINCHEY-BERROTH. Conditional Discrimination Learning in Bilateral Medial Temporal Lobe Amnesic Patients.

This study investigated the ability of bilateral medial temporal (MT) lobe amnesics to learn a conditional discrimination (CD) using eyeblink classical conditioning. Daum and colleagues found that unilateral temporal lobe patients were impaired in their ability to differentially respond to reinforced (S+) and nonreinforced (S-) trials in a CD paradigm. It is unclear from their study whether the temporal separation (1 s) between the S+/S- (light conditional stimulus) and the CS (tone conditioned stimulus) or the ability to acquire the conditional discrimination itself led to the observed impairment. We replicated the findings of Daum in our group of 7 bilateral MT amnesics and 8 matched control participants (NCs). A Group \times Condition repeated measures ANOVA revealed a significant interaction [$F(1,13) = 7.60, p < .05$] indicating that NCs were able to differentially respond on S+ ($M = 66\%$) Conditioned Response (CR) versus S- ($M = 30$) trials as compared to MTs, who were impaired in

their ability to acquire the conditional discrimination (S+ $M = 49$; S- $M = 39$). In Experiment 2, the temporal separation between the light and tone was eliminated. By eliminating the temporal processing requirement, it was hypothesized that amnesics might show successful conditional discrimination learning. To date, 7 MTs and 6 NCs have been tested. Preliminary results indicate that whereas NCs were able to acquire the conditional discrimination (S+ = 68; S- = 29), MTs were able to differentially respond to S+ ($M = 42$) vs. S- trials ($M = 37$). These findings support Daum et al.'s original hypothesis indicating the hippocampus is essential in forming a conditional discrimination in a delay paradigm.

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M. VAN ASSELEN, E. FRITSCHY, & A. POSTMA. Automatic and Effortful Components of Route Learning.

Since route learning is a process that is important for survival, it would benefit from automatic processing. According to Hasher and Zacks automatic memory processes must fulfil a number of criteria. One of these criteria states that automatic memory processes are not enhanced by intention to learn. In order to study whether route learning is an automatic process, 34 young adults were asked to meet the experimenter at a certain place in the university building. From this point participants walked to the test room following a predetermined route. Half of the participants were instructed to pay attention to the route. The other half was only told they were going to the test room, where the experiment would take place. None of the latter participants was aware of the purpose of the experiment until they were tested. Four tasks were used: recognition of landmarks, temporospatially ordering landmarks, drawing a map, and retracing the route. The intentional group was significantly better than the incidental group in drawing a map and retracing the route. However, no difference between the intentional and incidental group was found for the recognition of landmarks, and temporospatially ordering landmarks. In conclusion, it seems that landmark processing and temporospatially sequencing are automatic, while developing a maplike representation of a route and navigation are more effortful. These results are of great importance to the study of neurological patients with route learning disorders due to lesions in the hippocampus and temporal lobe.

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J.S. SMIGIELSKI, T.F. BERGQUIST, & Y.E. GEDA. Frontal Cognitive and Behavioral Symptoms in a Case of Bithalamic Infarction.

In recent years, an improved understanding of the relationship between subcortical processes and higher level cognitive functions has developed. Lichten and Cummings have provided a particularly useful explanation of the connections between thalamic nuclei and frontal brain regions. We present the case of a 50-year-old woman with bithalamic infarctions, which provides a striking example of the manner in which subcortical lesions may manifest symptoms that are commonly associated with primary frontal lobe dysfunction. This patient experienced her neurologic event as a complication of a cardiac procedure. She did not have a concurrent or previous history of disseminated cerebral vascular or cardiovascular disease, and thus is more likely to represent a "pure" thalamic syndrome. Clinically, she initially demonstrated a marked amnesic and dysexecutive syndrome. Data are presented from initial and follow-up neuropsychological evaluations. The initial exam about one-month post initial neurologic event utilized the Repeatable Battery for the Assessment of Neuropsychological Status (Form A). Follow-up examination 2 months later consisted of a comprehensive neuropsychological test battery. Scores from these assessments are presented, along with supplementary information from clinical observations, neuroradiologic evaluations and neuropsychiatric/behavioral neurology examination. Findings show the initial prominence of dysexecutive and amnesic symptoms, along with elements of mood and personality changes. Follow-up assessment information shows the

natural history of early recovery in this syndrome. The relationship of these findings to the underlying neuroanatomic connections is discussed, with specific reference to the orbitofrontal circuit syndrome per Lichter and Cummings. Approaches to the rehabilitation of residual deficits are reviewed.

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K. HEGDE & R. WEST. Active Memory and Subgoal Processing in a Vertigo Patient.

The concept of cognitive branching to maintain primary task goals while concurrently allocating attention to subgoals is of particular interest when assessing cognitive inefficiencies among clinical patients. This study presents the case of a 49-year-old, male with a high school education with a history of vertigo and relatively more recent cognitive inefficiencies. The patient had undergone extensive ENT and neurological, including CT, assessment that produced unremarkable results. During an initial assessment he complained of word-finding difficulties, problems related to aural comprehension, and cognitive fixedness with concomitant difficulty organizing, sequencing, and performing multiple step tasks. He also suggested that these problems were compounded when multiple stimuli needed to be evaluated. In contrast, the patient's speech was spontaneous, fluent, non-paraphasic, nondysprosodic, and without salient word-finding difficulty during conversation. The patient appeared to be cognitively intact (i.e., he performed within normal range on tests of short-term, immediate and delayed memory, vocabulary, and visuospatial abilities) with notable exceptions reflecting an apparent deficit in his ability to rapidly shift between information represented in active memory (e.g., he scored in the ninth percentile on the digit symbol task; demonstrated a marked discrepancy between his performance on forward and backward digit spans; encountered difficulty on a measure of nonverbal abstraction and concept formation (short category test); and he experienced difficulty on Trails A and B. He also committed multiple left hand suppressions on a double simultaneous processing task on sensory perception examination and responded positively to having multiple depressive symptoms.

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D. FLODEN, D.T. STUSS, C. GOJMERAC, M.P. ALEXANDER, D. KATZ, & D. IZUKAWA. Memory Interference Effects in Focal Lesion Patients.

Sixty-two patients with focal brain lesions completed a task assessing memory function under conditions of interference. The Brown-Peterson or Consonant Trigrams test has been well-researched in normal populations and furnishes multiple performance measures. Prior work in Korsakoff's patients and leukotomized schizophrenics points to heightened susceptibility to interference in orbitofrontal damage. We hypothesized that interference would have dissociable effects on the performance of patient subgroups based on lesion location in specific frontal *versus* non-frontal areas. Some, but not all, of our predictions were confirmed. The pattern of recall overall and at varying retention intervals was dependent upon the location of the damage in addition to the age and education of the patient. This work further supports the fractionation of the frontal lobes into functionally distinct areas and highlights the possible dissociations that may be detectable with a simple clinical test such as this.

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S. CAVACO, S.W. ANDERSON, & A. CASTRO-CALDAS. Procedural Memory for Spatially Defined Sequences in Amnesia.

It has been demonstrated that amnesics can learn specific sequences of responses to a series of discrete stimuli on the Serial Reaction Time Task. The question remains as to whether they can learn specific sequences of responses to non-discrete stimuli (i.e., defined only by spatial location,

and without defined boundaries). Such stimuli minimize the opportunity for verbal encoding or other declarative processing, thus further isolating procedural learning. The performances of 9 amnesic patients (3 HSE, 5 anoxics, and 1 thalamic CVA) and 40 matched normal controls were compared on a new perceptual-motor skill task. Training occurred over 2 days. The task consisted of tracking targets using a joystick in the reverse mode (i.e., the cursor moves in the opposite direction as the joystick). The subjects were asked to track a target with a cursor displayed on a horizontal bar, and press the trigger on the joystick when the 2 lines were matched. An embedded sequence of 8 target locations was continuously repeated 5 times per block. A novel set of targets was introduced on the final trial. The dependent measure was time to produce an accurate response. The amnesics showed normal learning and retention of the general perceptual-motor skill, and also showed normal learning of specific knowledge concerning the series of nondiscrete stimuli, demonstrated by a significant increase in reaction time to the novel set of target locations. In conclusion, amnesics can learn less constrained and more complex procedural memory tasks than previously demonstrated.

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E. GLISKY, S. RAPCSAK, L. RYAN, A. SOULE, & J. LAGUNA. Recall and Recognition Deficits in a Patient With Limited Hippocampal Damage.

Although damage to medial temporal brain regions has been reliably associated with an amnesic syndrome, there has been debate concerning whether bilateral damage to the hippocampal formation is sufficient to produce a global anterograde amnesia, affecting both recall and recognition. The alternative view asserts that such global impairment depends on more extensive damage that includes adjacent cortical regions, including perirhinal or parahippocampal cortex, and that damage confined to the hippocampus should impair recall but leave recognition memory relatively intact. We present a case study of Mr. R., a 71-year-old male with restricted lesions to the hippocampal formation bilaterally, confirmed by structural MRI. Despite the restricted lesion, Mr. R. exhibits a severe and global amnesia, affecting both verbal and visual episodic memory, and recall and recognition. Based on neuropsychological tests of recall and recognition memory, including the WMS-III, CVLT, Doors and People and the Warrington Recognition Memory Test, there is no indication that recognition memory is any less affected than recall. Mr. R. also reveals a severe retrograde amnesia for the events of his entire life with no clear indication of a temporal gradient. Nevertheless, he retains some personal semantic information about his past (although he is impaired), and appears to have intact knowledge of words that have entered the language at different times over the past 40–50 years. These findings implicate the hippocampal formation in both recall and recognition of episodic and autobiographical information.

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A. OGINO, Y. IKEJIRI, N. HATTA, T. NISHIKAWA, & M. TAKEDA. Basal Forebrain Amnesia Due to the Left Unilateral Lesion.

Background: Cases of amnesia with basal forebrain damage have been reported, although relationship between laterality of the lesion and variance of symptomatology has been unclear. *Objective:* We report a case of amnesia with a left unilateral basal forebrain lesion. *Methods and Results:* Case report. A 52-year-old, right-handed man had repeated attacks of complex partial seizure for 15 years. A CT scan of the brain revealed a tumor in the left basal forebrain. He underwent tumor removal operation, and his cognitive function was examined before and after the operation. Preoperative neuropsychological tests revealed mild impairment of attention and verbal memory. Postoperatively, he developed severe verbal and mild visual anterograde amnesia. He also showed retrograde amnesia and temporal order amnesia. An MRI after the operation demonstrated a confined left-side lesion including the septal nuclei, the nuclei of the diagonal band of Broca, the subcallosal area, and a part of the nucleus accumbens.

Conclusion: This case demonstrated that basal forebrain amnesia can be caused by left unilateral lesion, and that modality specificity (verbal and visual) in amnesia may exist according to the lesion side.

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M.I. BOULOS, K.K. ZAKZANIS, & A.A. ASHAMALLA. ERPs Associated With Word Recognition for a Patient With Amnesia.

The effects of a variable time delay (between study and test) and brain damage on the event-related potentials (ERPs) elicited during word recognition were examined. Previous research has shown that, on frontal recording sites, the correct recognition of old words is typically associated with two topographically distinct ERP old/new effects: an early, bilateral effect and a late, right-sided effect. During the current study, 26 students were taught a list of words and returned 1, 2, or 3 weeks later to perform a recognition task. A patient (F.P.), who had frontal and hippocampal lesions, was tested during a single session and had a 20-min delay between study and recognition trial. During all recognition tasks, right prefrontal activity was measured by electroencephalogram (EEG). Analysis of the ERPs in all the healthy participants revealed an old/new effect, which did not diminish with increasing retention intervals. The 1-week delay subjects elicited the greatest early, bilateral frontal activity, while the 2- and 3-week delay subjects elicited the greatest late, right frontal activity. These results support the view that the early effect is familiarity-driven, while the late effect functions to monitor retrieval. In the patient, the correctly classified *new* words, relative to the correctly classified *old* words, elicited the 2 positive-going deflections. To our knowledge, this is the first report of a reversal in the electrophysiology of the old/new effect. This effect can be thought of as a *new/old effect*, and may be a marker for certain brain injuries.

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J. OUELLET, I. ROULEAU, R. LABRECQUE, & P. SCHERZER. Two Routes to Losing One's (Past) Life: A Cerebral Insult (a Projectile), an Emotional Trauma.

We report 2 cases with profound, selective and permanent retrograde amnesia. In the first case, the retrograde amnesia followed a traumatic focal injury to the right temporal lobe (nail gun accident). The 2nd case is a 46-year-old female patient who was admitted to the hospital in 1998 after an aborted suicide attempt (she was stopped from jumping from a window). The scan performed at that time was negative. In both cases, pre-morbid autobiographical memory for people, places, and events was lost, and no feeling of familiarity was experienced during relearning. Both cases showed mild deficits on memory tests but neither presented any anterograde amnesia. In addition, both cases showed loss of some knowledge acquired prior to the onset of the amnesia. This contrasts with the relative preservation of some complex skills (repairing electronic circuits in Case 1 and typing in Case 2) without awareness of prior knowledge of these skills. These two cases share a common clinical profile although their aetiology is totally different. They will be discussed as a function of the mechanisms underlying the retrieval of remote memories.

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K. MCCOY, T. WARNER, L. ROTH, & A.B. MOORE. BVMT-R Normative Data for a Stroke Population: Means and T-Score Distributions.

Brevity, ease of administration, alternate forms, and learning trials contribute to the usefulness of the Brief Visuospatial Memory Test-Revised (BVMT-R) for assessing visual memory and learning in neurologically impaired populations. However, normative data for the BVMT-R is cur-

rently incomplete due to a lack of data reflecting the performance of stroke patients. Seventy-two post-stroke adults (*M* age 63.3 years, education 13.4 years) were administered the BVMT-R an average of 51 months post stroke. The sample included patients with bilateral (*n* = 8), left hemisphere (*n* = 45), and right hemisphere (*n* = 19) strokes of various etiologies. Right-handed (87.5%) White (85%) males (62.5%) composed the majority of the sample. Mean trial, recall, and learning scores were compared to those of the five distinct neurologically impaired groups and age-matched normal controls in the BVMT-R manual. Results indicate that stroke patients were significantly more impaired than normal controls on Trial 2 and Total Recall. Stroke patients performed significantly better on most indices than groups with vascular/mixed dementia or DAT but did not differ from groups with HIV-1 dementia or HIV-1 minor cognitive/motor disorder. Compared to amnesic patients, the stroke patients showed superior performance on learning and delayed recall. Additionally, T-score distributions for all the stroke patients' BVMT-R scores provide a much-needed supplement to the current manual.

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TBI: PSYCHOSOCIAL FACTORS

M. SCHEXNAYDER, D. NEMETH, L. CENAC, T. JENNINGS, K. WALTERS, K. RAY, & J. HAMILTON. The Effects of Multiple Brain Injuries on Adaptive Functioning.

Two women who had each experienced 3 traumatic brain injuries, 1 due to 3 separate motor vehicle accidents and the other due to one equestrian accident and two motor vehicle accidents, displayed similar affective yet different behavioral sequelae. Patient A, a 52-year-old, married, White female, displayed a pattern of anterior involvement. Patient B, a 37-year-old, single, White female, displayed a pattern of posterior involvement. Both had strongly compromised left hemispheres. Both were ambidextrous. Both had premorbid estimated Full Scale IQs of 103. Both experienced major neurocognitive disorders and depressive sequelae. In this regard, both exhibited the exaggeration of affective experience and response. Patient A, however, exhibited severe problems in impulse control and judgment. She often seemed unaware of her deficits and failed to learn from experience. Patient B was keenly aware of her deficits and would dissolve into histrionic tears when confronted with them (e.g., when she was unable to do simple arithmetic and sequencing problems). Patient A, therefore, was plagued by constant, ongoing interpersonal problems, usually of her own making. Whereas, Patient B tended to experience more intrapsychic distress and responded with Pollyannish avoidance. As both were considered to be maladaptive outcomes, each patient is being followed psychiatrically and psychotherapeutically.

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M. SHERER, R. NAKASE-THOMPSON, T. NICK, & S. YABLON. Patterns of Neurobehavioral Deficits in TBI Patients at Rehabilitation Admission.

Patients with significant traumatic brain injuries (TBI) show a variety of neurobehavioral deficits in the early period after injury. Our research on the post-traumatic confusional state has indicated that key early symptoms are disorientation, cognitive impairment, agitation, fluctuation of symptoms, sleep disturbance, daytime hypoarousal, and psychotic type symptoms. Using cluster analysis, we investigated patterns of these symptoms shown in 62 patients with moderate and severe TBI at admission to inpatient rehabilitation. Four clusters of symptoms emerged. Patients in 2 clusters exhibited post-traumatic confusion (PTC) while patients in the other 2 clusters were not confused. Patients in the most frequent of the 2 PTC clusters (*n* = 27) were characterized by agitation and a high occurrence of psychotic-type symptoms. Patients in the second PTC cluster

($n = 17$) were characterized by hypoarousal, absence of agitation, and a low occurrence of psychotic-type symptoms. Patients in both PTC clusters has high incidences of disorientation and/or cognitive impairment. Patients in the first non-confused cluster ($n = 12$) were characterized by no symptoms or cognitive impairment without disorientation. Patients in the second non-confused cluster ($n = 6$) were characterized by disturbed level of arousal as indicated by sleep disturbance and daytime hypoarousal. As would be expected, patients in the 2 PTC clusters sustained more severe injuries than those in the nonconfused clusters (*MDN* Glasgow Coma Scale scores = 7 and 8 vs. 11 and 10). These preliminary findings may lead to a nomenclature of confusion that will facilitate differential treatment for different patterns of symptoms.

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R. NAKASE-THOMPSON, M. SHERER, S.A. YABLON, T. NICK, & P. TREPACZ. Predictors of Acute Confusion Following Traumatic Brain Injury.

Impaired consciousness after traumatic brain injury (TBI) manifests in a variety of neurobehavioral impairments. This phase of recovery is commonly called post-traumatic amnesia (PTA) and investigations have primarily focused on disorientation and amnesia. Recent findings have emphasized the role of attentional impairments and consideration of this stage as one of confusion. This study compared traditional indices of PTA, confusion, cognition, and motor restlessness among neuro-rehabilitation admissions with TBI. Eighty-six consecutive NIDRR TBI Model System patients during inpatient rehabilitation were evaluated weekly during hospitalization yielding 357 observations. All were evaluated using the Galveston Orientation Amnesia Test (GOAT), Agitated Behavior Scale (ABS), Delirium Rating Scale (DelRS), DSM-IV Delirium Diagnostic Criteria (DDC), and Cognitive Test of Delirium (CTD). Multivariable logistic regression analyses revealed significant inter-quartile range odds ratio (IQR-OR) for GOAT (.35, $p = .01$), CTD (.31, $p < .001$), DelRS (10.1, $p < .001$), and time elapsed since injury (.45, $p = .04$) but not ABS, severity of injury, age, and education. The IQR-OR compared the odds of meeting DDC for subjects scoring at the 75th percentile with those scoring at the 25th percentile. For example, individuals with a GOAT score of 88 (75th %ile) were 35% less likely to meet DDC than individuals with a score of 32 (25th %ile). These findings suggest impaired consciousness after TBI is a multi-dimensional state consisting of disorientation, impaired cognition, and confusion. Improvement in our understanding of the multi-faceted nature of altered consciousness following TBI has implications improving prediction of long-term outcomes and the kind of therapies attempted during this stage of recovery.

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T. HART, J. WHYTE, R. FIDLER-SHEPPARD, M. POLANSKY, & G. KERSEY-MATUSIAK. Are Racial Differences in TBI Outcome Due to Differences in Pre-Injury Status?

Research on traumatic brain injury (TBI) has reported less favorable community outcomes for persons from racial/ethnic minorities compared to Whites. This study is following cohorts of African Americans ($n = 46$) and Whites ($n = 65$) with moderate to severe TBI to determine whether outcome differences may be related to (1) differential sensitivity of outcome measures across ethnic groups; (2) pre-injury differences in employment and other social factors. Subjects were recruited from inpatient/outpatient TBI rehabilitation and carefully screened for ability to provide reliable pre-injury information. A multi-racial focus group developed questions and selected outcome measures from the TBI Model System protocol. Pre-injury status was measured retrospectively as soon as feasible after injury. Outcome was assessed with the identical measures at 1 year post injury. Results from the first 70 subjects in follow-up (40 White, 30 African American) revealed that the 2 groups, derived from the same urban catchment area, did not differ on pre-injury education, income and

employment rate (>75% in both groups), nor on injury severity variables. Groups were also similar in premorbid community integration, satisfaction with life, and other psychosocial measures. However, racial differences were observed in some 1-year outcomes. While post-TBI employment rates were statistically equivalent (Whites 50%, African Americans 40%), income was significantly lower than premorbid income only for African Americans. African Americans also scored lower in social integration, reporting less contact with friends and fewer activities, even on items written to counteract measurement biases. Changes in life satisfaction, and across to rehabilitation services, did not vary by race. Results suggest that some TBI outcomes differ by race even when pre-injury demographic profiles are similar across groups.

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S. BROWN, S. McCAULEY, H. LEVIN, C. BOAKE, & C. CON-TANT. Gender Differences for Psychiatric Disorders and Outcome After Mild-to-Moderate TBI.

Mild-to-moderate traumatic brain injury occurs in females half as frequently as males, although females are at greater risk for developing a psychiatric disturbance. Gender differences for psychiatric disorders and outcome after mild-to-moderate TBI (MTBI) were assessed 6-months post injury, using the Structured Clinical Interview for DSM-IV, Glasgow Outcome Scale-Extended (GOS-E), and Short Form-36 (SF-36) in 55 female and 111 male patients. The groups were comparable for age, education, injury severity, and Glasgow Coma Scale score. Female MTBI patients met diagnostic criteria for psychiatric disorders nearly twice as often as that of males for postconcussive disorder (16% vs. 9%), major depressive episode (MDE, 18% vs. 8%), and posttraumatic stress disorder (PTSD) (18% vs. 3%). Of these disorders, the proportion of females meeting criteria for PTSD was significantly different ($p = .0001$) from that of males, while the difference in proportions of females to males for MDE approached significance ($p = .07$). Item analysis of PTSD symptomatology revealed a significant effect for endorsement for hypervigilance ($p = .04$). All female patients with PTSD reported being hypervigilant, while no male patient endorsed this symptom. Outcome was affected by gender. Within GOS-E outcome categories, a greater proportion of females (13/19, 68%) than males (11/31, 35%) functioned at the moderate disability lower level ($n = .04$) category; no differences were noted within the good recovery category. On the SF-36, females reported worse mental health functioning ($p = .013$) than males. In conclusion, female patients have more difficulty with management of stress following MTBI, which may contribute to development of psychiatric disorders and worse functional outcome.

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M.A. KEISKI, D.L. SHORE, & J.M. HAMILTON. Lateralized Effect of Depression on Motor Performance in a TBI Sample.

The relationship between depression scale elevations on the Personality Assessment Inventory (PAI) and motor performance was examined in 44 right-handed subjects, referred for neuropsychological evaluation following suspected traumatic brain injury. Hierarchical regression analyses were conducted to examine the effect of depression, after accounting for degree of cognitive impairment. It was found that elevated depression levels on the PAI were inversely related to performance on speeded motor tasks in the dominant hand only. Specifically, higher levels of depression predicted reduced performance on Finger Tapping and Grooved Pegboard tasks in the dominant hand. This relationship was more pronounced in the individuals with mild overall cognitive impairment. No relationship was found between depression and performance on speeded motor tasks for the non-dominant hand. Furthermore, there was no association between grip strength and depression in either hand. It is suggested that psychomotor retardation, associated with depression, reduces performance on speeded motor tasks to a greater degree than would be predicted on the basis of cognitive

impairment, particularly in mildly impaired individuals. The findings are discussed in relation to previous reports linking depression to impairment of the left hemisphere and left frontostriatal circuits in particular.

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S. SAADE NEEDHAM & P. SATZ. Effects of Head Injury Severity on Emotional Functioning as Measured by the NBAP.

Closed head injury (CHI) often results in physical, cognitive, and neurobehavioral deficits. Despite the limitations that arise with these physical and cognitive deficits, the literature suggests that neurobehavioral symptoms tend to be the most distressing symptoms for the patient. The present study examined the effects of CHI on emotional changes as measured by the Neuropsychology Behavior and Affect Profile (NBAP). This study is the first of its kind to use the NBAP to measure perceived changes in affect and behavior among four groups of head injury severity. NBAP scores of patients were compared with those of a relative. Results showed that both self-reports and other-reports showed significant increase in endorsed symptoms from pre-morbid to post-injury status on all NBAP scales except Mania across all levels of injury severity. These symptoms increased from mild to moderate injury and decreased from moderate to severe. Severe injury patients reported significantly less symptoms than other-report. These results suggest that (1) head injury patients who have experienced a mild, moderate, or serious head injury are probably more aware of changes in their behavioral and emotional functioning; (2) these results lend credence to the fact that emotional and personality changes occur in all head injury severities; and (3) the significant decrease in symptom endorsements by the severe head injury patients compared to their relative is compatible with other studies which show a marked deficit in self-monitoring in patients with severe head trauma. What is noteworthy is the presence of symptoms of anosognosia during the chronic period post injury. Correspondence: *Samar Saade Needham, 1104 Valley Circle, Costa Mesa, CA 92627. E-mail: ssn@strena.com*

J.M. SAWCHYN, C.A. MATEER, & R.S. LONGMAN. Awareness of Neurobehavioral Deficits and Emotional Adjustment in Acute Rehabilitation Following Traumatic Brain Injury.

This study examined injury-based and emotional adjustment factors that may influence an individual's self-awareness of neurobehavioral deficits in the acute phase of traumatic brain injury (TBI) recovery. The Patient Competency Rating Scale (PCRS) and Self-Awareness of Deficits Interview were used to assess the patients' awareness of deficit, while the Profile of Mood States and the Grief Experiences Inventory were used to assess emotional adjustment. Six patients and significant others were followed weekly during the course of inpatient rehabilitation, and were seen approximately 1 month after their discharge from hospital. While individual variability was observed, most patients reported minor changes in their level of competence and limited emotional distress. The individual perceptions of patients and of significant others were generally consistent over the course of inpatient care, and variations in patients' emotional adjustment appeared to be reasonable reactions to circumstantial factors. The emotional adjustment of significant others varied considerably among the individuals assessed, and this variability likely influenced their ratings of the patient. Staff ratings of the patients were also collected, and identified improvements in functional abilities over time. These results suggest that patient awareness is not a prerequisite for rehabilitation success. A lack of applied or practical experiences may also influence patients' ability to accurately rate their self-competence during the acute phase following TBI.

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J.M. SAWCHYN, C.A. MATEER, & J.B. SUFFIELD. Awareness of Neurobehavioral Deficits and Emotional Adjustment in Post-Acute Rehabilitation Following Traumatic Brain Injury.

This study examined 166 individuals referred for post-acute rehabilitation, using the PCRS and the Katz Adjustment Scale (KAS-R) to assess aware-

ness and emotional adjustment. Patients with a history of moderate and severe TBI showed good awareness of their abilities, based on PCRS Discrepancy Scores, while patients with mild TBI were likely to report greater impairments than observed by significant others. TBI patients showed significant emotional adjustment difficulties on the KAS-R, regardless of the severity of their injury, and there was a strong positive association between patients' acknowledgement of neurobehavioral problems and ratings of their emotional adjustment. General intellectual ability was also strongly related to patients' report of difficulties, such that low IQ and poor emotional adjustment were associated with low ratings of self-competence. On the other hand, the general location of cerebral trauma was not strongly associated with deficits in awareness. Thus, the nature and severity of TBI appeared to be less important than IQ and emotional adjustment in the post-acute rehabilitation patients, although mildly injured patients are more likely to report neurobehavioral deficits than moderate or severely injured patients. Strengths and weakness of the self-other discrepancy approach to measuring self-awareness were considered, and a robust approach to awareness assessment, based on multiple measures, is recommended. Available options include structured interviews, self-report, clinical observation, or objective testing.

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S. MISH & C. MATEER. Awareness of Strengths and Limitations in Adolescents With a Traumatic Brain Injury.

There are only a few studies examining self-awareness in adolescents with a traumatic brain injury (TBI) and a scant literature on self-awareness of strengths and limitations in adolescents in general. This study examined self-awareness in adolescents with a TBI using the Adaptive Functioning Rating Scale (AFRS), a revised self-report measure for adolescents, which was adapted from the Patient Competency Rating Scale (PCRS). Adolescents with a TBI (mild and severe), ranging in age from 13 to 19, were matched with controls according to age, gender, and reading scores. Both groups were administered a short neuropsychological test battery, and underwent behavioral competency ratings made by self-report, parents and teachers. Adolescents with a TBI overestimated their behavioral competency compared with teachers but not parents' ratings. No rating differences were found between controls and their parents or teachers. Scrutiny of control data elucidated an important finding, that in contrast to the TBI adolescents, the non-brain-injured adolescents actually appeared to underestimate their behavioral competency. This emphasizes that a developmental perspective is essential for accurate interpretation of self-awareness in adolescents with a TBI.

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C. EVANS, M. SHERER, R. NAKASE-THOMPSON, T. NOVACK, & T. NICK. Early Impaired Self-Awareness, Depression, and Subjective Well-Being Following TBI.

Impaired self awareness (ISA) and depression are frequent sequelae of TBI. Previous research with post-acute patients has shown that ISA and depression are negatively correlated and that both are predictive of long-term outcome. The present investigation extends previous research by examining the incidence and intercorrelation of ISA and depression in an acute inpatient rehabilitation setting, as well as their contributions to prediction of patients' subjective well-being at inpatient discharge. Participants were 75 TBI Model Systems patients evaluated during inpatient rehabilitation. Predictors were age, education, discharge scores on the Disability Rating Scale (DRS), depression as measured by the Center for Epidemiologic Studies-Depression scale (CES-D), and ISA as measured by discrepancy scores between patient and clinician ratings on the Awareness Questionnaire. Patients' subjective well-being was measured by the Satisfaction with Life Survey. Results of the linear regression analyses revealed that age ($p < .05$), CES-D ($p < .05$), ISA ($p < .05$) and DRS

discharge scores ($p < .01$) all made independent contributions to prediction of subjective well-being after adjustment for all other predictors. Correlational analyses demonstrated that ISA and the CES-D had a modest positive association with one another. Results support the idea that ISA and depression are important factors in determining subjective well-being in patients at acute rehabilitation discharge. Patient functional status (DRS) and age are also important factors in determining subjective well-being. In our patients, poorer self-awareness was associated with higher levels of depression, contrary to earlier findings with post-acute patients. Early interventions to decrease ISA and depression are indicated to improve TBI patients' subjective well-being.

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O. MAHMOOD, L.J. RAPPORT, R. HANKS, & N. FICHTENBERG. Neuropsychological Performance and Sleep Disturbance Following Traumatic Brain Injury.

Research investigating the effects of sleep disturbance on cognitive function among patients with TBI has been scarce and limited. The relationship between sleep disturbance and neurocognitive ability was examined among 77 patients with TBI admitted to a comprehensive outpatient neurorehabilitation program. Hierarchical regression was employed to determine whether performance on various domains of cognitive functioning improved prediction of sleep disturbance beyond that accounted for by injury severity and gender. Sleep disturbance was assessed using the Pittsburgh Sleep Quality Index (PSQI) and a battery of neuropsychological tests was used to measure patients' abilities in the domains of sustained attention, information-processing speed, fine motor ability, visuospatial construction, and executive function. Regression analyses revealed that the contribution of injury severity, as measured by Glasgow Coma Scale ratings, and gender in predicting PSQI scores [$R^2 = .22$; $F(2, 74) = 10.67$, $p < .001$] was significantly improved by the addition of neurocognitive variables [$R^2 = .36$; $F(6, 68) = 2.30$, $p < .05$]. One-way analyses of variance revealed that patients with mild TBI reported more sleep disturbance ($p < .01$) and performed better on neuropsychological measures ($p < .05$) than did patients with severe TBI. These findings suggest that sleep disturbance among patients with TBI may be associated with a particular constellation of neuropsychological abilities. These issues are discussed in relation to prior findings that indicate the involvement of additional neuropsychiatric factors associated with sleep disturbance in mild TBI.

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T. ERGH, R. HANKS, L.J. RAPPORT, & R. COLEMAN. Social Support Moderates Caregiver Satisfaction With Life Following TBI.

Social support is an important determinant of adjustment following traumatic brain injury (TBI) sustained by a family member. Caregivers of persons with TBI who experience little support are less effective partners in the rehabilitation process. The present study examined the extent to which social support moderates the influence of patient characteristics on caregiver well being. Sixty pairs of former patients who had sustained a moderate to severe TBI and their caregivers ($N = 120$) participated. Years post injury ranged from .33 to 10 ($M = 4.8$, $SD = 2.6$). Cognitive and neurobehavioral functioning of participants with TBI were assessed using neuropsychological tests and rating scales. Both caregivers and patients rated the patients functional abilities. Caregiver life satisfaction and perceived social support were assessed using self-report questionnaires. Results indicated that time since injury was unrelated to caregiver well being. Neurobehavioral disturbances of patients showed an inverse relation with caregiver well being. Social support emerged as an important moderator of caregiver well being for certain patient characteristics. Social support significantly interacted with executive functioning ($p < .05$) and showed a similar trend with unawareness of deficit ($p < .10$). Only among caregivers with low social support were patient executive dysfunction and

unawareness of deficit adversely related to caregiver life satisfaction. In contrast, these patient characteristics were unrelated to life satisfaction among caregivers with adequate social support. In sum, social support appears to be a powerful buffer in diffusing certain aspects of caregiver burden.

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R. SKELTON & M. JOSCHKO. Functional Outcome Profile: Assessing Brain Injury Impact on Survivors and Family.

Although acquired brain injuries (ABI) affect many areas of a survivor's life, no outcome measurement tool has been developed to comprehensively profile functional impact of ABI on community-living survivors and family members, and to track changes over time. Our structured-interview based Functional Outcome Profile (FOP) captures ratings of outcome in areas of a survivor's life ranging from sensory, motor and cognitive impairments to social and community functioning. It consists of 48 questions that call for self-report of functional outcome on new visuo-analogue scales of frequency, impact and satisfaction, plus the Scales of Independent Behaviour—Revised (SIB-R®). Here we report preliminary findings from 12 pairs of community-living participants (survivor plus a friend/family member) interviewed 3 times at 6-month intervals. Participants were 18 to 72 years old and 0.5 to 8 years post injuries that ranged from moderate to very severe (based on PTA). Interrater and test-retest reliability were good. Reported outcome levels were significantly worse for survivors than for 35 rehabilitation case managers. Areas of greatest "frequency of complaint" matched those previously reported, but areas of greatest problem frequency and functional impact were different. Consistent with clinical experience, self-reported impact of ABI on the family members was as great as self-reported impact on survivors themselves. Problem areas tended to remain stable over time. When asked to identify functional problem areas missed by the FOP, neither survivors, their family members, nor rehabilitation case managers noted any substantial omissions.

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J. DOUGLAS. Coping and Caring for a Family Member After Severe Traumatic Brain Injury.

Severe traumatic brain injury (TBI) is a prolonged and potent stressor which leads to significant changes for the survivors of the injury themselves, as well as their family members. Indeed, family-carers commonly experience significant emotional distress that does not appear to dissipate over time. The constructs of coping and social support are central to theoretical conceptualizations of human response to chronic stress, and adequacy of social support has been shown to contribute significantly to the prediction of depression in family-carers of adults with chronic disability, including TBI. However, the effect of coping strategies on emotional adjustment of carers following TBI has remained less clear. In this study, the degree of association between the carers' coping strategies, their perceived adequacy of social support and the criterion variable of depression was investigated. All of the participants ($n = 27$) had primary caregiving responsibility for an adult family member who had sustained a severe TBI (M PTA = 92.89 days), 4–10 years ago. Sixteen participants reported significant symptoms of depression. Strong-tie support and use of avoidance coping contributed significantly to the prediction of depression ($p < .01$); use of active cognitive and behavioral coping strategies did not. Thus, carers with few social resources and a tendency to use avoidance coping strategies were particularly at risk for clinical depression. These findings emphasize the need to provide ongoing support services in the community for adults with severe TBI and their family-carers.

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J. PONSFORD. Sexual Changes Associated With Traumatic Brain Injury.

Findings from numerous outcome studies have shown that people with moderate to severe traumatic brain injuries (TBI) experience relationship difficulties and changes in sexuality. However, there have been few investigations of these problems, which are also inadequately addressed. This paper will report the results of a study of sexuality following TBI, which aims to identify changes in sexual behavior, affect, self-esteem and relationship quality, and their interrelationships. 208 participants with moderate-severe TBI (69% males) have completed a questionnaire covering these areas 1–5 years post injury. Their mean age was 33.6 years (range = 14–78), and mean PTA duration 29.3 days (range = 1–180 days). Their responses have been compared with those of a group of 150 controls, matched for age, gender, and education. Thirty-six to 54% of TBI participants indicated that the importance of sexuality had decreased since injury, they had fewer opportunities and lower frequency of engaging in sexual activities, their sex drive had decreased, they reported negative changes in their ability to give their partner sexual satisfaction, to engage in sexual intercourse, their enjoyment of sexual activity, their ability to stay aroused and to climax. The frequencies of such changes were significantly higher than those reported by controls. A significant proportion of TBI participants reported decreased self-confidence, sex appeal, higher levels of depression, and decreased communication levels and relationship quality with their sexual partner. There were relatively few differences between males and females. Factors associated with sexual problems will be explored. Implications of all findings will be discussed.

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M.A. STRUCHEN & L.D. ROSAS. The LaTrobe Communication Questionnaire and Vocational Outcome Following Traumatic Brain Injury.

Social and behavioral factors play a major role in vocational status following traumatic brain injury (TBI). Brooks and colleagues identified conversational deficits as a major predictor of failure to return to work following severe TBI. Interpersonal difficulties were the most common cause of job separation following TBI. Most research relating interpersonal functioning and vocational outcome has utilized rating scales of broad aspects of cognitive and behavioral functioning, with assessment of communication involving only a few items. Douglas and colleagues developed the LaTrobe Communication Questionnaire (LCQ) as a measure of perceived communication ability for adults with TBI. This questionnaire is based on Damico's analysis of discourse categories, a commonly used method of evaluating conversation. Respondents rate on a 4-point scale how frequently a communication behavior occurs, with higher scores reflecting more frequent problems. The purpose of the current study was to investigate the relationship between self-ratings on the LCQ and vocational outcome for persons with TBI. Twenty-two participants with TBI, all of whom had received inpatient rehabilitation and were at least 1 year post injury, completed the LCQ and the Community Integration Questionnaire (CIQ). Scores on the LCQ were significantly related to productivity ($r = -.45, p < .05$) and to Total CIQ score ($r = -.44, p < .05$), but were not significantly related to home or social integration. This suggests that the LCQ may be a useful adjunct to neuropsychological evaluation for individuals with TBI.

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Y. RASSOVSKY, P. SATZ, M. ALFANO, & K. ZAUCHA. Memory and Frontal Systems as Mediators of Functional Outcome in TBI.

Following traumatic brain injury (TBI), patients commonly report becoming excessively forgetful and overall slower when needed to perform complex mental activities. Indeed, memory impairment and reduced speed of frontally mediated information processing have been frequently reported in the TBI literature. When present, these difficulties are likely to interfere with the patient's social and occupational functioning. However, the rela-

tionship between these constructs has not yet been elucidated. In the present study, we compared the relative contribution of memory and frontal systems/speed of information processing to functional impairment at 12-months post injury, in 87 patients with moderate-to-severe TBI. Employing a structural equation modeling technique, we found that frontal systems/speed of information processing (but not memory) significantly mediated the relationship between TBI severity (indexed with brain CT) and 12-month post-TBI adaptive functioning. Although memory had a significant relationship with TBI severity, this construct had no significant relationship with functional outcome. Frontal systems/speed of information processing, on the other hand, significantly related to both TBI severity and functional outcome. These findings suggest that, despite the pervasive memory complaints among patients with TBI, it is the impact of neurotrauma on frontal systems that appears to be primarily responsible for the patients' difficulties in social and occupational functioning.

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G. CARNEVALE, V. ANSELM, K. BUSICCHIO, V. WALSH, S. MILLIS, & M. JOHNSTON. Efficacy of Community-Based Behavior Management for Patients With Brain Injury: Results of a 4-Year Model System Project.

This symposium presents outcome data for a community-delivered behavior management program for persons with TBI and their caregivers. The study involves the use of a mobile outreach team with affiliation to a model system TBI treatment center. In determining efficacy, a control group was contrasted with an education only group and with education plus behavior skills training group with random assignment to conditions. Total number of participants was 45 persons with brain injury and their caregivers. Main outcome measures were behavior change data; changes in caregiver burden associated with behavior change were measured with questions on Questionnaire on Resources and Stress (QRS) and an adapted version of the Maslach Burnout Inventory (MBI). The design involved multiple baseline assessment with pre- and postmeasurement following each component of the program (education, behavior training). Three-month follow-up data were also analyzed. The repeated measures analysis of variance indicated significant changes in behavior from baseline for patients in the education only group with further moderate improvement noted with behavior skills training. Correlation of caregiver stress variables with behavior change data will be discussed, as well as methodological issues in the design and implication of community-based behavior management programs for patients with brain injury.

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Plenary Session 1/11:00 a.m.–12:00 p.m.**DISSOCIATIONS IN COGNITIVE MEMORY:
THE CASE OF DEVELOPMENTAL AMNESIA**

Faraneh Vargha-Khadem

Plenary Session 2/11:00 a.m.–12:00 p.m.**PHARMACOLOGIC TREATMENT OF
ATTENTION DEFICITS AFTER TBI:
METHODOLOGIC ISSUES AND
PRELIMINARY RESULTS**

John Whyte

FRIDAY AFTERNOON, FEBRUARY 7, 2003

Plenary Session 3/12:15–1:15 p.m.

CAN EXECUTIVE FUNCTIONS
BE REHABILITATED?

Ian Robertson

Poster Session 7/12:15–1:30 p.m.

COGNITIVE CHANGES IN AGING

L.C. BAXTER, R. CASELLI, S.J. JOHNSON, E. REIMAN, & D. OSBORNE. APOE ϵ 4 Affects New Learning in Cognitively Normal Elderly at Risk for AD.

The APOE ϵ 4 allele is an important risk factor for Alzheimer's disease (AD). Even cognitively intact individuals with the ϵ 4 allele show memory decline over time. Given the interest in early identification of at-risk individuals, we examined memory decline as a function of APOE status and age in cognitively intact participants ranging from age 48–77 years old. Participants were grouped by age (<60 vs. >60) and APOE status (presence or absence of ϵ 4 allele). Based on APOE status, no differences in age, education, VIQ, MMSE scores (all > 27), or exam interval were observed. Memory was assessed with the Auditory Verbal Learning Test (AVLT) at 2 timepoints over a 2-year interval. Longitudinal analysis showed a significant Age \times APOE interaction reflecting a decline in Total Word recall (new learning) for the >60 ϵ 4+ group only [$F(3, 109) = 4.56; p < .03$]. Delayed recall approached significance ($p = .51$). No effect was observed for other cognitive domains. Seventy-six percent of the >.60 ϵ 4+ group showed a decline vs. 32% of the <60 ϵ 4+ group, but the amount of decline on the AVLT over the 2-year interval within the >60 ϵ 4+ group was not further influenced by age within that group. That is, the size of the 2-year change was the same for 60 year-old as for 70 year-old subjects. These results suggest that longitudinal study of new learning is a sensitive measure for detecting early cognitive changes in at-risk individuals that precede the symptomatic onset of mild cognitive impairment and AD.

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D. ROYALL, R. PALMER, L. CHIODO, M. POLK. Decline in Learning Ability Best Predicts Future Dementia Type.

Purpose: To study longitudinal change in learning efficiency as a predictor of future dementia type among healthy, well educated, non-institutionalized elderly Comprehensive Care Retirement Community (CCRC) residents. *Design:* Longitudinal cohort study. *Methods:* Serial assessments of memory were obtained using the California Verbal Learning Test (CVLT). Latent growth (LG) models were developed from the first 5 CVLT learning trials at each of 3 CVLT administrations (e.g., baseline (CVLT1), 18 months (CVLT2), and 36 months (CVLT3)). Then, these growth curves were incorporated into a higher order LG model representing the dynamic change in learning efficiency over time (Δ CVLT). Δ CVLT was used to predict each subject's dementia type at 36 months [e.g., no dementia, Type 1 (AD) dementia or Type 2 (non-AD dementia)], after adjusting for CVLT1, baseline age, and baseline dementia type. *Results:* Non-linear (logarithmic) LG models of CVLT1–CVLT3 and Δ CVLT showed excellent fit to the data. There was significant variability about both CVLT1 and Δ CVLT, suggesting subgroups in the sample with significantly different baseline memory function, and rates of deterioration in learning efficiency. Age, baseline dementia type and Δ CVLT made significant independent contributions to final dementia type. CVLT1 did not

predict final dementia type independently of the other covariates. Baseline memory performance in non-demented well elderly retirees does not predict future dementia type independently of the dynamic rate of change in memory measures. Serial administrations of memory tests may help identify nondemented persons at greater or lesser risk for conversion to frank dementia in the near term.

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N. WILDE, E. STRAUSS, & D. HULTSCH. Dispersion in Cognitive Ability in Healthy Older Adults as a Function of Age and Intellectual Status.

We examined whether age and general intellectual status is associated with increased intraindividual dispersion among major cognitive domains in healthy elderly. The sample consisted of 196 community dwelling adults, aged 64 years and older. Dispersion was measured by the within individual standard deviation of test scores (ISD) and by the maximum discrepancy (MD) between age- and education-corrected scores on tests of semantic knowledge, reasoning, semantic fluency, verbal memory, visual scanning and motoric speed. In agreement with Lindenberger and Baltes and consistent with the dedifferentiation hypothesis of age-related cognitive change, the old-old (75+) showed less dispersion than the young-old (64–74). Dispersion also varied as a function of crystallized intellectual status: lower NAART or WAIS—III Vocabulary scores were associated with higher dispersion. There was no interaction between the effects of age and cognitive status on dispersion scores. The finding of increased dispersion in our lower-functioning individuals may be a reflection of the unique nature of our sample. People with very high or very low IQ might be expected to show little dispersion. A large proportion of our sample was very high functioning and it is therefore not surprising that dispersion was only evident in more “average” individuals. Finally, our findings revealed that the larger the discrepancy between estimated and obtained FSIQ, the greater the dispersion, but only in the young-old group. This suggests that greater dispersion in this age group may be a marker of cognitive decline.

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N. PACHANA, F. ALPASS, J. BLAKEY, & N. LONG. Comparisons of Cognitive Screening Tasks in an Elderly Veteran Population.

Cognitive screening instruments have been developed for administration over the telephone as well as face-to-face. The efficacy of such screens when used on a hearing impaired population is as yet unknown. Performance of hearing impaired veterans was compared on telephone-administered (Telephone Interview for Cognitive Status—modified; TICS—m) and face-to-face administered (Mini-Mental State Exam; MMSE) instruments. Correlations between the MMSE and the TICS—m ($r = .39$) were lower than those previously reported in the literature. Participants had difficulty perceiving words from the TICS—m on registration and thus also on later recall, regardless of whether hearing aids were worn. Further analyses revealed that when these items were removed from the TICS—m scores, correlations with the MMSE improved significantly. Regression models supported the hypothesis that some proportion of variance in performance on both of these cognitive screens was due to hearing loss and/or use of a hearing aid. Performance on the MMSE, particularly with respect to more accurate registration (and thus subsequent recall) of the word list, was, however, superior to the TICS—m. It was hypothesized that respondents were possibly utilizing lip-reading to aid in their comprehension of the word list. A subsequent study examined this hypothesis by use of a screening device to block the view of the tester's lips. While this hypothesis was not entirely supported by the data, evidence of differing levels of

concentration when comparing telephone *versus* face-to-face administration, rather than better registration of the words, *per se*, emerged.

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R. DIXON, S. MacDONALD, & D. GARRETT. Does Head Circumference Relate to Cognitive Decline in Healthy Aging Adults?

Recent neurological reports have linked head circumference (HC) to incidence of probable Alzheimer's disease (AD). Theoretically, HC may indirectly reflect an AD patient's brain reserve and protection from cognitive decline. Tisserand et al. also observed small cross-sectional correlations between HC and selected cognitive abilities in nondemented older adults. HC is measured over the eyebrows and the occipital protuberance, and is partialled appropriately (e.g., gender). We examined HC-cognition relationships in data from the Victoria Longitudinal Study (VLS). First, VLS Sample 1 (tested on five 3-year occasions), provided data on HC and actual changes on select cognitive measures (e.g., memory systems, speed, Gf, Gc). Complete 12-year data are available for $N = 125$ healthy adults (Wave 5: age range = 67–95; $M_{MMSE} = 28.5$). Concurrent (Wave 5) univariate results (e.g., HC gender effect; HC-MMSE $r = .1$) were similar to Tisserand et al. However, using Cox regression and hierarchical linear modeling, few reliable links were observed between HC and long-term cognitive change, even for a subsample ($N = 32$; age range = 71–95; $M_{MMSE} = 27.8$) evincing the most 12-year decline. Second, we are presently examining cross-sectional data from VLS Sample 3 (Wave 1: $N = 450$; age range = 55–85; $M_{MMSE} = 28.7$), a larger and more cognitively diverse group (including individuals who will attrite due to AD). We expect to observe relatively larger HC–cognition relationships. HC–cognition relationships are discussed in terms of constraints (e.g., sample selectivity and differences, static *vs.* assessments) and implications (e.g., potential brain reserve indicator, clinical applications).

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C.L. BALDWIN. Impact of Hearing Impairment on Neuropsychological Test Performance.

It is well recognized that advanced age is associated with changes in both sensory and cognitive functioning. Less appreciated, however, is that sensory loss may interact with cognitive changes to compound observed performance decrements. In two dual-task studies, young participants with normal hearing and cognitive abilities performed a simulated driving task concurrently with an auditory task involving either mental arithmetic task or sentence verification. When auditory stimuli were presented at levels simulating age-related hearing impairment (50 and 55 dB SPL), young participants demonstrated performance decrements mirroring those of older participants observed in a previous study using a similar dual-task paradigm. Sensory deficits may impair performance on neuropsychological tests either directly, by degrading the reception of testing material, or interactively by requiring the expenditure of more cognitive effort. Neuropsychological testing procedures typically do not adequately take into account changes in basic sensory functions. If these are acknowledged at all, it is often assumed that any such effects may be restricted to those elderly who are in poor health, or that the influence of sensory loss is likely to be additive with cognitive changes. The present results indicate that neuropsychological test performance and cognitive aging research findings cannot be fully understood without also examining sensory functioning.

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A. SHAPIRO, J. BRANDT, A. SHORE, J. KASPER, B. BLACK, & P. RABINS. Neuropsychological Correlates of Functional Impairment Among Community Residing Elderly.

The relationship between neuropsychological test performance and functional ability was examined in a large sample of community-residing el-

derly. Although many researchers have studied this relationship, our study is unique in that our sample has a large African American representation (54%) and a mean education level of 7.9 years. Nearly 500 people, age 65 and older ($M = 80.7$), completed the MMSE, CERAD Verbal List Learning Test, Digit Symbol subtest of the WAIS-R, Category Fluency, and BNT (15-item), and a knowledgeable informant provided information regarding each participant's functional status. Participants were classified as demented or nondemented based on their neuropsychological test performance. As expected, individuals classified as demented were rated significantly more impaired in all ADLs and IADLs (with the exception of housework) than those classified as nondemented ($ps < .01$). Among demented participants, performance on neuropsychological tests was predictive of functional impairment after controlling for demographic factors (R^2 change = .36 and .21 for physical and instrumental ADLs, respectively). The MMSE and Digit Symbol, in particular, were significantly predictive of impairment in nearly every individual ADL and IADL. In contrast, there was little relationship between cognitive ability and ADL/IADL impairment among nondemented participants. Both race and education made unique contributions to the prediction of functional ability. Interestingly, it was the more highly educated, White participants who were more functionally impaired. Results are discussed in terms of the unique characteristics of this sample.

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C. SCHUTTE, W. VANVOORST, A. NAGRA, & R. SKEEL. Cognitive and Sensory Characteristics in Continuing Care Retirement Community Residents.

Continuing care retirement communities (CCRC) provide residents several levels of care, ranging from no medical assistance to fully dependent nursing home services. While individuals receiving skilled nursing care would be expected to exhibit characteristics of traditional nursing home residents, little is known about neuropsychological and sensory characteristics of CCRC residents receiving no healthcare assistance. Based on the rationale that residents entering such a facility would be reacting to a decline in overall level of functioning, it was hypothesized that residents would show reduced cognition and decreased sensory functioning compared to a community sample. The sample included 24 individuals living in a CCRC who were not receiving healthcare assistance and 24 community-dwelling individuals. Consistent with previous research, the CCRC sample ($M = 82.79$, $SD = 5.23$) was significantly older than the community sample [$M = 76.75$, $SD = 4.82$; $F(1, 46) = 17.3$, $p < .001$]. Cognition was measured with the Repeatable Battery for the Assessment of Neuropsychological Status (RBANS) and Trails A & B, while vision was measured with a contrast sensitivity chart. Contrary to hypotheses, results suggested the CCRC sample showed superior cognition [$F(1, 46) = 4.66$, $p < .05$] as measured by the RBANS summary score, superior visual contrast sensitivity [$F(1, 46) = 6.50$, $p < .05$], and superior speed of processing [Trails A: $F(1, 46) = 4.77$, $p < .05$]. Results suggest residents of CCRC's may show overall higher levels of functioning than community samples, potentially reflecting SES characteristics of the CCRC sample. Practical implications for care decisions and long-term planning are discussed.

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J. RAZANI, K. BOONE, I. LESSER, L. CHANG, & T. ERNST. The Effects of Demographic and Health Risk Factors on Neuropsychological Functioning in Normal Older Adults.

The effects of specific demographic variables (e.g., age and education) on cognition have been documented, but less is known about how specific health-risk factors affect neuropsychological performance. The purpose of the present study was to examine the combined role of demographic and health variables on cognition in older adults. A sample of 200 relatively healthy, community-dwelling adults between the ages of 50–83 was selected for the present study. All participants were carefully screened out for serious medical illnesses, such as head injuries, seizures, strokes, neuro-

logic disease, major affective or psychotic disorder, or history of substance abuse. A comprehensive neuropsychological battery including measures of intellectual functioning, memory, attention, visual-spatial, and executive skills were administered. Additionally, information regarding health-risk factors, such as smoking history, cardiovascular disease (e.g., history and treatment of heart disease and hypertension), and hormone replacement therapy were collected during the interview. Stepwise regression analyses using age, education, Full Scale IQ (FSJQ), gender, vascular disease, and smoking history as predictor variables revealed that age and FSIQ accounted for significant portions of variability in most neuropsychological measures. However, above and beyond these two factors, vascular disease accounted for variability in information processing speed, divided attention/working memory, and specific executive measures. Interestingly, smoking history accounted for verbal fluency performance, and gender accounted for variability in a word recognition memory test and scores on an executive measure (i.e., Wisconsin Card Sorting Test). These findings suggest that specific health-risk and demographic factors must be taken into account when considering cognitive test scores of normal, healthy older individuals.

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S. STREUFERT & U. SATISH. Age and Cognitive Dysfunction: Medication and Social Impacts.

Cognitive deterioration in aging individuals has been explained by progressive brain cell death, morbidities such as Alzheimer's, decreased stimulation after retirement, and more. Data on deficits are often drawn from observation or from neuropsychological tests. The present research employed a task that has been used in recent years to measure multiple components of executive functioning relevant to real-world day-to-day effectiveness. The SMS simulation has been validated across national, cultural and continental boundaries and is used to measure deficits following head injury, drug treatment, stress etc. Four hours of simulation participation generates 25 computer calculated scores assessing competencies ranging from effectiveness in simple (e.g., activity, speed of response), intermediate (initiative, information utilization) to complex (breadth of approach, strategy) task components. Sixty 4-person teams aged 28 to 35, 45 to 55 and 65 to 75 participated. All team members were currently active in professional job settings (retired persons were now executives in benevolent organizations, etc.). Older teams performed at lower levels (on several measures) than their younger counterparts. While cohort differences cannot be excluded, data analysis suggested two underlying causes for the deficiencies: (1) older individuals consumed more medications. While incidence of morbidity (illness) of team members had little effect, a strong relationship between number of medications taken by team members during the last 24 hr and lower levels of team performance was obtained, and (2) older teams spent considerably more time in social (not necessarily friendly) interaction, often ignoring incoming information and task demands.

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P. MAKI, K. MORDECAI, & J.B. RICH. Longitudinal Changes in Conceptual but not Perceptual Implicit Memory.

Cross-sectional studies show differential effects of age on tests of conceptual and perceptual implicit memory (IM). Here we report the first longitudinal study to examine age effects on different types of IM. The primary outcome measures were scores on tests of perceptual skill learning (identification of newly presented fragmented objects), perceptual priming (faster identification of repeated objects relative to new ones) and conceptual priming (above-chance generation of previously studied, uncommon category exemplars, such as *donkey*, in response to a category cue, such as *animals*). Our previous cross-sectional study of 164 adults aged 21–91 from the Baltimore Longitudinal Study of Aging revealed age differences on all 3 types of IM. In the current study, we obtained longitudinal data from 73 of the original participants who were available for repeat testing and were not demented. They ranged in age at Time 1 from 22–81, with a

mean interval between assessments of 7.9 y. Paired *t* tests showed significant longitudinal declines in conceptual priming and skill learning (effect size = .11 and .07, respectively), but not perceptual priming. Age affected the magnitude of decline in conceptual priming, with older adults showing greater declines compared with younger adults ($R^2 = .06$). Verbal Recall and Hidden Patterns score predicted perceptual priming ($R^2 = .22$). Differences in the patterns of age effects between the longitudinal and cross-sectional analyses underscore the importance of longitudinal studies of IM. Future studies will explore age changes in procedurally similar conceptual and perceptual tests.

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NEUROPSYCHOLOGICAL CORRELATES OF PEDIATRIC DISEASE

K. WILLS. A Pediatric Neuropsychologist's Report From the 1st Symposium on Pediatric Neurotransmitter Diseases.

This presentation is designed to increase neuropsychologists' awareness of the clinical picture, prognosis, and treatment of the 4 disorders discussed in the First Symposium on Pediatric Neurotransmitter Diseases [sponsored by NIH Office of Rare Diseases, NINDS, and the Pediatric Neurotransmitter Disease (PND) Association, in Bethesda, MD, May 18–19, 2002]. Neuropsychologists need to know about PNDs for 3 reasons: (1) We may help to detect and diagnose them, e.g., succinic semialdehyde dehydrogenase deficiency (SSADH) has been misdiagnosed as autism, and dopa-responsive dystonia (DRD) as conversion disorder. (2) Neuropsychological studies may help characterize the clinical picture; e.g., anecdotal reports and a case study suggests that an increased incidence of ADHD or dysexecutive symptoms characterize children with dopa-responsive dystonia, who lack an enzyme critical to dopamine synthesis. (3) Studying neurotransmitter deficits may help in understanding developmental functions of neurotransmitters in general. This poster will focus on DRD and SSADH which mimic more common childhood syndromes, but also will describe 2 syndromes that present with severe mental retardation and epilepsy: THD (tyrosine hydroxylase deficiency) and ALADD (aromatic L-amino acid decarboxylase deficiency). In all 4 disorders, early detection, accurate diagnosis, and early treatment may improve prognosis. Correspondence: *Karen E. Wills, Psychology (17-301), MPLS Childrens Hospital, 2525 Chicago Ave. South, Minneapolis, MN 55404. E-mail: karen.wills@childrenshc.org*

S. HEPWORTH, E. PANG, & J. ROVET. Selective Memory Deficits in Children With Congenital Hypothyroidism: Clinical and ERP Studies.

Extensive research on animals has shown that thyroid hormone (TH) is essential for the development of neural structures important for memory (e.g., hippocampus). While this is less well defined in humans, several conditions provide models for examining TH and memory effects. In congenital hypothyroidism (CH), a disorder affecting 1 in 3500 newborns from an absent or dysfunctional thyroid gland, children diagnosed and treated early in life by newborn screening show specific cognitive impairments, including selective memory deficits. These deficits are associated with their postnatal TH insufficiency. We present here our findings from two studies evaluating memory in different cohorts of CH children assessed via clinical or electrophysiological approaches. Study 1 compared 48 CH and matched controls (7–12 years) on the Children's Memory Scale (CMS) and Everyday Memory Questionnaire (EMQ) while Study 2 compared 9 CH and matched controls (11–13 years) neurophysiologically using a repetition paradigm for words repeated after a zero or 5-item lag. Study 1 indicated that on the CMS, CH had deficits in immediate recall of spatial locations and word pairs and on the EMQ, they experienced difficulty remembering places and their own and others' speech. Study 2 found that while CH were similar to controls behaviorally in distinguishing "old" from "new" items, CH had a reduced repetition effect in the immediate but

not delayed condition over parietal electrodes (Interactions: P3: $p < .01$; PZ: $p < .05$). Thus, their dampened neurophysiological response to repeated items in Study 2 may explain some of their clinical and everyday memory difficulties in Study 1.

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P.E. ANDERSON & B. BANWELL. Long-Term Intellectual and Academic Functioning in Pediatric Multiple Sclerosis: A Prospective Investigation.

Multiple sclerosis (MS) is a relatively rare demyelinating disease, with approximately 3.5–7.5/100,000 persons newly diagnosed with MS each year. Pediatric MS is much rarer, as only 3–5% of total diagnoses are made at 16 years of age or younger. Adult onset MS has been well-studied, while the available literature on pediatric MS is in its infancy. Prospective investigation of 10 children and adolescents (9–17 years of age) with clinically definite MS completed two neuropsychological batteries, one year apart. With regard to intellectual functioning, group performance did not differ across time. Those participants with a short time since diagnosis (i.e., <2 years; $n = 4$; STSD) earned higher scores on 3 indices (FSIQ, PIQ, PO) at the first time of testing than those participants with a long time since diagnosis (i.e., >2 years; $n = 6$; LTSD). No differences on these indices were noted at the second assessment. The performance of the STSD group on Digit Span was poorer at the second evaluation; no differences were noted for the LTSD group. With regard to academic functioning, group performance on a measure of spelling improved over the year. The STSD group had a better score at both evaluation points on a measure of mathematical reasoning than the LTSD group. The results underline the need for further investigation of children and adolescents with MS using larger samples and follow-up of these at-risk children as they develop into adolescence and adulthood.

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M. RIES, F. BOOP, P. ZOU, N. PHILLIPS, S. JOHNSON, & R. OGG. fMRI and WADA Determination of Language Lateralization: A Case of Crossed Dominance.

Accurate determination of language dominance is a critical factor in presurgical planning for tumor resection. The intracarotid sodium amobarbital procedure or WADA test has been a widely-used procedure for determining language lateralization. However, less invasive presurgical planning techniques such as fMRI offer a promising alternative. Recent research comparing the two techniques indicates that fMRI predicts postsurgical outcome as effectively as the WADA test. Furthermore, some studies indicate that fMRI and WADA results provide complimentary data that results in improved prediction of post-operative outcome. This poster presents a case study of a 13-year-old cancer survivor in which fMRI and WADA results were obtained for lateralization of language functioning. The patient's history was significant for the subtotal resection of a left mesial temporal subependymoma at age 3 and ongoing seizure activity. Although the residual tumor remained stable, the seizure disorder worsened. Presurgical evaluation of language dominance was requested by the attending neurosurgeon. Although the patient was left-handed at fMRI examination, the mother reported that the patient appeared to be right-handed prior to initial tumor diagnosis. Testing of language during the WADA procedure indicated that both receptive and expressive language were right-lateralized, with possible bilateral representation of expressive language. Analysis of the fMRI data provided information supplementing the WADA results. Selective activation of right temporal structures corresponding to Wernicke's area provided evidence for right-lateralized receptive language. However, activation of frontal regions around Broca's area was left-lateralized, suggesting a crossed-dominance pattern. Post-operative validation of WADA and fMRI results will be discussed.

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R. STARGATT, V. ANDERSON, & J. ROSENFELD. Attention and Memory in Children Undergoing Treatment for Posterior Fossa Tumors: Baseline and 12-Month Follow-Up.

Research indicates survivors of childhood intracranial tumors show neuropsychological deficits and poor academic outcomes at follow-up. A number of research papers indicate that decline in IQ scores continues over time. Dennis proposed that children fail to assimilate new verbally based knowledge at a developmentally appropriate rate. More recently Palmer et al. demonstrated that children with medulloblastoma acquired knowledge and skills at a slower rate than their healthy same age peers. Attention and memory deficits have been identified in children treated for brain tumor by some research groups. Twenty children diagnosed with posterior fossa tumor meeting recruitment criteria from consecutive presentations at the Royal Children's Hospital, Melbourne, Australia, were included in a longitudinal design. Children were assessed on a variety of neuropsychological measures at baseline and 12 months following diagnosis. This study examines the performance of children treated for posterior fossa tumor on attention and memory tests and their relationship with measures of IQ and academic achievement.

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M. CAREY & L. BARAKAT. Affect Recognition and Social Competence in Pediatric Brain Tumor Survivors.

Survivors of pediatric brain tumors are often described as having deficits in social competence, in addition to cognitive and academic impairments following treatment. We have previously reported that 15 children treated for brain tumors demonstrated significantly better verbal compared to nonverbal skills and that parent report of social function was positively correlated with nonverbal performance, but not to verbal performance. Deficits in affect recognition skills have been reported in children with nonverbal learning problems. The purpose of the present study was to examine the relationships between affect recognition skills, cognitive function and social function in pediatric brain tumor survivors. Fifteen survivors of pediatric brain tumors, ages 8–12 years, were identified through the Neuro-Oncology Tumor Registry at The Children's Hospital of Philadelphia and recruited for participation in a social skills training group for children treated for brain tumors. Neuropsychological, psychosocial and affect recognition measures were administered approximately 1 month prior to the start of the intervention. A significant positive correlation between affect recognition skills and nonverbal skills was found, $r = .58$, $p < .05$, and, as previously reported, between nonverbal skills and two measures of parent report of social competence ($r > .50$, $p < .05$). However, there was no relationship found between affect recognition skills and any of the parent report measures of social function used. Based on these findings, affect recognition skills are not predictive of social competence in pediatric brain tumor survivors and suggest that social competence is a multifaceted construct that requires further investigation.

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B. NAGEL, S. PALMER, W. REDDICK, J. GLASS, K. HELTON, A. GAJJAR, S. WU, X. XIONG, & R. MULHERN. Hippocampal Volumetry in Pediatric Medulloblastoma Patients.

Background: Medulloblastoma is the most common malignant brain tumor of childhood. Patients demonstrate post-treatment neurocognitive deficits in a variety of areas, including memory dysfunction. Although several hypotheses have been put forth, there is no definitive understanding of the neuropathology underlying these functional deficits. Because it has been demonstrated that hippocampal integrity is crucial to the acquisition of new episodic memories, the current study examined potential changes in hippocampal volume as a possible mediator of memory dysfunction in medulloblastoma patients. *Methods:* Twenty-five pediatric patients underwent 159 serial MRI examinations ($M = 6$ exams/patient) for up to 5 years post irradiation and chemotherapy treatment for medulloblastoma. Right and left hippocampal volumes were manually traced. Random co-

efficient models were used to examine longitudinal change in hippocampal volume as a function of time since diagnosis. *Results:* Both right and left hippocampal volumes showed an initial decrease after treatment. After 4 to 5 years post diagnosis, hippocampal volumes demonstrated a return towards a normal developmental curve. Further analyses revealed that volume loss occurred predominately in the posterior region of both the right and left hippocampus. Covariates, such as female gender, low parental education, shunt placement, and seizure history, were also found to have a significant negative impact on hippocampal volume changes. *Conclusions:* Pediatric medulloblastoma survivors demonstrate abnormal hippocampal development after treatment. Radiation dose mapping will be presented to explain region-specific volume change. This study provides a rationale for further exploring the relationship between memory dysfunction and hippocampal pathology in this population.

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R. MULHERN, H. WHITE, J. GLASS, G. WILKINSON, & W. RED-DICK. Attentional Functioning in Survivors of Malignant Pediatric Brain Tumors.

Children surviving treatment for malignant brain tumors commonly have problems maintaining their premorbid levels of intellectual development and academic achievement. Our group has been especially interested in the effects of treatment on normal appearing white matter (NAWM) and the influence of NAWM volumes on cognitive functioning. The present study included 40 long-term survivors of malignant brain tumors, ranging in age from 1.7 to 14.8 (*Mdn* = 6.5) years at diagnosis, who had been treated with cranial radiation therapy with or without chemotherapy 2.6 to 15.3 (*Mdn* = 5.7) years earlier. Patients were assessed with the Conners' Continuous Performance Test (CPT) and quantitative MRI. On the CPT, 8 of the 11 indices were significantly deficient compared to age- and gender-corrected normative values. Principal components factor analysis of these 8 indices resulted in 3 factors, reflecting selective attention (SLA), sustained attention (SSA), and processing speed (PS), that accounted for 82% of the variance in the model. After statistically correcting for differences in age at diagnosis and time from treatment, total NAWM volumes accounted for 17% of the variance in SLA ($p < .01$) but had no significant association with SSA or PS. Both left and right hemisphere NAWM volumes were significantly associated with SLA ($ps < .01$); however, in a multivariate analysis using 8 regions subdivided by predetermined neuro-anatomic landmarks, only right prefrontal NAWM was significant ($p < .005$). The results of the present study further support the contention that NAWM is an important substrate for treatment-induced cognitive problems among survivors of malignant brain tumors of childhood.

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P. McDONOUGH-RYAN, D. RIS, & M. LAMBDA. IBED: A Novel Methodology for Modeling Late Effects of RT in Children.

While much has been written about the neurotoxicity of cranial radiation therapy (RT) in the treatment of children with brain tumors, this work has been based on crudely characterized radiation parameters (e.g., prescribed dose). The present study investigates the utility of a novel radiobiological metric called *integral biological effective dose* (IBED), which reflects not only dose, but also irradiated volume and fractionation schedule. This study is part of an ongoing longitudinal, prospective investigation of neuro-behavioral late effects of RT in children with brain tumors. There are 11 children who are now at least 2 years post RT and eligible for late-effects analysis. For theoretical and statistical reasons, we elected to focus on the effects of RT on the construct of attention, operationalized with the WISC-III Digit Span subtest and Conner's Continuous Performance Test. Testing was conducted at Years 1 and 2 post RT, and a change score between these 2 data points was calculated for each child. Preliminary results indicate a much stronger relationship between decline in attention and IBED ($p =$

.02), than decline in attention and prescribed dose ($p = .21$). These results suggest that this new methodology holds promise for improved modeling of behavioral late effects in children. Further elucidation of these effects may allow for refinements in treatment protocols aimed at reducing this morbidity.

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J. JANUSZ & G. GIOIA. Executive Functions Among Children Treated with CNS Therapies for Cancer.

Research has explored the effects of chemotherapy and radiation treatments for childhood cancers on later cognitive functioning. Most research has suggested that treatment at younger ages, particularly with radiation, may have a more deleterious effect. This study examined the effects of cancer treatment on executive functions in children. The CHEMO group consisted of children with non-central-nervous-system (CNS) cancers treated with CNS prophylaxis. The CHEMO+XRT group consisted of children with primary CNS tumors treated with both chemotherapy and radiation. Parents of all subjects completed the Behavior Rating Inventory of Executive Function (BRIEF) as part of a clinical evaluation. Participants ranged in age from 6 to 18 at the time of the evaluation. The CHEMO group was significantly younger at the time of diagnosis. Significant correlations were found between time since treatment and BRIEF Behavioral Regulation and Metacognition scales, ($r = .42$ to $.65$). Furthermore, differences between the treatment groups were found on the Working Memory and Plan/Organize domains of the BRIEF ($p < .05$), and a significantly greater percentage of children in the CHEMO group had elevations in the clinical range on these scales. Results indicate an association between longer time since treatment and greater executive deficits. Furthermore, chemotherapy at younger ages is a greater risk factor for later executive deficits than treatment with chemotherapy and radiation at older ages. This is in contrast to traditional findings of radiation having a more significant impact on cognitive abilities, and this finding requires further exploration.

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L. KENEALY, J. JANUSZ, & G. GIOIA. Impact of Chemotherapy and Radiation on Executive Functions in Children.

Relatively little research on the effects of radiation treatment and chemotherapy on later cognitive functioning has focused on executive function (EF), yet difficulties in this domain place children at risk for difficulties in academic, behavioral, and social-emotional functioning. This study examined the effects of cancer treatment on EF in children. The chemo group consisted of children with non-central-nervous-system (CNS) cancers treated with CNS prophylaxis. The chemo+XRT group consisted of children with primary CNS tumors treated with both chemotherapy and radiation. These subjects were matched on age, gender, and maternal education to normal controls, and groups were similar in ethnicity. Parents of all subjects completed the Behavior Rating Inventory of Executive Function (BRIEF). Participants ranged in age from 6 to 18. The chemo group was significantly younger than the chemo+XRT group at the time of diagnosis. MANOVA and *post-hoc* comparisons were run comparing the three groups on the 8 scales of the BRIEF. Children in the chemo group had significantly ($p < .05$) higher (more impaired) scores than either the CHEMO+XRT or the controls on Working Memory, Plan/Organize, and Monitor. The chemo group also had significantly higher scores than controls in the Shift scale. Furthermore, a significantly greater percentage of children in the oncology groups had elevations in the clinical range on the Working Memory and Monitor scales. Results indicate cancer treatment, particularly early chemotherapy, increases the risk of EF problems, which has important educational and behavior management implications for childhood cancer survivors.

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K. KAEMINGK, M. CAREY, M. HERZER, I. MOORE, & J. HUTTER. Math Deficits in Leukemia Survivors.

Math deficits are frequently reported in leukemia survivors. We compared math performance of 15 leukemia survivors (M age = 12.62 years, SD = 3.34) who completed treatment to a group of age and sex matched siblings and peers (M age = 11.97 years, SD = 3.16). The leukemia survivors were treated with systemic and intrathecal chemotherapy but not radiation. Mean diagnosis age was 5.97 years (SD = 3.25). Mean time since diagnosis was 7.18 years (SD = 2.16). There were 9 males and 6 females in each group, and there were no significant group differences in age ($t = .55$, $p = .59$). Leukemia survivors performed significantly worse ($p < .05$) than the control group on each math measure administered: Arithmetic of the WISC-III, Calculation from the Woodcock Johnson-Revised; Basic Concepts, Operations, and Applications Scales of the KeyMath-Revised. One sample t test revealed that the leukemia group's performance was below normative expectation ($p < .05$) on Arithmetic and the KeyMath-Revised but not Calculation. Thus, there was converging evidence of math deficits in leukemia survivors using multiple measures and comparisons to an appropriate control group and normative expectation. Performance on math measures was related ($r > .40$) to Vocabulary (WISC-III), attention (WISC-III Digit Span), visual motor integration (VMI), and verbal and visual memory (WRAML Story and Design Memory, respectively). There were also significant group differences ($p < .05$) in performance on measures of attention, visual motor integration, and verbal memory but not on measures of vocabulary or visual memory. Thus, other difficulties may be contributing to math performance. These relationships remain to be elucidated, and interventions targeting math are underway.

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K.R. KRULL, N. JAIN, P. BROUWERS, B. LAW, S. BOTTOMLEY, & Z. DREYER. Childhood Leukemia Survivors: Patterns of ADHD Symptomology.

With improvements in the long-term prognosis for children diagnosed with cancer, focus is shifting to quality of life and neurocognitive or neurobehavioral consequences of treatment. The current study reviews patterns of DSM-IV defined Attention Deficit Hyperactivity Disorder (AD/HD) among a large group of childhood survivors of leukemia, and compares performance on traditional measures of attention. Seventy-nine children were identified from consecutive follow-up visits to a large children's cancer clinic. Major subtype classifications of ADHD included those who met criteria for Predominantly Inattentive Type (ADHD-I), Hyperactive-Impulsive Type (ADHD-HI), and Combined Type (ADHD-C) as per parent ratings on a behavioral questionnaire. Sixteen percent of the total sample of childhood leukemia survivors met criteria for ADHD, which is significantly higher than expected in the childhood population at large. Of the ADHD children 62% were classified as Inattentive Type, 31% were classified as Combined Type, and only 8% were classified as Hyperactive-Impulsive Type. On the Trail Making Test, Part B, performance of the ADHD-I children was significantly lower than those leukemia survivors who did not meet criteria for ADHD. Statistical comparison to an expected distribution (based upon standardization means and deviations) revealed that this group also displayed performance significantly lower than expected levels. These results indicate that a significant number of children who are long-term survivors of leukemia display attention problems, evident to parents and observable on standard measures of neurocognitive performance.

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N. JAIN, P. BROUWERS, K. KRULL, B. LAW, S. BOTTOMLEY, & Z. DREYER. Treatment Length and Gender Affect Outcome for Childhood Leukemia Survivors.

The long-term prognosis for children diagnosed with childhood leukemia has greatly improved as a result of more targeted and intense treatments. Increases in long-term survival, however, have been associated with a

growing number of neurobehavioral sequelae, which may be associated with the biological and/or the psychosocial consequences of the disease and its treatment. Children treated for leukemia often experience the development of late effects between 2.5 to 5 years following treatment. Deficits in attention and psychomotor processing speed have frequently been noted as late sequelae. The current study examines performance on the Trail Making Test, Parts A and B, and the Grooved Pegboard Test in 99 long-term survivors of childhood leukemia. Age at diagnosis, length of treatment, months post treatment, current age, and gender were hypothesized to affect performance on the Trails and Grooved Pegboard tests. The mean length of treatment was 31 months. Average age at the time of diagnosis was 56 months of age, and the average age at the time of testing was 148 months. A hierarchical multiple regression model showed that length of treatment adversely affects performance on both Trails A and B for females but not for males ($p < .05$). Performance on the Grooved Pegboard was not differentially affected by any of the factors. These findings support previous reports that females may be more at risk for adverse late sequelae following treatment for childhood leukemia, particularly with therapies that may result in a greater insult to the central nervous system.

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R. BUTLER, M. KERR, & B. SZEWCZYK. Emotional Perception Deficits Following Cranial Irradiation for Childhood Cancer.

It is now generally accepted that cranial irradiation as a CNS prophylactic treatment for children with leukemia is associated with cognitive impairment. Additionally, accumulated evidence has implicated maximal deficits in nondominant hemisphere functions, as assessed by measures such as performance IQ, visual-motor integration, and nonverbal memory. It has also been independently established that affect perception is primarily a nondominant hemisphere function. We hypothesized that children who demonstrated maximal impairment in nondominant hemisphere functioning following cranial irradiation would also manifest deficits in the ability to identify affect, based on facial expression. Subjects were 55 children and adolescents who were off treatment for leukemia. All participants had received cranial irradiation. Participants were subdivided into 2 groups based on performance IQ. Upon inspection of the overall distribution, it appeared that using a split criterion of a performance IQ = 94 resulted in 2 well differentiated subgroups: *Low-performance IQ* ($M = 78$, $SD = 13$) and *high performance IQ* ($M = 107$, $SD = 8$). The two groups significantly differed in the expected direction on a test of emotional facial identification, but not on a presumed less challenging task of discrimination. This difference cannot be ascribed to facial recognition abilities because the 2 groups were not significantly different on a test measuring this function. We conclude that there is preliminary evidence to suggest that individuals who experience significant neurocognitive decline following cranial irradiation may also have difficulty in accurately perceiving affect, based on facial expression.

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C.J. MILLER, M. COHEN, T.S. GARRISON, C. BUNYAPEN, & G.W. HYND. Extracorporeal Membrane Oxygenation in Neonates and the Resulting Neuropsychological Outcomes During the Pre-school and Early School Years.

Extracorporeal membrane oxygenation (ECMO) is an invasive medical procedure used to treat individuals experiencing near or total failure of the respiratory system. Research on ECMO suggests that children who experience life-threatening medical conditions as neonates have long-term deficits, regardless of medical treatment utilized. The purpose of this study was to compare the neuropsychological outcomes at 4-6 years and 7-9 years for children who were treated with ECMO during the neonatal period and children who were considered for ECMO as neonates but responded to conventional medical treatment (CT). In the ECMO group,

children were divided into 2 subgroups: those who exhibited seizure activity (SZ) and those who did not (NSZ). Across groups, children did not significantly differ in their primary and secondary medical diagnoses, nor were there significant differences on demographic variables. In the younger group, there were no differences between CT and NSZ groups on measures of verbal reasoning, visual reasoning, verbal memory, visual memory, or school readiness, but significant differences were noted in all areas between NSZ and SZ groups. Furthermore, adaptive behavior and overall cognitive ability scores indicated generally subaverage functioning in the SZ group. In the older group, verbal reasoning and visual memory performance significantly differed between SZ and NSZ groups. Fingertapping in the left and right hands, math calculation, social skills, and adaptive behavior distinguished the three groups. Overall, results from this study suggest that children who experience seizures during or following ECMO are at significantly greater risk for negative outcomes.

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J. WASSERSTEIN & G. STEFANATOS. Erb's/Klumpke's Palsy: A Marker for Possible Encephalopathy?

Obstetric brachial plexus injury (i.e., Erb's and/or Klumpke's palsy) is a common birth trauma following shoulder dystocia. The incidence is estimated to be about 0.37–2/1,000 live births. Known sequelae are neuromuscular, and complete recovery is expected in a substantial percentage of infants. However, upper limb palsy is a marker for traumatic delivery, sometimes associated with other neurological risk factors (such as low Apgar scores and need for resuscitation). We report on consecutive Erb's/Klumpke's cases with remarkable parallels in diagnoses and underlying neuropsychological profiles. Specifically, children examined in this series consistently demonstrated (1) attention deficit hyperactivity disorder (ADHD), combined or inattentive type; and (2) developmental coordination disorder (irrespective of effected limb). Language, learning and adjustment disorder were present to variable degrees. Traditional perinatal indices for encephalopathic risk (such as low Apgars, acidosis or asphyxia, meconium aspiration, etc.) varied widely. Thus the presence of Erb's, irrespective of its ultimate level of resolution, may be a potent predictor for late neuropsychological sequelae. These findings are discussed with reference to the Lou model of perinatal hypoxic–hemodynamic encephalopathy and pathogenesis of ADHD.

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NEUROTOXINS

A. KEUNING, C. CLASON, R. HOPKINS, J.G. BUCKWALTER, & W.S. BROWN. Carbon Monoxide Poisoning, Cognitive Performance, and Callosal Morphology.

The relationship between integrity of subregions of the corpus callosum (CC) and neuropsychological functioning is poorly understood. This study investigated CC size and neuropsychological performance in 31 carbon monoxide poisoned patients whose exposure was severe as indicated by length of loss of consciousness and carboxyhemoglobin (COHb) level. Outlines of the CC were generated from midsagittal MRIs and divided into 99 widths. Ten contiguous CC subregions identified in a previous study with similar methodology were used to specify regions of interest. After controlling for age, the size of CC subregions for each subject were correlated with neuropsychological performance. Significant correlations with CC subregions were found for approximately one-third of the neuropsychological measures. Hierarchical stepwise regression that controlled for demographic variables revealed that size of the splenium was positively correlated with better visuospatial skills and executive functioning, but was negatively correlated with attention. The size of the genu was correlated with executive functioning (Trails A, a positive correlation; Categories Test, a negative correlation). Loss of consciousness correlated with smaller areas in 6 of the 10 CC subregions. However, reduced form

equations suggested little role for total intracranial volume, loss of consciousness, intubation, and COHb in mediating relationships between CC subregion size and neuropsychological measures. Taken together, these results suggest that integrity of the CC plays a role in the neuropsychological functioning of carbon monoxide poisoned patients.

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T. JENNINGS, D. NEMETH, M. SCHEXNAYDER, K. WALTERS, & J. HAMILTON. The Neuropsychological Effects of a Neurotoxic Exposure to Methyl Parathion.

Organophosphates such as methyl parathion have been used safely in agricultural settings for years. The problem is when they affect humans via direct exposure such as in this case. Organophosphate vapors, via inhalation exposure, can produce mucous membrane upper airway irritation, and bronchospasms followed by chemical muscarinic, nicotinic, and central nervous system effects. Subtle neuropsychological deficits may be a part of the neurological sequelae. Other delayed effects may include impaired memory and defects in cognitive functions. Results of a neuropsychological evaluation of a 38-year-old single White male who experienced such an exposure in an agricultural setting were consistent with the research literature with one major difference. No psychological sequelae was noted. Although experiencing pain, discomfort and neurocognitive problems, the patient was able to maintain a positive affective and behavioral stance. No post-traumatic sequelae was found. No work absences were noted. This paper will address the patient's compromised brain–behavior functions and adaptive affective functions. Hypotheses will be offered.

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C. TILL, S. SWARTZ, G. KOREN, C. WESTALL, & J. ROVET. Assessment of Visual Functioning in Infants Exposed to Organic Solvents *In Utero*.

We previously reported that prenatal exposure to organic solvents is associated with increased risk of color vision deficits and reduced visual acuity in young children. These findings prompted us to evaluate visual functioning in solvent-exposed infants using more sensitive noninvasive visual evoked potential (VEP) techniques. This poster will describe recently developed VEP methods for assessing selective visual functions in infants. VEPs are recorded via 3 active electrodes fitted over the occipital cortex while infants view changing visual stimulation. The sweep VEP is used to assess contrast detection by presenting sinusoidal gratings that “sweep” across a range of contrasts and spatial frequencies. Transient VEPs are used to assess responses to equiluminant chromatic- and luminance-modulated sinusoidal gratings presented in pattern onset–offset format. Color-normal infants were tested in a longitudinal design over the first postnatal year. While waveform shapes changed little with age, latencies to chromatic stimuli decreased with increasing age, signifying the refinement of chromatic neural mechanisms. In 6-month-old infants, chromatic responses were characterized by a negative deflection occurring about 130 ms after onset of the red–green stimulus, and 145 ms after onset of the blue–yellow stimulus. A larger study is now being conducted with 35 solvent-exposed and 35 control infants, but to respect masking, results are not available until study completion. A single case study will be presented showing abnormal chromatic responses and reduced contrast sensitivity following prenatal exposure to organic solvents. These VEP techniques therefore appear promising for the clinical assessment of visual toxicity in pediatric populations.

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M. HIRT, S. GYSENS, A. GLEESON, L. MORA, & R. BOWLER. Neuropsychological Impairments in Lead-Exposed and Organic Solvent-Exposed Groups.

The present study explores the relationship between 2 types of toxic exposure and neuropsychological test performance. Twenty-six individuals

environmentally exposed to lead, and 30 individuals occupationally exposed to organic solvents were examined. Participants were administered a neuropsychological screening battery which included: Finger Tapping, Dynamometer, Grooved Pegboard, Santa Ana, Trail Making, Stroop, Symbol Digit Modalities, Rey-Osterrieth Complex Figure, WAIS-III Digit Span, Cancellation H, Consonant Trigrams, and Animal Naming. Seven participants were excluded for: scoring <7 on the Rey 15, history of alcohol abuse, insufficient vision, missing data, or a significant past head trauma. A one-way ANCOVA, between groups design, was used. The variables age, ethnicity, total years of exposure, and years of education were entered as covariates. Results revealed that the lead exposed individuals scored significantly lower on tests of psychomotor function (Finger Tapping, Dynamometer, Grooved Pegboard, and Santa Ana). This supports previous literature indicating psychomotor impairment as a primary symptom following lead exposure. The lead exposed group also had significantly lower test scores than the group exposed to organic solvents, on Trails A and B, Stroop color, Symbol Digit Modalities, Rey-Osterrieth Copy, and Digit Span reversed. Although attention, processing speed, cognitive flexibility, and visuospatial deficits are often cited after exposure to both lead and organic solvents, the present results may indicate different degrees of impairment based on type of exposure. Impairment levels within each group will be discussed.

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K. SULLIVAN, M. KRENGEL, V. HONN, S. PROCTOR, & R.F. WHITE. Neuropsychological Functioning in Gulf War Veterans Potentially Exposed to Chemical Weapons at Khamisiyah, Iraq.

Gulf War (GW) veterans have reported several health symptoms since returning from the war, including memory and concentration difficulties. One hypothesis for these reported symptoms includes exposure to chemical or biological weapons (CBW). One documented chemical exposure of U.S. soldiers occurred in Khamisiyah, Iraq. This study assessed whether GW veterans notified of potential CBW exposure due to physical proximity to the Khamisiyah site (K) differed from GW veterans not exposed to the Khamisiyah site (NE). Most GW veterans were not aware of their exposure status during the time of this cognitive evaluation. It was hypothesized that GW veterans in the Khamisiyah group would show more cognitive impairment than GW veterans not exposed (NE). A multiple analysis of variance was performed and results showed that the K group showed significant differences in the areas of executive system functioning and fine motor control. They also differed on the amount of reported fatigue and confusion. From these data, it appears that GW veterans notified of potential CBW exposure from the Khamisiyah site performed worse than GW veterans not exposed to this site on measures of executive system functioning, mood and fine motor control. These cognitive domains are consistent with neurotoxicant exposure patterns that cause subtle changes in specific cognitive domains and not a generalized pattern of deficit.

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L. O'FARRILL-SWAILS & M.L. ROHLING. The Neurotoxic Effects of Mercury Exposure: A Meta-Analysis.

This meta-analysis investigates the neurotoxic effects of mercury exposure. Previous research has examined 3 forms of mercury exposure: sea-food consumption (e.g., longitudinal studies in the Seychelles and Faroes Islands), mercury vapor, and elemental mercury contained in amalgam tooth fillings. The study is designed to resolve differences in research methodology, types of exposure, and severity of impairment. To accomplish this, a comprehensive search of the literature was conducted. Results were analyzed to develop a dose-response relationship. Study inclusion criteria consisted of both pre- and postnatal exposure. Furthermore, studies were coded in terms of exposure type: food consumption, health-related (e.g., dental work), and occupationally related (e.g., miners). Studies were also coded by self-reported symptoms (sensory, pain, and psycho-

logical well-being) and objective performance (perceptual organization, attention, memory, verbal skills, executive functioning). This meta-analysis attempts to determine the magnitude of adverse neuropsychological effects, as well as the influence of exposure on emotional and personality functioning. The study also attempts to determine at what level the adverse effects of mercury exposure are statistically significant and clinically meaningful.

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S. HUGHES, C. JORDAN, B. ROCHE, & E. SHAPIRO. Two-Factor Parent Model Predicts Developmental at 36 Months In At-Risk Children.

Maternal factors can mitigate the effects of poverty and associated environmental conditions or may increase the risk status of offspring. Previous work by the authors proposed a model of parental competence consisting of two empirically-derived factors: *Assets* (Raven Progressive Matrices, Home Observation Measure of the Environment, and Child Abuse Potential Inventory cognitive rigidity scale), and *Distress* (Global Symptom Index from the Brief Symptom Inventory, and Child Abuse Potential Inventory distress scale). Mothers of children in their second year of the DREAMS Child Development Study were divided into risk categories based on high/low dichotomization of these factor scores. A one-way ANOVA revealed significant group differences in child Mental Development Index (MDI) scores from the Bayley Scales of Infant Development at 36 months [$F(3,87) = 5.8, p = .001$]. *Post-hoc* analyses indicated that *high risk* mothers (Group 1: low assets, high distress) produced children with significantly lower MDI scores than *high competence* mothers (Group 4: high assets, low distress). Factor score configurations of *low asset/low distress* (Group 2) and *high assets/low distress* (Group 3) yielded intermediate MDI scores. These results support the validity of this 2-factor model of parent competence and the utility of categorization based on these factor configurations in predicting outcomes. Future research will focus on the utility of this model in predicting participation in longitudinal research. In addition, this model could serve to differentiate parents truly at risk from more competent parents living in high-risk communities.

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C. JORDAN, S. HUGHES, & E. SHAPIRO. Maternal Risk Factors Predict Child Lead Burden.

Lead overburden is typically believed to be the result of poor housing conditions. It has been thought that maternal factors such as IQ and depression affect child development and their variance has been removed from that of developmental outcome in studies of lead sequelae. The relationship between maternal factors and risk of lead poisoning is not well understood but is relevant to understanding lead overburden as well as appropriate methods for controlling confounding variables in lead research. Previous work by the authors has proposed a model of parental competence consisting of the empirically-derived factors *Assets* (Raven Progressive Matrices, Home Observation Measure of the Environment, and the Cognitive Rigidity scale from the Child Abuse Potential Inventory, CAPI) and *Distress* (Brief Symptom Inventory Global Symptom Index and Distress score from the CAPI). The relationship between parental competence and risk for lead poisoning was examined in 76 mother-child pairs participating in the DREAMS Project, a prospective study of lead effects. Lead levels were collected every 4 months from 4 to 36 months and area under the curve computed. Cumulative child lead exposure at 36 months was compared between 4 maternal groups (*high asset/low distress, low asset/high distress, etc.*) using ANOVA ($F = 2.92, df = 3, 73, p < .05$). *Post-hoc* analyses documented a significant difference between Group 1 (low asset/high distress) and Group 4 (high asset/low distress). Maternal risk factors may help focus lead prevention strategies and need to be considered in decisions regarding treatment of confounding variables in lead research.

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M. McDIARMID & K. ESPY. Relation Between Low-Level Lead Exposure and Attention in Preschool Children.

Approximately 900,000 children currently are exposed to levels of environmental lead (Pb) exceeding national guidelines set by the U.S. Center for Disease Control and Prevention. In general, a small to moderate inverse relation between low-level lead exposure (LE) and global measures of cognitive functioning has been reported in addition to a negative relation between LE in early childhood and later academic outcome. Although regulatory and executive aspects of attention often are correlated with LE, systematic investigation has not been undertaken. Forty-five preschool children (age 30–66 months) with low-level LE (peak Pb screening results $\geq 5 \mu\text{g}/\text{dl}$; LLE group) were compared to 34 children with negligible Pb screening results (*very low-level* LE; VLE group). Using a preliminary principal components analysis, three attention factors (Focus/Execute, Sustain, Shift) were identified, comparable to those described by Mirsky et al. in older children. The Sustain and Shift component composite scores differed as a function of LE group, even after covariates (age, maternal education, estimated child IQ) were controlled statistically. LLE children responded more perseveratively, evidenced by more optimal scores on measures of sustained attention and less optimal performance on tasks requiring mental flexibility. Multiple regression analyses failed to discern a dose–response association between peak BPb levels and any cognitive or behavioral attention measure, suggesting that LE effects at this low level represent a threshold rather than a continuum.

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M.D. RIS, J. COSCIA, P. SUCCOP, & K. DIETRICH. Domain Specific Effects Over Time of Early Exposure to Lead.

Using growth curve analysis, verbal and visuoconstructional skills were modeled from ages 6.5 to 15 years in a lead-exposed cohort ($\Psi = 196$). Higher lead exposure was associated with decelerations in verbal development by 15 years of age in contrast to the trajectory of visuoconstructional ability which was unrelated to lead exposure. This study represents the first application of growth curve modeling to one of the international prospective studies (Cincinnati Lead Study) on environmental lead effects, and suggests differential impact over time across 2 key domains of neuropsychological functioning.

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R.M. BOWLER & E. DIAMOND. Manganism: Neuropsychological and Neurological Signs and Symptoms in Welders.

Clinical neuropsychological evaluations were performed on 15 former and current welders, including the WAIS–III, and WMS–III, Motor Tests, Trails A & B, Rey–Osterrieth, SCL90–R, BAI, and BDI. Welders worked for a mean of 2 ± 1.9 years and had an average of 10.8 ± 1.9 years of education. They reported visible haze/smoke during welding. They gradually developed pulmonary, CNS and PNS symptoms and 13 became totally disabled. Manganese (Mn), contained in the welding rods, has been implicated with CNS damage following exposure. Symptoms of manganism, a characteristic cockwalk, including resting tremor similar to PD, was observed. Test results show moderate to severe deficits in visuospatial and cognitive function, with motor efficiency severely to profoundly impaired. Drawing tests showed a moderate to severe tremor in all but one welder. Verbal learning ability and simple attention are still intact, although low, visuospatial skills (a prior strength in welders) are moderate to severely impaired. The welders are moderate to severely depressed (BDI and SCL90–R) and score severely anxious on the BAI. Mood disturbance is one of the earliest signs of manganese poisoning. Manganism has been described among miners, welders and manganese alloy production workers worldwide. It is characterized by extrapyramidal dysfunction and neuropsychiatric symptomatology and is a progressive disorder. A levodopa/placebo trial, administered by a neurologist, did not improve their extrapyramidal dysfunction, a further sign that their disease is due to

manganese poisoning and not Parkinson's disease. None had familial PD—their deterioration began during welding and exposure to Mn fumes.

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S. GYSENS & R.M. BOWLER. Neuropsychological and Emotional Dysfunction in Welders.

Welding has been shown to be a hazardous vocation due to the frequent exposure to primarily manganese, but also chromium, iron oxide and degreasing agents. Progressive extrapyramidal dysfunction and neuropsychological and neuropsychiatric symptoms have often been described in welders. The present study compares the neuropsychological and emotional functioning of 76 male welders and 42 male demographically similar controls. The following tests were administered: Rey 15; WRAT–3; Boston Naming Test, Cerad version; selected subtests from the WAIS–III and the WMS–III; COWAT; Stroop; Cancellation H; Dynamometer; Finger Tapping; Grooved Pegboard; Trails; and Luria Motor test. Checklists to assess emotional status included BDI, BAI, BSI and POMS. Results indicated that, while welders and controls performed similarly on tests of verbal skills, welders performed more poorly on tests of working memory, cognitive flexibility, visuomotor processing speed, and motor efficiency. They also reported poorer emotional status and had more psychiatric symptoms. Within the group of welders, the number of life-time hours spent welding was negatively related to scores on working memory, cognitive flexibility and motor efficiency tests, as well as on mood tests.

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D. STRONGIN & R.M. BOWLER. Poisoned Brains: The Validity and Sensitivity of Neuropsychological Tests for Neurotoxic Assessment.

The validity of neuropsychological tests commonly used to assess cognitive functions of chemically exposed populations was examined. Construct validity was determined by comparing the component structures of chemically exposed and regional referent control groups. The fact that the component structures were the same for these samples indicated that the tests measured the same cognitive constructs in the 2 groups, and a legitimate comparison of performances on these neuropsychological tasks across groups could be made. The neuropsychological tests used in this study were intended to measure cognitive function in 6 components (i.e., *verbal, working memory, learning, cognitive flexibility, visuospatial/visuomotor and processing speed*). However, three components were obtained for both groups: Education, Processing Speed and Memory/Learning. The exposed and control groups scored similarly on the Education and Memory/Learning components. Verbally and educationally weighted tests were the least sensitive to the effects of neurotoxicity in these 2 groups. The reason for this finding may be that participants did not have the verbal or educational skills for adequate performance on the tasks. Performance differences between the 2 groups existed on the tests that loaded on the Processing Speed component. The tests on this component target fluid intelligence, which represents the integrity of the central nervous system. Because the central nervous system is particularly vulnerable to organic solvents, these tests are most sensitive to neurotoxicity. Appropriate normative comparisons, and more sensitive neuropsychological tests can provide accurate information to prevent further neurotoxic damage to chronically exposed workers.

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VISUAL PROCESSING AND DISORDERS

K.K. ZAKZANIS, S.J. GRAHAM, R. MRAZ, & G. QUINTIN. The Functional Neuroanatomy of Human Spatial Navigation.

We have developed a virtual reality environment (VE) called *Sunnybrook City*, a virtual town that provides a realistic, yet controlled testing environment where subjects are asked to navigate throughout using an egocen-

tric perspective. To elucidate the functional neuroanatomy of this basic neuropsychological function, we also developed an fMRI compatible VE platform where we could articulate those areas of the brain that are recruited in spatial navigation. We present brain activations from 5 route-learning trials (encoding and recall), an interference trial (Path B), and immediate and long delay route recall trials from a healthy normal volunteer. We found that learning to navigate through the VE produced bilateral prefrontal activity. We also found that this activity decreased over the learning trials particularly on the left side, but was found similar in magnitude to the 1st learning trial during a 2nd (Path B) route. Short and long-term delayed recall produced activity in the right parahippocampus with additional activation in left parietal cortex during long-delay recall. Our marriage of immersive virtual reality and functional brain imaging may prove useful in the development of ecologically sound neuropsychological measures while at the same time, provide a unique opportunity to relate the constituent cognitive behavior involved in the task to its specific neuroanatomic underpinning.

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G.P. LEE, D.W. LORING, & K.P. BRADLEY. Category-Specific Recognition and Site of Lesion in Prosopagnosia.

Recent investigations into the type of category-specific recognition deficit in the associative visual agnosia, prosopagnosia, have suggested recognition for living things are selectively impaired relative to nonliving things. Site of lesion causing prosopagnosia frequently involves bilateral damage to the occipitotemporal gyri and underlying white matter. To more fully scrutinize these observations, the investigators evaluated a 40-year-old, right-handed male who developed prosopagnosia after a left anterior temporal lobectomy for intractable seizures. In addition to the left temporal lobectomy, postoperative MRI showed an old lesion in the right posterior temporal–anterior occipital lobe extending into the deep white matter. Following surgery, the patient had a right superior quadrantanopsia, right hemiachromatopsia, and an inability to recognize familiar faces. All neuropsychological measures were essentially normal except visual–spatial learning and memory and gestalt closure. In addition to severe deficits discriminating among living things (e.g., family members, famous people, pets), the patient showed significant impairments in distinguishing members of nonliving object classes, such as foods, clothing, automobiles, containers, famous monuments (e.g., Statue of Liberty, Eiffel Tower), and natural wonders (e.g., Grand Canyon). Results in this case are consistent with the suggestion that damage to deep occipitotemporal white matter bilaterally causes prosopagnosia, and that both a visual categorization deficit and a material-specific memory deficit combine to produce prosopagnosia. However, the living–nonliving recognition defect distinction was not evident in this case suggesting the critical variables underlying the visual recognition defect in prosopagnosia may be visual subtlety and complexity.

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R. MRAZ, G. QUINTIN, S.J. GRAHAM, & K.K. ZAKZANIS. Evaluating Brain–Behavior Relationships for Tasks Involving Facial Recognition and Visual Form Discrimination.

The purpose of this study is to investigate the neural substrates involved during Facial Recognition and Visual Form Discrimination, 2 commonly employed neuropsychological tasks developed by Benton. Lesion studies have long supported the idea that both of these tasks are sensitive to function of the right parietal lobule. Functional magnetic resonance imaging (fMRI) experiments were designed to validate this hypothesis. Four healthy, right-handed subjects were tested (*M* age 26). Each task was adapted for fMRI suitability and subsequent analysis, and consisted of 5 practice trials, 30 stimulus trials, and 30 baseline trials. Presentation and selection of images were achieved using MR-compatible goggles and a joystick. Accuracy was .71, $\sigma = .07$ for Facial Recognition and .92, $\sigma =$

.03 for Visual Form Discrimination. In both cases, a distributed network of activations was observed, including right parietal, right frontal, and bilateral occipital cortex, as well as sensorimotor cortex associated with joystick manipulation. The networks showed strong similarity, although some differences were evident particularly in frontal and occipital regions. Our findings are consistent with the notion that these tasks are sensitive to right hemisphere disorder, but imply sensitivity to frontal and occipital disorder as well. This latter point should be taken into account during neuropsychological interpretation of these Benton measures.

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J. RENFREW, R. GRAVES, & D. SAUMIER. Role of the Left Hemisphere in Recognizing Prototype Faces.

This study investigated whether the left and right cerebral hemispheres differ in regard to the type of representations they form in memory when learning new faces. Using a face morphing technique, pairs of original photos of 2 different individuals' faces were partially (70% one, 30% the other) blended together to create 2 similar, yet distinct, stimuli termed *instances* plus a complete (50% of each) blend, termed a *prototype*. In the study phase, 24 undergraduate participants were shown only instance faces on the center of a computer screen. In the recognition phase, previously seen instance faces, unseen prototype faces, and unseen distractor faces were presented to the left or right hemisphere via the right and left visual field respectively. Results showed that unseen prototypes in the left hemisphere were recognized more confidently than the actually seen instance faces and that instance faces were recognized more confidently in the right than left hemisphere. These findings suggest that the left hemisphere may play an important—but previously overlooked—role in recognizing prototypes of new faces.

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M. HAMBY, A. DESAI, D. GOKCAY, & D. BOWERS. Digitizing the Moving Face During Non-Emotional Expressions.

In a previous study, we found that the left side of the face moved more than the right during dynamically produced emotional expressions. Although the basis for this asymmetry is unclear, the role of the right hemisphere in emotion processing has been a popular explanation. In this study, we applied a novel computer imaging technique to learn whether *nonemotional* expressions also induced movement asymmetries favoring the left. Methods: Forty-eight dextral adults were video-recorded while they produced voluntary non-emotional gestures (i.e., lower lips, raise brow). For each expression, a 900-ms video segment was digitized on a frame by frame basis and analyzed for changes in pixel intensity using custom software. This software automatically segmented the face into distinct regions (upper vs. lower, right vs. left) and computed movement changes over time. Results: The major finding was a significant movement asymmetry over the lower region of face ($p < .01$), whereby more movement occurred over the left than right lower face. This result corresponds to our previous findings with emotional expressions. No movement asymmetries occurred over the upper face. Discussion: Our findings of dynamic movement asymmetries during nonemotional expressions argue against a purely “emotion” explanation for expression asymmetries. Possible mechanisms underlying these dynamic asymmetries will be discussed.

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K.M. KODALEN & C. MATEER. ERP Correlates of Covert Facial Processing in Static and Dynamic Conditions.

This study employed electrophysiological measurement to investigate 2 key aspects of our ability to recognize faces; covert facial recognition and

the role of dynamic movement. The endogenous P300 waveform was recorded in a prosopagnosic subject and a group of healthy controls to provide evidence for the categorization of familiar and unfamiliar faces. Photographs of 96 University of Victoria undergraduate students were used as facial stimuli. It was hypothesized that greater P300 amplitude would reflect categorization of a stimulus even when this categorization occurred outside of overt recognition. It was further hypothesized that P300 waveforms in healthy subjects would provide a reliable indicator for differential encoding of facial information between faces presented in dynamic movement as compared with faces presented statically. To establish familiarity, faces were presented in 1 of 2 formats; sequentially rotated through a series of angles giving the impression of movement, and a static presentation. Using an oddball paradigm, participants then completed a forced-choice recognition task for a static photograph of a face presented at an angle not viewed in either the rotated or static conditions. Control subjects displayed no difference in P300 amplitude or latency in response to familiar and unfamiliar faces, nor did they display differences between presentation conditions. A prosopagnosic subject did not demonstrate the expected covert recognition for familiar faces based on P300 amplitude. Possible explanations for the lack of differential electrophysiological responses proposed include difficulty in establishing familiarity and difficulty in assessing familiarity.

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Q. ZHANG, K. MOGI, & M. IDESAWA. Neural Representation of Volume Perception With Binocular Viewing in Human Cortex.

One of the greatest mysteries in cognitive science is the human ability to perceive visually presented objects with high accuracy and lightning speed. The neural substrates of our innate ability to perceive and identify objects remain elusive. Volume perception is one of the important issues in the study of human visual perception. Some previous research reported that the lateral occipital complex (LOC) was involved in human volume perception by using some 2-tone figures. Here we studied the neural representation of the volume perception using binocular stimuli. The object perception with binocular viewing utilizes the disparities between the 2 eyes to recover the 3D information of an object, and the disparity is one of the most important clues for human to perceive a 3D object in the real world. So the study on the 3D object perception with binocular viewing is very important. A new visual effect named as mime effect was found in recent years, in which an illusory 3D volumetric object is perceived due to some stereoscopically displayed inducing objects. Applying this kind of stimuli, we conducted fMRI experiments to measure the activities in the human cortex when subjects attained the volume perception. It is found that, besides the occipital visual cortex (including LOC), the right frontal cortex in charge of the cognitive processes like reasoning and judgment was also activated for the volume perception. This implies that much intention and computation are needed to perceive volumetric objects with binocular viewing.

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Y. IKEJIRI, T. NISHIKAWA, Y. MASAKI, N. HATTA, H. TOKUNAGA, & M. TAKEDA. Neural Correlates of Metamorphopsia.

Background: Metamorphopsia is a kind of visual illusions that includes distortions of visual objects. Although the symptomatology, etiological, and lesional diversity of the symptom has been elucidated, cases with a discrete lesion have been rarely reported. *Objective:* We report 3 cases with metamorphopsia due to localized lesions. *Methods and results:* Case reports: Case 1: A 47-year-old right-handed man was surgically treated for the tumor in the lateral ventricle. After the operation, he complained of distortion of his wife's face and objects. Case 2: A 63-year-old right handed woman suddenly developed metamorphopsia of the left side of faces of other people, which disappeared after about 8 hr. Case 3: A 26-year-old, right-handed man was operated on for the tumor in a lateral ventricle. He

developed complex partial seizure and metamorphopsia for the right side of faces after the operation. MR images of the 3 cases demonstrated a localized convergent lesion in the major forceps of corpus callosum. *Conclusion:* Metamorphopsia might be caused by a small lesion of the major forceps of corpus callosum, which is involved in integration of visual information of objects in both hemispheres.

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A. BERARDI, S. KOSSLYN, & A. RIFFLE. Imagery Processing Battery: Task Structure in Visual Perception and Mental Imagery.

The Imagery Processing Battery (IPB) is a set of tasks designed to evaluate a wide range of visual perceptual and mental imagery abilities, such as imagery for faces, common objects, colors, words, mental rotation, scanning, image maintenance, auditory imagery, and tactile imagery. The objective of this study was to determine the factors and dimensions that underlie visual perceptual and mental imagery abilities in young healthy participants. A second objective was to compare the underlying pattern of factors and dimensions obtained in the imagery tasks with those obtained in the corresponding perception tasks. The 15 tasks from the IPB were administered to 32 young participants (age range: 18–25 years). All participants were right-handed Harvard University undergraduates matched for sex. Response times and error rates were correlated for the imagery and for the corresponding perception tasks separately. The obtained correlation matrices were then analyzed using multidimensional scaling and principal components analyses. The analyses consistently revealed the presence of 2 major clusters, 1 corresponding to tasks that rely on the “ventral” object-properties system and 1 corresponding to tasks that rely on the “dorsal” spatial-properties system. Similar patterns were observed for the visual perception and the mental imagery tasks. The results indicate the segregation of the 2 major visual processing systems in visual imagery in young healthy participants.

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C. J. MILLER, J. SANCHEZ, G.W. HYND, & J. GILGER. Verbal–Nonverbal Reasoning Discrepancies Within an Extended Family: Is Spatial Reasoning Heritable?

Significant differences in verbal and nonverbal reasoning abilities have been described in the neuropsychological literature, particularly in reference to individuals with learning disabilities. Yet, very few studies exist which examine the presence of verbal–nonverbal discrepancies in families where a genetic influence in cognitive patterns may be manifest. For this familial case study, we describe an extended family that evidences average verbal reasoning with above average to superior nonverbal reasoning skills, as measured by the Wechsler Abbreviated Scale of Intelligence (WASI). Across twelve family members, the average difference between verbal and performance abilities (V/P split) was more than 21 points and ranged from 5 to 45 points. 10 out of the 12 family members exhibited V/P splits in excess of 15 points, yet according to information describing the WASI standardization sample, only 17.6% of the population has V/P splits of this magnitude. If these individuals had been selected from the population randomly, the likelihood of identifying 10 out of 12 people with V/P splits in excess of 15 points is approximately 1:50,000,000. Although research on the heritability of intellectual functioning suggests that related family members should be more alike in spatial reasoning than randomly selected individuals, these results are nonetheless particularly striking. Of additional note, this family also exhibited extremely high spatial reasoning/constructional praxis skills with an average score 1.5 standard deviations above the mean. These results suggest a strong genetic component for giftedness in nonverbal reasoning skills. Implications and future directions for research will be discussed.

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J. SANCHEZ, C.J. MILLER, & G.W. HYND. Reversed Asymmetry of the Planum Temporale and its Relation to Discrepancies in Verbal and Performance Intelligence: A Family Case Study.

The planum temporale, located within Wernicke's area in the perisylvian cortex, has long been associated with language. According to research, the left planum temporale is larger than the right in 65% of subjects and deviations from this normal pattern of asymmetry have been associated with disorders relating to speech, language, and reading. This case study examines the ratio of the length of the right and left planum temporale in a nuclear family of 6 who showed an interesting pattern of performance on the Weschler Abbreviated Scale of Intelligence. Specifically, all six family members scored from one to three standard deviations higher on the Performance scale than on the Verbal scale, with Performance IQ in the above average to superior range and Verbal IQ in the average to above average range. Verbal-Performance discrepancies of this magnitude ($M = 27$ points) are rare and unlikely to occur by chance within a family, implicating genetic and/or neurobiological influences. Reversed asymmetry of the planum temporale was found in 5 of 6 family members, the father and 4 sons, who also exhibited the largest differences in their Verbal and Performance IQ scores. These results suggest that a comparatively larger right planum temporale may be associated with strengths in nonverbal reasoning. Correspondence: Juliana Sanchez, CCDN G-10 Aderhold Hall, University of Georgia, Athens, GA 30602. E-mail: juliana-sanchez@hotmail.com

V. MARK & A. WOODS. Speed versus Organization Measures on Cancellation Following Stroke.

The cancellation test can assess diverse processes involved in visuospatial search beyond unilateral neglect. Some studies indicate that brain injury may slow cancellation, while others concur that stroke patients are often considerably disorganized during cancellation, unlike healthy subjects. However, the assessment of cancellation organization is laborious compared to speed and spatial attention measures, requiring close monitoring of sequential target markings. We therefore evaluated whether cancellation speed may be a proxy measure for organization. *Methods:* We videotaped acute stroke patients on a modified Star Cancellation Test (no instructions on speed given) and reconstructed their target marking paths. We identified 23 patients who canceled at least half the targets with minimal or no perseveration. From their paths we calculated 3 objective measures of search organization: total cancellation path length, number of path intersections (both variables adjusted for number of targets marked), and the higher correlation coefficient of the marked targets' sequential horizontal (x) or radial (y) coordinates. From the recordings we also calculated the time on task from 1st to last target marked and thus the mean cancellation speed (targets/s). Finally, we correlated speed and organization measures. *Results:* Two of the objective measures (path length and intersections) were significantly correlated with cancellation speed ($r_s > .5$, $p_s < .02$). *Conclusion:* In stroke patients, cancellation speed may be a reliable indicator of organization during visuospatial search.

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V. MARK & A. WOODS. Face Validity of Search Organization Measures on Cancellation Tests.

In addition to assessing unilateral neglect, cancellation tests may be used to evaluate visuospatial search strategies. Stroke patients, in particular, may be considerably disorganized on cancellation tests. While several approaches can quantify search organization on cancellation, it is unclear whether such measures match a subjective impression of organization. *Methods:* We videotaped acute stroke patients on a modified Star Cancellation Test and reconstructed their target marking paths. We identified 23 patients who canceled at least half the targets with minimal or no perseveration. From their paths we calculated 3 objective measures of search organization: total cancellation path length, number of path intersections (both variables adjusted for number of targets marked), and the higher correlation coefficient of the marked targets' sequential horizontal (x) or

radial (y) coordinates. Fifty healthy adults (ages 18–67, M age 41) graded each cancellation path on a scale of 1–10 (10 = best organized, 1 = worst organized). A mean subjective organization score was calculated for each path. We then calculated the correlations between the mean subjective organization scores and each objective measure. *Results:* Only the correlation coefficient measure correlated with subjective ratings ($p = .011$). *Conclusion:* The correlation coefficient score best corresponds to a subjective judgment of "organization," probably because it is particularly sensitive to cancellation progress organized by rows or columns, unlike the other objective measures.

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T. WARNER, K. MCCOY, L. ROTH, & A.B. MOORE. Unexpected Finding in Visuospatial Processing in Right versus Left Hemisphere Stroke.

Studies of hemispheric specialization have established that the left hemisphere is dominant for processing of verbal material while the right hemisphere is typically dominant for spatial tasks. Cognitive performance of 72 stroke patients (45 left hemisphere, LH; 19 right hemisphere, RH; 8 bilateral) was examined on several measures of visuospatial processing and memory. The 2 lateralized groups did not differ significantly in age, gender, ethnicity, time since stroke, or handedness, but the RH group was better educated. Battery included the Brief Visuospatial Memory Test-Revised (BVMT-R), Trail Making Test, Rey-Osterrieth Complex Figure Copy, and WMS-III Spatial Span. Significant correlations were found between all the measures in the battery. We hypothesized that performance on these measures would be mediated by lesion location with RH stroke patients performing more poorly than LH stroke patients on measures of figural learning and recall. Contrary to expectation, multivariate analyses revealed that RH stroke patients performed significantly better on Trails B time and all BVMT-R scores, except Learning. The observed pattern of performance suggests that the group differences are not due to deficits in initial encoding, psychomotor speed, or attention and working memory. Superior performance by RH stroke patients on the BVMT-R likely results from the use of verbally-mediated strategies to aid in encoding and recall. Findings suggest that the right hemisphere may not play as great a role in visuospatial processing as previously thought.

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B.H. LEE, J.M. PARK, S.E. KWON, Y. JEONG, M.J. BAEK, S.J. KANG, & D.L. NA. Line Quadrisection Errors in Patients with Hemispatial Neglect.

The previous line quadrisection study of normal subjects revealed that line quadrisection errors tended to deviate toward each end of the line. In searching for the midpoint of left or right half of the total line, the line's endpoint may appear more salient than the subjective midpoint of the total line. Likewise, we posited that line quadrisection errors in patients with hemispatial neglect would be affected by the salience of line's ends. Subjects were 43 consecutive patients (18 with neglect and 25 without neglect) with right hemisphere stroke and 24 normal controls. They performed bisection, left quadrisection (LQ), and right quadrisection (RQ) tasks on the horizontally placed lines (240 mm). Also, as control tasks, they performed bisection tasks on the shorter lines (120 mm) placed on the left, center and the right-side of the pages. The same tasks were performed on radially presented lines, which included near quadrisection (NQ) and far quadrisection (FQ). We analyzed whether the subjective quadripoints deviated from the expected quadripoints derived from the subjects' bisection performances. The controls and the patients without neglect did not show any bias in RQ and FQ, however, they quadrisected to the left in LQ and toward the bottom in NQ. Patients with neglect did not show any deviation in RQ but they quadrisected toward the endpoint in LQ, NQ, and FQ.

These results suggest that bisection and quadrisection errors of patients with neglect may be influenced by the salience of line's end.

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G.R. JEWELL, M. MENNEMEIER, J. SALEM, & S. HARTLEY. Contaminated Perception and Responses in Neglect.

Magnitude estimation is an experimental task in which subjects rate perceptions of sensory stimuli. In normal subjects, sensation is a power function of stimulus intensity. However, patients with right-hemisphere brain damage and neglect make systematic errors in magnitude estimation, as evidenced by lowered power function exponents. One factor capable of lowering power function exponents is sequential order bias, also known as stimulus context effects. There are several reasons why patients may be more susceptible to sequential order bias than normal subjects. We examine 2 hypotheses: (1) that patients are unable to fully attend to current stimuli and are abnormally influenced by memories of the preceding stimulus, i.e., contextual effects; (2) that patients are influenced by the last response given and executive dysfunction "spoils" the response, i.e., perseveration. Data from 2 samples of elderly controls ($N = 20$) and right-hemisphere brain-damaged patients, most with signs of neglect, ($N = 18$) were summarized using power functions for visual bisection and loudness estimation tasks. Data from correlation analyses for both subject samples supports both hypotheses. While normal controls and brain damaged patients' performance is correlated with the stimuli they are currently being presented, only brain damaged patients were significantly biased by previous stimuli (Auditory: $r = .5, p < .05$; Bisection: $r = .18, p < .05$) and previous responses (Auditory: $r = .61, p < .05$; Bisection: $r = .48, p < .05$). Thus, perception in neglect is contaminated by contextual effects and perseveration.

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L. HEMMY, L.D. ROSENSTEIN, & M.P. NORRIS. Mixed Validity of the Mesulam Nonverbal Cancellation Task.

M. Mesulam's Nonverbal Cancellation task was designed as a test of inattention and neglect. However, there is little data available on the convergent or discriminant validity of the test. Indices derived from the task include the time required to complete the cancellation task, as well as the number of omission and commission errors. This study sought to provide preliminary validity data for the test in a clinical population of older adults (ages 55–92 years old) presenting for neuropsychological evaluations at a primarily outpatient clinic. As would be expected, after controlling for age, the time to complete the task was significantly associated with tests of attention, visual scanning, and spatial organization (e.g., Trails A and B, Rey-Osterrieth copy, Key Search task). Time for completion was also significantly associated with tests of verbal ability and memory (Boston Naming Test and CVLT), although these indices did not account for as great a proportion of the variance as the above measures of attention, scanning, and spatial organization. Errors of omission demonstrated a similar pattern in which after controlling for education, they were significantly associated with both conceptually similar and dissimilar measures, with similar measures accounting for a greater proportion of variance than dissimilar measures. However, commission errors did not demonstrate such a pattern and conceptually similar or dissimilar measures were not differentially related to the number of errors. Separating omission and commission errors by right *versus* left did not change the general pattern of results.

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L.J. ELIAS, M. HRABOK, A. MACFADDEN, A. SHEERIN, & D. SAUCIER. Free Viewing Perceptual Asymmetries for Judgments of Brightness and Quantity: Eye-Tracking Investigations.

Previous research has indicated that neurologically normal participants exhibit strong leftward biases during free viewing perceptual judgments of brightness, quantity, and size. When participants view 2 symmetrical objects and they are forced to choose which object appears darker, more numerous, or larger, participants usually select the stimulus with the relevant feature on the left side. It has been hypothesized left-right scanning biases underlie this effect, but right-left readers also exhibit leftward biases on these tasks. The present study investigated the visual scan patterns of participants completing this task in order to determine whether asymmetries in visual exploration contribute to the lateralized perceptual bias. Twenty-eight neurologically normal students completed 60 trials of a brightness comparison task and 60 trials of a quantity judgement task while their eye movements were monitored with a remote infrared eye-tracker. Participants exhibited strong leftward biases on both tasks, choosing the object with the salient feature on the left side 66% of the time and responding more quickly when exhibiting the leftward bias. These participants also spent 66–75% of their viewing time focused on the stimuli on the left half of the computer screen. When the stimuli were explored across the midline, these explorations tended to extend from left to right. Collectively, these eye-tracking results suggest that biases in the visual exploration during similar free viewing tasks contribute significantly to the subsequent perceptual biases.

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L. ELIAS, L. LEJBAK, B. NORRIS, D. SAUCIER, & G.E. SARTY. Free Viewing Perceptual Asymmetries for Judgments of Brightness and Quantity: fMRI Investigations.

Previous research has indicated that neurologically normal participants exhibit strong leftward biases during free viewing perceptual judgments of brightness, quantity, and size. When participants view 2 symmetrical objects and they are forced to choose which object appears darker, more numerous, or larger, participants usually select the stimulus with the relevant feature on the left side. It has been hypothesized leftward (right hemispheric) attentional biases for spatial judgments underlie this effect. The present study investigated the neuroanatomical substrates underlying this perceptual bias. Fourteen neurologically normal participants completed 20 trials of a brightness judgment task and 20 trials of a quantity judgement task during functional neuroimaging with a 1.5T Siemens Symphony MRI. Ten Axial sections (8 mm thick) were taken during each 2.4-s trial. The activation maps were computed by correlating the time course of each individual block blood oxygenation level dependent (BOLD) response with the average time course. Both tasks produced large asymmetries in activation. The tasks produced much more right hemisphere activation, and most of the lateralized activity was focused in the posterior parietal lobe. However, some participants also exhibited large asymmetries in activation in the right frontal lobe, in and around the frontal eye fields. Previous studies have demonstrated that the perceptual biases on these tasks are accompanied by asymmetries in visual exploration. Given the results of the current study, it is possible that these asymmetries in exploration are caused by asymmetric activation of right-hemisphere frontal and parietal structures.

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P. SERVOS, K. MUNHALL, A. SANTI, & M. GOODALE. Perceiving Visual Speech in a Visual Form Agnostic.

Speech perception is both a visual and an auditory process; the intelligibility of auditory speech perception is enhanced when a listener can view a talker's face. We examined a visual form agnostic to determine if she was able to make use of such dynamic visual cues despite her profound shape recognition impairment when only static visual cues are available. DF is a

46-year-old woman who suffered carbon monoxide poisoning damaging Brodmann's areas 18 and 19 but with apparent sparing of areas 17, 20, 21, and 37. DF was tested with a set of static and dynamic visual displays of three vowels /i/, /u/, and /a/. Five conditions were used: 1) auditory only which provided only vocal pitch information. Thus, this stimulus contained minimal spectral information about which vowel was being spoken so that listeners were unable to identify the vowel. However, when such vocal pitch information is presented in the context of the dynamic visual cues associated with the original vowel (see condition 3) observers are able to identify the vowel; 2) dynamic visual only; 3) dynamic audiovisual with vocal pitch information; 4) dynamic audiovisual with full voice information; 5) static visual only images of postures during vowel production. DF's accuracy was comparable to the controls in each condition (25%, 83%, 75%, 100% for auditory-only pitch, visual-only, audiovisual pitch, and audiovisual voice respectively). However, she was greatly impaired in the static vowels condition, scoring at chance (29%), while the controls performed almost at ceiling. Our results indicate that DF has

preserved dynamic visual speech perception in the face of impaired static shape perception suggesting that the neural substrates underlying these two processes are dissociable.

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Presidential Address /5:00–6:00 p.m.

Use-Dependent Learning and Neural Plasticity: A Revision of the Pessimism Surrounding Neurorehabilitation

Leslie J. Gonzalez Rothi

SATURDAY MORNING, FEBRUARY 8, 2003

Poster Session 8/8:00–9:15 a.m.

DEVELOPMENTAL DISORDERS: AUTISM AND DOWN SYNDROME

S. SIKLOS & K. KERNS. Assessing Family Needs in Parents of Children With Autism and Down Syndrome.

Parents of children with autism frequently turn to the health service delivery system to access supports to help adapt to the challenges of having a child with a life-long impairment. Although several studies have suggested various supports and coping strategies that are effective in adapting, very few studies have examined parents' own perceptions of needs, and whether parents felt those were met. In the present study we modified the Family Needs Questionnaire (FNQ), to address needs specifically for children with developmental disorders. The FNQ assesses the importance of needs in various domains such as personal supports (help with household), community supports (respite), and professional supports (OT for their child), and also assesses if these needs are met. A sample of 56 parents of children with autistic spectrum disorders and a comparison group of 32 parents of children with Down syndrome completed the FNQ. The groups didn't differ significantly on the number of important needs reported, nor the number of important needs that were being met. However, examining the 10 most important needs for each group using 2 separate methods (the mean score for each item and the 10 most endorsed items using Rasch analysis), it became apparent that the specific needs rated as most important for each group differed dramatically. The autism group reported more needs for their child, but did not differ from the comparison group in the number of personal needs. The implications of these differences will be discussed.

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J. EDGIN, B. PENNINGTON, C. MERVIS, J. MOON, J. STEDRON, & L. NADEL. Executive Functions in Down Syndrome.

The cognitive phenotype in Down syndrome (DS) includes mental retardation and a characteristic profile of impaired expressive language and syntax. In addition to these well researched areas of impairment in DS, behavioral and brain evidence have suggested deficits in hippocampal long-term memory (LTM) processes and executive functions (EF) mediated by the prefrontal cortex. While recent research has found consistent

deficits in LTM in DS, findings in the executive domain have been less consistent. We will present the results of studies of executive functions in individuals with DS across a wide age span: young children (ages 5–11), adolescents (ages 11–18), and adults (ages 19–40; overall $N = 70$). Performance on EF measures in these age groups was compared to typically developing mental age (MA) matched controls and to individuals with Williams syndrome. The groups were compared on measures of response inhibition, planning, and set-shifting. The group with DS had particular difficulty on tasks in which there was a component of the task requiring verbal regulation (i.e., the Zelazo dimensional card sorting task and gratification delay measures in which the participant had to internalize an instruction to wait for a bell to ring to receive a snack or wait without peeking while the experimenter wrapped a gift). The results showed no difference between groups on nonverbal EF measures, such as the CANTAB Stockings of Cambridge and tests of motor inhibition. These results suggest that the difficulties with executive control in DS could be linked to difficulties in the internalization of language representations.

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J. STEDRON, B. PENNINGTON, J. MOON, J. EDGIN, & L. NADEL. Hippocampal Function in Down Syndrome.

The current research aims to clarify the developmental profile of hippocampal function (HF) in persons with Down syndrome (DS). Adolescents with DS, ages 11–18, have been shown to perform worse than MA controls on a variety of hippocampal measures. The current study addresses whether this HF deficit is present in younger (ages 5–11), and older (ages 30–40), individuals with DS. Children and adults with DS and MA controls performed several tasks thought to tap hippocampal function. Like adolescents, young children with DS ($N = 12$) performed significantly worse than controls ($N = 9$) on the CANTAB Pattern Recognition task in which the participant is shown a series of abstract visual patterns and then asked to select the familiar pattern from a pair of patterns. Older individuals with DS ($N = 7$) also performed significantly worse than controls ($N = 12$) on the Pattern Recognition task and on the CANTAB Paired Associates task, which requires the participant to learn and remember associations between an abstract visual pattern and its location on a computer screen. In contrast, the performance of the young DS and control groups did not differ on three additional tasks thought to tap hippocampal function: deferred imitation, secret word recall, and find the hidden object. Older DS and control groups also performed similarly on the secret word recall task. In conclusion, the results of these studies provide further evi-

dence for HF deficits across a range of ages in DS. Possible reasons for performance differences across hippocampal tasks are discussed.

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S. ÄYSTÖ. On Neurosocial Profiles of Speech Difficulties and Disorders in Mental Retardation.

Cognitive capacity and social adaptation define mental retardation. Neurological factors as an etiology of mental retardation point to the need of finding behavioral clusters with a neuropsychological content to describe more precisely different subgroupings and intervention plans. From a representative sample of persons with mental retardation ($n = 258$; age 2–64 years) 3 groups of clinically observed speech disorders were taken: (1) intact speech ($n = 85$); (2) mainly articulatory speech problems ($n = 123$); and (3) severe speech difficulty with no expressive speech at all ($n = 45$). A battery of neuropsychological and cognitive tasks were presented concurrently with the AAMD Adaptive Behavior Scale. One-way ANOVA showed significant differences between the groups on neuropsychological, cognitive and adaptation measures. Compared to the other groups Group 1 showed overall better performance on neuropsychological and cognitive tasks but was also characterized by antisocial and untrustworthy behavior, psychological and social disorders. Group 2 was cognitively characterized with low performance on Word Recall backwards and Sentence Recall backwards. Group 2 scored lowest on maladaptive behavior showing some inappropriate and unacceptable behavior. Group 3 showed the most deficient performance on neuropsychological functions such as praxias, visual, tactile and auditory perception, receptive and expressive speech, naming, classification, academics and higher cortical functions. Group 3 scored lowest on independent functioning and highest on aggressive and withdrawal behavior, motor disturbances, stereotyped and inappropriate behavior than the others. Since the means for the age (respectively 24.4, 16.4, and 12.4 years) and the level of retardation differed significantly between the groups the interaction of age and level of retardation with speech problems needs to be further studied.

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S. RICE, E.D. BIGLER, J. LAINHART, W. McMAHON, H. COON, & S. OZONOFF. Corpus Callosum Morphology in Autism.

Some differences in corpus callosum (CC) surface area in autism have been reported. However, there is also a higher frequency of macrocephaly in autism, which could be a factor in CC size, but has not been investigated as such. In the current study we examined CC surface area in autism as well as those with macrocephaly by controlling for head size by entering each subject's scan into Talairach space. MRI scans were placed into Talairach space and surface area measurements of the genu, splenium and isthmus regions of the midsagittal area of the corpus callosum were based on MRI scans from 12 autistic subjects and 12 autistic subjects with macrocephaly using the Witelson protocol. Autistic subjects met ADI-R, ADOS-G, and DSM-IV criteria for autism. There were no significant size differences in the CC between autistic normocephalic and autistic macrocephalic subjects once head size differences were controlled. Accordingly, increased CC size in macrocephaly is simply proportional to larger head size and does not represent a unique size difference. Some theories of autism include speculations concerning abnormal growth as the basis for some differences in brain structures. However, these findings do not support any unique size differences in the overall structure of the CC. This study does not address smaller regional differences nor the shape and contour differences in the CC.

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C. BLOSS, F. HAIST, & E. COURCHESNE. Source Memory in Autism: fMRI Evidence for Cerebellar and Frontal Lobe Deficits.

Researchers have used the status of long-term memory to identify the neurological underpinnings of autism. For example, the medial temporal

lobe and/or frontal lobe have been implicated in autism based on the performance of autistic patients on various memory tasks. We investigated long-term recognition memory in autism using a source memory event-related functional magnetic resonance imaging (fMRI) paradigm that required participants to identify remember studied items and the modality in which they were studied. Participants studied common English words under visual and auditory conditions. Subsequently, participants received 2 recognition memory tests during fMRI scanning, 1 auditory and 1 visual, in which participants indicated via a button response whether the presented word had been studied in the visual or auditory condition, or if the word was “new” (i.e., not previously studied). To date, we have tested 3 high-functioning adult autistic males and 8 controls. Overall, autistic patients were mildly impaired in the ability to correctly identify previously studied words (autism = 79%, controls = 92%); however, autistic patients were normal in their ability to correctly reject novel words (autism = 81%, controls = 84%). Autistic patients demonstrated a profound source memory deficit demonstrated by a deficit in their ability to correctly ascribe learning context to recalled memory (autism = 45%, controls = 72%). Preliminary fMRI results indicate cerebellar and frontal lobe activation during the retrieval task in normal participants, but little activation in patients with autism. These results are consistent with proposals for cerebellar and frontal lobe dysfunction in autism.

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Y. YAMAMOTO & Y. KAMIO. Interaction of Self–Other Monitoring Processing and Verbal Processing in Verbally Able PDD: The Effects of Subject-Performed Tasks and Experimenter-Performed Tasks.

We studied the interaction of self–other monitoring processing and verbal processing in people with verbally able PDD. People with PDD demonstrate the impairment of self–other monitoring processing. We considered how the impairment of self–other monitoring interacts with language processing in verbally able PDD. In the present study, we focused on the relationship between action aspects of self–other monitoring processing and language processing. We employed the cognitive experiment tasks: subject-performed tasks (SPTs) and experimenter-performed tasks (EPTs). The SPTs contained subjects encoding the verbal phrase of action while executing the phrase. The EPTs contain subjects encoding the verbal phrase of action while observing another person executing the phrase of action. We consider how the SPTs showed the interaction action aspect of self–monitoring and language process. EPTs show the interaction of other–monitoring and language process. These tasks have higher recall performances than verbal tasks (VTs) in which phrases are presented only visually, by the precede researches. In the present experiment, the results show the group of individuals with PDD, recall after SPTs and after EPTs each was better than after VTs, and after SPTs and after EPTs were almost same. In our MA-matched control group, recall after SPTs better than EPTs, after EPTs better than after VTs, after SPTs better than after EPTs. These results indicate that the developmental process, in which both self–other monitoring and language interact mutually in MA-matched group; on the other hand, do not in PDD.

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E. KELLEY, A. JANOVICZ, L. MAYEUX, J. PAUL, D. VEAR, D. FEIN, & L. NAIGLES. Narrative Ability, Language Ability, and Social Functioning in Children With a History of Autism.

Individuals with autism have been found by many researchers to have difficulty with the pragmatic aspects of language; that is, how to obtain what one needs through communication, how to carry on a mutual conversation, and how to tell a story. Intensive early intervention is often quite effective for toddlers with autism. Many children who undergo early interventions are able to perform age-appropriately on standardized language and IQ tests. However, no in-depth examination of the language

capabilities of these children has been undertaken. This study examined whether children who had successfully completed intensive early interventions had “caught up” to their peers in their ability to narrate from a wordless picture book. These children had been mainstreamed into regular classrooms and were no longer receiving educational assistance. Their performance on standardized language tasks was comparable to that of their typically developing peers, and no significant differences between the groups were observed on number of words, clauses, or connectives. However, assessments of narrative structure revealed systematic impairments in the children with autism. They produced fewer causal attributions, discussed fewer major events, were less likely to discuss the character’s motivations, and were less likely to use narrative devices. The relationship of these narrative difficulties to overall functioning (as measured by the Vineland Adaptive Behavior Scales), general language ability, and understanding of *theory of mind* is discussed. Although these children may appear to be functioning normally, there are still subtle deficits in their social understanding.

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S. JOHNSON, D. BUB, & S. KINE. Impaired Memory for Social Scenes in Asperger’s Disorder.

Theoretical accounts of autism and Asperger’s Disorder emphasize amygdala dysfunction, implicated in impaired ability to detect socially salient information. We hypothesized that impaired recognition of and attendance to socially salient stimuli subsequently disrupts memory for such information. The present study assessed recognition and recall of social scenes in 11 individuals diagnosed with Asperger’s disorder (AD) and 9 normal controls (NC), matched for age, education, and estimates of verbal and nonverbal IQ. Fifty brief videotaped social scenes were presented and participants were required to detect and describe verbal and nonverbal “abnormalities” within the context of a social interaction. The Social Scenes task included both ‘normal’ and ‘abnormal’ scenes. Immediately following this task, brief portions of 10 scenes were presented (9 original scenes, 1 foil). Participants were asked to indicate if the scene was viewed previously and if yes, to describe the content of the scene. There was no group difference for Recognition, but a high false positive rate is possible. The NC group recalled more scenes than the AD group. Of the scenes that the NC group recognized, 88% were accurately identified. The AD group accurately described only 53% of the recognized scenes. Moreover, the AD group recalled the details of abnormal scenes (70%) better than normal scenes (51%), while this was not the case for the NC group (abnormal = 85%; normal = 82%). Results indicate that recall of social information is impaired in AD. Furthermore, level of initial processing may impact subsequent recall.

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S. JOHNSON, D. BUB, & S. KINE. Emotion Recognition in Asperger’s Disorder.

A deficit in emotion recognition may contribute to the social deficit in individuals diagnosed with Asperger’s disorder. The present study assessed recognition of emotion in visual (Face Expression), auditory (Voice Expression), and lexical (Emotion Definitions) modalities in 11 individuals diagnosed with Asperger’s disorder (AD) and 9 normal controls (NC), matched for age, education, and estimates of verbal and nonverbal IQ. The Face Expression task included a subset from Ekman and Friesen, depicting anger, disgust, fear, happy, neutral, sadness, and surprise. The Voice Expression task used nonsense phrases depicting anger, anxiety, boredom, disgust, excitement, fear, happiness, interest, pride, and sadness. Overall, there were significant group differences on the Face Expression task [$t(18) = -1.813, p < .05$], and the Voice Expression task [$t(18) = -2.33, p < .05$]. No group difference was found for the Emotion Definitions task, indicating intact semantic knowledge of various emotions and cognitive states.

Analysis of individual emotions for faces yielded a significant group difference for neutral items ($p < .05$), and trend differences for sadness ($p = .06$), surprise ($p = .05$), and anger ($p = .10$). Voice Expression comparisons were significant for anger ($p < .01$) and boredom ($p < .05$), and at trend for sadness ($p = .08$). Results indicate a cross-modal emotion recognition deficit in AD and raise interesting questions regarding neuroanatomical correlates of impairment in specific emotions, primarily anger and sadness. Findings are discussed in relation to recent work indicating multimodal deficits in processing specific emotions in neurological populations. Correspondence: Shannon Johnson, Indiana University, Department of Psychology, 1101 E. 10th Street, Bloomington, IN 47405. E-mail: sjohnso4@indiana.edu

J. LORD, J. WOLF, J. PAUL, & D. FEIN. Affective Processing in Children With Autism Spectrum Disorder.

Autism spectrum disorder (ASD) is a developmental disorder characterized by impairments in communication, and socialization and stereotypical patterns of interest and activity. Previous research has indicated that individuals with ASD exhibit impairments in affective processing. The present study investigated affective processing in children 6–12 years of age diagnosed with ASD ($n = 10$) and typically developing children ($n = 10$) matched by age and Stanford-Binet-IV Vocabulary standard score. Two batteries of affective processing (Objects, Faces, Affects, Situations Matching Test and the Children’s Affective Prosody Exam) were administered to examine the participants’ ability to match affects, faces, and situations and to identify affect from visual and auditory stimuli. Univariate ANOVA results suggested that children with ASD have significantly greater difficulty identifying affect when the task contains an auditory component than do typically developing children (CAPE Part 2, $p = .016$; CAPE Part 3, $p = .033$). This is consistent with research showing poor auditory processing in this population and suggests that future research on affect processing should take modality of presentation into account as an important factor.

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K. CULHANE-SHELBURNE, P. WINKIELMAN, B. PENNINGTON, & S. ROGERS. Classical Conditioning of Emotional Response in Autism.

One of the most debilitating aspects of autistic spectrum disorders is the impact on emotional functioning; however, these deficits remain poorly understood, particularly at a physiological level. The purpose of our ongoing study is to examine the conditioning of physiological responses associated with emotion in persons with autism. The study will replicate a classical conditioning method used to study emotional conditioning in individuals with bilateral amygdaloid and hippocampal damage. Two competing hypotheses regarding the classical conditioning of a physiologically defined emotional response in individuals with autism will be evaluated, both of which are based on evidence from the current literature: amygdaloid dysfunction and sensory modulation deficit hypotheses. Pilot data have thus far been collected on 2 individuals with a diagnosis of autism (AS) and 2 typically developing adults (TYP). The patterns of unconditioned fear response (i.e., to a 100 dB sound), emotional conditioning, and habituation to stimuli differed for AS subjects vs. TYP subjects. Specifically, the TYP subjects acquired the conditioned response (CR) on early trials and went on to habituate quickly to both the UCS and CS. In contrast, AS subjects took more trials to acquire a CR, had lower amplitude responses, and habituated more slowly. The subjects with autism also seemed to have a different sensory response to the UCS, in that they often generated 2 or 3 discrete electrodermal responses per presentation of the sound. These preliminary results are consistent with an amygdaloid dysfunction hypothesis.

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A. WAGNER, L. KENWORTHY, T. AHLUVALIA, L. SIRIAN, P. LEE, & L. GILOTTY. Neuropsychological Profiles in High-Functioning Autism and Asperger's Disorder.

Efforts to differentiate HFA and AD based on clinical symptomatology and cognitive profiles have produced conflicting results. Some findings suggest qualitative differences while others argue that AD is simply a higher functioning variant of HFA. Those investigators finding distinct neuropsychological profiles emphasize left hemisphere-related strengths in AD and right hemisphere-related strengths in HFA. We hypothesized that, instead of showing global left hemisphere strengths, the AD group would demonstrate a specific facility with learning and remembering verbal databases. Participants consisted of HFA ($N = 33$) and AD ($N = 31$) patients consecutively evaluated in a neuropsychology service. Diagnoses were confirmed by independent chart review by 2 experienced clinicians using DSM-IV criteria. Groups matched on age (range = 6–16 years; HFA: $M = 10.6$; AD: $M = 10.1$), Perceptual Organization Index (HFA: $M = 96.2$, $SD = 18.8$; AD: $M = 103.4$, $SD = 17.5$), and gender (31 HFA males, 28 AD males). All subjects had $FSIQ \geq 65$. Subjects completed a comprehensive neuropsychological battery. They were compared on the following domains: executive function (attention, inhibition, working memory, planning/organization, shifting); language (functional communication, verbal knowledge, phonological segmentation, expressive abilities); visual perception (visual construction, visual motor integration); learning and memory (verbal/visual learning, delayed recall); social functioning; and fine motor. Analyses of variance revealed no significant group differences with the exception of verbal knowledge ($p < .001$), on which the AD group performed better than the HFA group (AD: $M = 116.7$, $SD = 19.0$; HFA: $M = 97.1$; $SD = 16.2$). These findings are consistent with previous reports of higher IQ in AD, but indicate that this difference may be accounted for by strengths in specific language skills.

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P. DIXON, J. KLEINMAN, M. BARTON, J. GREEN, S. ALLEN, D. ROBINS, & D. FEIN. Agreement Among Four Diagnostic Instruments for PDD in 2-Year-Olds.

The early detection of autism spectrum disorders is crucial for intervention and therefore optimal prognosis. The Modified Checklist for Autism in Toddlers (M-CHAT) is a parent-report checklist designed to detect pervasive developmental disorders (PDD) in young children. In this study, 18–30-month-old children (M age = 27 months) were screened with the M-CHAT. Those who failed the screening were evaluated with four diagnostic measures: Autism Diagnostic Observation Schedule (ADOS), Autism Diagnostic Interview-Revised (ADI-R), Childhood Autism Rating Scale (CARS), and clinical judgment based on DSM-IV criteria. Data analyses indicate diagnostic reliability between the ADOS, CARS, and clinical judgment based on the DSM-IV criteria for determining whether a child is on the autistic spectrum (either autism or PDD-NOS; $p < .001$). However, the ADI-R did not show significant agreement with any of the other three measures; it often under diagnosed children relative to the other instruments ($p > .33$). This may be because the ADOS and DSM-IV both have specific scoring criteria for diagnosing autism and PDD-NOS, whereas the ADI-R only diagnoses children as being autistic or not autistic. Therefore, it may be beneficial to develop a scoring algorithm for diagnosing PDD-NOS with the ADI-R in very young children.

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N.C. WALZ, M.D. RIS, N. WALLER, C. MOLLOY, J. BROWN, M. BRASINGTON, & P. MANNING-COURTNEY. Taxonicity in Autism Spectrum Disorders Using Indicators From the ADOS-G.

The diagnostic nomenclature for autism spectrum disorders (ASD) continues to evolve. An unsettled question is whether or not there are naturally occurring boundaries, or whether categorical distinctions within ASD

are arbitrary. The purpose of this study was to investigate the discrete versus continuous nature of ASD. Participants included all individuals age 5 and older ($n = 350$) who were referred to a large hospital-based ASD clinic for an initial diagnostic evaluation. As part of the diagnostic evaluation, all individuals were administered the Autism Diagnostic Observation Schedule-General (ADOS-G) from which the diagnostic indicators were drawn. This study improves upon previous research by using multivariate taxometric procedures to investigate the taxonicity of ASD and identify indicators for a putative ASD taxon. Implications for clinical diagnosis and treatment will be discussed.

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G. GOLDSTEIN & N. J. NINSHEW. Conceptual Reasoning in Autism.

A study was conducted of abstraction and related conceptual reasoning abilities in individuals with high-functioning autism. A group of tests was administered to samples of 50 individuals with high-functioning autism and 65 age, education, and IQ group matched normal control participants that assessed various aspects of conceptual reasoning through the use of an extensive battery of tests of abstract reasoning and problem solving. These tests were categorized into different tasks including attribute identification, rule-learning, concept formation, inductive reasoning, forming and manipulating mental representations, plan generation, and cognitive flexibility. Data were analyzed by power analysis ranking differences between the autism and control groups in power to reject the null hypothesis. The most powerful tests were those that assessed cognitive flexibility and planning ability. It was concluded that the conceptual deficits that most clearly discriminate between individuals with high-functioning autism and normal controls involve the abilities to spontaneously form organizational strategies and to change hypotheses as required for promoting problem solving. This pattern of cognitive function is proposed as a possible explanation for the difficulties with complex social behavior, ritualized activity, and need for maintenance of environmental stability associated with autism.

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M. LISS, C. SAULNIER, & D. FEIN. Sensory Disturbances in Individuals With PDD.

Although sensory abnormalities are not part of the diagnostic criteria for PDD, they are often described in first person accounts and observed by parents and professionals. Nevertheless, systematic research on this phenomenon is sorely lacking. Several theoretical hypotheses have been offered to explain these disturbances including one that hypothesizes that sensory abnormalities are related to overarousal and overfocused attention. It is possible that these relationships are particularly pronounced in a subgroup of individuals with PDD. This investigation examined parent report of sensory overreactivity, underreactivity and seeking behaviors in 252 individuals with PDD (range 1–23, M age 8). Additionally, parents were given a measure of diagnostic severity, overselective attention and an assessment of exceptional memory. Furthermore, 191 of the parents were administered the Vineland Adaptive Behavior Scales (VABS). A cluster analysis was performed to determine whether an overfocused/overreactive subgroup could be identified. The results confirmed the existence of such a subgroup. Approximately 10% of the sample had a strongly overfocused pattern of symptoms including overreactivity, perseverative behavior, overfocusing, and having an exceptional memory. An additional 33% of the sample had a mildly overfocused/overaroused pattern. Thus, overreactivity to sensory stimuli is related to overfocused behavior in some individuals with PDD.

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C. MRKOTSKY, A. HEFFELFINGER, & J. LUBY. Executive Functions in Preschoolers With Autism: Effects of Risperidone and Applied Behavior Analysis.

The primary objective of this study was to investigate the impact of pharmacological and behavioral treatment on executive functions (EF) such as working memory, attentional shift, and set maintenance in preschoolers with autism spectrum disorders (ASD). We evaluated changes in executive functions and other cognitive abilities of 23 preschoolers with ASDs (age 30–69 months) over a 6-month period during which children were randomized to risperidone ($N = 11$) and placebo ($N = 12$). Children also received Applied Behavior Analysis (ABA) during this period, and were divided into a group of more intensive (≥ 20 hr/week; $N = 13$) and less intensive ABA (< 20 hr/week or none; $N = 10$). Treatment subgroups were comparable for age, gender, SES, and nonverbal reasoning. Groups were compared on EF tasks (*A-not-B*, *delayed response-DR*, *spatial reversal-SR*, *alternation*), language, and nonverbal measures at baseline and 6-month retest. At baseline the total sample was also compared to age-matched unaffected controls ($N = 10$) on the EF tasks. ASD children performed more poorly in shifting (alternation: $p < .01$), with more perseverative errors ($p < .05$), and somewhat lower in working memory (DR: $p < .1$). Repeated measures analysis for the ASD treatment subgroups revealed greater improvement on working memory (DR) and rule-learning (SR) in children treated with more intensive ABA. Risperidone treatment also improved working memory, yet effects were at trend level. No other differences were significant. Findings suggest that basic working memory is more sensitive to treatment than other executive functions. A randomized trial of ABA is warranted to further investigate these treatment effects on working memory.

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S. CHRIST, D. HOLT, D. WHITE, & L. GREEN. Inhibitory Abilities in Children With Autism.

Previous research involving children with autism has revealed impairments across a range of neuropsychological abilities including cognitive flexibility, planning, and working memory. Whether such children also experience difficulties with inhibitory abilities, however, remains unclear. We present evidence that children with autism demonstrate a particular pattern of sparing and impairment across different aspects of inhibitory ability. Performance of children with autism ($N = 20$) was compared with that of age-matched controls on 4 separate inhibitory procedures, namely, computerized versions of the Stroop, flanker, go–no-go, and stimulus–response reversal tasks. In the Stroop task, children responded to the color the stimulus words were printed in. The stimulus words were congruent (*blue* presented in blue), neutral (*dog* presented in blue), or incongruent (*blue* presented in red). In the Flanker task, children responded to the identity of a target stimulus by pressing 1 of 2 buttons. Targets were closely flanked by distracter stimuli that were mapped to the same response as the target (compatible), a different response (incompatible), or no response (neutral). In the go–no-go task, children were presented with a series of stimuli and asked to respond (go) only to targets and to withhold their responses to non-targets (no-go). In the stimulus–response reversal task, children were presented with left or right targets. For half the trials, they pressed a button located ipsilateral to the target; for the other half, they pressed a button located contralateral to the target. Findings are interpreted within the context of recent models of inhibition.

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N.M. KLEINHANS, N.A. AKSHOOMOFF, & E. COURCHESNE. Executive Functioning in Autism and Asperger's Syndrome: Results From the D-KEF.

High functioning patients with autism are typically impaired on tests of executive functioning (EF). However, multiple cognitive operations are required to perform most EF tests and patients with autism can vary

significantly in terms of cognitive strengths and weaknesses. We utilized selected tests from the Delis-Kaplan Executive Function System (D-KEF), which allows fundamental skills to be isolated from higher-order cognitive processes and provides comprehensive normative information. The participants were males with autism or Asperger's syndrome, aged 16 to 42 years, with borderline to high-average intellectual abilities. On the Trail Making Test, a specific deficit in set switching was not found. Subjects were either unimpaired, or showed significant impairment on both set-switching and visual scanning conditions. Performance on Design Fluency was unimpaired, although a few subjects had low production rates. All subjects, regardless of ability level, performed average or above on Letter and/or Category Fluency. However, performance on Category Switching was impaired relative to Category Fluency performance. Inhibition on Color-Word Interference was not specifically impaired. Scores were in the average range or commensurate with Color-Naming or Word-Reading scores. However, approximately half of the sample showed a significant decrement in the Inhibition-Switching condition relative to Inhibition. Overall, the most consistent finding was a deficit in endogenously driven switching in the verbal domain. In addition, many subjects had difficulty switching after building up a prepotent response. The component process utilized by the D-KEF appears to be a useful tool for identifying specific weaknesses in EF in this type of heterogeneous patient population.

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A. DAVIS & A. HEFFELFINGER. Adaptive Functioning and Ability Correlates in PDD Spectrum and Externalizing Preschoolers.

In assessment, a common assumption is that cognitive abilities relate to day to day functioning. Past research has related adaptive versus ability functioning in some patient populations, but research is sparse in preschool children. This study examined the relationship between adaptive behavior (Vineland Adaptive Behavior Scale; VABS) and ability (IQ and language (LA) scores) in children classified as *externalizers* (EX, $n = 19$) or pervasive developmental disorder spectrum (PDD, $n = 21$). This latter group was further subdivided into autism ($n = 11$) and PDD, NOS ($n = 10$). Gender did not differ between groups but the PDD subjects were younger ($M = 44.7$ months) than the EX subjects ($M = 55.4$ months). It was hypothesized that adaptive functioning would correlate with IQ and LA for the entire group and subgroups. The PDD subjects were lower than the EX subjects on IQ, LA composite, and VABS composite (all $ps < .0005$). High correlations were found for the entire sample for VABS composite with IQ ($r = .790$) and with LA ($r = .809$), all $ps < .0005$. VABS Communication composite was strongly correlated with expressive LA ($r = .753$), receptive LA ($r = .881$), and LA composite ($r = .905$), all $ps < .0005$. IQ correlated significantly with the 4 VABS indexes (all $rs > .75$, $p < .0005$). These strong relationships held for both the EX group (all $ps < .005$) and the PDD group (all $ps < .05$). When the PDD group was further subdivided, although most of the correlations remained significant, the strength of these relationships was stronger for the PDD, NOS group than the autism group (all $ps < .05$). These findings suggest that the VABS serves concurrent predictive validity for neuropsychological measures and that parents are accurate reporters of their child's ability level across varied diagnostic preschool populations.

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S. SIKLOS & K. KERNS. Impact of Autistic Characteristics on Parent Needs, Stress, and Satisfaction.

Parents of autistic children exhibit more stress and poorer coping than parents of children with many other disorders, such as mental retardation, Down syndrome, and externalizing disorders. However, there has been contradictory evidence surrounding the relationship between severity of the child's disorder and parent stress. The current study aimed to delineate the impact of each of the triad of autistic symptoms on measures of stress,

satisfaction, and self-reported needs. A sample of 56 parents of children with autistic spectrum disorders completed three questionnaires, including (1) the Child Characteristics Questionnaire, a scale that separately assesses the communication, social, and behavioral characteristics associated with autism; (2) a family needs questionnaire; and (3) a diagnostic survey, which asked about the diagnosis, including parents' stress levels/satisfaction regarding the process. Significant correlations were found between the number of perceived important needs (FNQ) and the behaviour scores (CCQ). Significant correlations were also found between the communication scores (CCQ) and stress surrounding the diagnosis, satisfaction with the diagnostic process, and the services received since the diagnosis. There was also a trend towards increased social concerns being linked to fewer met needs. Results indicate that having an autistic child with greater communication difficulties may be linked to an earlier diagnosis, being less stressed by the diagnosis, and to obtaining more services for these children. Having a child with greater nonlinguistic behavioral difficulties may be related to a parents' need for more supports, while having a child with social impairments may be linked to receiving fewer needed supports.

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DEPRESSION AND ANXIETY

J. O'JILE, D. ELKIN, J. RHUDY, & C. SIMPSON. Effects of Mood on Neuropsychological Testing in Children.

Although the effects of depression and anxiety on neuropsychological testing have been well investigated in adults, these effects in children are not as well understood. Early studies evaluated this by testing before and after treatment with antidepressants, but control groups were not used to assess for practice effects. More recently research demonstrated deficits in depressed children on the CVLT-C and subscales of the WISC-R Block Design, Coding, and Digit Span. In this study, we report on psychological effects on neuropsychological testing in a heterogeneous sample of 60 children (22 females) ranging from 5 to 16 years of age. These children were administered a full neuropsychological battery, and they provided a self-report of mood, using the Children's Depression Index and the How Do I Feel questionnaire. These self-report measures demonstrated no relationship to any subtest performance of the WISC-III. Further, there was no relationship between self-report of mood and memory measures (CVLT-C and Visual Learning from the WRAML) and several measures of executive functioning (CPT, WCST, and Trails B). However, in a subset of 47 subjects who were administered Trails A, a significant relationship was found with self-report of mood ($r = .32, p < .05$). This suggests that there is minimal change in neuropsychological results as a result of self-reported depression and anxiety in children.

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K. KAEMINGK, B. DAVID, P. KLAAS, & S. QUAN. Interhemispheric Transfer Task Performance in Children With Depression Symptoms.

We hypothesized that performance on an interhemispheric transfer task would be reduced in children (ages 6–12 years) with depression symptoms ($n = 33$) compared to those without depression symptoms ($n = 91$). Children were participants in a prospective study of sleep, cognitive function, and behavior, the Tucson Children's Assessment of Sleep Apnea study. Children with scores ≥ 60 on Withdrawn or Anxious/Depressed Scales of the Child Behavior Checklist were placed in the depression symptom group. Those in the comparison group had scores < 60 on both scales. There were no group differences in age (depression $M = 8.14, SD = 1.82$; comparison $M = 8.44, SD = 1.66$; $t = .9, p = .37$) or parent education ($t = 1.4, p = .18$). Mean contralateral and ipsilateral reaction times to laterally presented light flashes were measures of psychomotor speed. The mean

difference between contralateral and ipsilateral reaction times was used to estimate interhemispheric transfer time because information crosses hemispheres when the hand contralateral to the visual stimulus is used to respond. Using one-tailed t tests, the group with depression symptoms had significantly longer contralateral ($t = -1.69, p = .05$) and ipsilateral ($t = -2.04, p = .02$) reaction times. Mean contralateral response was 497 ms ($SD = 169$) in the depression group and 455 ms ($SD = 101$) in the comparison group. Mean ipsilateral response was 494 ms ($SD = 140$) in the depression group and 447 ms ($SD = 103$) in the comparison group. There was no group difference in mean differences between contralateral and ipsilateral reaction times. Thus, psychomotor speed, but not interhemispheric transfer speed, was reduced in children with depression symptoms. Correspondence: *Kris Kaemingk, 1501 N. Campbell Avenue, Tucson, AZ 85724. E-mail: kaemingk@peds.arizona.edu*

R. HATFIELD, S. LANGENECKER, I. SMET, D. MAIXNER, & B. GIORDANI. Memory Functioning and White Matter Disease in Treatment Resistant Depression.

Verbal and visuospatial memory was examined in 20 patients (M age = 66, education = 13 years, and IQ = 86) who met DSM-IV criteria for major depression. All patients were hospitalized, were medication refractory, and were awaiting the initiation of ECT. Patients were administered a battery of tests prior to the onset of ECT that included measures of general mentation, intellect, memory, attention, language, executive processing, motor abilities, and mood. Results were adjusted for age, education, and gender effects where appropriate and converted to a standard score relative to a normal population. Neuroimaging procedures (MRI/CT) were performed on all subjects prior to the onset of ECT and results were coded for the presence or absence of small vessel disease (SVD) without known CVA based upon radiological reports. Analysis of performance on the California Verbal Learning Test and the Rey-Osterrieth Complex Figure Test revealed significant differences between subjects with SVD and those without on verbal memory ($F = 6.91, p = .017$) and nonverbal memory ($F = 8.77, p = .016$). *Post-hoc* analyses revealed that patients with SVD performed more poorly on measures of verbal immediate and delayed recall and on nonverbal immediate recall and recognition than did patients without SVD. Verbal recognition memory and visual spatial delayed recall as well as general mentation did not differ between the 2 groups.

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Å. HAMMAR, L. SØRENSEN, A. LUND, & K. HUGDAHL. Long-Lasting Cognitive Impairment in Recurrent Major Depression.

The aim of the study was to investigate long-lasting cognitive dysfunction in major depression. The Stroop Color-Words test was administered at 2 test occasions: at diagnosis and after 6 months. Three Stroop cards were used. The 1st card consisted of colored dots and the patients were instructed to name the dots as fast as possible. The 2nd card consisted of color words written in black ink and the patients were instructed to read the words as fast as possible. The last card consisted of color words, written in incongruent colors. The patients were instructed to name the color of each word, as fast as possible, ignoring the word information. Reaction time and errors were recorded for all 3 cards. Twenty patients with recurrent major depression according to DSM IV-R and a Hamilton Rating Scale (HDRS) score at > 18 were included in the study. HDRS mean score at diagnosis was 21.6 and 11.4 after 6 months. The control group was matched for age and gender individually for each patient. The results showed that the depressed patients had impaired performance compared to the controls on the incongruent color-word card at the 1st test occasion. The impairment was still present at the second test occasion, despite symptom reduction as reflected on the HDRS scores.

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K.S. RICHARDS, L.J.G. ROTH, N.R. CHUMBLER, A.B. MOORE, B. CROSSON, & S.E. NADEAU. Use of the Zung Self-Rating Depression Scale in a Chronic Stroke Population.

Depression has been cited as a disabling and common psychological consequence of stroke survival. Thus, accurate identification of depression is critical. However, diagnosis of depression in stroke is difficult, given that stroke sequelae can mimic/mask symptoms of mood disorders. The Zung Self-Rating Depression Scale (SRDS) is a self-administered depression questionnaire in usage with stroke patients, yet common neuropsychological difficulties such as aphasia and anosognosia can decrease the validity and reliability of such self-administered assessments. Thus, the purpose of this study was to examine the performance of the SRDS in identifying depression in chronic stroke patients. The 20 (somatic and psychological) items of the SRDS involve a multiple-choice response format. Fifty-seven (35 M, 22 F; M age = 62.6 years) chronic stroke survivors were administered the SRDS as part of a cognitive screening battery. The overall mean score was 38.9, with a range of 25–53. Using the standard cut-off score of 60, suggested for the medically ill elderly, no subjects met criteria for depression; with a cut-off score of 50, 3 subjects met criteria. Information gathered in informal interviews revealed a far greater incidence of suspected depression in this experimental group, and this along with comparisons to estimates of incidence in this population in the literature suggests that the SRDS did not capture the instances of depression expressed in this sample, implying that it is not an adequate measure of depression in this population.

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G.G. POTTER, K.A. WELSH-BOHMER, H.R. WAGNER, & D.C. STEFFENS. Detection and Staging of Cognitive Impairment in Geriatric Depression.

Distinguishing between the cognitive impairment of geriatric depression and that of primary progressive dementias is a challenging task that may be facilitated by understanding the profile of cognitive function related to various levels of depression severity (*mild to severe*). To address this issue, we studied the cognitive presentation of 103 clinically depressed individuals and 148 non-depressed community-dwelling research volunteers, aged 60 and above. Depressed participants were categorized as mildly, moderately, or severely depressed based on clinician ratings (MADRS scores). All participants were administered the CERAD battery along with other measures of memory, language, and executive function. Planned comparisons revealed that depressed and non-depressed were best predicted by Trails-B, CERAD Delayed Word List Memory, and Shipley vocabulary. In terms of profiling depression severity, mildly depressed individuals were discriminated from nondepressed by Trails B, CERAD Naming, and Constructional Praxis. While no tests significantly discriminated mildly from moderately depressed, this latter group was discriminated from the severely depressed group by CERAD Delayed Word List Memory and Logical Memory-II. These results indicate that mild depression is associated with reduced executive functions and diffuse suppression of performance, whereas severe depression is characterized by memory loss. These distinct profiles raise the possibility that severe geriatric depression is associated with a different etiology than mild depression, perhaps reflecting an underlying AD comorbid process.

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V. ELDERKIN-THOMPSON, A. KUMAR, J. MINTZ, K. BOONE, E. BAHNG, & H. LAVRETSKY. Executive Dysfunction and Visuospatial Ability Among Elderly Depressed Patients.

Visuospatial ability is frequently compromised among elderly depressed patients, but it is unclear whether the impairment is a consequence of a visuospatial deficit or of an executive dysfunction that impacts visuospatial ability. The Boston Qualitative Scoring System is a method of scoring the Rey-Osterrieth Complex Figure (ROCF) that separates the contribu-

tions of visuospatial ability from executive functioning. Using the BQSS scoring system, the possibility that executive dysfunction mediated the effect of depression on nonverbal recall was tested. Participants were screened for other Axis I disorders with the Structured Clinical Interview for DSM-IV Diagnosis, diagnosed per DSM-IV criteria, and administered a cognitive battery that included the ROCF. The executive variable of Planning, the qualitative score for the process by which the figure is copied, mediated the association between depression and the percent of the figure recalled after the short delay ($z = 1.84, p < .05$). The significance of the depression-to-recall pathway was eliminated when Planning was controlled for, but planning remained related to percent recalled ($B = -6.90, p < .007$). A repeated measures ANCOVA of executive scores during the copy phase and drawing scores from the recall phase separated the diagnostic groups [$F(1,59) = 4.14, p = .05$] and [$F(1,59) = 6.88, p = .01$] respectively. Follow-up ANCOVAs showed that executive planning during the copy phase and ability to recall the structural elements and minor details made the most significant contributions toward separating the diagnostic groups. A dimension of executive dysfunction, represented here by planning, may be one underlying source of the observed decline in nonverbal recall among elderly depressed patients.

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S. GONTKOVSKY, N. McDONALD, M. HANTLA, & W. RUWE. Relationship Between Patients' and Family Members' Ratings of Depression.

This investigation examined the association between the endorsements of a sample of patients with heterogeneous neurological dysfunction on the Beck Depression Inventory-II (BDI-II) and quantitative ratings of these patients' level of depressive symptomatology by family members/caregivers on the 24-item Depression (D) Scale of the Cognitive Behavior Rating Scales (CBRS). Participants were 33 patients (20 males, 13 females; M age = 4.10 years, $SD = 13.9$; M education = 13.6 years, $SD = 1.9$) with medically confirmed central nervous system dysfunction referred for comprehensive outpatient neuropsychological evaluation. Ninety-one percent of the sample was White, with the remaining 9% being African American. Both instruments were administered as part of a larger flexible neuropsychological assessment battery. Pearson correlational analysis revealed a significant association between CBRS D scores and BDI-II scores, $r = .59, p < .01$. No statistically significant relationship was found between scores on either measure of depressive symptomatology and various demographic variables (i.e., age, educational level, gender, race, and marital status). These findings support the D scale of the CBRS as a valid indicator of depressive symptomatology in patients with neurological dysfunction and suggest that family members/caregivers are capable of rating accurately the presence/severity of patients' depression.

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A. FREYMUTH, B. GIORDANI, G. HAIG, D. FELTNER, M. BENE-DICT, & T. HUNT. Neuropsychological Effects of Pagoclone on Healthy Volunteers.

Pagoclone (CI-1043) is a novel partial GABA_A receptor agonist that may have clinical utility for treatment of panic and generalized anxiety disorders. This is a double-blind, placebo-controlled, rising dose tolerance study of the cognitive/motor performance of 48 healthy volunteers taking Pagoclone. Six equivalent groups were formed. Two participants in each group received placebo, the remaining received 1 of 4 doses (.6 mg, 1.2 mg, 1.8 mg, 2.4 mg). Neuropsychological testing was performed predosing (Day 1) and 4 hr post-dosing on Days 1, 7 and 8. Tests included Stanford Sleepiness Scale, Buschke Selective Reminding, Motor Screening, Simple/Choice Reaction Time, Rapid Visual Information Processing, Digit Symbol, Visual Analogue Scale (VAS) and Purdue Pegboard. Individual repeated ANOVAs were used to compare the data across dosage and test days, covarying Day 1 performance. Significant Day main effects were found

for Motor Screening, Digit Symbol, Information Processing, Choice Reaction Time, Simple Reaction and Movement Times, Pegboard, and Immediate and Delayed Recall ($ps = .0001-.006$). Significant Dose main effects were found for Sleepiness, VAS Contentedness, Pegboard, Digit Symbol, Choice Reaction Movement Time, Simple Reaction Time, and Intrusions and Delayed Recall on the Buschke ($ps = .0001-.027$). Significant Day by Dose interactions were found for Digit Symbol, Simple Reaction Time, and Buschke Immediate Recall ($ps = .033-.049$). Declines were most evident on Day 1, though this was not reflected in self-report. Subjective report of fatigue, motor performance, information processing and memory were most impacted at ≥ 1.2 mg doses. Interactions suggested most evident declines on Day 1, with limited effects present on Days 7 and 8. Neuropsychological testing provides a reasonable technique for early identification of cognitive/behavioral effects in Phase I studies.

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R. ROBILLARD & M. LIOTTI. Anxiety Sensitivity Index (ASI) Correlations to Positron Emission Tomography (PET) Scans of Individuals Coping With an Anxiety Producing Situation.

In an attempt to identify neural correlates of the propensity to develop anxiety reactions, Positron Emission Tomography (PET) was used with 2 groups of healthy young participants (with significantly higher and lower ASI scores) in conjunction with repeated exposure to 8% CO₂ inhalation. Hyperventilation is a key symptom in patients with acute anxiety or panic disorder. The Anxiety Sensitivity Index (ASI) has been shown to predict respiratory and subjective responses to an anxiety producing challenge (CO₂ inhalation) in healthy volunteers and patients with panic disorder. The outcome of this study is a correlation of the ASI to the self-reported and imaged results. Implication was determined using regional blood flow (rCBF) changes in correlation with ASI, temperament, and state and trait anxiety scores. Results indicate that there are significant differences in rCBF in the anterior cingulate between subjects with higher and lower ASI scores. In the low group there was a significant deactivation in the right anterior cingulate ($z = -6.4$) as well as a strong activation in the left anterior cingulate ($z = 5.4$). In the high ASI group there were similar activations in the right anterior cingulate ($z = 6.4$), however the deactivation in the left anterior cingulate was minimal and not significant. The cingulate has been linked to regulation of sad emotional information, and this may be the basis for using information from the ASI as a predictor of susceptibility to anxiety disorders and to better understand adaptive and maladaptive brain processes involved in the regulation of anxiety.

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EPILEPSY STUDIES

A. SCHWARTE & L. CONANT. Attention and Related Functions in Childhood Absence Epilepsy and ADHD.

Studies have suggested that individuals with a history of typical absence epilepsy may show difficulties on measures of sustained attention. In addition, a significant history of childhood behavior problems, diminished academic and occupational attainment, and persisting impulsive behavior patterns have been reported in this population. Similar findings are reported in Attention Deficit Hyperactivity Disorder (ADHD). Furthermore, aberrant thalamocortical rhythms have been implicated in the pathogenesis of absence seizures, and the pathophysiology of ADHD has been postulated to involve basal-ganglial-thalamocortical circuitry. In the current study, aspects of the neuropsychological functioning of 13 children with childhood absence epilepsy (CAE), 12 children with ADHD, and 13 healthy controls (HCs) were investigated using the WISC-III Processing Speed Index, Gordon Diagnostic System Vigilance Task Correct and Commissions scores, Tower of London, and Childhood Behavior Checklist (CBCL) Attention Problems Scale. Significantly greater levels of parent-

reported attentional problems were seen in the CAE and ADHD groups than in the HCs [$F(2,36) = 13.75, p < .01$], with the ADHD group also exhibiting greater problems than the CAE group ($p < .03$). No significant group differences were found on any of the cognitive measures. Thus, although the two clinical groups differed in the magnitude of reported attentional problems, they showed a similar pattern of differences from the HCs across all measures. Behavior ratings distinguished both groups from the HCs, whereas the cognitive measures failed to differentiate either group from the HCs.

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L. CONANT, A. WILFONG, & C. INGLESE. Cognitive and Behavioral Functioning in Childhood Absence Epilepsy.

Childhood absence epilepsy (CAE) is generally presumed to be a benign form of epilepsy with little cognitive or behavioral dysfunction thought to be associated with it. In the current study, multivariate analysis of variance was used to compare the neuropsychological functioning of 15 children with CAE with that of 12 children with insulin-dependent diabetes mellitus (IDDM) and 15 healthy controls (HC). Because aberrant thalamocortical rhythms have been implicated in the pathogenesis of CAE, it was hypothesized that the CAE group would show greater difficulties in domains such as attention/behavioral inhibition, executive functions, and complex motor control/syntax, which are thought to be subserved by basal-ganglial-thalamocortical circuits. Although no significant differences were noted in attentional test performance, parent-report behavior ratings suggested greater attentional problems in the CAE group as well as greater social withdrawal and unusual thought or behavior patterns than reported in the other groups. The groups did not significantly differ on synchronization motor timing tasks, but the CAE group showed greater variability on a complex motor timing task involving a working memory component. The children with CAE also showed significantly greater difficulty than the HCs with regard to visual-motor planning/integration. Results for the executive function composite approached significance. No significant group differences were found with regard to memory, academic achievement, or fine motor speed. These results suggested that children with CAE may show difficulties in neuropsychological functions thought to be subserved by the same regions implicated in the pathogenesis of the disorder.

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J. KOOP, P.S. FASTENAU, T. MCCALL, D. DUNN, & J. AUSTIN. Sleep as a Moderator of the Relationship Between Spike-Wave Discharges and Behavior.

A previous study correlated behavior in children with epilepsy with slow-wave background activity but not SW. This lack of correlation might be due to subtler undetected SW. Sleep deprivation increases EEG sensitivity to SW; thus, it was hypothesized that degree of sleep attained during EEG might moderate the SW-behavior relationship. Caregivers of 204 children with epilepsy (age: $M = 9.5, SD = 3.0$; age at onset: $M = 7.4, SD = 3.6$) completed the Achenbach Child Behavior Checklist (CBCL). The most recent EEG report was coded for degree of sleep attained (*none, drowsy, stage-2*). On the Total Problem scale, the chronic sample ($M = 61.4, SD = 11.7$) scored higher than the recent-onset sample ($M = 56.3, SD = 10.0$; trend, $p < .08$); Internalizing scores repeated the pattern ($p < .05$). The SW-sleep relationship was examined; although not significant ($\chi^2 = 2.31, p < .05$), more children showed SW with stage-2 sleep (61%) than those without (39%). A 2×3 (Presence of SW \times Level of Sleep) ANOVA on Total Problem scores showed no main effect for sleep [$F(2,201) = .50, p > .05$], SW [$F(1,201) = .08, p > .05$], nor an interaction [$F(2,201) = .05, p > .05$]. Additional ANOVAs on Internalizing and Externalizing scores showed similar non-significant results. The pattern of means for the 6 groups supported the hypothesis, but was more evident in the recent-onset sample, perhaps due to a shorter EEG-CBCL time lapse ($p < .005$).

The SW-sleep relationship also followed the predicted pattern but was nonsignificant, possibly due to the sample constitution. One-half had recent-onset seizures; limited variability in SW and/or behavioral problems may have attenuated effect sizes.

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B. PARKINSON, S. BONGIOLATTI, S. EISENSCHENK, R. GILMORE, & D. BOWERS. Diurnal Mood Variability Following Anterior Temporal Lobectomy.

Findings of mood-related laterality effects following anterior temporal lobectomy (ATL) have been inconsistent at best. Although previous studies have examined mood at isolated points in time post surgery, this approach provides little information about intrinsic diurnal variability. In the current study, we explored for the first time whether variability in emotional reactivity would be more associated with right versus left ATL. *Methods:* Twelve patients with unilateral ATL completed multiple measures of stress and mood, 5 times a day over the course of 5 days. Mood measures included ratings of stress, affect intensity, and valence using Likert scales. Patients completed ratings in their home environment at predetermined times relative to waking. To index variability in daily mood, we calculated daily standard deviations for each patient on each measure. These data were analyzed using repeated measures ANOVA. *Results:* The right ATL group showed significantly more variability in their daily ratings of stress and affect intensity than the left ATL group. These findings were not due to differential use of antidepressants or seizure medications with mood-stabilizing effects (i.e., Depakote, Lamictal) or the occurrence of seizures. The two groups did not differ on valence ratings or a standard depression measure (Beck). *Conclusions:* This is the first report that right ATL patients display greater diurnal mood variability than left ATL patients. Potential factors underlying this difference will be discussed including the possibility of lateralized alteration of hippocampal systems involved in HPA feedback regulation.

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M.T. ROGISH, D. BOWERS, R.M. BAUER, & R. GILMORE. The Differential Contributions of Perceived Social Support and Surgical Outcome on Depression in Post-Surgical ATL Epilepsy Patients.

Background: Recent studies have shown that the perceived aspects of social support are important for modulating depressive symptoms in chronic medical conditions, including epilepsy. In the present study, we examined whether depression following anterior temporal lobectomy (ATL) for intractable epilepsy was more influenced by medical/surgical outcome, by perceived social support, or by both. *Methods:* Subjects included 49 TLE patients who had undergone seizure surgery (20 RATL, 29 LATL). The ATL groups were matched on age, gender, and years since surgery. Depression was assessed using the SCID, MMPI-2, and the BDI. *Surgical outcome* variables included Engel scores and number seizures/auras post-surgery, whereas *social support* variables were drawn from the Received Support Survey (perceived support, and desire for support) and the Social Support Questionnaire (satisfaction with support, number of people available). *Results:* There were no laterality group differences on any of the social support, seizure outcome, or mood measures. Multiple regression analyses were run with social support variables, surgical outcome variables, or a combination of both as predictors for depression. The surgical outcome variables alone [$R^2 = .286$; $F(4,46) = 4.211$, $p = .006$] and the social support factors alone [$R^2 = .449$; $F(4,46) = 8.565$, $p < .001$] significantly predicted post-surgical depression. When combined, only the social support variables continued to predict depression [$R^2 = .548$; $F(4,46) = 13.056$, $p < .001$]. *Conclusions:* Perceived social support predicts depression more than surgical outcome. Assessment of social support provides clinicians with an important predictor of psychological maladjustment post-surgically.

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S.M. TESTA, B.K. SCHEFFT, E.A. GETZOFF, & J.D. FARGO. Tripartite Model of Depression and Anxiety in Epileptic and Psychogenic Seizures.

Mood and anxiety disorders are reported to be more prevalent among individuals with psychogenic nonepileptic seizures (PNES) as compared to individuals with epileptic seizures (ES). At the same time, individuals with PNES may minimize their subjective experience of distress and underreport symptoms on self-report measures. In some instances, this may decrease the sensitivity of such measures when used in this population. The current study seeks to determine how the pattern of symptom endorsement differs between ES and PNES using a self-report instrument based on the tripartite model of depression and anxiety. The Mood and Anxiety Symptom Questionnaire (MASQ) was designed to measure the general distress related to both depression and anxiety, as well as the unique symptoms related to each; namely anhedonic depression and anxious arousal. The MASQ was administered to 116 individuals (51 ES; 65 PNES) undergoing video/EEG monitoring for medically intractable seizures. The multivariate effect of patient group was significant [Hotelling's $T^2(4,111) = 5.05$, $p = .001$] and univariate one-way ANOVAs revealed significantly higher scores on all subscales of the MASQ for individuals with PNES as compared to ES ($F = 6.97-34.67$, all $p < .03$). Clinically significant elevations, however, were only observed on the specific symptom subscales of Anhedonic Depression and Anxious Arousal. These findings suggest that individuals with PNES may minimize self-reported general distress relative to symptoms that are more unique to anxiety and depression. Correspondence: S. Marc Testa, Department of Psychology, University of Cincinnati, PO Box 210376, 429 Dyer Hall, Cincinnati, OH 45221-0376. E-mail: testasm@email.uc.edu

J. BARRASH & N. SILVERBERG. Characterization of Psychopathology With the MMPI-2 and PAI in an Epilepsy Population.

Psychiatric disturbance, especially depression, is common in patients with intractable temporal lobe epilepsy (TLE). We compared the ability of the MMPI-2 and Personality Assessment Inventory (PAI) to assess psychopathology in TLE. Subjects were 30 candidates for temporal lobectomy. Severity of psychiatric disturbance was rated on a 3-point scale by the neuropsychologist (agreement with a 2nd rater: $Kappa = 0.74$), then collapsed into presence/absence characterization ($Kappa = 0.87$) for primary analyses. This characterization was considered the gold standard. Valid profiles were produced on 73% of MMPI-2s and 87% of PAIs. Among valid profiles, sensitivity and specificity were .75 & .39 with the MMPI-2, .57 & .50 with the PAI. Their percent agreement on the presence of a type of psychopathology ranged from very good for somatization (71%) and mania (100%), to very poor for anxiety (0%) and depression (17%). The PAI was particularly insensitive to depression: incidence = 7% per PAI, 40% per MMPI-2 (the latter is consistent with the literature). Agreement between the neuropsychologist's ratings and MMPI-2/PAI indication of overall severity of psychopathology was poor for both instruments (for reasons to be discussed); the MMPI-2 tended to overestimate severity and the PAI tended to underestimate it. We conclude these instruments have comparable accuracy in an epilepsy population, but the MMPI-2's higher sensitivity, particularly to depression, makes it the preferred instrument in the context of the preoperative evaluation.

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T.Z. KING, E.B. FENNELL, L. GRANDE, & R. GILMORE. Cognitive Performance of MMPI-2 Profile Groups of Presurgical Epilepsy Patients.

Our previous cluster analytic study identified 3 MMPI-2 profiles of individuals with intractable epilepsy who underwent comprehensive multidisciplinary evaluation for neurosurgical interventions. Demographic and seizure variables were not found to be significantly different between the cluster groups. However, trends were found in years of education and FSIQ differences, which suggest that cognitive abilities may help to distinguish between these 3 groups. The purpose of the current study was to examine the possible cognitive differences between the 3 MMPI-2 profile groups. Significant differences were found in verbal expression abilities

[Vocabulary: $F(2,90) = 3.28, p = .04$], psychomotor speed [Digit Symbol: $F(2,90) = 3.25, p = .04$], and list learning [CVLT total: $F(2,90) = 5.01, p = .009$]. However, there were no significant differences between groups across other cognitive abilities including confrontation naming, verbal fluency, executive functions, or memory for lists, stories, or complex figures. On average, the individuals who endorsed more distress (Cluster 1) evidenced significantly more impaired psychomotor speed and list learning efficiency compared to the performance of the 2 other groups. Verbal expression was also lower in Cluster 1 group *versus* Cluster 2 (who were on average within normal limits on MMPI-2). No significant cognitive performance differences between Cluster 2 and 3 groups were found. These findings are consistent with previous reports of the role of educational background and cognitive abilities in patients' adjustment to the functional consequences of neurological conditions, independent of hemispheric lateralization.

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T.Z. KING, E.B. FENNEL, L. GRANDE, R. GILMORE, & S. ROPER. MMPI-2 Cluster Profiles Change in a Postsurgical Epilepsy Group.

Our previous cluster analytic study identified 3 MMPI-2 profiles of individuals with intractable epilepsy. A subset of these individuals underwent temporal lobectomy and follow-up neuropsychological evaluation. The purpose of the current study was to examine potential changes in MMPI-2 profiles among individuals who underwent neurosurgery. On average, there were no clinically significant elevations ($>65T$) in the postsurgical group. However, when examining the individuals based on their respective pre-surgical cluster profile membership, the individuals who were classified in Cluster 1 continued to endorse significant psychological distress evidenced by clinical elevations on many scales (D, Pd, Pt, & Sc). Whereas, the 2 other cluster profile groups, on average, had profiles within normal limits. The individuals in Cluster 3 group on average endorsed less somatic concerns as evidenced by lack of clinically significant elevations on Hs, D, and Hy postoperatively. The potential impact of seizure control and the individual's experience of living with intractable epilepsy are discussed. Correspondence: *Tricia Zawacki King, Psychology Department, Georgia State University, 140 Decatur Street, Suite 1141-UL, Atlanta, GA 30303. E-mail: tzking@gsu.edu*

R. LANGE, G. HOPP, & G. CHELUNE. Profile Analysis of WAIS-III and WMS-III Performance Following Temporal Lobe Lobectomy.

Much of the literature in neuropsychology continues to focus on the importance of prototypical cognitive profiles as clinically relevant diagnostic markers. In a recent large-sample study, Lange demonstrated that a patient's neurological diagnosis was not influential in determining cognitive performance. However, these findings were considered somewhat confounded by the inclusion of broad diagnostic groups. Thus, the purpose of this study is to further explore the presence of prototypical cognitive patterns in a more homogenous sample. Participants were 122 (53.2% male) patients with seizure disorder post temporal lobectomy, divided into 2 groups based on lesion laterality (right, $n = 65$; left, $n = 57$). Measures included the WAIS-III and WMS-III. Cluster analysis was used to identify the presence of sub-profiles in each group separately. Two sub-profiles were identified in both groups. One subprofile from each of the two groups was highly similar ($r = .89$) and was characterized by high intellectual functioning and low memory. The remaining subprofile from each group appeared to be unique ($r = -.23$), and reflected the classic double dissociation between laterality and memory function. Nonetheless, only 53.3% of the sample did manifest a mean profile that could be considered prototypical of lesion laterality, while the other half failed to show the expected differential modal profile. These findings fail to support the presence of prototypical cognitive profiles within a given diagnostic group, even in this neurologically homogenous sample.

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R. DOSS, G. RISSE, J. GATES, D. KISPURT, & B. CARLSON. Relationship of Cognitive Impairment to MRI and ¹H-MRS Temporal Lobe Abnormality in Epilepsy Patients.

Prior research has described memory impairments associated with metabolic and structural changes in the hippocampus as detected by ¹H magnetic resonance spectroscopy (MRS) and conventional MRI, respectively. There may be less cognitive morbidity when the MRS shows abnormality but the MRI is negative. This study sought to determine whether degree of mesial temporal sclerosis (MTS) as inferred by MRI and MRS is associated with extent of cognitive impairment. The sample was 35 epilepsy patients who received both MRI and MRS under an epilepsy imaging protocol. Sixteen patients showed no evidence for MTS on MRI or MRS (-MRI/-MRS), 6 had a negative MRI but positive MRS (-MRI/+MRS), and 13 showed evidence for MTS on both MRI and MRS (+MRI/+MRS). Cognitive measures consisted of index scores from the WAIS-III and WMS-III. The 3 groups did not significantly differ on age, education, medications, Full Scale IQ, or Working Memory Index. The +MRI/+MRS group had a significantly longer duration of epilepsy ($p < .001$) than the -MRI/-MRS group. We first compared cognitive performance among those subjects with MTS (+MRI/+MRS and -MRI/+MRS) and without (-MRI/-MRS). The MTS group scored significantly lower on the Processing Speed Index ($p < .01$) and General Memory Index ($p < .05$). Further analyses revealed a clear but nonsignificant trend for the -MRI/+MRS group to perform better than the +MRI/+MRS group but worse than the -MRI/-MRS group on all measures. These preliminary data suggest that extent of cognitive impairment is associated with degree of MTS as detected by MRI and MRS.

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V.S. PHATAK, S.J. SWANSON, D.S. SABSEVITZ, A.M. MEYERS, G.L. MORRIS, & W.M. MUELLER. Changes in Spatial Memory Following Nondominant Anterior Temporal Lobectomy.

Past studies have found verbal memory decline after left ATL and less routinely nonverbal decline after right ATL. The purpose of the present study was to determine if factors that predict verbal memory decline after left ATL (e.g., better preoperative memory, age at onset of epilepsy, presence of mesial temporal sclerosis, and Wada memory asymmetry scores) also predict spatial memory decline following right ATL. Subjects were 77 non-retarded, left hemisphere dominant patients who underwent ATL (43 right and 34 left). Spatial learning over trials and delayed recall of a spatial pattern were measured using the 7/24 Spatial Memory Test prior to and 6 months following ATL. No significant group differences in memory were found for pre-, post-operative, or change scores. Preoperative learning and delayed recall scores correlated significantly with post-operative change scores in patients with right ATL ($r = -.617, p < .0001$; $r = -.624, p < .0001$, respectively). Left ATL patients did not have a significant correlation between preoperative learning and learning change scores, but the correlation between preoperative delayed recall and delayed recall change was significant ($r = -.523, p = .002$). Wada memory asymmetry scores, age at onset, and presence of MTS did not correlate with learning or delayed recall change scores for right ATL patients. These results indicate that higher preoperative spatial learning and delayed recall scores are associated with a greater risk for spatial memory decline following right ATL. Additionally, higher preoperative spatial recall was associated with greater decline in spatial recall after left ATL, suggesting some left hemisphere involvement in this spatial memory task.

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M.F. DULAY, J.D. FARGO, S.M. TESTA, B.K. LEBOWITZ, M.K. WESTBELD, & B.K. SCHEFFT. Type of Naming Error Predicts Visual Naming Ability in Temporal Lobe Epilepsy.

Greater confrontation naming deficits exist in patients with left temporal lobe epilepsy (LTLE) compared to patients with right temporal lobe epi-

lepsy (RTLE). To further characterize naming deficits associated with TLE, the present study evaluated the type and frequency of interictal paraphasias produced by 125 patients with unilateral TLE (63 left, 62 right) and 57 patients with psychogenic seizures. Naming errors produced in response to the Boston Naming Test (BNT) were classified as verbal semantic paraphasias (semantically based errors; e.g., saying *seagull* for *pelican*), literal paraphasias (confusion between phonemes; e.g., *nazzle* for *muzzle*), a combination of verbal/literal paraphasias, and exclusions (e.g., circumlocutions). Results indicated that LTLE patients produced significantly more literal paraphasias than patients with RTLE and psychogenic seizures [$F(2, 179) = 8.79, p < .001$]. There were no significant between-group differences in the number of verbal paraphasias produced (average per group ≈ 3.3). Age, education, WAIS-R verbal intelligence quotient (VIQ), age at onset, number of literal paraphasias, and number of verbal paraphasias were entered into stepwise regression analyses to examine what predicts BNT performance. Number of literal paraphasias was the best predictor of BNT total raw score in LTLE ($r^2 = .42$), followed by VIQ (.09). In RTLE, VIQ ($r^2 = .51$), age (.06), and number of verbal paraphasias (.03) were significant predictors of BNT performance. Results suggest that a disturbance in phonological word retrieval, rather than in semantic knowledge, makes a more significant contribution to confrontation naming deficits in LTLE.

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D.L. DRANE, G.P. LEE, H. CECH, J.S. HUTHWAITE, R.L. YUSPEH, D.W. LORING, & K.J. MEADOR. Using Structured Cueing on a Semantic Fluency Task to Differentiate Between Epilepsy Patients With Temporal Versus Frontal Lobe Seizure Onset.

Research indicates that patients with frontal lobe dysfunction (e.g., Huntington's disease) benefit more from cueing on measures of semantic fluency than do patients with damage to temporal lobe structures (e.g., Alzheimer's disease). This differential benefit from cueing suggests that different neurocognitive functions are impaired in these two groups (i.e., patients with frontal lobe dysfunction have difficulty with the organizational aspects of this generative fluency task while patients with temporal lobe impairment are limited by deficits in semantic memory). We attempted to extend this research by examining the performance of patients with complex partial seizures of frontal (FL: $n = 11$) or temporal (TL: $n = 29$) lobe onset as determined by ictal EEG recordings on standard and cued measures of semantic fluency administered in a counterbalanced sequence across groups. These groups did not differ significantly in terms of age, education, gender, age of seizure onset, or intelligence, and all patients ultimately underwent surgery for intractable epilepsy. Results of a Mann-Whitney test revealed that TL patients performed better on the standard semantic fluency paradigm than the FL patients [TL: $M = 18.90, SD = 5.08$; FL $M = 12.91, SD = 6.20$; $U = -2.61, p < .008$]. ANCOVA results demonstrated that the FL patients showed significantly greater performance improvement than the TL patients when provided with a cued semantic fluency format even after correcting for baseline differences in ability on the standard semantic fluency task [TL: $M = 2.00, SD = 6.07$; FL: $M = 9.09, SD = 5.03$; $F = 4.48, p < .05$]. These findings support previous research suggesting that frontal and temporal structures contribute uniquely to semantic generative fluency and suggest that using a combination of standard and cued semantic fluency tasks may improve localization of seizure onset in partial epilepsy.

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H. YOO. The Wisconsin Card Sorting Performance in Temporal Lobe Epilepsy and Schizophrenia Patients.

We usually acknowledge that WCST measures only the frontal lobe function of the brain. We found that WCST also reflects the function of other parts because of the interconnection between the frontal lobe and the other areas of the brain, and that other cognitive functions such as intelligence,

attention, and memory can influence the performance of the WCST. *Methods:* WCST, Korean Wechsler Intelligence Scale (KWIS), Logical memory, visual reproduction, digit span and visual memory span were administered to patients with left temporal lobe epilepsy (LTLE, $N = 78$), patients with right temporal lobe epilepsy (RTLE, $N = 77$), patients with schizophrenia ($N = 75$). *Results:* We found no differences in the WCST performance among 3 patient groups. In stepwise multiple regressions of the three patient groups, we used the five indices of the WCST as the dependent variables. Attention and FSIQ were the influential variables of the WCST. In addition, we found visual immediate memory to be an influential variable of the WCST in the RTLE, and verbal immediate memory to be an influential variable in schizophrenia. *Conclusions:* The results confirm that the WCST also reflects the function of other parts because there is an interconnection between the frontal lobe and the other areas of the brain. Moreover, we have to consider the variants like attention, intelligence, and memory when we interpret the result of the WCST. Correspondence: *Heejung Yoo, Department of Psychiatry, 388-1 Ulsan University College of Medicine, Asan Medical Center, Pungnab-Dong, Songpa-gu, Seoul 138-736, Korea. E-mail: hjyoo@amc.seoul.kr*

N. SILVERBERG & J. BARRASH. The Ability of Psychomotor Measures to Predict Side of Seizure Focus.

This study evaluates the lateralizing value of 2 common psychomotor measures, the Finger Tapping Test (FT) and the Grooved Pegboard Test (GPT), in temporal lobectomy candidates. It is presumed that relatively deficient performance with one hand implicates a contralateral seizure focus. Deficient performance was 1st defined as exceeding the 95% confidence interval of intermanual discrepancy scores. These cut-offs were applied to the FT and GPT performance of 44 patients with intractable unilateral temporal lobe epilepsy (28 left and 16 right, as identified by comprehensive multidisciplinary surgical evaluation). Only 11–16% obtained discrepancy scores exceeding the cut-offs; percent accuracy was moderate to poor (72–50%). The failure of this conventional approach warranted further *post-hoc* analysis. Relaxing cut-offs to ± 1.5 SDs classified more patients, but percent accuracy declined to chance levels. Next, *optimal* cut-offs were derived empirically to balance classification accuracy with the proportion of patients classified as having significant discrepancies. When applied to percent-discrepancy scores, percent accuracy remained moderate to poor (77–54%) for both measures, but coverage improved (50–93% of patients showed significant discrepancies). Using both the FT and GPT in conjunction improved diagnostic accuracy overall, but not to acceptable levels. Even when performance on both measures exceeded cut-offs in the same direction, the incorrect hemisphere was implicated in 20%. In conclusion, psychomotor functioning does not add to lateralization in epilepsy surgery candidates. This is likely due to pre-morbid psychomotor variability (in that a baseline of superior preferred hand performance cannot be assumed).

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S. KEEDY, R. ERWIN, B. HERMANN, & M. SEIDENBERG. Components of Attention and MRI Correlates in Healthy and TLE Patients.

Attention is a complex neurobehavioral domain that has been shown to be composed of separate but related underlying dimensions. In this study, Mirsky's 4-factor model of attention was confirmed in a sample of healthy individuals ($n = 53$) and temporal lobe epilepsy patients ($n = 72$). In addition, mean factor scores were significantly higher for the control group on the Encode and Focus/Execute factors. Correlations between the attention factors scores and regional brain volumes obtained from quantitative magnetic resonance imaging were also explored, controlling for intracranial volume. A significant relationship was noted for healthy individuals between hippocampal volume and the Encode factor ($r = .39, p < .05$). Healthy individuals also displayed significant relationships between the Focus/Execute factor and right-side tissue measures, including right parietal ($r = .34$), right occipital ($r = .42$), and overall right-side tissue ($r = .35$). Among temporal lobe epilepsy patients, a significant correlation was evident between the Focus/Execute factor and total tissue volume ($r = .57$), total frontal lobe ($r = .42$) and total parietal lobe volumes ($r = .61$).

These findings are partially consistent with the putative neural circuitry underlying each of these attentional factors. In contrast, expected relationships between regional MRI volumes and the Sustain and Shift factors were not evident. These findings are considered in the context of current research examining the neural circuitry of attention and the nature of attentional impairment in temporal lobe epilepsy.

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FORENSIC TESTING: SUSPECT EFFORT AND MALINGERING

E.K. HILL, S. LLANES-MACY, A. AMMAR, J. FINK, R. LEE, K. KELLEY, & N. PLISKIN. Effects of Litigation on Neuropsychological Functioning in Electrical Injury.

The neuropsychological sequelae of electrical injury (EI) often include cognitive and psychiatric difficulties, including compromised attention and mental efficiency, and depression and anxiety. The influence of litigation on neuropsychological functions in this population has been likened to mild traumatic brain injury (MTBI) findings; however, empirical examination of these relationships in an EI sample is warranted. This study examined the effects of litigation on neuropsychological functions after accounting for psychological distress in an EI sample. Seventy-one participants were included after application of exclusion criteria (WAIS IQ; Rey 15 Item Memory Test; MMPI-2 Cannot Say, F, and F-K). Hierarchical multiple regression showed objective neuropsychological performance (attention/mental efficiency measured by Wechsler subtests of working memory and processing speed, and Trails A & B), after controlling for psychological distress (MMPI-2 Scales 2, 7, Repression), was not predicted by litigation as a main effect. However, the interaction between litigation and depression predicted better objective neuropsychological scores, whereas the interaction of litigation and anxiety predicted poorer objective neuropsychological scores. In a separate analysis examining subjective neuropsychological functioning (cognitive complaints on the Neuropsychological Symptom Checklist), the interaction of litigation and depression was associated with fewer subjective neuropsychological complaints. Alternative explanations for these findings were examined (motor functions, injury severity). The results of this study suggest that litigation is not associated with poorer neuropsychological performance or greater amounts of subjective complaints in EI patients screened for level of effort, differentiating them from MTBI samples.

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J. ANDRIKOPOULOS. Psychomotor Performance in Mildly Head-Injured Litigants.

The present study examined non-organic psychomotor dysfunction, as measured by grooved pegboard (GP) and finger tapping (FT) in a group of mild head injured litigants. A mild head injured litigant group ($N = 111$) was compared to a severely head injured inpatient non-litigant group (CHIG, $N = 34$). A subset of patients in the mild head injury group (MHIG, $N = 52$) had a level of neuropsychological impairment (excluding psychomotor tests) that equaled the CHIG. A significantly greater percentage of patients in the CHIG ($n = 24$, 75%) failed (standard score of 75 or less) GP compared to the MHIG [$n = 11$, 22%]; $\chi^2(1, N = 83) = 23.01, p = .0001$]. There was no difference in failure rate between the two groups on FT. A second chi-square analysis was conducted within groups. Within the MHIG, 18 patients (34.6%) failed FT and 11 (21.2%) failed GP [$\chi^2(1, N = 51) = 13.29, p = .001$]. In the CHIG, 13 patients (37.1%) failed FT and 24 (75%) failed GP [$\chi^2(1, N = 32) = 4.84, p \leq .05$]. Despite equivalent levels of neuropsychological impairment between the MHIG and the CHIG, the MHIG did not show the expected disproportionate impairment on GP relative to FT that the CHIG showed. The second major finding was the demonstration of a double dissociation. Within the MHIG, FT was

failed significantly more than GP while the opposite pattern was observed in the CHIG. Both of these observations taken together suggest non-organic explanations for the impairment demonstrated by the MHIG.

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M. SUMANTI, K. BOONE, I. SAVODNIK, & R. GORSUCH. PAI and Cognitive Effort Tests in a Worker's Compensation "Stress" Claim Population.

Information is lacking regarding the prevalence of fraudulent psychiatric and cognitive symptoms in the "stress" claim worker's compensation population. In this present study, the incidence of feigned psychiatric symptoms, measured by malingering indices of the Personality Assessment Inventory (PAI; Negative Impression Management, NIM; Malingering Index, MAL; Rogers Discriminant Function, RDF; and the rate of exaggerated cognitive symptoms, measured by the Rey-15 and Dot Counting Tests, among 241 subjects who claimed psychiatric "stress" disability were investigated. Using the 3 malingering indices of the PAI, between 9 and 29% of the sample were identified as having noncredible psychiatric symptoms. On the Dot Counting Test (using a cut-off of ≥ 15 on the combination score, 15% of the subjects were determined to have noncredible cognitive symptoms, although only 8% displayed suspect effort on the Rey-15 (using the criterion of < 9 total items, consistent with evidence that the Dot Counting Test is 50% more sensitive than the Rey-15 Test). Correlations between PAI and cognitive effort scales were nonexistent to modest ($r = .00$ to $-.3$), and between the two cognitive indices were minimal to moderate ($r = -.17$ to $-.49$), indicating that the various malingering indices are measuring different aspects of noncredible symptom production. It was predicted that PAI profiles of participants displaying exaggerated cognitive symptoms would be elevated on the Somatic Concerns, Antisocial, and Borderline scales, however, elevations (relative to subjects with credible cognition) were noted on the Somatic Concerns, Depression, Anxiety, Anxiety-Related Disorders, and Schizophrenia scales. Correspondence: Kyle Boone, Department of Psychiatry, Harbor-UCLA Medical Center, 1000 West Carson St., Building F-9, Box 495, Torrance, CA 90509. E-mail: kboone@rei.edu

M. KELLY, J. McCONNELL, & V. INGRAM. Stroke, the PDRT, and Cognitive Impairment: A Change of Heart, a Change of Mind.

A 55-year-old right-handed White male suffered a well documented left basal ganglia infarction, with sudden onset right-sided weakness and expressive aphasia, secondary to a left middle cerebral artery perisylvian perforating branch occlusion. The patient was an active duty army warrant officer who presented for neuropsychological evaluation 20 months post stroke to determine the extent of residual impairment for military disability determination purposes. Performance on the Portland Digit Recognition test (PDRT) revealed below chance performance for both easy trials (12/36 correct) and hard trials (7/36 correct), consistent with a deliberate attempt to feign impairment. The patient was provided with feedback that the results of the evaluation were not valid. At the request of his attorney he was referred for re-evaluation 36 months post stroke. On re-evaluation he had perfect performance (zero errors) on the PDRT, with concurrent dramatic improvement on measures of intellectual functioning, language, attention, verbal memory, and executive functioning. The evaluation revealed circumscribed impairment of verbal fluency, executive functioning, and motor performance consistent with the location of his stroke. This case is presented as a rather rare example of (1) impaired performance on motivational testing in an individual with stroke; and (2) a reversal of performance on motivational testing with consequent dramatic improvement on standard neuropsychological tests. This unique case provides data from an unplanned clinical experiment to illustrate the range of functions affected by poor motivation, and demonstrates the utility of motivation testing in individuals with *bona fide* brain disease.

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P. LU, K. BOONE, & L. COZOLINO. Sensitivity of the Rey-Osterrieth Complex Figure Test and the Recognition Trial in the Detection of Suspect Effort.

The Rey-Osterrieth Complex Figure Test (ROCFT) is a popular measure of visuoconstructive skills and visual memory. A recognition memory trial was developed by Meyers and Meyers and attached to the standard administration of the ROCFT. The addition of this recognition paradigm (comprised of 12 small designs from the original ROCFT stimulus interspersed among 12 foils) makes ROCFT a potentially useful instrument in capturing suspect effort because patients displaying inadequate effort operate from the misconception that recognition memory is as impaired as free recall in brain injury and, as a result, suppress recognition performance. The ROCFT, with the recognition trial, was administered to 3 sets of participants: 57 patients with suspect effort; 58 neuropsychology clinic patients not in litigation or attempting to secure disability; and 31 normal controls. Group comparisons revealed significant differences in direct copy, delayed recall, and recognition scores on the ROCFT ($p < .0001$) with the suspect effort group displaying significantly worse performance in all 3 scores than the clinic patients and normal controls, who did not differ from each other. Furthermore, qualitative examination of the recognition trial revealed the presence of "atypical recognition errors" that were almost exclusively endorsed by the suspect effort patients. A combination score incorporating the copy score, true positive recognition, and atypical recognition error yielded a sensitivity of 74% while misidentifying approximately 10% of clinic patients and 3% of normal controls. Thus, the ROCFT + recognition trial show considerable potential for detecting non-credible effort.

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D. SHERMAN, K. BOONE, P. LU, & J. RAZANI. Re-Examination of a Rey Auditory Verbal Learning Test—Rey Complex Figure Discriminant Function to Detect Suspect Effort.

Bernard and colleagues identified a discriminant function, derived from Rey figure recall score and RAVLT Trial 1 and recognition, which discriminated simulators and controls with 77–85% accuracy. However, in the current study, application of the discriminant function to actual patients with suspect effort (as evidenced by failed performance on at least 2 other "effort" tests and at least 1 behavioral criterion; $n = 38$), patients with brain injury (as documented by significant brain imaging abnormalities and/or coma; $n = 34$), and controls ($n = 33$), revealed excellent sensitivity (95%) but low specificity (33% for patients, 61% for controls). A new discriminant function using the same Rey figure and RAVLT scores [$D = .006(\text{RAVLT Trial 1}) - .062(\text{Rey figure delay}) + .354(\text{RAVLT recognition}) - 2.508$], but derived on our "real world" patients with documented suspect effort and patients with confirmed brain injury, resulted in an overall classification of 85% correct, with only 16% of suspect effort and 15% of brain injured patients misidentified. Use of a discriminant function score of $\leq -.40$ resulted in sensitivity of 71% while maintaining specificity of $\geq 91\%$. At a base rate of 36% suspect effort, this cutting score was associated with a positive predictive value of 90% and a negative predictive value of 74%. Thus, this discriminant function appears to hold promise as an additional tool for clinical differential diagnostic use, allowing the clinician to identify patients with suspect effort without adding additional test measures to the assessment battery.

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M.L. ROHLING, L.M. ALLEN, & P. GREEN. Who's Exaggerating and Who's Not: The Development of an Algorithm to Improve Diagnosis.

This study examined the effects of effort on neuropsychological assessment and test performance patterns among genuine and exaggerating patients with and without neurological findings as aids to diagnosing symptom

exaggeration. The sample consisted of 561 consecutive patients involved in compensation claims that were assessed over two days with a flexible neuropsychological test battery. The sample included 303 patients evaluated for traumatic brain injury, 55 patients with neurological disease, and 203 patients assessed for other conditions (e.g., depression or chronic pain). An average of 38 ability measures per patient were used to generate an overall neuropsychological test (NPT) domain score. Composite scores were also computed for symptom validity tests (SVT), self-report measures of psychiatric symptoms (PSX), and a memory complaint inventory (MCI). Seven NPT cognitive subdomain scores were multiply regressed onto the SVT composite and accounted for 45% of its total variance. Patients were also assigned to *genuine* or *exaggerator* groups based on SVT performance. The NPT for *exaggerating* patients averaged 1.43 SDs below that of *genuine* patients, suggesting that NPT scores for most *exaggerating* patients are underestimates of their true ability. Factor analysis results differed between these groups. Finally, an algorithm was generated so that clinicians might avoid falsely identifying genuine patients as exaggerating. The algorithm incorporates patients' self-reports of psychiatric symptoms and memory complaints into the diagnostic process.

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C. GRILLS, K. BOONE, P. LU, & G. BUCKWALTER. The Influence of Demographic Factors on Neuropsychological Tests of Suspect Effort.

The use of neuropsychological measures of suspect effort has become an increasingly important part of the neuropsychologist's expertise as neuropsychologists are increasingly being called upon to engage in medicolegal evaluations. At the present state of knowledge, however, it is not known to what extent basic demographic factors such as age, education and gender impact performance on these "effort" tests. Clearly, measures of effort are rendered less effective to the extent that performance can be explained by demographic variables. Thus, the influence of age, education and gender was investigated on 8 measures of suspect effort: the "b" Test, the Rey 15-Item Test, the Rey Dot Counting Test, the Rey-Osterrieth Complex Figure, Rey Word Recognition, Digit Span, Warrington Recognition Memory Test—Words, and the Rey Auditory Verbal Learning Test recognition trial in a sample of 117 clinical patients who have met criteria for suspect effort. The following variables of suspect effort were found to be significantly correlated with Education at the $p < .01$ level: Rey-O Copy ($r = .43$), Rey-O False Positives ($r = -.44$), Rey-O Rare False Positives ($r = -.34$), RAVLT—Recognition ($r = .34$), and Rey 15 Total Score ($r = .29$), FIT Combination Score ($r = .45$) and RAVLT Combination Score ($r = .35$). No significant correlations for age or group differences for gender were found. Sensitivities by education group are computed and implications for clinical practice are discussed.

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N. NELSON, K. BOONE, P. LU, & A. DUECK. Establishing Correspondence Between Eight Current Measures of Suspect Effort.

Numerous measures have been applied to identify persons who do not put forth their most concerted efforts during neuropsychological testing. It has been recommended that multiple measures be employed concurrently to provide converging evidence regarding the presence of suspect effort. However, if the tests are highly correlated then they do not represent independent sources of information. To date, no study has examined the correspondence between these measures. The present study measures the relationships between 8 measures of suspect effort (i.e., Rey's 15-item Memorization, Rey's Dot Counting Test, Rey's Word Recognition Test, Rey's Auditory Verbal Learning Test, Rey-Osterrieth Complex Figure Test, Digit Span, the Recognition Memory Test, and the "b" Test) in a sample of 117 patients who demonstrated suspect effort during neuropsychological testing. Moderate correlations were observed between the tests' overall relationships with 95% of the correlations yielding less than 50% shared variance. Moderate correlations were also observed between the individual indices of elapsed time, recall, recognition, and false positive

scores. Implications are discussed in terms of the tests' utility as clinical measures of motivation.

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J. PRICE, M. ALLISON, D. SLICK, D. HULTSCH, & E. STRAUSS. The Effect of Examiner Feedback on Effort Testing.

Neuropsychologists have developed numerous measures to detect suboptimal effort (e.g., Victoria Symptom Validity Test, Rey Fifteen Item Test, Test of Memory Malingering, etc.). Unfortunately, there are no empirical guidelines suggesting how clinicians should respond once suboptimal effort/malingering is suspected. The current study aimed to provide some guidance in this area. Thirty university students were asked to fake believable deficits on the VSVT. The test was given twice: before and after feedback. Half the participants were provided with feedback indicating they were suspected of suboptimal effort (*warned* group), while the remainder were given neutral feedback (*nonwarned* group). Not surprisingly, participants performed poorly on the VSVT, with scores on the VSVT hard items in the below chance range. There was also slight, but significant improvement in performance on the second VSVT administration. More importantly, following feedback, 12/15 warned participants improved their scores on the hard items while 10/15 of the nonwarned participants stayed the same or reduced their performance ($\chi^2 = 6.65, p = .025$). In fact, 2 of the warned participants shifted classification status from suspect to valid performance. None of the nonwarned individuals moved into the valid range. The results highlight the importance of the examiner's responses to clients and suggest that the type of feedback provided may make it more difficult to detect suboptimal effort.

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R. TEMPLE, A. McBRIDE, R. TAYLOR, & M. HORNER. Personality Characteristics of Patients Showing Suboptimal Cognitive Effort.

Independent literatures exist describing individuals who exaggerate psychiatric symptoms *versus* cognitive deficits. Little has been written, however, about the psychological characteristics of individuals who feign cognitive impairment. The present study examined the relationship between performance on the Portland Digit Recognition Test (PDRT) and the MMPI-II. Participants were 50 veterans referred for clinical neuropsychological evaluation, who were administered a PDRT and MMPI-II. Three groups were created, consisting of individuals who passed both easy and hard trials of the PDRT, failed both trials, or passed easy but failed hard trials. Dependent variables were MMPI-II T scores for the validity and clinical scales. ANOVAs were conducted for each MMPI-II scale, and 2 planned contrasts were made. The first compared individuals who failed the PDRT (failed the hard trial or both trials) to those who passed both trials. The second compared the group who passed the easy but failed the hard trial to those who passed both trials. Participants who passed the PDRT evidenced higher T scores on Scale 3 than those who failed [$F(1,44) = 4.11, p < .05$]. Participants who passed both trials showed higher scores on Scales 1, 2, and 3 than those who passed the easy but failed the hard trials ($F_s > 4.7, p_s < .04$). Thus, individuals exhibiting optimal effort in this study manifested more psychological distress than those who failed the PDRT. Patients who fail the PDRT may be invested in appearing cognitively, but not psychiatrically impaired, while individuals exhibiting optimal effort may be distressed and reporting it in a valid way. Correspondence: Michael Horner, Department of Veterans Affairs, Ralph H. Johnson Medical Center, Mental Health Service (116), 109 Bee St., Charleston, SC 29401. E-mail: hornermd@musc.edu

M. WEINBORN & S.P. WOODS. Ecological Validity of the TOMM in a Forensic Psychiatric Setting.

Studies evaluating neuropsychological test-taking effort/malingering often employ simulation designs, in which subjects are instructed to feign neurocognitive impairment. However, this methodological approach raises ecological validity concerns. Fewer studies have compared clinical groups

who, due to situational variables, may have differing motivation to perform well or poorly. This is particularly true for groups with higher rates of chronic mental illness or lower premorbid intelligence. The present study evaluated the ecological validity of one commonly used measure of test-taking effort. The Test of Memory Malingering (TOMM), in 50 consecutively referred involuntary state psychiatric inpatients with differing forensic status. The first group ($n = 22$), which was composed of individuals being evaluated for Competency to Stand Trial and/or Mental State at the Time of Offense related to pending legal charges (CST/MSO), was hypothesized to be more likely to feign cognitive impairment to avoid prosecution or incarceration. In contrast, it was hypothesized that civilly committed individuals and persons previously adjudicated Not Guilty by Reason of Insanity (CIVIL/NGRI; $n = 28$) would be less likely to feign cognitive impairment, given their potential motivation to demonstrate the cognitive capacity necessary for discharge. The 2 groups were comparable in age, education, estimated premorbid intelligence, and severity of psychiatric symptoms. As predicted, a significantly greater proportion of CST/MSO patients (32%) scored below a recommended cut-off for suboptimal effort, relative to the CIVIL/NGRI group (4%). Findings support the utility and ecological validity of the TOMM in a forensic psychiatric population.

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K. ERDAL. Motivation and Coaching Interact to Affect Level of Malingering on Both Verbal and Visual-Spatial Tests.

Litigation of head-injury claims resulting from motor vehicle accidents (MVAs) involve an assignment of blame for the MVA as well as a judgment regarding compensation for damages. Blame and compensation are therefore 2 motivations for those attempting to malingering neuropsychological impairment. Malingerers may also be coached on how to display neuropsychological impairment through their own research on head injury or by their attorneys. Motivation and coaching were manipulated in this experiment in order to assess their effects on both a verbal and visual-spatial task. Psychology and neuroscience students ($N = 145$) were asked to malingering a head injury on the Benton Visual Retention Test (BVRT) and the WAIS-R Digit Span subtest. They were randomly assigned to conditions that varied *motivation for malingering* (to obtain compensation for injuries incurred in a MVA, to avoid blame/punishment for causing a MVA, or for no given reason; i.e., controls). They were also randomly assigned to one of three *coaching conditions* (coached on symptoms of postconcussion syndrome, coached on symptoms plus warned about faking too flagrantly, or given no information; i.e., controls). An ANOVA on BVRT total score and a MANOVA on Digits Forward and Digits Backward both revealed a Motivation \times Coaching interaction such that participants performed the most poorly when they were uncoached and given a motivation to malingering ($p < .02$). This is consistent with several studies indicating that coaching improves believable malingering and may also help to explain several studies suggesting negligible effects of coaching. That is, it seems that, in experimental paradigms, the manipulation of motivation is necessary to elicit the effects of coaching. Analogous conditions likely arise in clinical settings.

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G. J. LARRABEE. Exaggerated Pain Report in Litigants With Malingered Neurocognitive Deficit.

Pain symptoms are common in personal injury litigants claiming neuropsychological deficits. Although many procedures exist for detection of exaggerated neuropsychological deficits, the Turk and Melzack *Handbook of Pain Assessment* does not review evaluation of malingering. Fourteen female and 8 male litigants, who met criteria for definite or probable malingered neurocognitive deficit (MND) and scored > 22 on the MMPI-2 FBS ($M = 29.8, SD = 4.1$), were examined 37.6 months post trauma. Mean number of pain complaints was 4.3 ($SD = 3.2$), and mean maximum pain (0–100 scale) was 104.0 ($SD = 26.6$; 2 had pain > 100). The MNDs

had a mean McGill Pain Questionnaire (MPQ) of 34.8 ($SD = 11.8$), compared to a mean MPQ of 30.9 ($SD = 4.8$) for 315 pain patients, $p < .005$. Mean MND Pain Disability Index (PDI) was 53.1 ($SD = 9.6$) compared to a mean PDI of 45.0 ($SD = 7.8$) for 401 pain patients, $p < .0005$. Mean MND Modified Somatic Perception Scale (MSPS) was 16.2 ($SD = 6.3$), compared to a mean MSPS of 4.8 ($SD = 4.4$) for 652 pain patients, $p < .0005$. Effect sizes were 2.58 for the MSPS, 1.03 for the PDI, and .70 for the MPQ. The MSPS alone correlated with the MMPI-2 FBS ($r = .42$). Setting specificity at .90 resulted in sensitivity of .86 for MSPS > 10 , .50 for PDI > 55 , and .41 for MPQ > 36 . In conclusion, the MSPS is superior to the PDI and MPQ in detecting malingered pain report.

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J. TAN, D. SLICK, E. STRAUSS, D. HULTSCH. A Survey of Experts' Views on Malingering.

A survey was carried out addressing practices of expert neuropsychologists in handling financial compensation claim or personal injury litigation cases. Potential participants were identified by publication history. Responses were obtained from 24 out of the 39 neuropsychologists. Their opinions were based on about 720 claimants seen in the past year. Approximately 79% of the experts reported using at least 1 specialized technique for detecting malingering in every assessment. Half stated that they always give specialized tests at the beginning of the assessment. The Test of Memory Malingering and the Rey 15-Item test were the most frequently used measures. Evaluation of indexes of suboptimal effort from standard neuropsychological tests was also reported as a common technique. Based in part on these methods, experts estimated that approximately 35.7% of the cases were definitely malingering while 43.3% were possibly malingering. Experts were split on whether or not warning should be given before the test session that poor effort may be detected by the tests. However, when the client's motivational status was suspect, 58.3% altered their assessment routine at least on some occasions by encouraging good effort (70.8%) or administering additional SVTs (73.4%). Fewer directly confronted or warned clients (25%), terminated the examination earlier than planned (16.6%), or contacted the referring attorney immediately (29.2%). Experts almost always stated an opinion in written reports (95%). However, 41.7% rarely used the term "malingering"; 12.5% never used the term. Most experts ($>80\%$) typically stated that the test results were invalid, inconsistent with the severity of the injury or indicative of exaggeration.

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K.W. GREVE, K.J. BIANCHINI, & T.R. IRVIN. Malingering Following Toxic Exposure.

Neuropsychologists are often called upon to evaluate claims of cognitive and emotional injuries due to toxic exposure as part of a workers compensation or civil litigation case. Large toxic tort cases, sometimes involving thousands of claimants and billions of dollars, are becoming more common. In this context, patients stand to benefit substantially from being impaired, so malingering is an issue which must be addressed. Considerable progress has been made in the detection of malingering in the context of traumatic brain injury. However, there is little or no research on malingering following toxic exposure though it may occur in as many as 30% of neuropsychological evaluations. Here we present 4 patients who claimed cognitive deficits following apparent occupational exposure potentially toxic substances and who were ultimately diagnosed as malingering on the basis of the criteria of Slick and colleagues. The goals of this paper are to (1) illustrate the use of the Slick Criteria for the diagnosis of malingering; (2) discuss what is known and not known about the neurological and cognitive effects of toxic substances and how our current level of knowledge affects clinical decision making; (3) discuss the application of the Slick Criteria, specifically, and malingering research, generally, to toxic exposure cases; (4) outline directions for future research. Ultimately, good science and competent forensic practice demand that potential malinger-

ing as well as other nonneurological sources of impaired test performance be addressed in a scientifically supportable manner when evaluating the potential neurocognitive effects of toxic exposure.

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P. LU & K. BOONE. Suspect Cognitive Symptoms in a 9-Year-Old Child: Malingering by Proxy?

Despite the saying that children never lie, most people have had firsthand experience with a child denying something that they did or claiming to be sick in order to avoid going to school. Even though the veracity of children's claims of psychiatric symptoms has received increased attention in recent years, identification of noncredible neuropsychological symptoms in children has been virtually overlooked in clinical practice and research. A case is presented of a 9-year-old child involved in litigation regarding a head injury sustained when he was struck by a car. Neuropsychological evaluation revealed evidence of feigned cognitive symptoms; the child displayed noncredible performance on several specialized tests designed to discreetly assess effort and an atypical pattern of responses on standard cognitive measures. Discrepancies were also documented between neuropsychological scores and tests administered in school and the rehab setting. Results demonstrate that children as young as 9 years of age are capable of feigning cognitive impairment, which highlights the need for routine evaluation of effort, irrespective of the age of the patient.

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M. HUSKEY & S. HALL. Are Participants Able to Differentiate Malingering Tests From Standard Tests?

This experiment examined the face validity of several tests commonly used in neuropsychology. The tests included 2 measures of malingering (Test of Memory Malingering, TOMM; and Portland Digit Recognition Test, PDRT), 4 standard tests (Trail Making Test A and B, TMT; Digit Symbol Coding; and Incidental Learning), and a personality questionnaire (Brief Symptom Inventory, BSI). After completing the tests, 96 college students' beliefs regarding the purpose of each measure were obtained before (naïve) and after (informed) participants were warned that some tests were designed to detect feigned brain damage. Participants' responses in the naïve condition, as categorized by 2 independent raters, indicated that they viewed the malingering tests as memory measures and were generally accurate in identifying the nature of the other measures. Chi-square analysis showed that participants in the informed condition endorsed the TOMM, the TMT, and the Digit Symbol Coding Test as malingering measures at a rate significantly higher than chance. The PDRT and the Incidental Learning Test were just as likely to be viewed as malingering tests as not. Finally, the BSI was not significantly endorsed as a malingering test. These results indicate that in the naïve condition, both malingering tests have good face validity as memory tests and the other measures have good face validity as well. In the informed condition, participants' views of the tests change substantially yet remain largely inaccurate. This suggests that clinical patients are likely to be unsure about which tests are designed to detect malingering.

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J. TURNER, M. ROPACKI, & C. HINKIN. A Comparison of Modality of Stimuli Presentation in Three Malingering Measures.

While a number of tests designed to assess symptom exaggeration have recently been introduced, few investigations have focused on the effects of modality of stimuli presentation in detecting poor effort. This study directly compared the Test of Memory Malingering (TOMM), Victoria Symptom Validity Test (VSVT), and Word Memory Test (WMT), representing pictorial, numerical, and verbal stimuli respectively, in their ability to detect symptom exaggeration. Thirty-four normal adults were adminis-

tered the TOMM, VSVT, and WMT as part of a larger neuropsychological assessment battery. All participants were provided information from the public domain (i.e., Internet websites) regarding the typical sequelae following a mild traumatic brain injury. Using the recommended cut-off of 45, the TOMM correctly classified 70% of the sample as exaggerating; however, only 12% of participants were incorrect on more than 50% of items. For the WMT, 30% were classified as providing *good effort*, whereas 24% were classified as *very poor effort* and 46% *extreme exaggeration*. Again, only 12% of participants were incorrect on more than 50% of WMT items. The VSVT Easy items incorrectly classified as *valid* 97% of the sample. Classification rates for the VSVT Hard items were 39% *valid*, 39% *questionable*, and 21% *invalid*. In contrast to the other tasks, 46% of participants were incorrect on more than 50% of VSVT Hard items. These data suggest that cut-off scores suggested by test authors yield significantly different hit rates. However, examination of actual test performance suggests simulated malings may perform more poorly on the VSVT.

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PSYCHOSOCIAL ASPECTS OF AD

J. SUHR & G. FRY. Experience With Alzheimer's Disease (AD), AD Fear and Belief in Aging Stereotypes.

We assessed the relation of fear of Alzheimer's disease (AD) and belief in aging stereotypes to potential predictors, including cognitive complaints, depression, demographics, and actual cognitive performance. We expected personal experience with AD would affect the relation among potential predictors and AD fear. Individuals over 50 who responded to community-wide advertisements for free memory screening were assessed; 21 with family members, close friends, or spouses of AD patients or who were caring for someone with AD; and 28 with no personal experience with AD. Groups were not different in age, education, sex distribution, self-reported memory difficulties, self-reported depression, fear of AD, belief in negative aging stereotypes, or performance on cognitive tests. Hierarchical regression analyses revealed two-way interactions between memory complaints and group status, and actual cognitive performance and group status, in the prediction of fear of AD and belief in aging stereotypes. In adults with AD experience, self-reported memory complaints were highly related to fear of AD and to belief in aging stereotypes, while these variables were not related in adults without experience with AD. However, in adults without AD experience, actual memory performance was strongly related to both fear of AD and belief in aging stereotypes. Results suggest that having some personal experience with AD does lead to a perception of everyday memory errors as pathological. These findings have implications for use of self-reported complaints in the assessment of age-related cognitive decline, and for memory interventions for older adults with memory complaints.

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R. MARTIN, R. GRIFFITH, K. BELUE, A. SICOLA, E. ZAMRINI, L. HARRELL, & D. MARSON. Declining Financial Capacity in Patients With Mild Alzheimer's Disease: A 1-Year Prospective Longitudinal Investigation.

This study investigated prospective longitudinal change in financial capacity in patients with mild Alzheimer's disease (AD). Mild AD patients ($n = 18$, M MMSE = 24.8, $SD = 2.4$) and healthy seniors ($n = 14$, M MMSE = 29.2, $SD = 1.1$) were evaluated using the revised Financial Capacity Instrument (FCI-9). This instrument assesses 19 everyday tasks comprising 9 domains of financial activity: basic monetary skills, conceptual knowledge, cash transactions, checkbook management, bank statement management, financial judgment, bill payment, knowledge of personal assets/estate, and investment decision making. The AD group exhibited significant declines over 1 year ($p < .01$) on 5 of the 9 domains and on overall financial capacity score. The control group showed no significant declines. Significant Group \times Time interactions ($p < .05$)

were found on 4 of the 9 domains, including basic monetary skills, cash transactions, and financial judgment (detecting fraud risk), and also on overall score. In contrast, interactions were not significant for domains such as conceptual knowledge, checkbook management, and bill payment. These findings suggest that, at this disease stage and time interval, AD patients are increasingly losing basic financial skills. More complex conceptual knowledge, bill payment, and checkbook management skills are showing relatively less decline over time, presumably because substantial decline has already occurred. The findings support the sensitivity of the FCI-9 to financial decline in AD. In particular, the interaction effect findings reveal different time frames and trajectories of change for specific financial abilities in mild AD.

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H.R. GRIFFITH, K. BELUE, A. SICOLA, E. ZAMRINI, L. HARRELL, & D. MARSON. Neurocognitive Predictors of Financial Decline in Mild Cognitive Impairment.

Recent research has documented short-term memory loss and executive dysfunction in individuals with amnesic mild cognitive impairment (MCI). However, the relationship between cognitive decline and functional change in MCI remains unclear. This study investigated cognitive predictors of financial capacity in MCI patients using the Financial Capacity Instrument (FCI-9), a psychometric measure of financial abilities. Twenty-one older normal controls, 21 patients with amnesic MCI, and 22 mild AD patients were administered the FCI-9 and a comprehensive neuropsychological test battery. Controls performed significantly better than MCI and AD patients on the FCI-9 total score, several domains of the FCI-9, all memory measures, and on some measures of executive function and attention. MCI patients performed better than mild AD patients on FCI-9 total score, several FCI-9 domains, all episodic memory measures, and some measures of executive function, visual construction, and attention. For controls, stepwise multiple regression analyses revealed that a measure of processing speed (Trails A) predicted FCI-9 total score ($R^2 = .57$, $p < .001$) and performance on many domains. For the MCI group, an executive clock drawing task (CLOX) predicted FCI-9 total score ($R^2 = .61$, $p < .001$) and many domain level scores, although episodic memory predicted MCI patient performance on some domains. For the AD group, measures of written arithmetic, short term episodic memory, and working memory predicted FCI total score (cum. $R^2 = .89$, $p < .001$) and many domain level scores. The results suggest that executive dysfunction and not episodic memory decline may be the neurocognitive mechanism for early functional change in amnesic MCI.

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M. PATTERSON, S. SAMI, D. DANNER, G.W. HOUGHAM, D. RIPICH, P. WHITEHOUSE, & G. SACHS. Cognitive Correlates of Capacity for Informed Consent in Dementia Research.

Concern that persons with dementia lose their ability to make informed decisions about research participation has led to increased regulatory scrutiny of the informed consent process. We sought to determine how cognitive deficits relate to decision-making capacity in a research setting. Participants with dementia (M MMSE = 22.2) were presented vignettes of 5 hypothetical research studies of varying levels of risk and benefit by research assistants (RAs). Participants were interviewed about their willingness to participate in each study, and their reasons for each decision. RAs rated participant's decision-making competence for each decision on 4-point scales. Cognitive ability was separately assessed with a mental status exam and 10 neuropsychological measures in domains of memory, attention, language, executive function, and visual-spatial ability. For 30 participants with complete data, RA ratings of competence summed over the 5 vignettes correlated at the $p < .05$ level with measures of mental status, verbal fluency, auditory comprehension, verbal memory, attention, and spatial ability (r s of .37-.47). Stepwise multiple regression produced a multiple R of .47, with auditory comprehension the only significant

predictor of competence. Our findings suggest that language deficits may play a particularly important role in assessments of decisional capacity. Those responsible for capacity assessment and informed consent discussions should be trained in techniques that facilitate communication with dementia patients.

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L. VAN WIELINGEN, H. TUOKKO, K. CRAMER, C. MATEER, & D. HULTSCH. Awareness of Financial Skills in Dementia.

The present study examined the relations between hierarchical levels of cognitive functioning, executive dysfunction and awareness of financial management capabilities among a sample of 42 community-dwelling persons with dementia. Financial tasks on the Measure of Awareness of Financial Skills (MAFS) were categorized and organized in a hierarchy of task complexity based on Piaget's operational levels of childhood cognitive development. Severity of global cognitive impairment and executive dysfunction were significantly related to awareness of financial abilities as measured by informant-participant discrepancy scores on the MAFS. For persons with mild and moderate-severe dementia, and persons with and without executive dysfunction, proportions of unawareness within simple and complex financial task categories were tabulated. Significantly more unawareness of financial abilities occurred when tasks were complex, as compared to when simple tasks were considered. Individuals with mild dementia demonstrated significantly less unawareness of abilities on simple items, whereas persons with moderate-severe dementia demonstrated a large and equivalent degree of unawareness of abilities across simple and complex tasks. Similar patterns of unawareness were observed for individuals with and without executive dysfunction. These findings demonstrate a hierarchical pattern of decline in awareness in relation to complexity of financial tasks and support literature suggesting that deficits first occur for complex cognitive tasks involving inductive reasoning or decision-making in novel situations.

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D. BOHAC, W. BURKE, J. PETZEL, M. WAGNER, D. McARTHUR-MILLER, & J. POTTER. Psychosocial Relationships of Caregiver Stress in Dementia.

Background: Caregiving has been identified as an independent risk factor for mortality among elderly spousal caregivers. Alspaugh et al. demonstrated that caregiver's feelings of captivity in their role were the most powerful predictors of the risk for chronic clinical depression. This involuntary restructuring of the relationship is a major source of stress in caregivers. The level of stress reported by caregivers may be influenced by their locus of control and the levels of cognitive impairment and self-reported depression in the patient. *Method:* Nineteen spousal caregivers of patients with dementia seen in a geriatric assessment clinic were screened for cognitive impairment and asked to complete the following questionnaires: Perceived Stress Scale, Locus of Control Scale, and the Geriatric Depression Scale-Short Form. Patients completed a variety of measures including the MMSE. *Results:* Eleven males and 8 females with a mean age of 76.6 years were enrolled in this pilot study. All caregivers scored within normal limits on the Short Blessed (max score observed = 6). The level of stress reported by caregivers was correlated with how depressed they viewed their demented spouse, $r = .71, p = .0007$, and to a lesser degree the level of gross cognitive impairment demonstrated by their spouse, $r = -0.46, p = .05$. Caregiver stress was not related to patient self-report of depressive symptoms, $r = .37, p = .13$. Caregiver locus of control was not related to patient cognitive impairment or disturbance of mood. *Conclusion:* Caregivers of persons with dementia may be more vulnerable to effects of stress whenever they see their spouse as exhibiting more symptoms of depression and as level of cognitive impairment increases. Interventions targeted at caregiver education about depression may be useful in alleviating levels of stress in caregivers.

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L. MESSINIS & G. ANTONIADIS. Cortical-Subcortical Differentiation of Alzheimer's-Type Dementia From Depression With Cognitive Impairments.

The present study compared Alzheimer's type demented patients with mild cognitive impairments (ATDP) to depressed cognitively impaired patients (DCIP) on neuropsychological measures able to distinguish between a cortical versus subcortical pattern of cognitive deficits. Neuropsychological measures assessing language, memory, praxis and visuospatial functions were utilized. A cross-sectional comparisons design was utilized among an ATDP, DCIP and NC group. Participants were recruited from the outpatient neurology departments of the University Hospitals of Patras and Larissa in Greece. The Groups consisted of 12 ATDP and 12 DCIP participants. These groups were matched for age, education, gender, and reading ability. Twelve NC patients matched for age, education, and gender were also assessed. Assignment of participants into ATDP, DCIP and NC groups was based on GDRS scores, MMSE, DSM-IV structured clinical interviews and NINCDS-ADRDA criteria for dementia Alzheimer's type. Participants were excluded if they had any other disorder that could have an impact on neuropsychological performance. Results showed impaired performance of the ATDP group on tests of language, praxis and gnosis. These impairments were not found in the DCIP group. The DCIP group showed inconsistent impairments in perception and visuospatial processing, while their performance on recognition memory tasks was better than recall. The NC group showed only age related cognitive decline. The above findings, although preliminary, indicate the clinical usefulness of the cortical-subcortical distinction in differentiating depression with cognitive impairments from Alzheimer's type dementia. They further provide support for the earlier onset of apraxia, along with other cortical dysfunction in Alzheimer's type dementia.

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W.S. HOUSTON, M.W. BONDI, N.L. MARCHANT, S. ILES-JOHNSON, L.J. THAL, & D.V. JESTE. APOE Genotype Influences Depression in Alzheimer's Disease: Results From a Structured Diagnostic Interview.

Depression is a common comorbid condition in Alzheimer's disease (AD), although prevalence rates vary considerably across studies. Moreover, inconsistencies exist across studies investigating whether the genetic susceptibility factor for AD, the $\epsilon 4$ variant of the apolipoprotein E (APOE) gene, modifies the risk for depression in AD. Variability in findings across studies may be due to both small sample sizes as well as the use of self-report, brief or wide-ranging psychopathologic inventories. Instead, defining and characterizing depression from rigorous structured interviews is needed. The current study was designed to address these inconsistencies by employing the use of a standardized DSM-based interview for depression (i.e., NIMH Diagnostic Interview Schedule for the DSM-III-R) in a large sample of probable AD patients who have undergone ApoE genotyping. The determination of AD with depression required the agreement of 2 board-certified psychiatrists. Patients were divided into 2 groups on the basis of the presence or absence of depression (including 32 dementia with depression, 5 Major Depression, 2 Dysthymic Disorder, and 1 each with Adjustment D/O with depressed mood and atypical depression). The 2 groups were comparable with respect to demographic (age, education, gender) and cognitive status (Dementia Rating Scale total scores; verbal memory). Regarding APOE genotype and depression, those AD patients with depression were significantly more likely to possess an APOE- $\epsilon 4$ allele (33/41) than were those without depression [108/188; $\chi^2(1, N = 229) = 7.55, p < .006$]. These findings stand in contrast to other recent studies and suggest that, despite similarities in demographic and cognitive status, the presence of an $\epsilon 4$ allele confers an increase in the likelihood of depression in patients with AD.

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B. HOYT, P. MASSMAN, & C. SCHATSCHNEIDER. Individual Growth Curve Analysis of ApoE $\epsilon 4$ Associated Cognitive Decline in AD.

This study utilized individual growth curve analyses to investigate the role of the apolipoprotein $\epsilon 4$ allele on cognitive and functional decline in a longitudinal sample of 189 Alzheimer's disease (AD) subjects. It was hypothesized that the $\epsilon 4$ allele would be associated with a faster rate of decline, in a dose-dependent fashion according to the number of $\epsilon 4$ alleles subjects possessed. Contrary to hypotheses, subjects possessing 2 $\epsilon 4$ alleles declined at a *slower* rate than subjects with either 1 or no $\epsilon 4$ alleles on 1 measure of global cognitive functioning, the Mini-Mental State Exam, and 2 measures of activities of daily living (PSMS, IADL). Subjects with 2 $\epsilon 4$ alleles also declined at a *slower* rate than subjects with 1 $\epsilon 4$ allele on the Alzheimer's Disease Assessment Scale. Differences in rate of decline across specific neuropsychological measures were not significant. These findings are consistent with 2 other studies that found that the $\epsilon 4$ allele is associated with a *slower* rate of decline. Furthermore, the present study is one of only 2 studies that have utilized statistical techniques ideally suited to the analysis of longitudinal data in large subject samples. Thus, this study lends further strength to the conclusions that the $\epsilon 4$ allele is associated with a *slower* rate of cognitive and functional decline in AD and that the biological processes that lead to the onset of AD differ from those that determine its clinical course.

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H. TUOKKO & D. GARRETT. Cognitive Decline in High-Functioning Older Adults: Reserve or Ascertainment Bias?

The detection of dementia and mild cognitive impairment in high-functioning older adults can be difficult. To improve this situation, it is important to establish those factors that influence accurate detection. The present study examined the effects of educational and occupational attainment, and premorbid IQ in a prospective, population-based study of incident dementia using data from the Canadian Study of Health and Aging (CSHA). In accordance with both the threshold and cognitive reserve models, we observed that fewer high-functioning older adults were diagnosed with dementia at CSHA-2. Contrary to expectations based on the cognitive reserve model, no difference between high and low functioning persons was observed on rate of memory deterioration once impairment was detected. Logistic regression revealed that education and premorbid IQ were the best predictors of diagnostic status over time. When performance on memory measures at CSHA-1 was examined for high-functioning older adults, significantly more of those with dementia at CSHA-2 ($N = 59$) had scores falling 1 to 2 SD below the mean, when compared to those who continued to show no cognitive impairment ($N = 145$). Notably, few of the available norms adjusted for demographic factors other than age. Given the participants' level of functioning as defined by educational attainment and premorbid IQ, our findings suggest that such adjustment may facilitate the early detection of cognitive impairment in high-functioning older adults, and that the lower incidence of dementia in this group may be the result of ascertainment bias.

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R. HOLTZER, M. TANG, S. ALBERT, A. RIBA, K. MARDER, K. BELL, M. ALBERT, J. BRANDT, & Y. STERN. Rate of Cognitive Decline and the Risk of Reaching Functional Milestones in AD.

Introduction: Although, the relationship between cognitive status and functional deficits in Alzheimer's disease (AD) has been documented in cross-sectional and longitudinal research, studies have yet to examine whether the rate of cognitive decline is related to the risk of reaching clinical-functional milestones. *Objective:* To determine whether the rate of cognitive decline during the 1st year of follow-up provided incremental prediction regarding the risk of reaching clinical functional milestones in subsequent

years of follow-up in patients with probable AD. *Methods:* Patients with probable AD ($n = 236$) were recruited at 3 sites and followed longitudinally (M follow-up = 3.5 years; $SD = 2.75$). Modified Mini-Mental Status Examination (mMMS) and the Dependence Scale, administered at 6-month intervals, were used to determine the level of cognitive status and functional dependence, respectively. *Results:* General Estimating Equations (GEE) revealed that the odds of reaching clinical-functional milestones increased significantly as function of decrements in cognitive status. Cox survival analyses showed that the rate of cognitive decline (determined by the slope of mMMS scores) during the 1st year of follow-up predicted the risk of reaching clinical-functional milestones in subsequent years. Specifically, fast rate of decline was associated with an increase in risk while slow rate appeared to provide protection against such outcome. This incremental prediction remained significant when analyses controlled for baseline and end of 1st year mMMS scores as well as for age, gender, and education. *Conclusion:* First year rate of cognitive decline provides incremental information regarding the risk of reaching clinical-functional milestones in subsequent years in patients with probable AD.

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J. CERHAN, R.J. IVNIK, & G.E. SMITH. Alzheimer's Disease Patients' Cognitive Status and Course Years Prior to Symptom Recognition.

The purpose of this study was to look at Alzheimer's disease (AD) patients' cognitive status and course prior to recognizing or reporting symptoms of the disease. Cognitive performances of 20 persons in a neurologically normal cohort who subsequently developed probable or possible AD were compared to the performances of 60 persons in the same cohort (matched on demographic variables) who remained free of dementia symptoms. All subjects had at least 2 exams (M interval 2.6 years), and for the AD patients both exams occurred prior to reporting AD symptoms ($M = 4.2$ years, $SD = 2.6$ years, range = 1.4–10.3 years). Test data included the Mayo Cognitive Factor Scores (MCFS). Results revealed strong group differences on the Learning and Retention factors, with AD patients scoring lower than controls even years prior to reporting cognitive or behavioral symptoms of the disease. The absence of a significant interaction effect (Group \times Testing Session) for memory retention suggests that decline in the preclinical period may be too slow to be a useful indicator of future AD diagnosis. A small but significant interaction was seen for the Verbal Comprehension factor, suggesting that there may be subtle verbal decline across the preclinical years in AD, whereas controls showed mild improvement on this measure. Overall, the results suggest that extremely slow memory decline may begin years prior to recognition of overt AD symptoms. Alternatively, the results may reflect a manifestation of the *cognitive reserve* concept by showing vulnerability to AD in persons with weaker premorbid memory ability.

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Paper Session 6/8:45–10:30 a.m.

MEDICAL ILLNESS: NEUROPSYCHOLOGICAL AND NEURAL CONSEQUENCES

D.J. MOORE, M. CHERNER, E. MASLIAH, R. GONZALEZ, C. CAREY, A. GONGVATANA, T. MARCOTTE, R.K. HEATON, I. GRANT, & THE HNRC GROUP. Neuropsychological Impairment Predicts Multi-Region HIV-Related Neurodegeneration.

Global neuropsychological (NP) impairment is related to neurodegeneration (ND) observed postmortem in the midfrontal cortex of HIV-infected individuals. The current study assessed the utility of NP testing in identi-

ifying HIV-related ND in additional brain regions. Postmortem tissue sections from three brain regions of interest (midfrontal cortex, hippocampus, and putamen) were examined in 28 HIV-infected individuals with antemortem NP evaluations. To measure ND, tissue was immunostained with microtubule-associated protein 2 (MAP2). Laser scanning confocal microscopy (LCSM) was used to determine the percent area of the neuropil occupied by MAP2 immunoreactive dendrites for each of the three regions. Using a previously established cutpoint, severe ND was found in 29% (8/28) of tissue samples from the midfrontal cortex, 36% (10/28) of those from the hippocampus (CA1), and 36% (10/28) of those from the putamen. Antemortem global NP impairment was related to having at least one region with severe ND [$\chi^2(1.26) = 4.8, p = .03$]. Using the presence of severe ND as the gold standard, antemortem NP status demonstrated a sensitivity of 81% (i.e., 13/16 NP impaired individuals had severe ND in at least 1 brain region) and a specificity of 58%. Furthermore, it appears that antemortem NP impairment is increasingly more likely as the number of regions with ND increases: NP impairment rates were 42%, 71%, 83%, and 100%, respectively, in individuals with ND in zero, 1, 2, and 3 brain regions. These findings continue to support the utility of NP testing in identifying ND in HIV-infected individuals.

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E. RYAN, K. ISAACS, S. MORGELLO, & THE MANHATTAN HIV BRAIN BANK. Executive Dysfunction in AIDS Patients Co-Infected With Hepatitis C.

Among HIV-infected individuals, there is a greater prevalence of hepatitis C (HCV) infection compared to the general population. Current prevalence rates suggest that 25–33% of HIV-infected individuals are co-infected with HCV. While the neuropsychological consequences of HIV have been well characterized, the cognitive manifestations of co-infection with HCV have not. We compared the neuropsychological functioning of those co-infected with HCV ($N = 31$) to those not co-infected ($N = 29$) within an advanced AIDS cohort. Groups were similar in CD4 count but those not co-infected had a significantly higher viral load. Serum ALT level were significantly higher in the AIDS–HCV group whereas BUN level was not. More AIDS–HCV individuals showed impairment in executive functioning than those with AIDS only (43% vs. 26%). Significantly more perseveration ($p < .05$) was exhibited. There were also greater rates of impairment on Trails B among the AIDS–HCV group. Executive dysfunction was not reflected on the neurologic exam as the AIDS–HCV group was not more likely to exhibit frontal release signs. The groups were equivalent in ratings of wellness and on the Karnofsky Performance Scale of functional ability. The findings indicate that those with AIDS–HCV exhibit greater impairment in executive functioning but do not appear to require greater assistance with personal care than those not co-infected.

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N. CHIARAVALLI, J. DELUCA, F. HILLARY, W. LIU, & A. KALNIN. The Frontal Systems Behavior Scale, fMRI Activation Patterns, and Atrophy in MS.

This study examines the relationship between brain activation patterns during working memory task performance and Frontal Systems Behavior Scale (FrSBe) behavioral ratings in 7 multiple sclerosis (MS) and 6 healthy control (HC) subjects. Functional magnetic resonance imaging (fMRI) was performed on a 1.5 Tesla GE scanner to assess brain activation during a modified Paced Auditory Serial Addition Test. There were no differences between groups in age, education, or estimated premorbid IQ. Data were analyzed using statistical parametric mapping (SPM99) software, with a stringent significance level ($p < .005$, voxel extent ≥ 8). All data points for each significant cluster were calculated and submitted to the Talairach Daemon to determine voxel location. The MS group showed significant increases in behavioral ratings of *disinhibition* following diagnosis, on

both self and family report forms, and a significant increase in ratings of *executive dysfunction* on the family report form only. Correlations indicated a moderate, positive relationship between a measure of cerebral atrophy and FrSBe family and self-report *apathy* ratings, as well as FrSBe self-report *executive control* ratings. There was also a significant positive relationship noted between fMRI activation patterns in the right frontal lobe and patient and family ratings of *apathy*, as well as family ratings of *executive dysfunction*. Greater right frontal lobe activation was associated with more *apathy* and executive dysfunction. Activation in the left frontal lobe was not related to the FrSBe. No relationship was noted between right or left frontal lobe activation patterns and FrSBe ratings for the HC group. Correspondence: Nancy Chiaravallotti, Kessler Medical Rehabilitation Research & Education Corporation, 1199 Pleasant Valley Way, West Orange, NJ 07052. E-mail: nchiaravallotti@kmrrec.org

L.A. BIELIAUSKAS, A. FREYMUTH, R. FONTANA, C. BACK-MADRUGA, M. BURTON-WILLIAMS, E. WRIGHT, L. PADMANABHAN, H. SLEEPER, Z. KRONFOL, K. LINDSAY, & THE HALT-C TRIAL STUDY GROUP. Cognitive Impairment Patterns With Hepatitis C and Advanced Hepatic Fibrosis.

Individuals chronically infected with hepatitis C virus (HCV) have been reported to show increased prevalence of cognitive impairment with associated changes in the basal ganglia and white matter on MR spectroscopy. The aim of our study was to determine the prevalence and clinical characteristics of cognitive impairment in a large group of HCV patients entering the NIH–NIDDK sponsored HALT–C treatment trial. Impairment was defined as T scores falling more than 1 standard deviation below the mean on at least 4 of the 12 tested cognitive domains. On this basis, 54 of 139 subjects (39%) were identified as cognitively impaired (CI) at entry. All subjects showed decreased recall as measured by the Selective Reminding Test (SRT). CI subjects also demonstrated impairment on scores representing visual recall, digit span, and Trails B with lowered (less than 1 SD below normative mean) scores on Digit Symbol, Trails A, and Wisconsin Card Sort Categories. Shipley C.Q. scores were significantly reduced and in the impaired range for the CI group ($C.Q. = 78.9 \pm 14.0$); C.Q. is often interpreted as an impairment index and reflective of decreased reasoning ability. This pattern of scores is consistent with earlier reports of decreased attention/concentration and speed of working memory, with additional findings of decreased recall and reasoning. These findings are consistent with a subcortical cognitive deficit pattern previously described in other chronic infections such as HIV. The possibility of HCV-associated CNS impairment is supported.

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E. ZIEGLER, R. HILSABECK, M. CARLSON, W. MYERS, T. HAS-SANEIN, & W. PERRY. Cognitive Functioning of Pretransplant Patients With Chronic Hepatitis C.

Chronic hepatitis C virus (HCV) is a major problem worldwide and the leading indication for liver transplantation in the U.S. Research shows cognitive deficits exist in patients with chronic HCV, but little is known about the neuropsychological profile associated with HCV. The purpose of this study was to examine neuropsychological functioning in HCV-infected patients. Participants were 35 patients (21 males, 14 females) with end stage liver disease (ESLD). Average age was 50.6 years, and average education was 12.4 years. Whites comprised 74%, Latinos 20%, and 6% Asian Americans. Patients were administered the Repeatable Battery for the Assessment of Neuropsychological Status (RBANS), Trail Making Test (TMT–A & TMT–B), Grooved Pegboard (GP), and Controlled Oral Word Association Test (COWAT). The mean RBANS Total index score was 84, which is low average range. RBANS index scores were 89 on Immediate Memory, 83 on Visuospatial/Construction, 85 on Attention, 94 on Language, and 89 on Delayed Memory. TMT–A, TMT–B, and COWAT were within normal limits (T scores = 42, 45, and 41, respectively). In contrast, GP scores were significantly impaired bilaterally (T scores = 30 and 32 with dominant and nondominant hands, respectively).

In summary, results of this study suggest patients with ESLD secondary to HCV have significant psychomotor slowing bilaterally and weaknesses in visuospatial/constructional skills and attention. Memory, language, phonemic fluency, and sequencing generally were intact. This cognitive profile is similar to that seen in other types of chronic liver disease and suggests possible basal ganglia involvement. Possible resolution of these cognitive difficulties post-liver-transplantation is an area of future study. Correspondence: *William Perry, Ph.D., UCSD Medical Center, 200 W. Arbor Dr., San Diego, CA 92103-8620. E-mail: eaziegler@ucsd.edu*

Symposium 12/8:45–10:30 a.m.

CAN LITERACY CHANGE BRAIN ANATOMY?

Organizer and Chair: Feggy Ostrosky-Solis
Discussant: Yaakov Stern

F. OSTROSKY-SOLIS. Can Literacy Change Brain Anatomy?

Several studies have postulated that education and/or literacy may protect not only against the effects of biological aging but also against the clinical manifestation of cerebral neuropathology. In clinical neuropsychology, much debate has centered on whether the brain is more likely to degenerate as a result of overuse or underuse. There is a popular belief that an active mental life may delay the cognitive deterioration associated with normal aging. Animal studies also support the concept that environment can influence brain development. This symposium analyzes the impact of literacy on the functional organization of the adult brain. Cognitive neuroimaging studies, event related potentials and neuropsychological data of literate and illiterate subjects will be presented. Discussion will be focused on how specific life experiences such as learning to read and write can change patterns of brain activation. Suggestions for further research will be presented.

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J. MANLY, P. TOURADJI, D. BYRD, & Y. STERN. Literacy and Cognitive Change Among Ethnically Diverse Elders.

Literacy may be a more powerful indicator of brain reserve than years of education or occupational level. Literacy level may be a proxy for life experience (education) or native intellectual capacity that can compensate for brain damage or provide brain reserve. Alternately, the experience of acquiring literacy skills may in itself change the organization of the brain and increase protection against cognitive decline. However, because people with low levels of literacy obtain poor scores on most cognitive measures, only longitudinal studies can elucidate the role of reading ability in reserve. We determined whether literacy skills could predict cognitive change in a sample of 371 African American, White, and Hispanic elders selected from a longitudinal aging study in New York City. All participants were nondemented at their initial, baseline evaluation, as determined by a physician's independent exam. Literacy level was assessed using the WRAT-3 reading subtest among English-speakers and the Word Accentuation Test among Spanish-speakers. Mean follow-up duration was 5 years. After accounting for age at baseline and years of education, literacy predicted change on a battery of neuropsychological tests, including measures of verbal learning and memory, figure memory, abstraction, naming, fluency, and visuospatial skill ($p < .05$ for all). Our findings suggest that literacy skills are protective against cognitive decline in both verbal and nonverbal domains.

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F. OSTROSKY-SOLIS, M. ARELLANO, & M. PEREZ. Probed-Evoked Potential Indices of Differential Hemispheric Engagement in Literate and Illiterate Adults.

It has been suggested that learning to read and write during childhood influences the functional organization of the adult human brain. In the present study cortical evoked potentials to a probe click stimulus were used to assess the extent of activation of the 2 cerebral hemispheres during a verbal (word recognition memory) and nonverbal (face and music recognition memory) tasks in literate and illiterate subjects. Literate subjects show greater left-hemisphere activation during language and music processing than illiterate subjects, whereas no differences between groups were found during the face recognition memory task. These data support the view that the brain of illiterate subjects show patterns of activation that are different than those in literate subjects, thus reflecting the fact that environment can influence brain organization.

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Y. STERN, N. SCARMEAS, E. ZARAHN, C.G. HABECK, J. HILTON, J. FLYNN, & J.R. MOELLER. Imaging the Neural Basis for Reserve and Compensation.

The cognitive reserve model suggests that variables such as education and IQ are associated with cognitive reserve (CR) and may mediate differential susceptibility to age-related memory changes. We have proposed 2 complementary facets to CR: *reserve*: individual differences in the capacity to perform task; and *compensation*: the use of alternate brain networks or cognitive processes to cope brain pathology. To explore the anatomical basis for CR in healthy young and old individuals, we used H₂[¹⁵O] PET to explore the relationship between CR and task-related activation during the performance of a nonverbal recognition memory test. We first identified voxels where slopes of the relation between activation and CR were similar in the young and old subjects. These areas may mediate *reserve*. Other areas were noted where these slopes differed in the 2 groups. These may represent areas where *compensation* for the effects of aging has caused a functional reorganization of the neural substrate for task performance. For the young subjects this brain network may be used to cope with increasing task demands, and may represent a neural manifestation of *reserve*. Differential utilization of this network by older subjects may represent *compensation* for the effects of aging. These exploratory analyses suggest that it is possible to identify the neural substrate for these 2 aspects of cognitive reserve.

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A. CASTRO-CALDAS, V. NUNES, R. FERNANDES, & R. SIMÕES. Absence of School Attendance in the Proper Age as a Handicap for Adult Learning to Read and Write.

Previous studies demonstrated that the absence of school attendance in the proper age was relevant to explain poor performance in several neuropsychological measures. It was also shown that there were differences in the pattern of brain activation between literate and illiterate subjects while performing selected tasks. Therefore there is evidence to support that learning to read and to write in the adult life may be based on a particular biofunctional substrate different from that used by children. The performance in several tasks of adult subjects that attended school in the proper age was compared to that of those who learned late in life. The tasks were selected according to hypotheses raised from previous work. Results suggest that there are interesting differences between the groups in several tasks. It is possible that learning in adult life recruits different biofunctional networks from those used in earlier life.

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Symposium 13/8:45–10:30 a.m.

**THE FORGOTTEN CRANIAL NERVE:
STUDIES OF OLFACTORY FUNCTION
IN NEUROPSYCHOLOGY**

**Organizer and Chair: Paul J. Moberg
Discussant: Bruce Crosson**

**P.J. MOBERG, R.L. DOTY, D. KAREKEN, L. HARPER MOZLEY,
& S.J. KANES. The Forgotten Cranial Nerve: Studies of Olfactory
Function in Neuropsychology.**

Neuropsychologists have expanded a great deal of effort investigating and developing methods to assess various sensory abilities and the brain regions underlying these functions. A relatively neglected, but in some respects ideal, probe of frontolimbic system physiology and integrity is olfaction. The olfactory system is unique, among the sensory modalities, in that it does not utilize the thalamus as a central relay station. Thus, 1 synapse lies between sensory receptors and primary olfactory cortex, providing the most direct environmental access to several brain structures implicated in a number of neurological and neuropsychiatric disorders. Additionally, measures of olfactory function can provide a window into brain regions characterized by high plasticity and connectivity, which may be vulnerable to genetic or stress-mediated neurodevelopmental processes. This symposium addresses the role of olfactory assessment in neuropsychological research and practice examining olfactory processing in both healthy and patient populations. In the 1st presentation, Dr. Doty will review basic olfactory anatomy and the psychophysical techniques used to assess olfactory abilities. Dr. Kareken will present recent work examining the processing of olfactory stimuli in healthy individuals using functional MRI. Dr. Moberg will detail work on olfactory function in patients with schizophrenia, utilizing psychophysical, structural MRI and electrophysiologic methods. Metabolic studies of the olfactory system using FDG PET will be presented by Dr. Harper Mozley in healthy subjects and patients with schizophrenia. Lastly, Dr. Kanès will discuss the development and validation of mouse models of the olfactory abnormalities seen in neurologic and neuropsychiatric disorders.

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R.L. DOTY. Olfactory Anatomy and Psychophysical Techniques.

Until recently, the sense of smell has been an enigma to scientists and lay persons, largely because of inherent difficulties in exploring their biologic bases and the widely propagated myth that they are of little importance to humans. Fortunately, remarkable progress has been made in the last few decades in understanding the function of this sense and dispelling this myth. In the first part of this presentation, I will provide an overview of the olfactory peripheral structures and physiology as well as the functional anatomy, central connections and neurochemistry of the human olfactory system. The relevance of these brain systems to neurologic and neuropsychiatric disorders will also be discussed. With regard to the assessment of olfactory function, numerous procedures have been devised to evaluate the ability to smell. Many of these procedures, however, have proved to be too unreliable or time consuming to be practical for clinical or research use. More recently however, standardized means for assessing olfactory function have become generally available. In the second portion of this presentation, I describe psychophysical test procedures that have been employed to measure olfactory function. Emphasis is placed on practical psychophysical tests employed to test olfactory function in academic, industrial, and clinical settings. Issues related

to test reliability are discussed, along with variables known to influence test scores.

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D. KAREKEN, R.L. DOTY, D. MOSNIK, & G. HUTCHINS. Aging and Changes in Cortical Processing of Olfactory Perception.

Alzheimer disease involves a loss of odor perception and olfactory-evoked blood flow in the medial temporal area, but we know little about the cortical processing of odors in healthy aging. We studied odor sensation (SEN), discrimination (DIS), and identification (ID) in 5 healthy young (HY; 27.7 ± 4.49) and 6 healthy older (HO; 71.00 ± 3.41) adults. *Methods:* HO and HY were matched by odor identification scores, but HO odor detection thresholds were slightly elevated compared to HY ($p < .05$). Subjects underwent H₂[¹⁵O] PET during sniffing (SN), SEN, DIS, and ID. For SEN, subjects made a *yes-no* button-press if an odor was present. Subjects responded similarly for DIS to indicate if paired odors were identical. For ID, subjects indicated if odors matched a target name. SEN used SN as a baseline, while DIS and ID used SEN as a baseline (analysis = SPM99, random effects, $p < .005$, 20 contiguous voxels). *Results:* SEN evoked bilateral piriform activation that was insignificantly different between groups. DIS activated the hippocampus (left above threshold, right below) while ID activated the left prefrontal–Broca’s area. During DIS and ID, HO activated gyrus rectus–middle orbital gyrus (GR/MOG) more than HY. In HY there was a trend for greater SEN activation in GR/MOG, where detection threshold also correlated with SEN across all subjects. *Conclusions:* DIS may use the hippocampus to hold odors in working memory, while left prefrontal activation may reflect semantic decisions in ID. The effects of diminished sensory threshold are most apparent downstream in tertiary olfactory areas (GR/MOG), possibly precluding automatic higher-order processing during SEN. HO with elevated thresholds may not activate this area until they explicitly perform higher-order odor judgments.

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P. J. MOBERG, B.I. TURETSKY, S.E. ARNOLD, R.L. DOTY, & R.E. GUR. Scent of a Disorder: Olfactory Function in Schizophrenia.

There is growing evidence to suggest that schizophrenia is a neurobehavioral disorder that affects frontotemporal areas of the brain. Efforts to precisely characterize the nature of these frontotemporal deficits and their clinical correlates have employed a variety of methods and an array of neurobehavioral probes, including physiologic assessments of declarative memory, working memory, executive function and vigilance. A relatively neglected, but in many ways ideal, probe of the frontolimbic system is olfaction. Olfactory processing is mediated by limbic structures implicated in the pathophysiology of schizophrenia. Patients with schizophrenia have significant olfactory deficits which occur at the first onset of illness. Unlike the relatively static pattern of cognitive deficits seen over the course of illness, though, olfactory abilities appear to decline in a linear fashion, independent of normal aging and gender effects. Family studies, however, have also demonstrated significant deficits in olfactory identification in unaffected first-degree relatives of schizophrenic probands. It would seem, therefore, that olfactory brain regions are affected by genetically mediated developmental, as well as neurodegenerative processes. In this presentation, we will present data from our lab examining olfactory processes in schizophrenia patients using a variety of psychophysical, structural MRI and event-related potential techniques. These findings will be extended and integrated with recent post-mortem and olfactory epithelium biopsy results from our group which suggest this dysfunction is present at the molecular as well as the behavioral level. Given the configuration and relevance of the underlying neural substrate, plus the evidence of performance deficits, probes of the olfac-

tory system may hold special promise for understanding schizophrenic pathophysiology.

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L. HARPER MOZLEY & P.J. MOBERG. Olfaction and Regional Cerebral Glucose Metabolism in Schizophrenia.

Deficits in olfaction have been reported in schizophrenia and several brain regions purportedly involved in olfaction have been implicated in the pathophysiology of the disorder. We studied odor identification in 7 healthy controls (M age = 37.9; 4 M) and 13 patients (age = 29.0; 10 M) who met DSM-III-R criteria for schizophrenia. *Methods:* Quantitative resting FDG-PET scans were acquired on a continuous slice scanner. Seven regions of interest, selected *a priori*, were placed on the MRI scans of each subject and transposed onto the corresponding PET images after both sets of images had been re-aligned and resliced to match each other. The University of Pennsylvania Smell Identification Test (UPSIT) was administered unilaterally and performance was classified as normal or impaired for age and gender. *Results:* In controls, higher metabolic activity in the left insula was associated with better UPSIT performances for the left nostril ($p < .05$) and performance decrements for the right nostril ($p < .05$). Higher left insular activity was associated with better right nostril UPSIT performance in patients ($p < .05$). Decrements in right nostril performance were associated with higher left orbital frontal and left temporal pole metabolism in patients with overall normal UPSIT scores ($n = 7$; $p < .0001$ and $p < .025$), but not in impaired patients. *Conclusions:* The pattern of relationship between metabolic laterality and UPSIT performance was similar for healthy controls and nonimpaired patients. The absence of the pattern of facilitation observed in controls may be further evidence for left hemispheric dysfunction in schizophrenia.

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S.J. KANES, P.J. MOBERG, S.E. ARNOLD, B.I. TURETSKY, & R.E. GUR. Mouse Models of Olfactory Dysfunction: Relevance and Relationship to Neuropsychological Research.

Many neuropsychiatric disorders including Alzheimer's disease, Parkinson's disease and schizophrenia are accompanied by specific deficits in olfactory threshold, discrimination, and memory. These deficits are accompanied by characteristic anatomic and pathologic findings in olfactory epithelium and olfactory bulb. In addition, olfactory deficits are often observed in unaffected 1st-degree relatives indicating a likely shared genetic contribution to both the abnormalities in olfaction as well as illness itself. To explore the genetic and neurobiological basis of olfactory abnormalities will require appropriate behavioral models of olfaction, as well relevant mouse models of disease. There are several behavioral paradigms that are now being explored as potential animal models for olfactory deficit. Using air-dilution olfactometry, odor detection threshold, olfactory memory and discrimination can all be evaluated in mice. Such behavioral measures can be correlated with gross and microanatomical measures to develop a deeper understanding of brain behavior relationships in the olfactory system. This talk will focus on the development and validation of mouse models of the olfactory abnormalities seen in neuropsychiatric disorders. This will be followed by a description of the use of these measures in the evaluation of genetically engineered mouse models of Alzheimer's disease, Parkinson's disease and schizophrenia as well as in the assessment of inbred strains of mice. The utility of such models for ongoing human neuropsychological and functional genomics research will be emphasized.

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Symposium 14/8:45–10:30 a.m.

INTEGRATING THEORIES OF COGNITION, EMOTION, AND BEHAVIOR IN NEUROPSYCHOLOGICAL REHABILITATION

Organizers: Barbara A. Wilson and Catherine Mateer
Chair and Discussant: Leslie Gonzalez Rothi

B.A. WILSON. Integrating Theories of Cognition, Emotion, and Behavior in Neuropsychological Rehabilitation.

This symposium recognizes that neuropsychological rehabilitation is a field that needs a broad theoretical base incorporating frameworks, theories and models from a number of different areas. Because people with brain injury are likely to face multiple difficulties including cognitive, social, emotional and behavioral problems, no one model or group of models is sufficient to deal with all these issues. In order to improve cognitive, social, emotional and behavioral functioning in everyday life we should not be constrained by one theoretical framework. The 1st paper considers some of the models that have influenced neuropsychological rehabilitation in the past and presents a provisional, comprehensive model of neuropsychological rehabilitation. The 2nd paper discusses the interface between cognitive impairments and emotional distress through consideration of 3 people with the amnesic syndrome (all of whom are well known in the literature on memory). The 3rd paper is concerned with the facilitation of adaptive coping in people who have sustained a traumatic brain injury and whether it is possible to influence coping styles and emotional adjustment. The final paper describes how a combined treatment approach using cognitive and cognitive-behavioral interventions can enhance both cognitive and emotional wellbeing. The discussant will attempt to synthesize the main messages of the symposium and suggest how neuropsychological rehabilitation could further progress in the next decade. Correspondence: Barbara Wilson, MRC Cognition and Brain Sciences Unit, Box 58, Addenbrookes Hospital, Hills Road, Cambridge CB2 2QQ, UK. E-mail: barbara.wilson@mrc-cbu.cam.ac.uk

B.A. WILSON. Theoretical Influences on Neuropsychological Rehabilitation.

Neuropsychological rehabilitation is concerned with the amelioration of cognitive, social and emotional deficits caused by an insult to the brain. The main purposes of such rehabilitation are to enable people with disabilities to achieve their optimum level of well being, to reduce the impact of their problems on everyday life and to help them return to their own, most appropriate environments. Because of the complexities of the difficulties facing people with brain impairments, neuropsychological rehabilitation should draw on a number of theoretical approaches in order to address the functional, everyday problems that people with brain injury and their families try to overcome. This paper considers some of the theories, models or frameworks that have influenced neuropsychological rehabilitation and attempts to synthesize these into a broad, comprehensive theory of rehabilitation. Of the many theories that impact on rehabilitation, 4 areas are, perhaps, of particular importance namely theories of cognitive functioning, of emotion, of behavior and of learning. Representative theories from each of these areas are described. Consideration is also given to theories of assessment, recovery and compensation. A case study is presented to show how these theoretical influences can be combined into a successful rehabilitation program for a brain-injured person. Finally, a tentative, comprehensive model of neuropsychological rehabilitation is provided in an attempt to integrate the above mentioned models and theories into a unified whole.

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R.L. TATE. Anosognosia, Anosodiaphoria and Defensive Denial in the Amnesic Syndrome.

It is well known that effective cognitive rehabilitation of individuals with acquired brain injury (ABI) must also take into consideration emotional impairments. Disturbances in emotional functioning after ABI are common and may arise from (1) direct effects of the injury when lesions are strategically placed and/or (2) indirect consequences (i.e., secondary psychological reactions and responses to impairments and adverse lifestyle changes). Disentangling the relative contribution of direct and indirect factors is a difficult but important task because management approaches may differ depending upon aetiology. In this respect, study of people with circumscribed lesions is heuristic and this paper analyzes the reported emotional functioning in a series of cases with amnesic syndromes, including the famous cases N.A., H.M., and S.S. Although each individual showed dramatic alteration in their personal situations and social lifestyles at virtually all levels, they did not exhibit significant emotional distress or concern about their circumstances. N.A. is described as being "steadfastly optimistic," H.M.'s emotional functions are described as "typically blunted," and the insight shown by S.S. is described as "entirely superficial." The amnesic syndrome itself, while not causing the emotional blunting, provides cognitive mechanisms that further attenuate emotional responsiveness. These include unawareness, diminished concern and psychological defence mechanisms, and they are considered in terms of their impact on rehabilitation therapies.

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J. PONSFORD, K. ANSON, & C. CURRAN. Facilitating Adaptive Coping Following Traumatic Brain Injury.

Findings from numerous outcomes studies have demonstrated that around 50% of those with moderate to severe TBI exhibit clinically significant depression and/or anxiety in the years following injury. Ponsford et al. found no significant association between anxiety or depression levels and injury severity or level of handicap, but a strong association with psychosocial adjustment. These findings suggest that how the injured person copes with the impact of the injury has a significant influence on psychosocial outcome. Results of a study investigating coping strategies in relation to emotional adjustment in 88 severe TBI individuals and 44 victims of orthopaedic trauma 1–5 years post injury will be presented. In both groups, nonproductive coping styles, characterized by worry, wishful thinking, self-blame, ignoring problems, keeping to oneself and using substances to relieve tension were strongly correlated with the presence of depression, anxiety and low self-esteem. This finding raises the question as to whether it is possible to therapeutically influence coping styles and thereby improve emotional and psychosocial adjustment. Preliminary findings will be presented from a controlled study evaluating a group intervention designed to develop skills to prevent and cope with anxiety, depression, low self-esteem, anger and promote adaptive coping with change following TBI. Changes following baseline, intervention and follow-up phases have been measured using the Hospital Anxiety and Depression Scale, the Rosenberg Self-Esteem Scale, the State–Trait Anger Expression Inventory, the Sickness Impact Profile and the Coping Scale for Adults. Factors influencing ability to benefit from the intervention will be explored. Correspondence: *Jennie Ponsford, Monash University, Department of Psychology, Melbourne, Australia. E-mail: jennie.ponsford@sci.monash.edu.au*

C. MATEER. Integrating Cognitive and Cognitive-Behavioral Interventions.

It is widely acknowledged that alterations in both cognitive and emotional functions are a common consequence of acquired brain injury. However, impairments in these areas are often seen as stemming from separate underlying sources. As a consequence, cognitive and affective components are often targeted separately in treatment, addressed by difference practitioners, and/or done "in stages." This paper argues for the importance of integrating interventions for cognitive impairments with a strong

focus on the underlying affective responses that frequently accompany changes in cognitive functioning. Emotional responses to cognitive inefficiency and memory failures can increase anxiety, result in increased expectancy of failure, and eventually lead to a withdrawal from and/or avoidance of cognitive challenges. Negative beliefs about one's cognitive abilities have been shown to decrease motivation and effort put forth on cognitive tasks. This phenomena may share features with other forms of "learned non-use" following neurological injury or damage. This presentation will discuss the role of cognitive self-efficacy in recovery of adaptive functioning. Outcome data from controlled studies using cognitively-oriented versus adjusted-oriented interventions will be presented. The presentation will also describe and provide outcome data for intervention strategies that incorporate cognitive-behavioral methods to increase the client's sense of self-efficacy and self-control over cognitive abilities, promote the use of anticipatory compensations, and lead to improved emotional self-regulation.

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Poster Session 9/9:30–10:45 a.m.

ASSESSMENT OF EXECUTIVE FUNCTION AND MEMORY

C. ADAMS, M. WELSH, E. WARNEKE, K. NORTON, & D. ORR. Validity Study of a Computerized Version of the Tower of Hanoi–Revised.

The purpose of this experiment was to examine a newly designed computerized version of the Tower of Hanoi–Revised (TOH–R) and validate it against the manual version of this task. A second purpose was to explore the influence of the personality style of impulsivity and the cognitive process of inhibition on TOH–R performance. The computerized version of the TOH–R (c-TOH–R), the manual version of the TOH–R (m-TOH–R), the Personality Adjective Inventory (PAI), and the Stroop were given in a randomized order to 50 undergraduate participants (M age = 19 years). The c-TOH–R and the m-TOH–R correlated at $.61$, $p < .01$, and the internal consistency of each task was strong ($\alpha = .873$: c-TOH–R; $\alpha = .803$: m-TOH–R). Based on the reliability of each task, the maximum correlation possible would be $.837$, and therefore, there was 23% performance variance that was not shared between the 2 tasks. Overall, the performance on the m-TOH–R was more accurate (61%) than the performance on the c-TOH–R (46%); however, the order of administration of the tests moderated this difference. The larger difference in performance was observed in the group that was administered the c-TOH–R *first*, such that performance on the computerized version was quite low (39% correct) and performance on the manual version was relatively high (67% correct). There was no evidence for an association between TOH–R performance and inhibition or impulsivity. In general, the computerized version of the TOH–R has strong internal consistency and appears to be convergent with the manual version; however, the reasons for the relative greater difficulty of the computerized task require further study.

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M.A. NORMAN, S.W. MILLER, & R.K. HEATON. Manual and Computerized Administration Comparisons on the WCST-64.

To date, little research has compared computerized and manual administrations of traditional neuropsychological tests. The traditional 128-card Wisconsin Card Sorting Test (WCST) requires abstraction, problem solving, and set-shifting abilities and is believed to be sensitive to executive dysfunction. The WCST-64 correlates highly with the 128-card version; however, little is known about performance differences between the manual and computer administrations. We hypothesized that subjects completing the manual WCST-64 would not differ from those completing the computerized WCST-64. Subjects included 170 African American Seniors volunteering as normal controls (NC) in a larger normative project at the

University of California, San Diego. Mean age was 68.63 (7.45) and mean education was 13.08 (2.42). Subjects were split into 3 age- (55–64, 65–74, 75–84), 3 education- (<12, 12–15, 16+), and 2 administration- (computer vs. manual) groups. A Multivariate Analysis of Variance was used to analyze demographic effects on WCST-64 categories completed, perseverative responses, total errors, and set losses. There was a significant main age effect for the number of completed categories ($p = .029$) and an education effect for the number of errors ($p = .024$). There were no interaction effects for any of the dependent measures. The oldest group attained significantly fewer categories than the youngest group ($p < .001$). Also, those with the highest level of education made significantly fewer errors than the other two education groups ($p = .001$). These findings suggest there are not differences between manual and computerized administrations of the WCST-64 and minimal age and education effects.

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K.W. GREVE, T.R. STICKLE, J.M. LOVE, A. BRENNAN, M.T. HEINLY, K.J. BIANCHINI, & M.S. STANFORD. A Confirmatory Factor Analysis of the WCST Using Non-Overlapping Variables.

The Wisconsin Card Sorting Test (WCST) has been the subject of considerable factor analytic research over the past 10 years, yet debate continues as to the exact number and composition of its underlying factors. We recently presented a CFA which test 1, 2, and 3 factor models. None of these models fit the observed data closely enough to be considered the “true” model, although the 3-factor model showed statistically significant improvement in fit over the 1- and 2-factor models. One possible explanation for the inadequacy of these models is the significant overlap among WCST variables. To address this possibility we used 10 scores selected to reduce the redundancy that exists among the standard WCST variables. The original variables from which the non-redundant scores were derived were excluded from the analysis unless they were themselves non-overlapping (e.g., perseverative errors). The sample consisted of 814 mixed clinical patients and nonclinical controls. The sample was randomly divided into 2 groups of 407 subjects. The scores of the 1st subgroup underwent exploratory factor analysis which resulted in the frequently-reported 3-factor solution and provided the initial model for the CFA. The 2nd subgroup was used to test and refine the model using CFA. The resulting models and fit indices are presented. The meaning of the results for both research and the clinical use of the WCST is discussed.

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W.S. HOUSTON, D.C. DELIS, J.A. HOLDNACK, & M.W. BONDI. Interest Scatter on the D-KEFS in the National Normative Sample: Analysis of the Primary Executive-Function Measures.

Recent studies have found that the average neurologically intact individual exhibits considerable discrepancy between his or her highest and lowest standardized scores on scales or batteries of cognitive tests. For example, on the Wechsler intelligence scales, which tend to assess more fundamental cognitive skills, the average intersubtest scatter for both children and adults has been found to be approximately 7 scaled-score points. These studies demonstrate that intrasubject variability of over 2 standard deviations across tests is the rule rather than the exception. For the present study, we examined interest scatter found on the 9 tests on the Delis-Kaplan Executive Function System (D-KEFS) in the national normative sample. It was hypothesized that interest scatter would be equal to or greater on executive function measures than on intelligence subtests, due to the often higher-level or multifactorial nature of executive function tasks. The average interest scatter across the primary executive function measures of the D-KEFS (excluding the baseline cognitive measures) was approximately 9.4 scaled-score points both for adolescents/adults (ages 16–89, $N = 811$) and for children (the children analysis involved 8 of the 9 tests; ages 8–15; $N = 533$). No significant age effects were found for adults in degree of scatter, and minimal age effects were found for chil-

dren. Our findings suggest that, although normal subjects exhibit considerable variability of performance across intelligence subtests, they may show somewhat greater variability on tests of executive functions.

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M. KURTZ, D. RAGLAND, P.J. MOBERG, & R.C. GUR. The Penn Conditional Exclusion Test: A New Measure of Executive Function With Alternate Forms for Repeat Administration.

Studies of change in neuropsychological function over time in both healthy and diseased populations have been hindered by the absence of alternate forms of most commonly used neuropsychological tests. The Penn Conditional Exclusion Test (PCET) was developed as a new neuropsychological instrument to assess executive-function with 4 alternate forms. A variant of the “odd man out” paradigm described by Flowers and Robertson, in this task participants are asked to decide which of 4 objects does not belong with the other 3. Objects are selected based on 1 of 3 sorting principles for each task. Participants have to infer the correct sorting principle based on response feedback and when the subject achieves 10 consecutive correct responses, the sorting principle shifts. There are three sorting principles for each version of this task and sorting principles are unique for each of the four test versions. In Study 1 the PCET was administered in counterbalanced order to 80 healthy undergraduates to establish equivalent test difficulty. Results revealed that the 4 versions were equivalent on categories achieved, total number of errors and total number of trials. In Study 2 the PCET was administered to 25 healthy adults with a battery of computerized neuropsychological tests to assess construct validity. Convergent validity was confirmed by correlations between the PCET and a measure of abstraction. Divergent validity was established through low, nonsignificant correlations between the PCET and measures of emotion recognition, word and face memory, visuospatial function, and verbal reasoning.

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J. RANDOLPH, H. WISHART, B.C. McDONALD, J.S. RAMIREZ, R.M. ROTH, & A.J. SAYKIN. The METEX: Initial Psychometric Data for a Brief Meta-Executive Measure.

Despite the importance and relevance of assessing executive functions during neuropsychological evaluation, few self-report measures exist that assess patients’ perceptions of these abilities. The present study was designed to provide initial psychometric data on the METEX (*METa-EXecutive Scale*), a new, brief measure of self-reported executive functioning. Twenty-four theoretically derived items assessing perceptions of mental flexibility, working memory, planning ability, strategy use, goal-directed behavior, and social self-monitoring were administered to a diverse neuropsychiatric sample ($N = 68$) presenting to a large medical center. Exploratory factor analysis using oblique rotation yielded 3 factors—Mental flexibility (MF), Planning and strategy use (PS), and Self-monitoring (SM)—which accounted for 44.9% of response variance. Internal consistency of factor scores and the entire scale was moderate to high. The three METEX factors correlated with items from a commonly used metamemory measure (Squire) assessing perceptions of working memory and attention ($p < .01$), but did not correlate with remote metamemory, age, or education. The MF factor was associated with WCST Perseverative errors ($p < .05$) but no other relationships emerged between METEX factors and executive or verbal memory tests. These findings offer preliminary support for the METEX as a brief measure of self-reported executive function and dysfunction. The scale will subsequently be refined based on item analysis, cross-validated in a separate sample, and examined in discrete patient groups.

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G. GIOIA, P.K. ISQUITH, & S.C. GUY. Development of the Behavior Rating Inventory of Executive Function–Self-Report Version for Young Adults.

The executive functions play a critically important role during the young adult years as independent problem-solving is central to personal, academic, and vocational success. Whereas the structured nature of the assessment situation can make examination of the executive functions challenging, the individual can often provide important insights into their own problem-solving behavior. We report on the development of the Behavior Rating Inventory of Executive Function–Self-Report Version (BRIEF–SR) for young adults, designed as a tool for external validation of clinical assessment. A sample of 244 young men and women enrolled in colleges (M age 21 years, $SD = 3.6$, range 18–42) with no significant psychiatric or learning problems completed the initial 135-item self-report form of the BRIEF. Individual item distributions were examined, poor items were discarded, and various scale configurations (5–8 scales) were tested via factor analysis. Items were then examined for the best fit within scales based on factor loadings, item-total correlations, and conceptual match. A 6-scale measure emerged (Inhibit, Mental Flexibility, Emotional Control, Working Memory, Task Problem-solving and Organization of Materials), with 10 to 16 behaviorally anchored items per scale. Item-total correlations were in the appropriate range with good internal consistency for each scale ($\alpha = .81$ to $.88$). Scale intercorrelations were low to moderate ($r = .2$ to $.6$), and factor analysis of scales suggested a 3 factor solution. There were no age differences in scale means, and males and females differed only on the Emotional Control scale.

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D. BEEBE, K. BYARS, A. NICHOLS, L. GROESZ, & C. WELLS. Psychometrics for a Shortened Behavior Rating Inventory of Executive Functioning.

The Behavior Rating Inventory of Executive Functioning (BRIEF) is the first empirically supported questionnaire designed to assess children's functional use of executive skills in daily life. In our clinical practice, we saw the need for an abbreviated alternative to the 86-item parent BRIEF to act as a screening tool. With the consent of the BRIEF's authors and publishers, we developed a 24-item parent-report short form (BRIEF–S). Three items from each BRIEF subscale were selected because of their high item–subscale correlations and their lack of redundancy with items from another behavior screener (the BASC Monitor). The BRIEF–S was administered to parents of children aged 5–16 who were referred for suspected ADHD ($n = 84$) or for suspected obstructive sleep apnea ($n = 32$). Despite the shortened format, internal consistency remained good (median $\alpha = .79$). Maternal and paternal reports were moderately correlated (median $\rho = .46$). The factor structure of the BRIEF–S was identical to that of the full BRIEF. Construct validity was supported by correlating the BRIEF–S with the corresponding scales from the full BRIEF (median $\rho = .88$), with the BRIEF scales omitting items from the BRIEF–S (median $\rho = .77$), and with the BASC Monitor. Children referred for suspected ADHD displayed poor BRIEF–S scores compared to norms, supporting criterion validity. There was evidence of a low ceiling on some scales at certain ages, but this was minimal on composite indexes of behavior regulation, metacognition, and overall executive functioning. Thus, there is preliminary psychometric support for the BRIEF–S as a screening tool, though ceiling effects can complicate subscale interpretation.

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S. LEBEDEV. The New Design of Immediate Visual Memory Diagnostics.

Immediate visual memory is frequently tested by neuropsychologists, but either, the experimental procedure lacks realism, or the material that should be retained is symbolized and structured. Our aim was to create a diagnostic toolkit to assess immediate visual memory. We organized the mea-

suring procedure in such a way, that the stimuli were exposed for almost differential threshold times with the large number of distracters. We made stimuli all alike. In such a paradigm we created 3 methods for visual memory assessment: (1) configurational test that uses ink spots as stimuli; (2) color test that evaluates person's color memory; (3) face tests that contains two subtests and assess both configurational and emotional memory. The Configurational Test consists of 10×15 cm cards with similar ink spots. There are 3–4 short exposure series, after each of them a subject is asked to recall the control stimuli and to choose them from the set. The Face Test consists of 7×9 cm cards with female faces on them. The pictures are monochromous, poor in quality, with contrast too high or too low to read the face details. The procedure is the same as in the previous test. The Color Test consists of 4×4 cm cards with colors, gradually changing from green to blue. The procedure is the same, except for the stimuli are exposed only once. All the methods, administered to different groups of healthy subjects, appeared to be highly discriminative and proved to be a valid instrument for measuring immediate visual memory.

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S. LEBEDEV. Improvement of Verbal Memory Assessment Procedure.

Objective: Verbal memory assessment is a common task for a neuropsychologist and yet, the methods due to the stimuli, used in Russian diagnostic toolkits, are unreliable and, thus, invalid. Often a measuring procedure has to be repeated. Therefore re-test reliability and internal consistency are important. It means that all the stimuli should be neutral and intersubstitutable, to prevent secondary associations. The goal of our study was to create the valid and reliable stimuli sets for the three well-known methods of verbal memory testing: "Ten words," "Two groups by three words" and "Fifteen words." *Method:* We have equalized and homogenized the word sets by the following word characteristics and using the following criteria: (1) age of acquisition: average; (2) frequency: low; (3) imagery: low; (4) abstractness: high average; (5) phonetic complexity: average; (6) elocution: low. The final sets were administered to different groups of healthy subjects and to groups of subjects with some sort of organic pathology such as Alzheimer's disease, substance related disorders, etc. As validity and reliability were theoretically improved, we assessed the discriminativeness to be sure the methods are able to distinguish people with slight memory problems due to bad mood, sleeping disturbances etc. *Results:* For all the groups (62 subjects) and methods, Ferguson's delta was between .82 and .94. We have created three word sets for every method. *Conclusion:* Our "modernized" methods are reliable and valid for verbal memory assessment and can be profitably used in both clinical and neurobiological research.

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M.M. SCHMITT, J.H. BANOS, & T.R. ELLIOTT. Factor Structure of the Rey Auditory Verbal Learning Test in Spinal Cord Injury.

The Rey Auditory and Verbal Learning Test (RAVLT) is a commonly used measure of learning and memory. However, little research examining the factor structure of the RAVLT has been published. Generally, previous studies have investigated RAVLT variables in conjunction with variables from other measures (e.g., WMS, WAIS). This study investigated the factor structure of the RAVLT in 243 individuals (ages 15–83) with spinal cord injury undergoing inpatient rehabilitation. Principal Components Analysis with Promax rotation yielded a 3-factor solution (accounting for 78.6% of the variance) comprised of: General Verbal Learning, Auditory Attention, and Inaccurate Recall. The General Verbal Learning factor is comprised of scores from Trials 2–5 of the original list, short-delay recall, long-delay recall and correct responses on the recognition task. The Auditory Attention factor includes performance on the first 2 trials of the original list and the alternate list. Finally, the Inaccurate Recall factor

consists primarily of false positives on the recognition tasks with a secondary loading from recognition hits. This solution is strikingly similar to analyses of comparable variables on the California Verbal Learning Test (CVLT). This is noteworthy in that it supports the validity of a clinically relevant Auditory Attention factor on verbal list learning tasks that is obscured when orthogonal rotation is applied. This suggests that orthogonal rotation is inappropriate for list-learning tasks and may obscure valuable information about the factor structure of these measures.

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CHILD DEVELOPMENT AND DISORDERS

D. MOLFESE, A. FONARYOVA KEY, D. GOZAL, N. CUNNINGHAM, M. KELLEY, S. KELLY, & S. ROBINSON. Effects of Sleep Disturbances on Auditory ERPs in Young Children.

In this project, auditory event-related potentials (ERPs) were recorded from 35 children age 5;8 to 7;4 years referred for sleep apnea assessments. The children were presented with six computer-synthesized syllables (e.g., /ba/; /gu/) presented in random order. ERPs were recorded using a 128-channel high-density geodesic sensor net. The data were submitted to PCA-MANOVA and a regression analysis relating electrophysiological data to measures of apnea/hypopnea and scores on the NEPSY neuropsychology test. The results indicated that although all children were able to discriminate between various consonants and vowels, the individual ERPs were related to the severity of the child's sleep disturbance. Regression models using 3 to 6 components of the ERPs accounted for 35 to 65% of the total variance. The results indicated that the scalp topography of brain electrical activity elicited in response to speech sounds changed as a function of the degree of sleep disturbance. The overall results provide general information concerning the impact of sleep on neurocognitive functioning and development in young children and may lead to identifying and minimizing the risks for children who may be more cognitively vulnerable because of chronic sleep disturbances.

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T. SUDO & K. MOGI. Generalization Over Image Variations in Infant's Word-Learning.

In an infant's language development, phonetic variations irrelevant in its native language become progressively unattended. When infants learn word-object pairing, the success of learning is contingent on the inattention to fine phonetic details. The evidence suggests an interesting relationship between successful sensory association and the inattention to the details of sensory input. Here, we investigate the pairing of nonsense words and objects in infants, where variation is given to the presented image. The image is varied in several ways, including (1) contextually similar (such as a whole apple and a peeled apple); (2) conceptually similar (such as a real cat and a cat doll); (3) physically similar (a filtered, distorted, or rotated image). After a habituation phase, where the infants learn the association between nonsense words and images, they go through the testing phase where varied visual images are presented with the nonsense words. By measuring the mean looking time, we investigate the ability of the infants (8–24-month-old) to generalize over image variations in associating the images with nonsense words. In a second set of experiments, we show the infants video images where the similar images are presented in a contingent context (such as an apple being peeled, a real cat playing with a cat doll, images under continuous physical transformation). We discuss the implications of the results in the context of cortical systems involved in language development.

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D. MOLFESE, V. MOLFESE, A. FONARYOVA KEY, S. KELLY, M. KELLEY, T. WILSON, N. CUNNINGHAM, & C. RUMAGE. High-Density Array Electrode Systems Identify Dynamic Processes During Speech Perception in Newborn Infants.

Although brain and behavior studies of speech perception development have produced many insights regarding the early bases for early language development, no studies to date have attempted to study the temporal dynamic events underlying the brain's processing of speech perception. However, with the recent advent of high-density array electrode systems, such questions are now more within our reach. In the present study auditory event-related potentials (ERPs) were recorded from 100 newborn infants (50 females) within 30 hrs of birth while series of randomly ordered consonant-vowel syllables were presented auditorily. ERPs were recorded using 128 electrode high-density array nets. Following standard artifact rejection, baseline correction, and averaging procedures the ERPs were submitted to multivariate component analyses in order to assess whether consistent spatial and temporal patterns were generated in response to consonant differences. Analyses identified consistent gender, hemisphere, and consonant related effects as well as higher-order interactions. Notably, temporal processing of the speech sounds revealed an initial central positivity, followed by an increasing negative deflection over the left temporal region. This in turn was followed by a pattern of temporal-parietal positivity and a subsequent right temporal region negative deflection. Results will be compared with populations of preschool children and adults who generated much more temporally dynamic patterns across hemispheres and between frontal, central, and parietal-occipital regions.

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M. KELLEY, R. RONAU, D. MOLFESE, A. FONARYOVA KEY, V. MOLFESE, S. TERRELL, M. FERGUSON, T. WILSON, N. CUNNINGHAM, & C. RUMAGE. Electrophysiological Correlates of Math Processing in Children.

Ratio discrimination abilities for 20 children (*M* age: 10 years 6 months; range: 9 years 3 month–12 years 1 month) were examined by recording behavioral responses and event-related potentials (ERPs) to pictorial and numerical stimuli. Children first viewed a picture that contained images of brown bags and red marbles (e.g., 3 bags displayed above 4 marbles), followed by a fraction. Children were asked to determine whether the fraction represented by the bags and marbles matched a fraction displayed as the second stimulus. Half of the comparisons were designated as *easy* comparisons (i.e., numerator in the first stimulus (bags or marbles) mapped directly to the numerator in the second stimulus) and half were designated as *hard* comparisons (i.e., the numerator in the first stimulus mapped to the denominator in the second stimulus). Reaction time and accuracy were recorded. ERPs were recorded using a high-density array of 128 Ag/AgCl electrodes embedded in soft sponges and arranged into a net. Individual ERPs were recorded to the presentation of the second (comparison) stimulus for every child, electrode site, and trial. A principal components analysis (PCA) identified 5 factors accounting for 88.25% of the total variance. Separate analyses of variance for each factor identified main effects for gender, electrode area, and hemisphere, as well as higher order interactions involving difficulty and match conditions. Data demonstrate that electrophysiological techniques can provide important insights into the neural bases of children's abilities to manipulate fractions.

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S. ROBISON, C. JORDAN, S. HUGHES, D. ZELINSKY-GOLDMAN, & E. SHAPIRO. Can Sustained Attention Be Measured in Children Less Than 3 Years Old?

Few measures exist to assess attention in young children. This study examined the validity of the Early Childhood Vigilance Task (ECVT), a computerized measure of sustained attention for very young children. The

ECVT was administered longitudinally to 189 children at 14, 20, 26, and 32 months. To assess concurrent and discriminant validity, the ECVT was compared to specific scales of the Minnesota Preschool Affect Rating Scale, the Toddler Behavior Assessment Questionnaire, and the Bayley Scales of Infant Development, which includes a Behavior Rating Scale. It was hypothesized that the ECVT would correlate with other measured thought to assess attention, and not with measures believed unrelated to attention. Exploratory analyses were conducted to assess the relationship between temperament and sustained attention, and the influence of cognitive development on ECVT performance. Results demonstrated consistent improvement in ECVT performance with age, which was unrelated to cognitive ability. A clear pattern of concurrent and discriminant validity did not appear until 32 months. However, examination of correlations amongst all variables aided interpretation of findings. At earlier ages, variability in motor skill attainment determined ECVT performance. Children who left their seat during testing performed more poorly. The effect of the child's temperament was more important at later ages. Regulation of negative emotion correlated with better performance. Findings suggest measurement of sustained attention in children less than 32 months is confounded by task demands, motor development and temperament. Sustained attention may not be measurable as an independent construct until at least the 3rd year of life.

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J.E. OBRZUT, C.A. BOLIEK, & A. ASBJORSEN. Does Attentional Cueing Affect Dichotic Listening Performance in Children?

The present study addresses the effects of voluntary *versus* automatic shifts of attention on dichotic listening (DL) performance with children. Theoretically, the automatic "pull action" of a tonal cue may be more effective in increasing attention than the effort-demanding voluntary "push" action following instruction. The inconsistency of studies reporting substantial effects of attention on ear asymmetries in children with or without learning disabilities may be due to a developmental difference in their ability to use verbal or spatial cues to select stimuli for recall. Subjects included 30 right-handed children (15 control, 15 learning disabled, LD) with a mean age of 10.8 years. Each subject received 60 trials of a monaural tone cue task, 60 trials of a binaural verbal cue task, and 60 trials of a monaural verbal cue task, to direct attention to either left or right ear before the presentation of CV syllable pairs in a DL task. A 2 (group) \times 2 (ear) \times 3 (cue condition) factorial design with repeated measures was performed on percent correct scores and indicated significant main effects for ear yielding the REA for both groups. More importantly, the Group \times Cue \times Ear interaction was found to be significant indicating that group performance on ear scores was dependent on type of cueing condition. Whereas all 3 cue conditions were effective in orienting attention for control subjects, larger shifts were apparent under both binaural and monaural verbal instructional cue conditions. In contrast, LD subjects showed larger shifts of attention under the tonal cue condition. Further, the binaural verbal cue task was least effective in producing attentional shifts for both groups. These results show that control subjects have greater ability to focus attention with the use of a voluntary push action cue, whereas LD subjects show greater ability to orient attention with the use of an automatic pull action tone (spatial) cue in reducing error rates in DL performance.

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A.E. ASBJØRSEN, E. MYKING, J.E. OBRZUT, C.A. BOLIEK, A. HOLMEFJORD, B.H. JOHNSEN, O. KLAUSEN, P. MØLLER, & S. REISÆTER. Impaired Auditory Attention Following Middle-Ear Infections.

The present study investigated auditory attentional skills in samples of children with otitis media with effusion (OME). Nineteen children with persistent OME and with more than 1 incidence of insertion of ventilating

tubes during preschool years were compared to a sample of 22 children with repeated episodes of OM but not found in the need for medical treatment and 40 control children with no known episodes of OM based on parental reports and medical records. Mean age during assessment was 9 years, and none of the children showed signs of impaired language functions. They were tested with dichotic listening to CV-syllables (DLCV-108) with the additional tasks of directed attention. The control children showed a right ear advantage during free recall and directed right, and with a tendency toward a left ear advantage during directed left. Both groups with a history of OM showed a predominant right ear advantage across all 3 tasks. Although some modulation of the ear accuracy did occur across tasks in all 3 groups, the main finding was impaired auditory attentional skills in both groups with a history of middle ear infections. Treatment with ventilating tubes did not appear to make any difference for the development of auditory attentional skills.

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J.F. KULAS & L.D. STANFORD. CPT-II Performance in Children Across Intellectual Levels.

The assessment of sustained attention in children remains an important element of a neuropsychological evaluation. The use of continuous performance tasks, such as Conners' Continuous Performance Test-II (CPT-II), is purported to provide an objective evaluation of sustained attention. Exploratory studies have suggested little relationship between intelligence and performance on the CPT-II. These studies were limited by small sample sizes overall, and they did not provide information concerning performance across various intellectual levels. The purpose of this study was to investigate sustained attention as measured by the CPT-II across differing IQ levels. Two hundred thirty-seven outpatients referred for neuropsychological assessment were administered the CPT-II and the Wechsler Intelligence Scale for Children-3rd Edition (WISC-III). Diagnostic categories were evenly distributed across IQ groups. CPT-II scores were found to be comparable across all IQ groups, with the exception of those with FSIQ scores less than 70. Within this group, scores on the CPT for Omissions, Hit Reaction Time, Hit Reaction Time Standard Error, Variability of Standard Error, Hit Reaction Time Block Change, Hit Standard Error Block Change, Hit Reaction Time ISI Change, and Hit Standard Error ISI Change were all found to be significantly elevated compared to other IQ groups. Attentionness (d') and Commissions were comparable across groups. These results suggest that attention as measured by the CPT-II, appears to be significantly impacted by impaired intellectual ability. Clinicians using the CPT-II are advised to interpret results from this measure with caution in the presence of impaired intellectual aptitude.

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M. ROSSELLI, E. MATUTE, A. ARDILA, & T. MONTIEL. The Effect of Age Over Children's Perceptual Skills.

The assessment of perception is almost always included in developmental neuropsychological test batteries. Little is known, however, about the effect of age in the development of perceptual measurements. In this presentation the effect of age on tactile, visual, auditory, and spatial perceptual abilities across five age groups (6-7, 8-9, 10-11, 12-13, and 14-15 years) is analyzed. One hundred and eighty-two Mexican children (87 boys, 95 girls) were tested using two tactile recognition tasks (right and left hand), 5 visual perceptual tasks (Identification of Superimposed Figures, Identification of Blurry Images, Visual Closure, Identification of Facial Expressions, and Integration of Objects), 2 auditory perception tasks (discrimination of natural environmental sounds and differences in musical notes), and 4 visual-spatial tests (right-left discrimination, recognition of figures in different positions, line orientation, and location of coordinates). An overall MANOVA (Hotelling's T) revealed a significant age effect over the neuropsychological measurements ($F = 2.44; p < .001$). Univariate MANOVAs demonstrated a significant age effect for most vi-

sual and spatial test scores. Older participants performed better than younger groups. Bonferroni *post-hoc* tests revealed that the more accentuated changes in the identification of superimposed figures occurred at the age 9 to 10, in the perception of blurry images at age 10 to 12, and in the ability to perform visual closure between 12 and 14 years. No significant differences were observed on tactile and auditory perception measurements across the age groups. These results demonstrate that the effect of age on perceptual test scores is not consistent across ages for all perceptual modalities. Furthermore, significant changes are usually observed at some crucial ages.

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E. TIDEMAN & J.-E. GUSTAFSSON. The WPPSI-R Considered in a Contemporary Perspective of Neuropsychological Development.

A common theme in the study of individual differences in cognitive abilities has been the question of whether abilities tend to become more differentiated with increasing age. Contemporary perspectives indicate that although there may be an interplay between cerebral systems, such systems mature separately and according to different trajectories, presumably due to differences in underlying processes such as myelination and synaptogenesis. The present study examines age-related differentiation in the structure of cognitive abilities among children 3–7 years of age, using raw data from the recently undertaken Swedish standardization of the WPPSI-R. A confirmatory factor analytic modeling approach is applied. Models with differing factorial components are tested against empirical data using the LISREL 8 program run under the STREAMS modeling environment. Results from the one-factor model show that the general factor accounts for more variance in the total WPPSI-R score in younger age groups than in older age groups. The 2-factor model demonstrates that the Verbal and Performance factors are less highly correlated in older age-groups than in younger. These findings support the notion that the organization of intelligence changes with age, proceeding from a general ability to a loosely organized group of more diversified abilities. The results provide empirical evidence for a change in the latent structure of cognitive abilities occurring at about age 5, an age at which cerebral maturational processes make possible the development of more advanced executive and cognitive functions influencing the performance on intelligence tests. The current results have important clinical implications for the interpretation of test scores.

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T. SENN, K. ESPY, M. McDIARMID, A. HAMBY, & P. KAUFMANN. Using Mplus to Reveal Executive Function Organization in Clinical Populations.

Most modern theories of brain function posit co-activation of multiple neural networks to accomplish complex cognition. However, most researchers apply univariate statistical techniques to analyze data. More sophisticated modeling techniques allow researchers to study underlying relations among cognitive constructs and then to relate this organization to salient predictors through group comparisons with constrained model fit. Recent statistical advances permit inclusion of participants with missing data, which is particularly important for clinical investigations or those with more challenging groups, such as preschoolers who may not complete all measures. Here, multiple group path analysis comparisons of executive function organization in typically-developing ($n = 82$), preterm ($n = 39$), and low-level lead exposed ($n = 41$) preschool children were performed using Mplus, to illustrate the utility of such techniques. Statistical models included measures of working memory, inhibition, and flexibility as predictors of problem-solving skills. Constraining path coefficients to be equal across groups generally resulted in poorer model fit, indicating that path coefficients differed across groups. In typically developing children, working memory and inhibition contributed equally to problem-solving, whereas working memory was the only significant predictor of problem-solving in preterm preschoolers. In low-level lead-exposed children, inhibition was the strongest predictor of problem solving. In all groups,

flexibility was unrelated to problem-solving skills. These statistical techniques provide a more thorough investigation of how a particular medical condition alters underlying neuropsychological organization, with wide latitude in the nature and complexity of models considered.

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R. McINERNEY & K. KERN. The CMAT: A New Test of Multitasking and Executive Function.

Multitasking is an ability that some authors regard as lying at the heart of competency in everyday life. Some research suggests that multitasking ability likely depends in part on executive functions. We developed the Children's Multiple Activities Task (CMAT) to address the paucity of instruments available to assess multitasking in a pediatric population. In previous work, we found that the CMAT related significantly to working memory and inhibition. It remained to be explored, however, whether the CMAT would be suitable for a nonpediatric population. To investigate that possibility, a sample of 44 undergraduate volunteers, and a replication sample of 25 children with ADHD, and 25 matched control children (ages 7–12) completed the CMAT along with measures of intelligence, working memory, and inhibition. In children, CMAT performance correlated highly with working memory and inhibition, but not with intelligence. Moreover, children with ADHD again performed significantly below control children on the CMAT, replicating the results of our initial study. The relationships among the variables differed, however, in the young adult sample. These findings and their implications will be presented and discussed.

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M. MAHONE, D. CUMMINGS, M. KRIEGER, T. MILLER, & H. SINGER. Effect of Guanfacine on Measures of Executive Function in Children With Tourette Syndrome.

In this study we evaluated the effects of the alpha-2a adrenergic agonist, guanfacine, on neuropsychological measures of attention and executive function, parent ratings of behavior and tic severity in children with Tourette syndrome (TS). Twenty-four children with TS participated in a 4-week, double-blind placebo-controlled study of guanfacine. Neuropsychological functioning, tic severity, and parent ratings of behavior were evaluated pre- and post-treatment. The sample had mild tic severity and subtle neuropsychological dysfunction pre-treatment. Ten children had parent ratings of symptoms consistent with ADHD. Post-treatment, patients receiving guanfacine were rated by parents as significantly improved (compared to placebo) on 1 measure of executive function (Metacognition). On all other parent ratings and performance-based neuropsychological measures, improvement was not significantly better than placebo. Tic severity was improved in the guanfacine group, although the result did not reach significance. While guanfacine may provide some benefit for patients with TS accompanied ADHD, it is unlikely to benefit children with mild, uncomplicated TS. As such, guanfacine is not clinically indicated to enhance executive function in children with mild TS unaccompanied by ADHD.

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K. ESPY, M. CWIK, & P. KAUFMANN. Understanding Executive Functions in Preschoolers: The "Baby" Bias Task.

Controlled, experimental methodology, which may be less sensitive to prefrontal function due to its structured nature, typically has been used to study executive functions. Performance on the Cognitive Bias Task, a context ambiguous task for adults, differs by frontal lobe lesion status and sex, presumably due to differential cerebral organization. A similar measure (Baby Bias Task; BBT) was developed to investigate emergent executive functions in young children. Because young females perform more poorly on a reversal task that is sensitive to orbital frontal lesions in monkeys, BBT performance was hypothesized to differ by sex. A target

stimulus character was shown to preschool children ($N = 72$; 2.5–5.11 years; $n = 36$ males), then 2 choice characters were shown that differed from the target in color, shape, and/or pattern. Children were instructed to choose their “favorite” figure. Total and deviancy scores were calculated, using ANOVAs to compare sex-related performance. BBT deviancy score differed by sex, [$F(1,70) = 5.24, p < .05$], with girls choosing the more deviant figure more often than boys. Marginal sex-related differences in BBT total score also were observed, [$F(1,70) = 3.61, p < .10$]. BBT performance was related to Spatial Reversal efficiency ($r = -.23$), where those preschoolers who made more context-independent choices achieved fewer reversal sets with more retrieval errors. These preliminary findings suggest that young girls make choices that are more context-independent, perhaps related to less functional maturity of the orbital prefrontal cortex. Correspondence: *K. A. Espy, Ph.D., Department of Family & Community Medicine MC 6503, SIUSOM, 600 Agriculture Drive, Carbondale, IL 62901-6503. E-mail: kespy@siumed.edu*

M. McDIARMID, K. ESPY, M. STALETZ, & A. HAMBY. Executive Functions and Emergent Mathematics in Preschoolers.

Mathematical ability is related to both activation of the prefrontal cortex in adult neuroimaging studies and executive functions, (e.g., working memory and inhibition) in school-age children. Children born preterm are at known risk for deficits in arithmetic and nonverbal executive functions, with identified neuroanatomical differences in frontal system structures. This study builds on these findings by investigating the relation between executive functions and emergent mathematical ability in preschool children born preterm and fullterm. First, performance on a battery of executive function tasks was reduced by principal components analysis, yielding Working Memory, Inhibitory Control, and Flexibility/Shift components. These components were used to predict emergent mathematical ability in 100 preschool children ($M = 3.90$ years). Both Working Memory and Inhibitory Control were related to mathematical ability, regardless of whether age, maternal education, and estimated child IQ were covaried. Flexibility/Shift, however, was not. When considered together, Inhibitory Control accounted for the greatest portion of variance in early mathematical abilities. The relations between executive functions and mathematics did not differ between those born preterm and fullterm. In contrast to school age children, individual differences in inhibitory control may contribute more to emergent mathematical ability in preschoolers. Prematurity does not alter the relation between executive function and mathematics, at least in this age range. Longitudinal studies are needed to address the ontogeny of early executive function development and later skill proficiency in varied populations.

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M. CWIK & K. ESPY. External Validity of the BRIEF–P in Normally Developing Preschoolers.

Executive function’s (EF) are postulated to play an important role in a number of childhood developmental and neurological disorders that emerge during the preschool period. Because of the historic view that the behaviors of young children are not “executive” and difficulties in precise EF definition, there are few measures available to specifically assess EF in this age range, particularly that measure the executive aspects of behavior in the everyday context. The Behavior Rating Inventory of Executive Function–Preschool version (BRIEF–P) is a new parent/teacher report EF measure in preschool age children. Here, the convergent and discriminant validity of the BRIEF–P were examined by relating BRIEF–P scale ratings to performance on laboratory EF measures and to Child Behavior Checklist (CBCL) scale ratings in normally developing preschoolers ($N = 59$). Correlations between the BRIEF–P scale scores and the laboratory EF composites ranged from $r = -.10$ to $-.21$, with relations of similar magnitude when age was controlled statistically. BRIEF–P and CBCL scores were correlated moderately ($r = -.02$ – $.64$) and specifically (e.g., BRIEF–P Inhibit–CBCL Attention Problems; BRIEF–P Shift–CBCL Anxiety/Depression). In normally developing, preschoolers, parents may not per-

ceive widely variable preschool behavior as problematic, thereby constraining BRIEF–P scores in relation to laboratory EF measures. Similar studies with clinical populations are necessary to further determine BRIEF–P validity in those at known risk for EF impairment.

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G.A. GIOIA, P.K. ISQUITH & K. ESPY. Construct Validity of the Behavior Rating Inventory of Executive Function, Preschool Version.

Assessing construct validity of executive function measurement tools is complex given the higher order, likely multidimensional, nature of the supervisory system. We examined the construct validity of the Behavior Rating Inventory of Executive Function, Preschool Version (BRIEF–P) via common factor analysis while exploring uni- versus multidimensional solutions. The BRIEF–P is a parent/teacher completed behavior rating scale tapping five theoretically and statistically derived subdomains of executive function in children ages 2–5 years. Parent ($N = 460$) and teacher ($N = 302$) ratings of children in the normative sample comprising the 5 scales (Inhibit, Shift, Emotional Control, Working Memory and Plan/Organize) were submitted to an exploratory principal factor analysis with oblique (promax) rotation to allow for intercorrelation of scales. Examination of 1-, 2-, 3-, and 4-factor solutions yielded a similar 3-factor structure for the parent (87% of variance) and teacher (92% of variance) ratings. The alternative models resulted in factors defined by single scales or poor separation, offering no greater interpretive value. For both groups, Factor 1 was defined by the Plan/Organize and Working Memory scales, reflecting emergent metacognition. Factor 2 was defined by Shift and Emotional Control scales, capturing flexibility and resistance to change. Factor 3 was defined by Inhibit and Emotional Control scales, summarizing inhibitory self-control. The stability of the 3-factor solutions across both normative samples provides strong support for the underlying factor structure of the BRIEF–P, and support a multidimensional model of executive function.

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A. MAERLENDER, P.K. ISQUITH, A. GERSON, & G. GIOIA. Executive Contributions to Children’s Emotional and Behavioral Functioning.

The relationship of personality and self-regulatory functions to specific brain structures has been recognized since the watershed case of the Vermonter Phineas Gage. The association between frontal systems and executive functions has since been well described. While it is established that self-regulatory deficits play a key role in disruptive behavior in children including delinquency and hyperactivity, and there is growing evidence of a frontal contribution to affective disorders, the executive component of other emotional and behavioral disorders is less clear. We examined relationships between children’s executive function and emotional functioning. Parents of 30 boys and 12 girls aged 5–17 years ($M = 11, SD = 3.2$) with mixed diagnoses (LD 15%, ADHD 30%, Mood 10%, PDD 35%, Conduct 5%, Anxiety 5%), referred for outpatient neuropsychological evaluation completed both the BRIEF and Personality Inventory for Children (PIC). T-scores were submitted to stepwise regression analyses with BRIEF Behavioral Regulation (BRI) and Metacognition (MI) indexes predicting PIC scales. Neither were related to PIC Intellectual Screening scale or IQ scores. The BRI contributed uniquely and significantly ($p < .01$) to PIC scales reflecting psychopathology and behavioral dyscontrol (Delinquency: $r = .72$, Anxiety: $r = .59$, Psychosis: $r = .67$, Hyperactivity: $r = .70$, Depression: $r = .71$, Social Skill: $r = .62$), while the MI index contributed only to a measure reflective of language development (Development: $r = .39$). The findings suggest that much of children’s psychopathology is associated with disruption of the fundamental regulatory functions, such as inhibitory control, emotional regulation, and flexibility.

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H. EMSLIE, F.C. WILSON, V. BURDEN, & B.A. WILSON. Assessing Executive Functioning in Children With TBI and Developmental Disorder.

In children and adolescents traumatic brain injury (TBI) is a major cause of disability and has been associated with a wide range of cognitive deficits including intellectual impairment, reduced memory and attention and poor reasoning, problem-solving and language skills. Similar cognitive deficits are observed in children with neurodevelopmental disorders such as Attention Deficit and Pervasive Development Disorder. Recently there has been a rapid increase in the number of children diagnosed as suffering from developmental disorders associated with impaired executive function and self-regulation and since the effects of DES are likely to become more severe with age as children have to cope with greater complexity in their educational, social and emotional life, early identification of DES is crucial. Yet accurate, reliable identification has been hampered by the lack of developmentally appropriate assessment tools. We report the results of a recently developed test, the Behavioural Assessment of the Dysexecutive Syndrome in Children (C-BADS) with 6 groups of children, those with TBI, ADHD, PDD, Early Onset Psychosis, hypoglycemia and congenital adrenal hyperplasia (CAH). Results reveal the usefulness of the various subtests of C-BADS in discriminating between these children and age matched controls and in assisting differential diagnosis. The relationship between the C-BADS scores and other tests of intellectual functioning including measures of attention, memory and speed of processing will be illustrated.

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J. BRUNNEKREEF, M. ALTHAUS, L. DE SONNEVILLE, F. VERHULST, R. MINDERAA, & J. ORMEL. Delineating Information Processing Profiles in a Large Sample of Pre-adolescents.

This study is part of TRAILS (TRacking Adolescents' Individual Lives Survey): a longitudinal study of the psychosocial development from pre-puberty into young adulthood. TRAILS will include about 2200 10- to 12-year-old children from a normal population. The first assessment will be completed in October 2002. Data are collected from interviews, questionnaires and somatic assessments. In addition, all children will have performed a subset of seven tasks selected from the Amsterdam Neuropsychological Tasks programme (ANT, de Sonneville, 2000). Our study aims at charting group-specific information processing profiles. In a preliminary study of 455 children we used a temperament questionnaire to form two pairs of subgroups by taking the P10 and P90 of two different behavior scales. These scales assess, respectively, impulse control and/or attentiveness (very low scores being associated with DSM-IV ADHD characteristics) and affiliation and/or sensation pleasure (very low scores being associated with DSM-IV PDD problems). Compared to the high scoring children, those with low impulse control/attentiveness showed significantly worse performance on almost all of the ANT tasks, while children with low affiliation/sensation pleasure significantly differed on only memory search and the identification of one particular facial expression. The data suggest that the task paradigms selected are (1) sensitive enough to detect differences within a normal population and (2) specific enough to show selective deficits for particular groups. At the time of our presentation the study will be replicated on the total sample size, while now conducting the comparisons on groups that are formed by taking the P2 and P98.

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L. DE SONNEVILLE, A. VERSCHOOR, C. NJIOKIKTIJEN, & J. CUPERUS. Attention and Facial Information Processing in Children with Contact Disorders.

This study focuses on attention and facial information processing characteristics in 31 children referred for contact disorders. Included were children with a psychiatric diagnosis (DSM-IV PDD-NOS, Asperger), age

between 7-11 years, PIQ > 80 and/or VIQ > 80. Excluded were children with epilepsy, serious motor problems and those under neuroleptic medication (except methylphenidate). The Amsterdam Neuropsychological Tasks (ANT) were administered to evaluate simple reaction time, sustained attention, attentional flexibility (executive function), recognition of abstract visuospatial patterns, recognition of unfamiliar faces, and identification and matching of facial emotions. On the basis of normative values, z-scores were computed for the RT and accuracy measures for all tasks. We determined the existence of face and facial emotion processing deficiencies as well as attentional problems, in isolation and in any possible combination. This outcome suggests the existence of double dissociations of the various aspects of information processing skills. As a consequence we could disregard the occurrence of attention deficits in our attempt to further clarify deficiencies in processing facial information. Four groups were identified: normal performance (n = 5), deficient face recognition (n = 3), deficient face and emotion recognition (n = 12), deficient face, emotion and abstract pattern recognition (n = 11). The data clearly indicate that contact disorders are associated with a high incidence of deficits in face and emotion perception. The findings will further be interpreted with reference to left/right hemisphere specialization, PIQ-VIQ discrepancies, and the outcome of recent information processing studies in autism and NLD. Correspondence: L. de Sonneville, Pediatric Outpatient Clinic, Vrije Universiteit Medical Center, P.O. Box 7057, 1007MB Amsterdam, The Netherlands. E-mail: lmj.sonneville@vumc.nl

H. SWAAB, L. DE SONNEVILLE, P. COHEN, H. VAN ENGELAND. Specificity of Information Processing Problems in Pervasive Developmental Disorder.

It is well known that information processing problems are common in children with child psychiatric diagnoses. Questions of specificity of these findings however are still unanswered. We focused our research on the information processing problems that underpin the specific social problems in children with Pervasive Developmental Disorder (PDD). In order to find specific deficits, we compared several aspects of information processing of 41 boys with PDD to the performance of 51 boys with Attention Deficit Hyperactivity Disorder (ADHD) and to the performance of 53 normal control boys in the age of 6 to 12. PDD children appear to be significantly slow in information processing, show significantly high fluctuations in processing speed and perform significantly less accurately than normal control children during a sustained attention task. However, ADHD boys show exactly the same problems. In addition, PDD children show significant problems in focusing their attention. As could be expected they have significantly more difficulty in neglecting information than normal controls. However, the same focused attention problem is found in ADHD. Differences between ADHD children and PDD children were found in the strategy of using their working memory capacity during a divided attention task. In addition to a capacity problem, PDD children show specific difficulty in using efficient cognitive strategies, especially if distracting information is present. The correspondence between these information processing problems and the severity of problems in daily life will be presented.

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M. ALTHAUS, L. DE SONNEVILLE, A. VAN ROON, L. MULDER, G. MULDER, & R. MINDERAA. Information Processing and Autonomic Reactivity in Autistic-type Children.

The way in which we process information forms the basis of our ability to build up coherent mental representations of our environment. The quality of these representations affects our flexibility of adapting to environmental demands. Our studies on normally intelligent children with autistic-type behavior problems (PDD-NOS) suggest that these children have specific information processing deficits. Compared to normally developing children they appear to need significantly more time for carrying out serial comparisons in working memory, and to be nearly insensitive to feedback on errors. Psychophysiological studies have shown that con-

scious (attention-demanding) information processing is accompanied by changes in autonomic activity leading to changes in body state. Part of these changes are *immediately* fed back to the brain, and there is increasing evidence for this feedback essentially contributing to the processed information becoming structurally anchored in novel and/or already existing neuronal networks. Repeated conscious processing of novel information accompanied by autonomic changes in body state will provide for the neuronal networks becoming more and more coherent until the information is finally stored as a meaningful mental representation of a complex whole (Gestalt). Our studies on normally intelligent children with PDD-NOS revealed that these children show significantly less autonomic responsiveness when performing an attention-demanding task. We consider the deficits found to contribute to one of the core problems characterizing children with a pervasive developmental disorder, that is, poor integration of information that builds up to the coherent mental representations necessary for appropriate social interaction.

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A. KALFF, L. DE SONNEVILLE, P. HURKS, J. HENDRIKSEN, M. KROES, F. FERON, J. STEYAERT, TH. VAN ZEBEN, J. VLES, & J. JOLLES. Early Identification of ADHD: Information Processing Profiles at Age 5–6 Years.

In view of the paramount importance of the early identification of ADHD an extensive study of attention and information processing skills was carried out with 5-6-year-old children at risk for ADHD, focusing on the question whether specific deficits contribute to the behavioral pattern of ADHD. After screening a community sample of 1317 children in Southern Limburg (The Netherlands) with the Child Behavior Checklist, 363 were selected and underwent a computerized neurocognitive examination. Eighteen months later, standardized psychiatric information was obtained which resulted in the following categorization: children with ADHD ($n = 33$), children with "situational ADHD" ($n = 75$), pathological controls (psychopathology other than ADHD, $n = 122$), and healthy controls ($n = 133$). ADHD and "borderline ADHD" children were slower and in particular *more variable* in their processing speed on all tasks than children with no or other pathology. These differences were most pronounced for the divided and focused attention tasks. Support for a sustained attention deficit was less convincing. With regard to accuracy, only the proportion of misses on a "Go-NoGo" task was higher in the ADHD group than in the other groups. Evidence was found for ADHD representing a dimensional trait (continuum), with ADHD at one extreme, followed by "borderline ADHD," and healthy controls at the other. It is concluded that already at a young age, children at risk of ADHD show impairments of central processing, especially when cognitive demands are high. This outcome suggests the presence of specific attention deficits. A lack of consistent effort is discussed as an underlying problem in ADHD.

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HORMONES AND COGNITION

G. TREMONT, J. RUFFOLO, A. BENDER, A. PODOLANCZUK, J. HENNESSEY, R. NOTO, & R. STERN. Association Between Brain SPECT and Neuropsychological Functioning in Graves' Disease.

Graves' disease, an autoimmune disorder, is the most common cause of hyperthyroidism. Cognitive changes associated with Graves' disease include poor concentration, slowed reaction time, decreased complex visual processing and spatial organizational abilities, and poor conceptual skills, possibly reflecting frontal systems dysfunction. The current study examined the relationship between brain SPECT and neuropsychological functioning in 12 thyrotoxic patients diagnosed as having Graves' by clinical exam, laboratory testing and when needed, thyroid uptake and scans. Half of the patients exhibited hypoperfusion defects on SPECT (mainly involving frontal and temporal lobes), with the remaining patients demonstrating

normal scans. Given the small sample size, trends in the data were identified by effect sizes. Those patients with abnormal SPECT findings showed worse performance than patients with normal SPECT findings on measures of selective attention and verbal recognition memory as well as more perseverative responses and false positives on figural fluency and verbal recognition memory tasks, respectively. Age, thyroid laboratory values, education, depression, and estimated IQ did not account for the effect. Two of the patients underwent repeat SPECT and neuropsychological testing once they were euthyroid for at least 4 months. One patient had normal SPECT on both exams, but showed neuropsychological improvement on follow-up examination. One patient with abnormal SPECT showed no change on follow-up scan, but exhibited improved neuropsychological performance. These preliminary findings suggest that both altered thyroid status and autoimmune factors may impact CNS functioning in Graves' disease, and, that similar to other autoimmune disorders, there is considerable variability between patients.

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G. MIRABELLA, C. WESTALL, E. ASZTALOS, D. FEIG, K. PERLMAN, & J. ROVET. Selective Deficits in Visual Processing in Infants Exposed to Reduced Thyroid Hormones *in Utero* Postnatally.

Studies with animals have shown that thyroid hormone (TH) is essential for the developing visual system. In humans, a reduced TH supply in pregnancy occurs from maternal hypothyroidism (HYPO), premature birth due to a severed maternal TH supply (PREM), and congenital hypothyroidism (CH). Studied at 3, 4.5 and 6 months of age were 17 HYPO, 13 PREM (GA 30–35 weeks, no neonatal disease), 10 CH, and 31 controls who were tested for contrast sensitivity (CS) and visual acuity using a sweep visual evoked potential technique. All infants were fitted with electrodes over the occipital cortex as they observed rapidly changing sinusoidal gratings (bars) of varying contrast or spatial frequency. Electrical signals were synchronized with computer-generated stimuli using Power Diva to obtain distinct contrast and spatial frequency thresholds from which a CS function was derived. Compared to controls, HYPO had significantly reduced contrast sensitivity at all ages ($p < .01$) while CH differed only at 3 months and PREM showed no overall group effect. Within-groups findings revealed that in (1) HYPO, correlations between mothers' TSH and infant processing showed adequate TH levels in the 3rd trimester are necessary for contrast sensitivity development, (2) PREMs, GA before 33 weeks gestation leads to poorer CS, and (3) CH, the athyrotic etiology (no thyroid) is associated with poorer CS than other etiologies. These findings support the view that selective aspects of the developing human visual system are vulnerable to a lack of TH and the 3rd trimester TH supply is critical for CS development.

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S. ELKADI, G. WARNE, & M.W. O'BOYLE. Prenatal Androgens and Cerebral Lateralization in Congenital Adrenal Hyperplasia Patients.

This study examined the effects of prenatal androgen exposure on patterns of functional cerebral lateralization in accordance with the theory proposed by Geschwind and Galaburda. Eight males and 7 females with Congenital Adrenal Hyperplasia (11–23 years of age; *Mdn* age 13.83 years) were recruited from the Royal Children's Hospital, Melbourne, Australia and studied along with a group of age and sex matched control participants. Individuals with CAH experience excess exposure to androgens prenatally due to an enzyme deficiency in cortisol production. Functional cerebral lateralization was measured using the free-vision Chimeric Face task (CFT), the Grey Scale Task (GST) and a fused dichotic words test (FDWT). Hand preference was also assessed using the Edinburgh Inventory. Results indicated that when compared to controls, CAH participants demonstrated (1) reduced left hemisphere lateralization for language (2) a more pronounced right hemisphere bias when performing the CFT and the

GST, and (3) a significantly weaker degree of right hand dominance. These findings are consistent with the predictions of the Geschwind and Galaburda model, and are discussed in terms of their implications for understanding the impact of prenatal androgens on patterns of cerebral lateralization, as well as sexual differentiation of the human brain.

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O. INOZEMTSEVA & E. MATUTE. Memory Deficit in Patients Suffering From Congenital Adrenal Hyperplasia.

Congenital adrenal hyperplasia (CAH) is a promising model to study the effects of glucocorticoids on cognition since these patients receive a chronic treatment with cortisol and it is difficult to adjust it to the physiological demands of the organism. It's well known that high levels of cortisol may have a neurotoxic effect on the hippocampus, and produce declarative memory deficits. Therefore, the aim of this study was to assess declarative memory in CAH patients. WISC-RM and TOMAL were used to assess 9 CAH girls receiving cortisol from the 1st year of their life and 9 control girls, aged 7 to 16 years (M age = 9.8) and from the same socioeconomic status. Groups were matched by age, school grade and school type (private or public). All subjects had a Full Scale IQ over 89. T tests show that the CAH group performed significantly lower than the controls on Full and Verbal IQ and the TOMAL 4 memory indices (verbal memory, nonverbal memory, composite memory and delayed recall). The CAH subjects obtained significantly lower scores than the controls in the following TOMAL subtests: memory for stories, word selective reminding, visual sequential memory, memory for location and delayed recall for stories. Correlation between WISC-RM scores: Full IQ, Verbal IQ and Performance IQ and TOMAL scores: Composite Memory Index, Verbal Memory Index and Nonverbal Memory Index was not significant in both groups. These findings suggest that declarative memory could be affected by chronic treatment with glucocorticoids regardless of IQ differences.

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M. SHIMONOVA, K. SCHENK, D. SCHOLLAERT, D. SWADBERG, K.N. TIERNAN, & M.M. CHERRIER. Effects of Testosterone on Aggression in Healthy Older Males.

Strong evidence for testosterone being a factor in aggressive behavior is present for animals but not for humans. Prior studies suggest a positive correlation between levels of testosterone and aggression in male subgroups of prison inmates, athletes and adolescents. Our study investigated the effects of supraphysiological doses of testosterone on aggression in healthy older males over the age of 54. During a 12-week study, 54 men, mean age 62, were randomized to receive 100 mg of testosterone enanthate or placebo weekly for six weeks followed by a washout period. A self-reported Aggression Questionnaire was administered at baseline (Week zero) and again at Weeks 3 and 6 of treatment. A repeated measure MANOVA indicated a trend towards a decrease in aggression in the treatment group ($p < .075$) and no change in the controls. This is discrepant with previous findings of an increase in testosterone correlating with an increase in aggression. Our findings suggest that testosterone does not appear to increase aggression in older men even when raised to the level of young men. Rather, testosterone may reduce subjectively reported aggression in older men.

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D. SCHOLLAERT, K.S. SCHENK, M. SHIMONOVA, K.N. TIERNAN, P. BOORKMAN, D. SWADBERG, & M.M. CHERRIER. Assessment of Changes in Working Memory From Hormone Supplementation in Older Men.

The Self-Ordered Pointing Task (SOPT) is as a measure of visual working memory. It is sensitive to aging and changes in hormone levels. Previous

studies, have found a positive relationship between T levels and working memory in older men. In this study we developed a computerized version of the SOPT to explore the effects of T supplementation on the loss of working memory associated with aging. Thirty-nine male subjects over the age of 50 (M age 66 years) were randomized into 3 groups: placebo ($N = 13$), testosterone enanthate 100 mg weekly (T) ($N = 14$), and 100 mg T enanthate + anastrozole (T+A) ($N = 12$). Anastrozole is a medication that blocks the conversion of testosterone into estradiol. A repeated measures MANOVA revealed a significant decrease in errors during treatment compared to baseline for the T group ($p < .01$). No significant changes were noted for the placebo or T + A groups, or for reaction time. These results indicate that our computerized version of the SOPT is a valid measure of working memory in older adults and is sensitive to changes in circulating hormone levels.

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D. SWADBERG, K.S. SCHENK, M. SHIMONOVA, K.N. TIERNAN, D. SCHOLLAERT, P. BOORKMAN, & M. CHERRIER. Assessment of Sleep Quality in Older Men Receiving Hormone Supplementation.

Estrogen replacement has been shown to improve sleep quality in post menopausal women who experience a decline in estradiol. This study examined effects of testosterone (T) supplementation on sleep quality in older men. The Pittsburgh Sleep Questionnaire (PSQ) was given to 31 men, mean age (62), at baseline (prior to treatment) and again after 6 weeks of treatment. Participants were randomized to receive 100 mg weekly T enanthate (T) or 100 mg weekly T enanthate plus 1 mg daily oral anastrozole an aromatase inhibitor that blocks the concomitant rise in estradiol (T+A) or placebo (P). Subjective sleep quality, latency, efficiency, duration, daytime sleepiness and the prevalence of distractions and use of sleep medication were examined. The pattern of the data was consistent with improved sleep quality overall and sleep duration for the T+A group, but not for the T or placebo groups. Sleep latency decreased for the T group, but not for the T+A or placebo groups. There was a significant difference in the placebo group for subjective quality ($p < .05$) in the direction of poorer sleep overall as well as a trend for worsening efficiency. Improvement or a decrease in daytime sleepiness was observed in the T+A group ($p < .03$) but not in the T or placebo groups. Results suggest that testosterone may influence daytime sleepiness which impacts daily cognitive functioning.

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E. HAMPSON, N. LEVY, & J.M. FINESTONE. Menstrual Cycle Effects on Visuospatial Tests Don't Depend on Dimensionality.

Serum estrogen levels at the time of testing have been found to influence women's level of performance on many, but not all, visuospatial and visuospatial tests. It has been proposed that tests employing 3-dimensional (3D) test items may be more affected by estrogen than tests using 2-dimensional (2D) depictions. To test this hypothesis, we assessed performance on a set of neuropsychological measures in healthy women (20–38 years old) randomly assigned to be tested at either low ($N = 17$) or high ($N = 16$) estrogen stages of the menstrual cycle. Estrogen levels at testing were confirmed using radioimmunoassays. Participants with psychiatric, neurological, or endocrine abnormalities were excluded, as were women using hormonal contraceptives. The final sample consisted of a normative group of healthy women with unassisted menstrual cycles. Though well-matched in overall ability, significant group differences were found on most spatial or perceptual tests included in the test battery. As predicted, low estrogen was associated with better scores on a 3D mental rotation test ($d = .70$). Contrary to the dimensionality hypothesis, low estrogen was also associated with better performance on a 2D rotation test matched in difficulty ($d = .67$), and on a simple test of visual closure ($d = .76$). Neither dimensionality nor the difficulty level of a test formed a

sufficient basis for predicting the menstrual cycle effect. The moderate to large effect sizes, combined with the prevalent use of medications that alter women's estrogen levels (e.g., estrogen replacement therapy, oral contraceptives) suggest that clinicians consider estrogen status when using visuo-perceptual tests in patient assessments.

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L.D. BAKER, B. CHOLERTON, C. GLEASON, K. HYDE, C. HALE, M. REGER, S. WATSON, S. PLYMATE, S. CRAFT, & S. ASTHANA. Hormone Replacement Therapy Favorably Affects Cognition for Postmenopausal Women.

Basic research provides ample biological support for multiple salutary neurotrophic and neuroprotective effects of estrogen. Results from controlled clinical trials regarding the cognitive benefits of estrogen for postmenopausal women have not been consistent. Findings from preliminary studies indicate that progesterone administration may override the beneficial effects of estrogen, despite reports of associated neuroprotective effects. Given that a combined regimen of hormone therapy is commonly administered to reduce the cancer risks, the therapeutic efficacy of opposed *versus* unopposed therapy need to be compared. Thirty healthy postmenopausal women (age 58–83 years) were randomized to receive either 0.625 mg/day of esterified estrogen + placebo, 0.625 mg/day esterified estrogen + 2.5 mg/day Provera, or 2 placebo tablets/day for 3 months. Plasma estradiol, estrone and insulin levels were sampled and cognitive tests were administered at baseline, at months 1, 2, and 3 on treatment, and then again 2 months following treatment termination. For women who received either unopposed or opposed estrogen, performance on the Stroop Interference test was significantly improved compared to the performance of placebo subjects ($p = .05$). This finding as well as data describing treatment-related changes in plasma estradiol, estrone, and insulin will be discussed. Overall, the results of this study support a beneficial effect of estrogen, without regard to whether it is coadministered with a progestin.

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S. AMANO, J.G. BUCKWALTER, K. TINGUS, & S. MCPHERSON. Cognitive Effects of Estrogen Replacement Therapy in Postmenopausal Women.

Recent studies have revealed mixed results regarding the role of estrogen replacement therapy (ERT) on cognitive functioning leaving the relationship between ERT and cognition poorly understood. ERT is believed to play a protective role against the development of Alzheimer's disease (AD) and to possibly enhance cognition in women with AD. ERT may also enhance cognitive functioning in non-demented women. However, discrepancy in results among studies has made it difficult to determine the point in which the use of ERT may be most efficacious. To better understand the role of ERT in helping to possibly mitigate cognitive decline, this study examined cognitive performance of 218 postmenopausal women on and off ERT in 3 diagnostic groups: AD ($N = 91$), Mild Cognitive Impairment (MCI; $N = 40$), and no cognitive impairment (controls: $N = 87$). It was hypothesized that women on ERT in all 3 groups would perform significantly better than those not on ERT. Contrary to our hypothesis, an ANCOVA of diagnosis by estrogen status (*on* or *off*) covarying age, education, and depression score revealed that, on most of the neuropsychological tasks, estrogen was not found to be associated with better performance in any of the groups and, on some tasks, women *not* on ERT showed better performance than women on ERT. Specifically, interactions of diagnosis and estrogen revealed that the AD group *not* on ERT had significantly faster performance on Trails B and Stroop C than AD women on ERT. However, the MCI group on ERT had significantly faster performance on Trails B than the MCI group not on ERT. These data suggest that ERT may not be associated with enhanced performance on cognitive mea-

asures in AD and if ERT yields any protective effects, it may be specific to the interim state of the disease process known as MCI.

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D. SPOONER, N. PACHANA, S. KHOO, & S. O'NEILL. Can Hormone Replacement Therapy Preserve Everyday Memory Functioning in Menopausal Women?

In recent years, there has been increasing interest in the effects of hormone replacement therapy (HRT) on various areas of cognitive processing in menopausal women, particularly memory functioning. Typically, research in the area has been limited to comparing HRT users and nonusers on traditional memory assessment tools, such as the Wechsler Memory Scales. However, the subtests in these measures do not necessarily mirror the practical, everyday type of memory tasks with which menopausal women commonly report difficulties. The current study took a novel approach to investigating the impact of HRT on memory functioning, by using an ecologically valid memory test (The Rivermead Behavioural Memory Test–Extended Version; RBMT–E) to assess performance on the types of memory tasks that are commonly encountered in everyday life. The sample consisted of 305 community-dwelling, perimenopausal women (age range: 42–78) who had self-selected to be a HRT user or nonuser. Approximately 40% of the participants were classified as current HRT users. The performance of the 2 groups was compared across all subtests of the RBMT–E. When the variables of education, IQ, age, and current affective state had been taken into account, HRT users were found to perform significantly better on some of the RBMT–E subtests, but not all. More specifically, HRT users performed superiorly on the tasks that required verbal memory processing. These findings are supportive of past research which suggests that HRT may help to preserve aspects of verbal memory functioning in menopausal women.

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G. STEFANATOS, D. ROELTGEN, & J. ROSS. Neurocognitive Performance in Premature Ovarian Failure.

Premature ovarian failure (POF) is a condition associated with a loss of ovarian function in women under age 40 and associated gonadal hormone deficiencies. The neurocognitive impact of this decrease in circulating gonadal hormones has not been extensively described. In this study, we administered a comprehensive neuropsychological assessment to 56 women with POF on estrogen replacement therapy. We compared their performance to a normal control group matched for age, SES and Verbal IQ. Domains of function assessed included intelligence, academic abilities, motor speed/coordination, spatial abilities, executive function, and affect. On most measures, the performance of POF women receiving estrogen therapy did not differ from normal controls. However, POF women demonstrated relatively depressed performance on measures of attention/impulsivity and in organizational aspects of performance on memory and visual constructional measures. In addition, they scored higher on indices of depression (Beck Depression Inventory–II, SCL90I–R) and had difficulties with aspects of affect recognition, specifically in identifying negative facial expressions (fear, anger, disgust). These findings point to differences in psychological functioning in women with POF involving selective aspects of attention and memory, spatial motor behavior, and affect. These differences are discussed in terms of the potential influence of earlier estrogen and ongoing androgen deficiency.

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J. DUNKIN, N. RASGON, S. DAVID, S. ELMAN, L. ALTSHULER, & A. RAPKIN. Effects of Estrogen on Cognition in Postmenopausal Women: A Placebo Controlled Trial.

Observational studies suggest that estrogen may be beneficial to cognition in postmenopausal women and may be protective against Alzheimer's

disease. However, placebo-controlled trials have been conducted only on small samples of surgically menopausal women, a unique population due to their dramatic decline in hormone levels postsurgically. In this study, 6 healthy, postmenopausal women were randomly assigned to receive estrogen, (transdermal patch at a release rate of 0.1 mg/day), and 6 were assigned to placebo (matching placebo patch) for a 10-week trial. Subjects were administered a complete neuropsychological battery at baseline and at the end of the trial. There were no significant differences between the groups on any demographic variable including age, education, or estimated premorbid verbal IQ. Tests were grouped by domain (e.g., verbal memory), and difference scores were analyzed using MANOVA to control Type I error. Due to the small sample size and possibility of Type II errors, effect sizes (*d*) were calculated as well. Results indicate that while all MANOVAs were nonsignificant, several effects in the medium to large effect size range were found. Medium effects for verbal and nonverbal memory were found, favoring the estrogen-treated group, and medium to large effects were found for psychomotor speed, but results were more inconsistent. Results suggest that estrogen may be moderately beneficial to cognition in healthy postmenopausal women, consistent with earlier studies. However, the literature appears to suggest that estrogen has a more powerful effect as a neuroprotective agent over long-term use, rather than as a treatment for memory and cognition in the short term.

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SPOKEN AND WRITTEN LANGUAGE NORMAL AND DISORDERED

G. STEFANATOS & S. MADIGAN. *Fine-Grain Temporal Analysis in Aphasia: Evidence From Auditory Gap Detection.*

Studies in man and non-human primates have observed laterality differences on auditory gap detection tasks, consistent with the left hemisphere's functional specialization in processing acoustic information requiring precise temporal resolution. Patients with aphasia have difficulties with processing temporal cues in sound, but there is little evidence implicating significant deficiencies in gap detection. We examined 2 forms of gap detection in aphasics and age matched normal controls by inserting silent gaps in narrow 250 ms band-limited noise bursts modeled after a second formant in speech. In a *within-channel* gap detection task, gaps of 10-, 20-, 40-, and 80-ms duration were inserted between formant-like bursts centered at 1 kHz. Gap onset was varied so that the initial noise bursts were 10, 20, and 40 ms in duration. In a *cross-channel* gap detection task, the initial noise burst was centered at 4 kHz while the trailing burst remained at 1 kHz. Burst durations of 10, 20, and 40 ms were paired with gaps of 20-, 40-, 80-, and 100-ms duration. On *within-channel* gap detection, aphasic patients were significantly worse at gap durations of 10 and 20 ms but at the longest duration (40 ms), they performed as well as normal controls. In the *cross-channel* task, the aphasics performed poorly at all gap durations. The findings are broadly compatible with suggestions that aphasic patients have difficulty on auditory temporal tasks but suggest that these difficulties cannot be fully accounted for on the basis of general limitations in auditory temporal integration.

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L.T. CONNOR, J.C. FOURNIER, & K. ALTERESCU. *Attention Impairment in Aphasic Individuals for Auditory but Not Visual Stimuli.*

We report the results of a study that sought to determine whether aphasic individuals have attentional impairments, and if so, have impairments that cut across visual and auditory modalities or are specific to the auditory modality. Participants (16 aphasic patients and 15 age-matched controls) performed both visual and auditory tasks graded in terms of their attentional demands, from very limited to quite demanding. In all conditions participants pressed a key when 2 consecutive trials contained different numbers of stimuli but did nothing when they were the same. In the *simple*

condition, only the stimuli were present, with no distracting information. In the *focused* condition, distracting background information was present but was irrelevant to the task. In the *divided* condition, participants responded if either the background or foreground information changed on consecutive trials. Aphasic participants (relative to age-matched controls) showed poorer processing of auditory stimuli in the conditions requiring focused attention to background stimuli (86% correct) and divided attention (82% correct) relative to the simple (96% correct) and focused attention to the foreground (96% correct) conditions. Their performance in the visual domain was quite accurate (98% correct or better in all conditions) with response latencies that did not differ across conditions. We interpret these data as consistent with a deficit in auditory attention that is most likely due to the presence of salient distracting information, as is the case when participants must switch attention to background information.

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H. WRIGHT, M. NEWHOFF, R. DOWNEY, & S. AUSTERMANN. *Additional Data on Working Memory in Aphasia.*

The purpose of this study was to determine if working memory capacity of adults with fluent and nonfluent aphasia is exceeded while processing inference revision sentence pairs, thus affecting comprehension of the sentence pairs. Forty adults participated in the study: 20 adults with aphasia (10 fluent aphasics and 10 nonfluent aphasics) and 20 neurologically intact (NI) adults. The working memory measure was the listening span task of Tompkins et al. The inference revision sentence pair comprehension task consisted of participants listening to sentence pair requiring an inference revision to comprehend, then answering 4 yes/no questions following each sentence pair. Two questions were based on factually presented information, and 2 questions required participants to make an inference about the information presented in the sentences. Not surprisingly, results of ANOVA revealed: (1) the fluent and nonfluent aphasia groups made significantly more errors on the listening span task than did the NI group; and (2) both aphasia groups missed significantly more questions on the inference revision sentence pair comprehension task than did the NI group; but, unexpectedly, (3) the aphasia groups did not differ significantly from one another on these measures. Pearson correlations indicated significant relationships between performance on the listening span and revised inference comprehension tasks for both aphasics and NI groups. These results supported the suggestion that processing requirements for comprehending inference revisions is resource demanding for aphasic individuals, thus exceeding their working memory capacity limits.

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S. PLUTH, Y. BOGDANOVA, R.F. WHITE, K. LUNGGREN, & M.L. ALBERT. *Examination of Auditory and Visual Memory Spans in an Aphasic Population.*

Objective: The Wechsler Memory Scale—Revised (WMS–R) Digit Span (DS) and Visual Memory Span (VMS) are neuropsychological tests used to assess attention and working memory. Clinically the measures have demonstrated sensitivity in discriminating individuals with Alzheimer's disease from elderly controls. One study has found an association of speech impairment and span deficits in an aphasic population. However, it has been argued that the forward and backward portions of the two tests are conceptually different tasks. This study presents normative data on forward and backward short-term auditory and visual memory spans in an aphasic population. *Methods:* English-speaking aphasic individuals who were administered both the DS and VMS subtests were included in this study. *Results:* The VMS tended to be longer on average than DS in both forward and backward conditions [DS Forward: $M(SD) = 4.17(2.41)$, DS Backward: 3.06 (1.88); VMS Forward: 6.75 (1.68), VMS Backward: 5.67 (2.01)]. Only DS backward showed a significant correlation with severity of language impairment ($r = 4.38, p < .05$). There was no significant difference between left and right-handers on the tasks. *Conclusions:* Findings support the notion that DS task is a language-dependent measure in

an aphasic population. Results suggest that VMS should be used when working with an aphasic population as a more unbiased measure of attention and working memory. Normative data are presented, broken down by level of language impairment. Results may be clinically useful in providing a basis for determining severity of cognitive impairment in aphasic populations.

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Y. MEGURO, T. FUJII, M. TABUCHI, Y. OTSUKA, K. SUZUKI, T. TSUKIURA, K. ENDO, & A. YAMADORI. Verbal STM in Mild Aphasics: Differences between Anterior and Posterior Lesion.

To clarify the nature of deficits in short-term memory in brain-damaged patients, we examined 9 patients with mild aphasia (3 with anterior lesion and 6 with posterior lesion). The following 4 tasks were used: a serial word task, a serial-pointing task from auditorily presented words, a serial oral recall task from visually presented words, and a serial-pointing task from visually presented words. The anterior group showed a grave impairment on the serial-pointing task from auditorily presented words despite a fair performance on the serial word repetition task. They also showed impairments on the 2 tasks in which stimuli were presented visually. On the other hand, the posterior group showed a profound deficit on the serial word repetition task with fairly preserved performance on the serial-pointing tasks from auditorily presented words. Though the score on the serial recall task from visually presented words was not different from that on the serial repetition task, the score on the serial-pointing task through auditorily presentation was significantly better than that through visual presentation. These results indicate that impaired processes in verbal short-term memory are different between the anterior and posterior groups. We hypothesize that there exist 2 parallel storing systems for verbal information in the human brain.

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J. FOGARTY, S. BEZEAU, & R. BLAIR. Verbal Skills Predict Functional Outcome in Stroke Rehabilitation.

Neuropsychological predictors of functional change were examined in a group of hospital inpatients. Forty-four individuals with various types of strokes were administered a comprehensive neuropsychological battery and were rated on the Functional Independence Measure (FIM) by a multidisciplinary team at admission and discharge from the hospital. A stepwise regression analysis using measures of verbal, visuospatial, and executive function abilities as predictors of FIM change was conducted. A similar analysis was used to examine the FIM subdomains of motor and cognitive function. The results indicated that verbal comprehension predicted overall functional and motor change, while a measure of executive functioning predicted cognitive change. Reasons for the relationship between these particular neuropsychological measures and functional improvement in hospital are discussed.

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R. NAKASE-THOMPSON, M. SHERER, S.A. YABLON, E. MANNING, C. VICKERY, & W. NG. Assessment of Language Among Neurorehabilitation Admissions: Convergent and Divergent Validity of the MAST.

Individuals with significant brain injury due to trauma, stroke, or tumor may demonstrate communication impairment in early periods of recovery. For patients with severe language impairments, lengthy aphasia batteries are inefficient for serial evaluations during brief inpatient hospitalization and may be excessive for patients with severe aphasia or poor endurance. The purpose of this study was to develop a 10-min screen to quantify communication abilities for patients with severe language impairment. The screening test (Mississippi Aphasia Screening Test, MAST) includes

7 subscales to measure naming, automatic speech, repetition, yes/no responding, object recognition, auditory comprehension, reading comprehension, writing to dictation, and verbal fluency that sum to 100. An initial validation study was conducted with a 33 individuals referred for neuropsychological consultation yielding 86 observations. Patients' diagnoses included traumatic brain injury, stroke, anoxia, encephalopathy, dementia, and brain tumor. A subgroup of patients received traditional neuropsychological tests and Pearson correlations were significant between the MAST and Boston Naming Test (.89), Controlled Oral Word association Test (.57), and MAE Token Test (.79) demonstrating convergent validity. Divergent validity was demonstrated with insignificant correlations between the MAST and a general measure of cognitive assessment (Mini-Mental Status Exam) and a measure of motor restlessness (Agitated Behavior Scale). Initial psychometrics for the MAST suggest that it does differentiate language abilities from other types of cognitive dysfunction for patients with a variety of neurologic disorders. Further studies to establish the test's usefulness are indicated.

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J. MAYER & L. MURRAY. Quantifying Word Retrieval in Aphasic Discourse: Validity and Feasibility.

The widespread prevalence of word-finding difficulties in aphasia is well-known. Although treatments for word retrieval can be effective, studies often use measurement of single-word performance (e.g., confrontation naming) to support such claims. In contrast, what matters most to patients with aphasia and their families is the ability to converse; likewise, it is in such situations that word-finding problems are most intrusive. Because it has been contended that generating names for single pictured stimuli bears little resemblance to the online, multifaceted word retrieval required during conversation, several studies have examined the relation between single-word and discourse level word retrieval abilities in aphasia but have thus far produced disparate results. Accordingly, the purpose of this study was to assess the adequacy of *Percent Word Retrieval (%WR)*, a measure of naming in discourse, to depict word retrieval in mildly ($n = 7$) and moderately ($n = 7$) aphasic patients. Specifically, we examined: (1) the relationship among word retrieval in confrontation naming, expository speech (picture description), and question-elicited conversational samples; and (2) the validity, reliability, and feasibility of %WR in quantifying such data. Results demonstrated a strong relationship between word retrieval in confrontation naming and in connected speech. Significant effects of word retrieval context and lexical class were noted, however, with superior word retrieval in connected speech versus confrontation naming, and better retrieval of nouns than verbs, across aphasia severity levels. Acceptable inter- and intrajudge reliability scores were obtained. Results and implications are discussed in the context of ecological validity and clinical applicability of the %WR measure.

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A.M. CIMINO-KNIGHT, A.L. HOLLINGSWORTH, S.A. McFAUL, J.A. McHONE, K.M. HEILMAN, & L.J.G. ROTH. Comparison of Quantitative Narrative Analysis in a Patient With Mania and a Patient With Fluent Aphasia.

Patients with mania and patients with fluent aphasia both demonstrate fluent incomprehensible speech. Although the underlying pathological mechanisms are different, it is possible that both of these disorders perturbate the same neural systems. If the altered neural systems are similar, the patients' language disorders should be similar. If the altered neural systems are different, the patients' language disorders should be different. While methods have been developed to assess the spontaneous discourse of patients with psychosis and patients with aphasia, a comparison of the language characteristics that distinguish these two groups has not been reported. The purpose of this study was to compare spontaneous discourse in a patient with mania and a patient with fluent aphasia using discourse

analysis, which allows the clinician to examine the integrity of language structure and content. Two discourse analyses were used to compare the 150-word language samples. The Communication Disturbances Index (CDI) quantifies discourse in terms of relevant content and organization of ideas (thought). The Quantitative Production Analysis (QPA) quantifies discourse in terms of grammatical structure and organization of syntax (language). Language samples were descriptions of pictures from the WAB and the BDAE. An important difference between these 42 patients appeared to be the presence of word substitution errors in the patient with aphasia and the predominance of unrelated utterances in the patient with mania. These results suggest that patients with these disorders probably have deficits of different functional linguistic systems. The patient with mania appeared to have a conceptual semantic deficit while the patient with aphasia appeared to have a lexical retrieval deficit.

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A. COLANGELO, L. BUCHANAN, & C. WESTBURY. Semantic and Phonological Neighborhood Measures in the Diagnosis of Acquired Reading Disorders.

The manifestation of acquired dyslexia is diverse. For example, some patients are unable to read aloud nonwords but can read most real words normally. Others can read aloud nonwords but are unable to correctly read exception words like *have* and *pint*. We have developed a relatively short but well specified list of words by which these patients can be appropriately assigned a diagnosis that accurately reflects their specific reading deficits. This list consists of 162 words that vary with respect to phonological and semantic neighbourhood size, as well as concreteness. We asked 28 acquired dyslexics to read aloud this list of words and examined the effects of these variables, first at the group level, and then at the individual level. We will show that patients dissociate with respect to their sensitivity to these theoretically motivated variables. At the group level, phonological neighborhood size predicts reading performance, whereas semantic neighborhood size concreteness does not. At an individual level, several patients show extreme sensitivity to all of these measures, whereas some show no sensitivity. A small subject of patients are sensitive to semantic neighborhood size and concreteness, but not to phonological neighborhood size. The reverse pattern is also evident. Furthermore, these sensitivities provide an index of disability that maps on to more traditional (and more time consuming) qualitative analyses of individual error types. Correspondence: *Lori Buchanan, University of Windsor, 401 Sunset Avenue, Department of Psychology, 173 Chrysler Hall South, Windsor, ON N9B 3P4, Canada. E-mail: buchanan@uwindsor.ca*

S. RAPCSAK & P.M. BEESON. The Role of Left Posterior Inferior Temporal Cortex in Spelling.

It has been proposed that the syndrome of alexia with agraphia is caused by damage to the dominant angular gyrus. By contrast, left temporo-occipital lesions typically produce alexia *without* associated spelling impairment. We now report 4 patients who demonstrated alexia with agraphia following left temporo-occipital damage due to infarction in the distribution of the posterior cerebral artery. None of these individuals had neuro-radiological evidence of angular gyrus involvement. The spelling impairment was more marked for irregular words than for regular words, and patients seemed to rely on a phonological spelling strategy. Interestingly, the lesions in our patients included the left posterior inferior temporal region (BA 37), a cortical area that showed activation in a previous functional imaging (fMRI) study where we asked normal subjects to generate written words from different semantic categories. Taken together, the neuropsychological and functional imaging data suggest that left posterior inferior temporal cortex plays an important role in spelling. Specifically we suggest that this cortical region is involved in the semantically guided retrieval of orthographic word forms. Therefore, this extrasylvian cortical area may be considered a possible neural substrate of the lexical-semantic spelling route.

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P.M. BEESON, S.Z. RAPCSAK, A. CHUNG, & J. CHARGUALAF. Neural Substrates of Sublexical Spelling.

Dual-route models of spelling postulate a lexical-semantic route in which orthographic knowledge is retrieved via semantics, and a sublexical phonological route whereby spellings are assembled on the basis of sound-to-letter correspondences. Lesion data from individuals with lexical agraphia and recent neuroimaging studies suggest that spelling via the lexical-semantic route relies on left extrasylvian cortical regions, including the angular gyrus and/or posterior inferior temporal cortex. By contrast, sublexical spelling procedures have been thought to rely on regions within the perisylvian language zone. Based on lesion analysis in patients with phonological agraphia, Roeltgen proposed that the left supramarginal gyrus and insula may play a critical role in sublexical spelling. However, this hypothesis has not been examined using functional neuroimaging. We report here on an fMRI study designed to examine the neural substrates of sublexical spelling in 12 neurologically intact right-handed adults. A 3-task paradigm included (1) writing of irregular words where spellings cannot be computed accurately on the basis of sound-to-letter conversion rules (e.g., *yacht*), (2) spelling of plausible nonwords which presumably require the application of sublexical phonological procedures (e.g., *flig*); and (3) drawing of common geometric shapes as a control for motor planning and implementation. Results indicated that, compared to irregular words, non-word spelling resulted in perisylvian activation localized to left posterior inferior and middle frontal gyri (BA 44/45/47), including Broca's area and the rolandic region for the face. These data are consistent with the central role of frontal perisylvian cortical regions in phonological processing. Correspondence: *Pelagie Beeson, University of Arizona, P0 Box 210071, Tucson, AZ 85721-0071. E-mail: pelagie@u.arizona.edu*

M. BALCONI. Different Cognitive Cortical Modules for Semantic and Syntactic Information?

Arguments about the existence of language-specific neural systems and specifically about the independence of syntactic and semantic processing have focused on the event-related brain measures (ERPs) as tool to monitor moment-by-moment the cognitive processes implicated. In the present experiments, the available evidence indicates that the ERPs response to semantic anomalies is at least partially distinct from the ERPs response to syntactic anomalies and that a syntactic parser is a plausible process included in sentences comprehension. Moreover, the perceptive modality of the stimuli and the type of cognitive task were added to the experimental design as explicative factors. ERPs were applied in the study of semantic and syntactic comprehension in the Italian language. The ERPs were recorded from 10 electrodes (10–20 international system) while subjects saw (Experiment 1) or listened (Experiment 2) to sentences containing semantic or syntactic anomalies. Final-word that was inconsistent with the sentence context elicited a negative-going wave at about 400 ms post stimulus (N400), whereas a final word incongruent with the grammatical structure (non-agreement between subject and verb) elicited a positive-going wave about 600 ms post stimulus (P600). Different ERP profiles were found, based on the perceptive modality of the stimulus (visual or auditory), with a more delayed peak for the auditory stimuli. Moreover, the frontal distribution of the ERPs N400 variation was considered as cortical marker of a semantic information processing.

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A. HUTCHINSON, D. WHITMAN, & B. LAKEY. Contextual Conflict and Semantic Priming: A Test of Semantic Edge Detection.

The current study was designed to examine the nature of lexical retrieval within and between cerebral hemispheres when the semantic system is challenged by an inconsistent semantic context in a divided visual field priming task. Double primes consisting of an ambiguous word and an associate of its dominant or subordinate meaning created a semantic context prior to target presentation (e.g., *Foot–Shoe* or *Foot–Inch*). Target words, which were presented 100 ms following the onset of the prime words, were consistent with, inconsistent with, or unrelated to the context

established by the prime words. Prime words as well as targets were lateralized, and both ipsilateral and contralateral prime pair-target conditions were analyzed in order to examine the influence that each hemisphere exerts on its counterpart. Results suggest that the left hemisphere activated a broad array of information following the establishment of a dominant context, including inconsistent targets, while concurrently inhibiting inconsistent targets in the contralateral right hemisphere. The left hemisphere was not as broadly activated following a subordinate prime context, with significant priming found only in the consistent condition, and it did not inhibit or prime any targets contralaterally. When primes were projected to the left visual field–right hemisphere, no significant priming occurred in either hemisphere, although subordinate targets were identified significantly faster ipsilaterally regardless of consistency with the prime context (i.e., subordinate consistent and dominant inconsistent conditions), whereas the reverse was true contralaterally. The results suggest a reciprocal interaction between the hemispheres resembling Cook's topographical inhibitory model of interhemispheric processing.

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T. FUJII, M. SUZUKI, Y. MAEDA, O. IMAIZUMI, T. MATSUE, & A. YAMADORI. Neural Correlates of Naming Processes With Regard to Body Parts and Tools.

Neuropsychological and neuroimaging studies have demonstrated that retrieval processes of names belonging to different semantic categories are subserved by different neural networks in the human brain. However, there have been only a few studies with regard to the naming processes of body parts. In this study, we employed fMRI to investigate neural correlates of naming of body parts (BP) and tools (TO). Ten right-handed male volunteers participated in this study. During the fMRI experiment, the subjects were presented with pairs of line drawings of BP or TO, each surrounded by a separate rectangle. The stimuli were presented visually at the rate of 1/3.5 s. The subjects performed 4 tasks: 2 requiring the same–different judgment of the number of syllables of 2 line drawings' names in the pair and the other 2 requiring the same different–judgment of the size of the rectangles surrounding the line drawings in the pair (control tasks). The fMRI data were analyzed with SPM99. BP naming, compared with its control task, was associated with activations in the left inferior frontal gyrus, parietal association area, and right occipital lobe. TO naming, compared with its control task, was associated with activations in the bilateral inferior frontal gyri, left fusiform gyrus, bilateral occipital gyri, and cerebellum. The results showed that retrieval processes of names of BP and TO were associated with activations in different areas, especially BP with parietal association area and TO with temporal association area.

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C. MATEER & S. REMPEL. Does Speed Matter When Measuring Word Retrieval?

A frequent concern of individuals with neurological disorders is difficulty with retrieval of familiar words. Clinically, however, many patients with such complaints perform well on the most widely used measure of word retrieval, the Boston Naming Test (BNT). The BNT measures retrieval of increasingly lower frequency words, and performance on the measure has been shown to be affected by level of education, vocabulary knowledge, gender, cultural background, and age. Apart from these potential biases, the untimed nature of the BNT may result in underestimating the efficiency of word retrieval. The purpose of this study was to develop a timed measure of word retrieval for adults, the Rapid Automatic Naming Test (RANT), which would reduce some of the inherent biases in the BNT, as well as increase sensitivity by providing an index of efficiency of word retrieval. Control subjects were compared to a mixed clinical group of nonaphasic subjects with word retrieval concerns. The 2 groups did not significantly differ on BNT performance or on the number of correct

words produced on the RANT, but the clinical group was significantly slower on RANT speed than the control group, even after controlling for simple talking speed. RANT performance was a better predictor of group membership than the BNT, suggesting that timed naming may be a more sensitive clinical tool in the detection of nonaphasic word retrieval difficulties than the BNT.

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B.H. GOLDSTEIN, J.E. OBRZUT, C.R. JOHN, & C.L. ARMSTRONG. The Effect of Left or Right Anterior and Posterior Brain Tumors on Verbal Fluency Performance.

Verbal fluency performance is vulnerable to left hemispheric brain damage. However, the results from functional imaging studies have suggested that verbal fluency requires bilateral participation. This study examined the impact of low-grade brain tumors on verbal fluency. We compared 25 patients with left hemisphere (LH) brain tumors to 26 patients with right hemisphere (RH) brain tumors on semantic and phonemic fluency. From the original group, 26 patients were classified into a combined anterior group (left or right anterior tumors) and compared to 20 patients classified into a combined posterior group (left or right posterior tumors). All groups were compared to 57 normal controls. It was hypothesized that there would be greater left than right hemispheric verbal fluency impairments. It was also predicted that the combined anterior group would demonstrate greater phonemic fluency impairments than the combined posterior group, given their respective retrieval and initiation requirements. Finally, it was contended that the LH patients would exhibit the greatest semantic fluency impairments, because prior neurodegenerative studies have reported posterior semantic memory dysfunction. However, the combined anterior group produced significantly fewer words than the combined posterior group on phonemic fluency. The LH group also produced significantly fewer semantic fluency responses compared to the RH group. Our results suggest a relationship between lesion location and verbal fluency performance, presumably because of the initiation/retrieval mechanisms required in language processing.

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D. BADENES, L. GARCIA, L. CASAS, N. CERULLA & M. AGUILAR. Phonemic and Semantic Verbal Fluency: Praecox Indicator in Frontosubcortical and Cortical Patterns.

Semantic and phonemic verbal fluency are used in order to evaluate dementia patients or suspicion. Principally, in Alzheimer disease both abilities decline under way of the illness but in frontosubcortical dementia as Parkinson disease affects phonemic fluency. *Aim:* The objective is to study verbal fluency (phonemic and semantic) in 2 groups of patients diagnosed with mild cognitive impairment (MCI) and Parkinson disease without dementia (PDWD). *Methods:* We studied the semantic fluency (animals and fruits) and phonemic fluency (words beginning with 'P' and 'R' in 1 min in 62 patients (26 MCI and 36 PKWD) as well as the number of clusters (burst of words over time that are semantically or phonemically related), repetitions and perseverations. In both groups MMSE was higher than 24. *Results:* The PKWD groups presented more clusters than MCI; these results were statistically significant in all fluencies (phonemic and semantic). Likewise, PSDW's presented a greater number of perseverations in 'p' and 'r' words (statistically significant). *Conclusions:* PDWD presented better efficiency in strategy of semantic search in relation to MCI. The PDWD presented more number of clusters. But the presence of perseverations in PDWD show less mental flexibility as well as alterations in working memory. The results in this study agree with the literature in respect of frontosubcortical and cortical patterns.

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A. BYARS, R. STRAWSBURG, V. SCHMITHORST, E. PLANTE, & S. HOLLAND. Functional MRI and the Development of Language Lateralization: Effects of Handedness.

The vast majority of right-handed individuals have left hemisphere dominance for language as demonstrated by invasive studies (i.e., Wada, cortical mapping) of patients with neurologic illness such as epilepsy. Left-handed individuals have higher rates of right hemisphere or mixed language dominance. Recent functional MRI (fMRI) studies of normal adults demonstrate similar findings with regard to language lateralization. This fMRI study investigated the development of language lateralization between 6 and 16 years of age. Fifteen left-handed children (11 boys, 4 girls) and 15 age- and gender-matched right-handed children (M age = 11) participated in a verb generation task used to assess language dominance in both PET and fMRI studies. This language task was interleaved in a block-periodic design with a bilateral finger tapping task. A T2*-weighted, gradient-echo, EPI sequence was used for fMRI scans with TR/TE = 3000/38 ms, FOV = 25.6 × 25.6 cm, matrix = 64 × 64, slice thickness = 5 mm. Lateralization indices were calculated based on the number of activated pixels in language-specific regions. In the left-handed group, eight participants (53%) demonstrated left-hemisphere lateralization and seven (47%) demonstrated a bilateral activation pattern, with one in the direction of right-hemisphere lateralization. In contrast, 11 (73%) of the right-handed children showed left-hemisphere lateralization and four demonstrated a bilateral activation pattern, all in the direction of left-hemisphere lateralization. Age was positively correlated with left lateralization for both left-handers ($r = .75, p = .001$) and right-handers ($r = .58, p = .02$).

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R. GRAVES, S. BEZEAU, J. FOGARTY, R. BLAIR, & P. O'HARA. Boston Naming Test Short Forms: Validation of Existing and New Versions.

The Boston Naming Test (BNT) is widely used to assess naming ability. In order to reduce administration time, various short-form versions have been developed. We compared the performance of the full 60-item BNT and a variety of short-form versions in identifying naming ability in a Canadian sample of 62 mostly elderly patients diagnosed as normal (M age 59, M MMSE 28.9/30) and 69 patients diagnosed with mild Alzheimer's disease (AD) either alone or in combination with vascular dementia (VD) (M age 75, M MMSE 25.8/30). In addition, we developed a new short-form version using item response theory principles to produce a test satisfying the Rasch measurement model. Our short form was developed on a larger 206-patient sample (all outpatients at a Memory Disorders Clinic) that included 75 additional neurological patients. Development was completely blind to diagnosis—only after completing item selection for the short form did we look at the normal versus AD/VD patients, an approach that should maximize cross-validation performance. For all tests an abnormality cut-off was chosen as the 10th percentile of the normals. The full BNT (reliability $\alpha = .91$) identified 43.5% of the AD/VD patients as abnormal on naming. The existing short forms identified from 15.9% to 40.6% of the AD/VD patients as abnormal. Our 30-item short form ($\alpha = .90$) identified 43.5% of the AD/VD patients as abnormal, a percentage identical to the full version, with 94% agreement with the full BNT on individual patient classifications.

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D. SIECHPINE, J. LEVY, K. PUTNAM, E. SPOOR, J. BERGESON, R. COHEN, & T. SUNDERLAND. Category-Specific Naming Impairment in Alzheimer's Disease on the Boston Naming Test.

Previous cognitive paradigms have suggested an animate-inanimate naming disparity in dementia of the Alzheimer's type (DAT). We aimed to determine if a psychometric measure is sensitive to this disparity and additionally whether there is an interaction with dementia severity in a

group of 67 DAT patients (M age = 70.3). Twelve animate and 12 inanimate frequency-matched objects were chosen from complete Boston Naming Test (BNT) administrations. Errors were coded mutually exclusive into 1 of the following 7 categories: no response (NR); semantic within category (SWC); semantic category label (SCL); correct description; phonemic; perceptual; other response type. The Global Dementia Scale (GDS) was used to stage dementia severity across DAT participants; neither age, education, nor estimated premorbid intellectual functioning differed significantly across GDS levels (M GDS = 3.97). In support of previous findings, significantly fewer correct responses were recorded for animate as compared with inanimate objects ($p < .05$). Significantly more errors were made for animate objects on the error categories of SWC, SCL, CD, and NR ($p < .05$ on all analyses). Moreover, stimulus type interacted with severity level on SCL ($p < .01$) as number of errors increased as a function of greater severity level only for animate objects. Overall, these results indicate that a widely used clinical measure (BNT) is sensitive to a category-specific naming impairment in DAT. In addition, the combination of semantic naming errors and visual stimulus type is related to dementia severity and possibly to the neocortical spread of neuropathology. Correspondence: James A. Levy, National Institute of Mental Health, Geriatric Psychiatry Branch, Building 10-3N228, MSC 1275, Bethesda, MD 28092-1275. E-mail: jlevy@codon.nih.gov

J. MORTENSEN, C.R. HANNAN, J. WHITE, M. FEARING, D. TATE, & E.D. BIGLER. The Boston Naming Test, Dementia, and Temporal Lobe Pathology.

Background and objectives: Deficits in Boston Naming Test (BNT) performance are clearly evident in dementia. However, how BNT deficits relate to atrophic brain changes associated with dementia have not been fully investigated. *Method:* Magnetic resonance imaging analyses were conducted on 20 control subjects, 77 Alzheimer's disease (AD), 16 vascular dementia, 30 mild/ambiguous, and 38 non-AD but mixed neuropsychiatric disorder subjects. Diagnoses were established by a consensus diagnostic approach. The BNT total number correct was recorded for each subject and the structures measured include the total temporal horn volume of the lateral ventricle, total hippocampal volume, and volumes of the superior, medial, inferior, fusiform, and parahippocampal gyri. Temporal horn volume is inversely related to volume of the temporal lobe. Accordingly, enlargement of the temporal horn is a sign of temporal lobe atrophy. *Results:* While a number of relationships were demonstrated in the combined groups, the total number correct on the BNT was negatively correlated with the total temporal horn volume ($r = -.31, p < .001$) and positively correlated with the hippocampal volume ($r = .19, p < .05$), and left temporal lobe volume ($r = .35, p < .001$). *Conclusion:* Clinical application of BNT performance as it relates to atrophic temporal lobe changes as well as differences between types of dementing illnesses will be discussed. Correspondence: Jennifer Mortensen, 283 Taylor Building, Provo, UT 84084. E-mail: Mortensen_Jennifer@hotmail.com

J.A. TESTA, R.J. IVNIK, & G.E. SMITH. Diagnostic Utility of the Boston Naming Test in MCI and Alzheimer's Disease.

In this study, the diagnostic utility of Boston Naming Test (BNT) in the diagnosis of Alzheimer's disease (AD) was examined and compared to the diagnostic utility of category fluency and delayed recall, other commonly used diagnostic tools in the diagnosis of AD. Diagnostic utility statistics suggested BNT scores were the least useful in predicting individual risk of AD. Likelihood ratio tables are provided for use in calculating the odds of AD for specific test scores generated by individual patients. The association of BNT impairments and dementia severity at initial diagnosis was examined. Few individuals presented to their 1st evaluation with naming impairments without accompanying memory impairments. Although BNT impairment occurred in each stage of AD, it was ubiquitous only in moderate-to-severe dementia. Finally the utility of these measures in predicting development of AD in either normal elderly or those with mild cognitive impairment (MCI) was assessed with a stepwise multivariate Cox proportional hazards analysis. Findings suggested BNT scores to

have little utility in predicting risk of developing AD. Collectively these results suggest that although BNT impairments become more common as AD progresses they are neither necessary for the diagnosis of AD nor relatively useful in identifying preclinical AD.

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E. CACCAPPOLO-VAN VLIET, L.S. HONIG, J. MANLY, K. MARDER, & Y. STERN. Language Functioning in Corticobasal Degeneration.

Corticobasal degeneration (CBD) is a neurodegenerative disorder particularly characterized by asymmetric akinetic-rigidity and apraxia, but many patients have behavioral changes, dementia, and language involvement. We examined 23 CBD patients (M age 65 ± 10.1) and compared their neuropsychological test performance to a larger group of patients with Alzheimer's disease (AD; M age 73.2 ± 9.3). We divided patients into 3 subgroups of dementia severity based on Columbia 57-point modified Mini-Mental Status scores: 45–55 *mild*; 35–44 *moderate*; and 20–34 *severe* and compared performance in each subgroup on tests of verbal letter fluency (CFL), category fluency (*animal, food, clothing*), naming (15-item BNT), and delayed verbal recall (Selective Reminding Test). In the mild and moderate groups, CBD patients had less impaired memory on delayed recall than AD patients. There was also a trend for CBD patients to have less difficulty with naming across all subgroups. Category fluency was similar in CBD and AD patients of comparable mMMS. In contrast, in the moderately demented group, letter fluency was relatively more impaired in CBD than in AD. These findings support greater frontal involvement in CBD.

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N. DONOVAN, D. KENDALL, A.B. MOORE, M. KODSI, J. ROSENBEK, J. TODD, & L. ROTH. Language Processes and Use in a Case of Corticobasal Degeneration.

Introduction: Corticobasal degeneration (CBD) a rare, progressive neurologic disorder involving neuronal loss/atrophy in cortical and subcortical regions, is described as initially involving limb-kinetic apraxia followed by cognitive deficits in abstract thought and memory. Little is known about language processing/use. Thus, we report results of language testing in a CBD patient. *Case Description:* A 60-year-old woman presented with complaints of impaired short-term memory, word retrieval, calculation and writing, along with difficulty organizing and completing activities of daily living. MRI revealed marked asymmetric parietal atrophy (right > left), mild bilateral temporal atrophy, and a chronic left cerebellar lacune. Neurologic and neuropsychological evaluations revealed frontal, visual, and motor deficits. *Results:* Intensive testing revealed fluent speech production; effortlessly and accurately produced. She spoke in complete sentences of normal complexity. She displayed anomia that was notable during confrontation naming tasks and in conversation. She displayed auditory comprehension failures only in the context of sentence (not word) level stimuli as well as alexia. On writing tasks, both legibility and spelling deficits were evident. Even more striking than the language process problems were language use deficits. This patient displayed significant and distracting problems during discourse, characterized by lack of discourse cohesion, excessive verbiage, and lack of respect for conversational turn taking. *Conclusion:* CBD patients are typically diagnosed based on movement disorders. Literature now reveals that some may initially present with cognitive symptoms; in this case these cognitive deficits also include a disorder of language process and use.

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J. GRANIER, R. HURTIG, S. ANDERSON, & N. DENBURG. The Influence of Frequency, Concreteness, and Grammatical Category on Semantic Processing and Word Retrieval in Probable Alzheimer's Disease.

Word-retrieval difficulties hamper the communicative abilities of individuals with Alzheimer's disease. Identification of variables that influence word retrieval performance in AD is an essential first step in the development of models of lexical access in AD. Retrieval and processing of a core set of target words selected on the basis of their frequency, concreteness, and grammatical category characteristics were assessed via word-nonword decision, definition, sentence completion, and naming to definition tasks. Participants included 20 elderly controls, 10 mildly impaired AD subjects, and 7 moderately impaired AD subjects. Concreteness had a greater impact upon AD performance for the definition and naming to definition tasks, which required effortful processing of the semantic representations of target words. Frequency exerted a greater influence on AD performance for the task that required minimal semantic processing, word-nonword decision, and the tasks in which the orthographic form of the target word was not given, sentence completion and naming to definition. Interactions of Concreteness \times Frequency in the results of the sentence completion task together with the effects of concreteness on definition and naming to definition performance suggest a connection between semantic and episodic memory impairments. Difficulty retrieving and processing abstract words associated with AD and normal aging has its root in a failure to subconsciously access episodic memory traces relating to previous linguistic experiences with abstract words.

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M. NICHOLAS & M. PAGE. Semantic Processing in Nonfluent Aphasia: Effect of Stimulus Input Modality.

This study investigates if people with severe nonfluent aphasia have access to the conceptual-semantic information they need for optimal use of picture-based alternative communication systems. We report findings from a group of 17 nonfluent aphasia patients asked to make semantic judgments about stimulus items from 16 categories. Two nonverbal tasks were performed: (1) category selection; and (2) exemplar matching. Each item was presented twice, as a picture and as a spoken word. Stimuli in the pictorial condition were 64 line drawings primarily from the Snodgrass and Vanderwart set of objects. Stimuli in the auditory condition were the spoken names of the same items. Participants made more errors on both tasks (category and exemplar selection) in response to words than to pictures, and also made more errors on the exemplar selection task than on the category task. However performance did not approach ceiling in the pictorial modality as expected; in fact the effect of modality (although significant) was not striking. Performance was remarkably *inconsistent* across stimulus modality when performance to each individual stimulus item was examined. Participants made 3 times as many single-modality errors as double-modality errors, a pattern found in all participants. These results reinforce the importance of considering task and stimulus variables when evaluating the integrity of information in semantic memory. While some results appear to be consistent with a storage deficit; others are more consistent with a deficit of access, supporting criticisms by Caramazza and colleagues about the distinction between storage and access deficits. Correspondence: *Marjorie Nicholas, Ph.D., Communication Sciences and Disorders Program, MGH Institute of Health Professions, Charlestown Navy Yard, 36 First Avenue, Boston, MA 02129. E-mail: mlnicholas@mghihp.edu*

M. NICHOLAS & M. PAGE. Category-Specific Effects Interact With Stimulus Variables in Nonfluent Aphasia.

Mechanisms underlying category-specific deficits in aphasia have been the subject of debate for years. We report findings from a group of 17 severe nonfluent aphasia patients asked to make semantic judgments about stimulus items from 16 different categories. Each item was presented

twice, as a picture and as a spoken word. Stimuli in the pictorial condition were 64 line drawings and in the auditory condition were the spoken names of the same items. Two nonverbal tasks were performed: (1) category selection; and (2) exemplar matching. We examined performance using several comparisons: (1) biological/natural kind *versus* manmade/artificial; (2) animals *versus* plants *versus* artifacts; (3) no grouping, with error profiles for each category. We found that a number of effects were dependent on stimulus modality, task, or grouping of categories. For example, in the first comparison, we saw worse performance for biological items in both modalities but only for exemplar matching. In the analysis comparing animals, plants, and artifacts, we saw that artifacts were best in the picture condition, yet worst in the auditory condition. Finally, in the examination of all 16 categories separately, we saw how some subcategories of animals (e.g., wild animals and insects) were among the easiest to categorize, whereas others (birds and farm animals) were among the hardest. Results are discussed in terms of suggested mechanisms for category-specific effects. The fact that different patterns of category difficulty were seen across the two modalities urges caution in the interpretation of category-specific deficits.

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R. FUKATSU, T. OIKAWA, S. SHIBUYA, H. MOCHIZUKI, & T. FUJII. Pure Anarthria Following an Infarct in the Precentral Gyrus.

Pure anarthria is a rare disorder of speech production. We studied six cases of pure anarthria following a cerebral embolism in the precentral gyrus with neuropsychological tests, MRI, and SPECT. All cases were right-handed. Three patients had damage to the left hemisphere: precentral gyrus alone (Case 1), precentral gyrus + postcentral gyrus (Case 2), and precentral gyrus + frontal operculum (Case 3). The remaining three patients had damage to the right hemisphere: precentral gyrus + an old infarction in the right angular gyrus (Case 4), precentral gyrus alone (Case 5), and precentral gyrus + middle frontal gyrus (Case 6). Two patients showed a severe disturbance in articulation with little improvement (Cases 1 and 2). Two patients had a severe disturbance in the beginning with a moderate improvement (Cases 5 and 6). One patient had a severe disturbance in the beginning, but recovered to almost normal in 1 week (Case 3). The 1 patient had a moderate disturbance in the beginning with a moderate improvement (Case 4). In 5 of them, the ability to write was preserved (the 1 patient had not learned letters well in his life). No patients showed any buccofacial apraxia. Our findings indicate that damage to the precentral gyrus is responsible for pure anarthria and that there might be a few individuals whose programming of articulation might depend more on the right hemisphere.

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Paper Session 7/10:45 a.m.–12:30 p.m.

**LEARNING AND MEMORY:
IMPLICIT AND EXPLICIT**

A. AMMAR, N. PLISKIN, J. FINK, A. PETERSON, K. KELLEY, R. LEE, & A. MALINA. Subjective and Objective Evidence of Impaired Learning Following Electrical Injury.

A significant proportion of EI survivors subjectively report a decline in memory, with a greater percentage of memory complaints found among patients more than 3 months post injury. Few studies have examined the relationship between their subjective memory complaints and objective performance. *Objective:* To examine subjective *versus* objective learning in EI survivors. *Subjects:* One hundred fifty-two EI patients and 28 elec-

trician controls participated in this study. All EI participants were injured from domestic or commercial power sources; had only peripheral electrical contacts; and had successfully passed all symptom validity measures.

Methods: The CVLT was administered to all participants; EI participants also completed the Self Rating of Memory (SRM). MANOVA was used to objectively assess the CVLT performance of EI participants and controls; then replicated with acute *versus* post-acute patients. schizophrenia ANOVA was used to examine the subjective report of learning dysfunction in 27 acute (>3 months post injury) and 47 post-acute (<3 months post injury) patients upon a SRM derived composite of learning related questions. *Results:* Upon objective assessment, EI patients demonstrated significant impairments in immediate and delayed free recall; decreased performance on immediate and delayed cued recall; and greater intrusions and perseverations on delayed recall trials. Post-acute patients subjectively complained of significantly greater levels of learning impairment than acutes; however, they did not demonstrate significant differences in their objective memory performance. *Conclusions:* EI patients demonstrated significant deficits in learning as compared with controls; however, these impairments appear to be independent of post-injury recovery status.

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J. PRICE, J.W. PRICE, & R. GRAVES. Lateralized Mere Exposure: An Analytic Non-Analytic Processing Approach.

It is known that individuals have a preference for items they have seen before, even when those items are presented so quickly that they cannot be consciously recalled. *Mere exposure* experiments investigate this phenomenon by flashing, very briefly, a series of pictures to an individual, and then having them answer 2 forced-choice questions (recognition and preference) at test. Studies have shown that individuals preferentially choose old items when answering the preference question but are unable to accurately choose old items when answering the recognition question. It seems strange that individuals consistently endorse previously seen items under the preference condition, but have no recollection of having seen these items under the recognition condition. Whittlesea and Price concluded that the mere exposure effect was an artifact of the alternative strategies (analytic *vs.* non-analytic) that subjects were using to generate information about stimuli they were exposed to at test. Specifically, a non-analytic strategy promoted target selection above chance, whereas an analytic strategy prevented target selection above chance. The current study elaborated on this analytic/non-analytic distinction. Many studies have demonstrated that the right hemisphere of the brain uses primarily a nonanalytic strategy for processing stimuli, whereas the left hemisphere uses primarily an analytic strategy for processing stimuli. Given this hemispheric dissociation, it was predicted that a mere exposure effect would be found when stimuli were initially presented in the right hemisphere, but not when initially presented in the left hemisphere. Results supported these predictions.

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J.B. RICH, N.M. RICHARD, V.H. KOVAL, & N.W. PARK. Evidence of a Mere Exposure Effect for Real Words: A Function of Valence?

The mere exposure effect (MEE) refers to an increased preference for recently presented stimuli. It occurs outside of conscious awareness and thus is a type of implicit memory. Although robust and ubiquitous with novel stimuli, the MEE tends not to occur with familiar items, such as real words. Previously, however, we obtained an MEE with attribute words (e.g., *polite, stingy*) that were paired with novel faces. This surprising result could have been due to the valence inherent in attribute words, or to their paired association with the unfamiliar faces. Two studies ($n = 24$ undergraduates each) tested these hypotheses, 1 replacing the attributes with occupations, and 1 replacing the faces with common first names. Study I (occupation-face pairs) revealed an MEE for the occupations [$F(1,23) = 4.76, p = .04$], which are real words without the inherent valence of attributes. Study II (attribute-name pairs) replicated an MEE for the attributes [$F(1,23) = 9.96, p = .004$], despite being paired with

familiar stimuli (common names). We have now found MEEs for real words following attribute–face, occupation–face, and attribute–name pairs. Taken together, it appears that preference for familiar words can be increased through presentation in a novel associative context. However, this effect may be mediated by word valence, as the MEE in all 3 studies was limited to normatively positive words (e.g., *creative, pediatrician*). Normatively negative words (e.g., *conceited, mortician*) and neutral words (determined in a pilot study) showed little or no increase in likeability following exposure.

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R.C. MULLIGAN, C.L. ELSINGER, R. ERWIN, T. PRIETO, A. HU-DETZ, K. LAUER, & S.M. RAO. Effects of Propofol Sedation on Auditory Verbal Memory: A Dose–Response Investigation.

This study examined the extent to which subjects are capable of learning new information while under propofol sedation. Eleven healthy subjects (ages 24–42; 6 females) passively listened to 4 lists of words (40 words/list). Word lists were matched according to Pavio-Yule ratings (letter length, usage, concreteness, and imageability) and were presented in a counter-balanced order across subjects. Each list was presented during one of four consecutive sedation conditions: alert (PRE), light sedation (LOW, 0.5 $\mu\text{g/ml}$ propofol plasma concentration), moderate sedation (MOD; 0.75 or 1.0 $\mu\text{g/ml}$), and return to alert baseline (POST). Order of LOW and MOD propofol conditions was counterbalanced across subjects. Sedation level prior to each word list was determined from 32-channel EEG recordings. One hour after last infusion, participants completed a free recall test followed by an auditory forced-choice recognition test (160 presented words, 160 foils). Results indicated that participants could not freely recall more than 14% of the words presented to them in any sedation condition. However, signal detection measures (d') showed that participants were significantly able to discriminate targets from foils at a level better than chance during the PRE, LOW, and POST conditions, but not during the MOD condition. A more liberal response bias was adopted during retrieval of words presented during the non-propofol conditions, but not for those presented during propofol dosage conditions. These data suggest that learning can occur during low doses of propofol sedation. A subsequent report will focus on functional neuroimaging findings.

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K. DOUVILLE, M. SEIDENBERG, J.L. WOODARD, S.K. MILLER, C. LEVERONI, K. NIELSEN, & S.M. RAO. The Relationship Between Level of Semantic Knowledge About Famous Names and Functional Activation Patterns.

The person–identity network (PIN), which underlies the recognition and identification of familiar and known people, is considered within the domain of the long-term semantic memory system. Knowledge of its neural underpinnings, derived primarily from brain-lesioned patients, suggests that the PIN may have important and unique features in comparison to the general object semantic system. In this study, we examined the relationship between semantic knowledge ratings and neural activation in 14 older (64–79) healthy subjects using fMRI. Subjects viewed 90 famous names from different time periods and were asked to determine whether or not each name was famous. Following the scan session, subjects rated their level of semantic knowledge about names that were correctly identified as famous. A significant ($p < .005$) positive correlation between level of semantic knowledge and degree of MR signal intensity change was observed bilaterally in the medial and lateral temporal lobe, medial and lateral frontal lobe, and posterior cingulate gyrus. In addition, a comparison between participants with high and low semantic knowledge ratings revealed greater activation in the right parahippocampus and hippocampus, bilateral middle and superior temporal lobe, and bilateral frontal lobe in the high semantic knowledge group. These findings suggest that level of semantic knowledge is related to increased activation in brain regions previously implicated in the PIN. These results from a healthy aging sam-

ple may have important implications for the detection of neural changes associated with retrieval failure from the PIN in mild cognitive impairment and early Alzheimer's disease.

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C. McDONALD, R.M. BAUER, L. GRANDE, S. ROPER, & R. GILMORE. Inhibition in Memory and Attention: The Role of the Frontal Lobes.

This research explores the nature and extent of inhibitory failures in patients with frontal lobe damage as they relate to impaired attention and retrieval from long-term memory. We evaluated whether patients with frontal lobe damage show impaired inhibition during memory retrieval, as well as during selective attention. We also evaluated whether disrupted retrieval from memory represents a generalized impairment, affecting retrieval from semantic and episodic memory. It was hypothesized that patients with frontal lobe damage would show a generalized impairment in inhibitory processing that would abolish attentional suppression and retrieval inhibition. These hypotheses were evaluated in 20 patients with frontal lobe damage and 20 controls across tasks of inhibition in selective attention (*negative priming*), episodic memory (*directed forgetting*), and semantic memory (*semantic priming*). We found that the frontal group as a whole was not impaired across domains, although there were significant laterality differences in disrupted inhibition. Patients with left frontal damage were impaired on all 3 tasks, suggesting disrupted inhibition in selective attention, episodic retrieval, and semantic retrieval. Those with right frontal damage were impaired only on a task of semantic retrieval, although they showed *reduced* inhibition in episodic retrieval. These results suggest that inhibitory processing is impaired in patients with frontal lobe damage, especially left frontal damage, and that inhibitory failures occur across domains of attention and memory. A unified theory of inhibitory processing is discussed, along with clinical implications of disrupted inhibition in patients with frontal lobe damage.

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Symposium 15/10:45 a.m.–12:30 p.m.

INTERACTIONS BETWEEN COGNITIVE, BEHAVIORAL, AND EMOTIONAL DYSFUNCTION IN CHILDREN WITH CNS DYSFUNCTION

Organizer and Chair: Vicki Anderson

Discussant: Keith Yeates

V. ANDERSON. Interactions Between Cognitive, Behavioral and Emotional Dysfunction in Children With CNS Dysfunction.

This symposium aims to explore the complex relationships between cognitive and behavioral/emotional impairments following CNS insult/injury in childhood. While, in many clinical settings, these problems are treated and managed in isolation, current research has identified close links across these domains which suggest a more holistic approach may lead to optimal outcome. Patterns of cognitive deficits in children with CNS dysfunction are now generally well established; however, there are only a small number of studies that have examined behavioral and emotional profiles in any detail. The challenge now is to understand the interaction among these dimensions, their primary and secondary effects and their joint impact on recovery and subsequent development. The papers included in this symposium will address key factors relating to these issues, including new approaches to assessing behavioral and emotional impairments which occur following cerebral insult, potential for distinguishing behavioral/emotion deficits due to brain pathology from secondary adjustment difficulties, differential prediction of residual behavioral and cognition measures and the nature of correlations between behavioral

and cognitive impairment. Changing patterns of impairments over time since injury and across developmental stages will also be addressed.

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D.P. SMIDTS, R. JACOBS, & V. ANDERSON. Development of Behavioral Regulation and Social Functioning in Early Childhood.

Intact social functioning is based on a number of executive processes, such as impulse control, flexible thinking, self-regulation, and paying attention. The frontal lobes, in particular the prefrontal regions, are believed to play an important role in the regulation of behavior, thought, and emotion. The nature and diversity of the behavioral functions subsumed by the frontal brain areas are determined by the patterns of neural connectivity, with the frontal regions coordinating and integrating information from all other brain regions. During childhood, these frontal areas are developing rapidly, and thus are vulnerable to damage. A number of studies have reported impairments in behavior and social functioning following childhood brain injury. Despite the importance of these impairments, the pediatric literature on the normal development of executive skills is limited. The present paper examines the development of a number of behavioral aspects of executive functions in early childhood. These aspects include inhibition, shifting, self-regulation, attention, and perspective taking. It was hypothesized that behavioral aspects of executive functions develop in a hierarchical manner, with complex processes, such as the regulatory control of behavior, developing later in life than lower-order processes, such as the ability to pay attention. Using a normative sample of 100 children between 3 and 7 years old (20 children in each age group), the development of executive skills through early childhood was investigated. Developmental trends were noted across age groups, with older children showing more regulatory control over behavior, thought, and action. These findings were consistent across behavioral and cognitive measures.

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K. GANESALINGAM, A. SANSON, & V. ANDERSON. Self-Regulation and Social Functioning Following Pediatric Traumatic Brain Injury.

Pediatric traumatic brain injury (TBI) is frequently reported to lead to substantial difficulties in social functioning, particularly in behavior and social skills. Yet, research has not identified the underlying mechanism(s) causing such difficulties. The present study proposed that self-regulation may be a core deficit and underlying mechanism in children who present with post-TBI difficulties in social functioning. Self-regulation is a biologically based attribute that develops from birth, and is governed by the prefrontal cortex, contributing to individuals' capacity to manage his/her own thoughts, emotions and behavior in adaptive and flexible ways. Self-regulation therefore includes cognitive, emotional, and behavioral domains. Children, 6 to 11 years of age, 2 to 5 years following moderate to severe TBI ($n = 40$), and age and gender-matched control participants ($n = 40$) were assessed for levels of self-regulation using the Matching Familiar Figures Test, Emotion Regulation Checklist, and a Delay of Gratification Task. The Eyberg Child Behavior Inventory, Sutter-Eyberg Student Behavior Inventory-Revised, and the Gresham and Elliot Social Skills Rating System were used to assess social functioning. Findings indicated that children with TBI had significantly lower levels of cognitive ($p < .01$), emotional ($p < .01$), and behavioral ($p < .01$) self-regulation, and higher levels of difficulties in social functioning ($p < .01$) than their noninjured peers. Further, substantial associations were found between levels of self-regulation and degree of difficulties in social functioning ($p < .05$). Results are discussed in terms of the significance of self-regulation in social functioning, and whether self-regulation plays a mediating role between pediatric TBI and post-TBI difficulties in social functioning.

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G. GIOIA. Contributions of Cognitive and Behavioral Assessment Sources in Understanding Children's Executive Function.

The reliable and valid assessment of the executive functions in the developing child is a complex and challenging process. Several different methods exist to assess executive function, including conducting performance tests with the child-, parent- and teacher-completed standardized ratings of the child's everyday behavioral manifestation, and the child's own self-report of their executive control capacities. The present paper provides a structural framework, to include micro and molar levels of analysis, within which to consider the role of these various sources, including the unique contributions and necessary interrelationships. We review existing studies conducted with diverse clinical populations that have examined the correspondence between cognitive performance tests and measures of the behavioral manifestation of executive function. The correspondence of cognitive tests with behavior ratings, based on correlational methods, is variable with generally low correlations, suggesting, on the one hand, an association between these sources yet also different contributions. A variety of factors are considered in this correspondence including the nature of the tasks being associated, the types of statistical methods used in the analyses, and the specific domains being examined. The relationship of these different assessment sources to social functioning in particular is further examined with particular reference to the issue of ecological validity in the assessment of the executive functions. We conclude that each assessment method offers unique and important information to our understanding of executive function and functional impairment in children.

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K. HOWARD, B. RILEY, D. THISELTON, R. RIBBLE, R. WILLIAMSON, R. DOB, K. MILL, & V. ANDERSON. Neurocognitive and Psychosocial Characteristics of Turners Syndrome.

Turners syndrome (TS), a genetic disorder affecting women, is associated with a distinctive neurocognitive and psychosocial profile. Although generally demonstrating intact verbal ability, women with TS, as a group, have specific deficits in visual-spatial abilities, motor functioning, executive skills, and attention, as well as difficulties with social relationships and adjustment. Previous findings have linked observed behavioral deficits to imprinted, X-inactivation-escaping loci on the X chromosome. In the present study, measures of IQ, executive skills and psychosocial function were collected for 104 cases of TS. For 73 cases where DNA was available, 24 cases were identified as monosomic where the X chromosome was maternal in origin (45,Xm) and 7 were identified as monosomic where the X chromosome was paternal in origin (45,Xp). As a group, TS girls recorded IQ in the normal range and cases did not differ on the verbal or performance components. Participants were significantly impaired on tests of executive functioning. Specifically, subjects showed deficits in attentional control, cognitive flexibility and goal setting. The pattern of performance exhibited by the two monosomic groups (45,Xp) and (45,Xm) was similar, both for IQ and executive functioning. These findings are not in accordance with previous reports of a discrepancy between these groups, suggesting that (45,Xp) females cannot be distinguished from (45,Xm) females by their performance on these tests. The results will be discussed in terms of the relationship between the neurocognitive and psychosocial characteristics of TS to possible brain dysfunction.

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H. NEWITT, V. ANDERSON, & S. BROWN. Adult Outcome Following Childhood TBI: Identifying Key Predictors.

This study aimed to examine psychosocial outcomes in adulthood following mild, moderate and severe childhood traumatic brain injury (TBI). Very little research has been done on this issue to date, with most longitudinal studies following children for only 2 to 3 years. The broad aim of this study was to plot the natural history of childhood TBI, with the more specific goals to identify critical risk and protective factors to guide clinical

cians in treatment and management. Outcome was explored with respect to injury severity, age at injury, premorbid function, access to rehabilitation, child and family factors and presence of disability. The sample included 60 young adults (18–30 years), ascertained from hospital records, who had sustained TBI between the ages of zero to 14 years. Young adults and their families were contacted and asked to complete questionnaires focusing on key areas of daily living including—education, employment, residual physical disability, living arrangements, social relationships and psychiatric status. These included the Sydney Psychosocial Reintegration Scale, NEO Personality Inventory–Revised, as well as a semistructured interview. A subset of the sample also underwent intellectual evaluation. Results show that, while severe TBI was most often associated with poorer outcome for all domains, this was not uniformly the case, with some severely injured participants functioning very well in all areas. Factors identified as contributing to possible outcome were (1) access to rehabilitation/education regarding TBI consequences (2) older age at injury (3) intact family function and (4) absence of disability.

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Symposium 16/10:45 a.m.–12:30 p.m.

NEUROPSYCHOLOGY OF SCHIZOPHRENIA: FROM GENES TO JOBS

Organizer and Chair: Robert M. Bilder
Discussant: Robert K. Heaton

R.F. ASARNOW, R.M. BILDER, J.M. GOLD, K.H. NUECHTERLEIN, & R.K. HEATON. Neuropsychology of Schizophrenia: From Genes to Jobs.

Neuropsychological deficits are accepted as core components of schizophrenia, which may be more robust predictors of real-world functional outcomes than other symptoms of the syndrome. As basic cognitive research identifies the molecular components of neurocognitive deficits, questions emerge about the practical significance of these findings, and the extent to which identified deficits retain ecological validity, particularly in the face of novel treatment options. New research is making progress identifying the genomic bases of vulnerability to schizophrenia, highlighting those neurocognitive aspects of the syndrome that are heritable. The UCLA family study identified significant neuropsychological differences among parents of probands with schizophrenia compared to ADHD and a community control groups, and examined the diagnostic efficiency of these measures, with implications for identification of risk and the conduct of genetic linkage studies (Asarnow). Association studies focusing on specific single nucleotide polymorphisms (SNP's) offer complementary insights. A functional polymorphism in the gene coding for catechol-O-methyl transferase (COMT) appears to have significant impact on neuropsychological abilities, including those showing significant enhancement with newer antipsychotic agents (Bilder). Paralleling these studies of genetic and treatment effects on neuropsychological deficit in schizophrenia, recent research is providing detailed information about the specific relations of neuropsychological deficits with real-world outcomes, including vocational outcomes for patients following the first episode of illness (Nuechterlein), and those who have an established chronic course (Gold). The discussion will focus on areas of convergence and divergence in the neuropsychological constructs most related to molecular and ecological targets, and to the strategies that may best foster the translation of basic science to clinical practice.

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R. ASARNOW. Are Neurocognitive Impairments Indicators of Genetic Liability to Schizophrenia and/or ADHD?

The assumptions underlying the study of certain neurocognitive functions as indices of genetic liability to schizophrenia, and the key methodological issues deriving from those assumptions will be reviewed. I will also briefly review illustrative examples of genes that have been shown to be associated with various CNS dysfunctions. Those issues will be illustrated by the UCLA Family Study, which tested the hypotheses that certain neurocognitive impairments index genetic liability to schizophrenia and ADHD. Parents of childhood onset schizophrenia (COS; $n = 79$), ADHD ($n = 190$) and community control ($n = 115$) probands were compared on 3 neurocognitive tasks shown in prior research to detect impairments in patients with schizophrenia and ADHD and in relatives of patients with adult onset of schizophrenia. On both the degraded stimulus CPT and Trail Making Test, parents of COS proband performed significantly worse than parents of community control and ADHD probands, who did not significantly differ from each other. Using rigorous cutting scores, a combination of scores on the three neurocognitive tests identify 20% of mothers and fathers of COS probands compared to zero percent of mothers and fathers of community control probands. There was some diagnostic specificity of the neurocognitive impairments. There were no significant differences in neurocognitive functioning between parents of ADHD and community control probands. A diagnostic efficiency analysis reveals that the combination of scores on certain neurocognitive tasks, using rigorous cut-offs, produces a level of diagnostic accuracy in parents of COS probands that is sufficient for use in genetic linkage studies.

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R.M. BILDER, J. VOLAVKA, J.L. KENNEDY, & J.A. LIEBERMAN. Effects of COMT Genotype and Novel Antipsychotics on Neuropsychological Abilities.

Neurocognitive deficits are recognized as a cardinal feature of schizophrenia but the determinants of these deficits remain unknown. Recent reports have suggested that a functional polymorphism, Val¹⁵⁸Met in exon III of the catechol-O-methyltransferase (COMT) gene may exert its effects by modulating prefrontal dopamine function, but few neurocognitive measures have been examined, leaving open questions about phenotypic specificity. We examined the effects of the COMT Val¹⁵⁸Met polymorphism in patients with chronic schizophrenia who completed a battery of 15 neurocognitive tests that were reduced to 4 reliable neurocognitive domain scores. The Met allele was associated with better performance in the Processing Speed and Attention (PSA) domain, but not with other domain sources measuring executive and visuo-perceptual functions, declarative verbal learning and memory, simple motor ability, or global neurocognitive function. Genotype shared approximately 11% of variance with PSA scores. The findings provide independent support for the hypothesis that the COMT Val¹⁵⁸Met polymorphism influences neurocognitive function in schizophrenia, and suggest that the functional effects may be expressed on measures of PSA, which were also enhanced significantly by novel antipsychotic treatments relative to haloperidol in the same cohort of patients who participated in a randomized clinical trial. These data suggest that PSA comprises a neurocognitive construct with convergent validation from psychometric, functional genomic, and psychopharmacologic sources. Correspondence: Robert Bilder, Nathan Kline Institute for Psychiatric Research, 140 Old Orangeburg Road, Orangeburg, NY 10962. E-mail: bilder@nki.rfmh.org

K.H. NUECHTERLEIN, K.L. SUBOTNIK, M.F. GREEN, C. YEE-BRADBURY, R.F. ASARNOW, J. VENTURA, M. GITLIN, B. SIEGEL, & J. MINTZ. Neurocognitive Predictors of Work Outcome in the Initial Course of Schizophrenia.

While the role of neurocognitive impairment in functional outcome in schizophrenia is now widely accepted based on studies of daily living skills and short-term response to rehabilitation training, surprisingly little data address the prediction of return to competitive work or school. Fur-

thermore, the predictive role of cognitive impairment early in the illness, before chronic disability is already established, is of particular interest. In a UCLA longitudinal study, we assessed recent-onset schizophrenia patients at an initial clinically stabilized outpatient point using 12 neurocognitive performance and psychophysiological response measures. Three independent factors were derived through principal components analysis: Immediate Encoding and Secondary Memory, Sensory Gating and Perceptual Discrimination, and Allocation of Attention. All patients were provided a combination of maintenance antipsychotic medication, social skills training, case management, and family education. A modified version of the Weisman Social Adjustment Scale was used to assess work outcome. Multiple regression indicates that the combination of 3 factors is highly predictive of return to work or school by 9 months after outpatient clinical stabilization. The strongest individual neurocognitive predictors of work outcome in this initial period of schizophrenia are measures of sustained attention and working memory, divided attention, and rapid perceptual encoding. These data strongly support the critical role of neurocognitive factors in successful return to work or school after an onset of schizophrenia. Correspondence: *Keith Nuechterlein, UCLA Department of Psychiatry & Behavioral Sciences Suite 2551, 300 Medical Plaza, Los Angeles, CA 90095-6968. E-mail: keithn@ucla.edu*

J. GOLD, C. WILK, R. McMAHON, & R. BUCHANAN. Cognitive Correlates of Successful Vocational Outcome in Schizophrenia.

It is widely accepted that cognitive impairment is a critical determinant of functional outcome among patients with schizophrenia. The research literature in this area has primarily focused on independent living skills and performance in rehabilitation settings. The cognitive features associated with competitive employment have rarely been studied. To address the issue of vocational disability, we studied a group of 38 patients with schizophrenia who held competitive employment (>20 hr/week, for at least 18 of the 24 preceding months), a group of 38 persistently unemployed patients, and a group of 43 healthy controls. All subjects completed an extensive cognitive battery including measures of IQ, memory, attention, language, visual perception, working memory, motor speed, and executive functions. Good outcome patients demonstrated superior performance across most cognitive domains relative to poor outcome patients. Measures of processing speed (WAIS PSI, Stroop word-reading) emerged as the most robust associate of outcome status (odds ratios >5). Executive function measures were not particularly discriminating of outcome status. Interestingly, the patient groups did not differ on multiple measures of episodic memory and visual attention with both groups demonstrating robust impairment relative to controls in these domains. The results suggest that certain cognitive impairments may mark the presence of the clinical illness across outcome groups whereas other deficits are more specifically related to the extent of vocational disability among ill patients. Such disability markers may be particularly important targets for both psychosocial and pharmacological treatment approaches.

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Symposium 17/10:45 a.m.–12:30 p.m.

AWARENESS AND ANOSOGNOSIA IN NORMAL AND PATHOLOGICAL AGING

**Organizer and Chair: Melissa Lamar
Discussant: Edith Kaplan**

M. LAMAR. Awareness and Anosognosia in Normal and Pathological Aging.

Studies of awareness of deficit in aging typically focus on Alzheimer's disease and stroke. This symposium highlights the ways in which awareness is influenced by these and other normal and abnormal aspects of the aging process. Expanding our investigation to various aging populations is

important as diminished awareness for somatosensory, cognitive or other behavioral alterations may prevent individuals from avoiding dangerous situations like driving. We begin with Lamar's discussion of the differences in neuropsychological contributions to awareness of normal slips of action and cognition. Mennemeier and Schnyer then compare normal and pathological aging. Thus, Mennemeier evaluates judgments of stimulus intensity among aging subjects, younger age cohorts and middle-aged neglect patients across a somatosensory perceptual continua while Schnyer assesses the role of prefrontal cortex in judgments of memory for patients with frontal lesions and matched controls. The final presenters focus on specific neurodegenerative disorders affecting older adults. Thus, Bowers assesses anosognosia in Parkinson's disease with a focus on the influence of laterality and understanding the subtle nuances of unawareness in this population. Kaszniak compares various methods for assessing awareness of deficit in Alzheimer's disease within the context of distinct theoretical constructs. Serving as discussant, Kaplan adds her clinical expertise to the topic of insight and aging.

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M. LAMAR, P.T. COSTA, & A.B. ZONDERMAN. Contributors to Errors of Action and Cognition in Normal Aging.

Traditionally, studies investigating anosognosia or lack of awareness focus on patient populations unaware of sensorimotor or cognitive limitations. Little work has been done to understand awareness of everyday errors committed by healthy individuals. The goal of the present research was to investigate the neuropsychological contributors to awareness in normal aging participants. We gave the Cognitive Failures Questionnaire (CFQ) to 112 Baltimore Longitudinal Study on Aging participants 55 and older (age = 71.7 ± 8.9 ; MMSE = 28.8 ± 1.2) in conjunction with measures of cognition and personality. A collateral source (CS; $n = 112$), typically a relative, completed a similar CFQ questionnaire pertaining to the participant. We calculated CFQ self-report scores (SR; 34.1 ± 10.5) as well as a discrepancy score (CS minus SR; -4.5 ± 13.7). Separate regression analyses for SR and discrepancy scores revealed differences in neuropsychological contributions to score variance after accounting for age and general intelligence. Only NEO PI-R Conscientiousness significantly contributed to SR score variance (34% of variance) while WAIS-R Digit Span-Forward (simple attention; 20%) and NEO PI-R Extraversion (12%) contributed to discrepancy score variance. These CFQ indices reflect different aspects of awareness, one related to the internal motivation that may influence errors of action and the other to the social context in which an individual commits such errors.

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M. MENNEMEIER, T. KRETZMER, H. MURPHY, G.R. JEWELL, & T. NUNN. Mental Representations of Stimulus Intensity in Neglect and Normal Aging.

Perception of stimulus intensity depends on the formation of mental representations of stimulus intensity. Normally, perceived intensity is a power function of physical stimulus magnitude. Patients with neglect demonstrate altered power functions when estimating stimulus intensity relative to age-matched normal control subjects. These deficits can not be explained by impaired attention. We hypothesize that mental representations of stimulus intensity are normally formed by the brain system implicated in neglect. Aging might also negatively impact brain systems that form mental representations of stimulus intensity. In our behavioral experiments, elderly subjects often perform like patients with neglect, though to a lesser degree. To learn if aging alters perception of stimulus intensity, we asked 2 groups of normal subjects (M ages 71.8 and 27.4 years, respectively) to judge the intensity of stimuli across 12 different perceptual continua. The method of magnitude estimation was used. Power function exponents were compared between the 2 groups of normal subjects and

with those of neglect patients (M age 47.5 years). Exponents were lower for elderly than young normal subjects (71% of comparisons). Patients with neglect produced lower exponents than elderly normal subjects. Whereas somatosensory perceptual continua, such as tactile pressure, temperature and proprioception, tended to be altered in normal elderly subjects, all types of perceptual continua were altered in patients with neglect. Mental representation of stimulus intensity are altered by aging and neglect but the alteration is more pervasive and exaggerated in neglect.

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D.M. SCHNYER, M. VERFAELLIE, G. LAFLECHE, J.K. PANNU, & A.W. KASZNAK. Localizing Judgments of Memory Ability in the Prefrontal Cortex: Evidence From Patients With Frontal Lesions.

A growing number of experimental studies have demonstrated impairment in judgments of memory functioning in patients with lesions to frontal cortex. This, and theories of frontal functioning, have led many investigators to suggest a critical link between prefrontal cortex (PFC) and metamemory. While some studies have suggested a right hemisphere focus, there still is not clear evidence that a particular region of PFC is responsible for these abilities. Our current investigations focus on identifying the critical regions of frontal cortex associated with judgments of memory functioning. In one set of studies, patients with frontal lesions engaged in a new episodic learning task, during which they made both prospective judgments of their recall performance and predictive judgments of recognition performance. Patients were equally impaired on both of these judgments, relative to matched controls. While there were strong correlations between the 2 abilities in patients, no such correlation was evident in normal controls. Finally, in the patient group, tests of frontal function that are related to the production, maintenance and manipulation of information were not related to either the accuracy of prospective or predictive judgments while performance on a test of complex concept formation (WCST) was highly correlated with the accuracy of both. There was a great degree of variability among our patients in both memory and metamemory abilities. We are currently engaged in lesion analysis that promises to provide greater information about whether memory and metamemory abilities can be dissociated as well as identifying regions of frontal cortex critical to metamemory judgments.

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D. BOWERS & B. LERITZ. Awareness Deficits in Parkinson's Disease.

The hallmark features of Parkinson's disease (PD) include specific motor and cognitive deficits and associated impairments in activities of daily living (ADL). Reports of anosognosia in PD have also been documented, with unawareness of motor, cognitive, and social impairments. Thus far, findings of anosognosia in PD have been inconsistent across studies. This presentation will address several key questions: What factors predispose the development of unawareness in PD? Does lack of insight directly correlate with severity of frontal lobe dysfunction or more broadly to cognitive deficits in general? Is lack of awareness in PD domain-specific (i.e., motor vs. cognitive)? Are patients with right versus left hemiparkinsonism more likely to demonstrate anosognosic symptoms? What are the possible mechanisms underlying awareness deficits in Parkinson's disease? Is disruption between subcortical/cortical circuitry secondary to depleted dopaminergic innervation of frontal lobe systems the key mechanism? Ongoing work in our laboratory has suggested that although nondemented PD patients do not demonstrate frank anosognosia, there may be subtle symptoms of unawareness that are specific to side of handedness. The importance of laterality investigations, as well as systematic studies of PD patients at varying stages of illness in order to more accurately determine the role of insight in the disease will be discussed.

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A.W. KASZNAK & L.M. DUKE. Assessing Awareness of Deficit in Persons with Alzheimer's Disease: Method and Theory.

Neuropsychological studies of awareness of deficit in persons with Alzheimer's disease have employed various methodologies, including (1) comparisons of patient self-report and relatives' ratings of patient disability; (2) evaluation of the accuracy of patients' performance predictions for specific cognitive tasks; and (3) feeling-of-knowing paradigms. Conclusions about the presence and degree of impaired awareness of deficits have varied across published studies, and may be dependent upon the particular method employed, since different methods provide information relevant to different theoretical constructs concerning the nature of metamemory impairment. This presentation reviews results of recent cross-sectional and longitudinal studies conducted in our laboratory, comparing different methods. In this review, an emphasis is placed on what each method reveals about three distinguishable theoretic constructs: (1) knowledge about how memory functions and the utility of different strategies in memory tasks; (2) memory self-monitoring (i.e., awareness of the current state of one's own memory system); and (3) self-referent beliefs about memory (memory self-efficacy beliefs).

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Poster Session 10/11:00 a.m.–12:15 p.m.

COGNITIVE AND NEURAL CHANGES IN AD

J. TAYLOR, J. ROSENBLUM, B. OTT, & W. HEINDEL. Semantic Processing and Word-Stem Completion Priming in Alzheimer's Disease.

Alzheimer's disease (AD) patients are frequently impaired on verbal priming tasks such as word-stem completion. This impairment could be due either to an inability to activate intact semantic representations or to a degradation of the semantic representation itself. To examine this issue, AD patients and age-matched normal controls (NC) were given a word-stem completion task under two study conditions: the standard single-word condition with a likeability judgment task, and a paired-word condition with a relatedness judgment task intended to promote semantic processing. Within each condition, target words were grouped by semantic set size: small (10 or fewer associates) and large (14 or more associates). In the standard single-word condition, the AD group primed significantly less than the NC group. Moreover, the magnitude of priming was affected by the semantic set size only in the NC and not the AD group, suggesting that AD patients did not engage in semantic processing to the same extent as NC subjects. In the paired-word condition, the AD and NC groups displayed equivalent magnitudes of priming. Both groups also displayed greater priming for words with a large semantic set size, suggesting that the relatedness judgment task induced both groups to engage in comparable levels of semantic processing. These results suggest that the AD priming impairment may be due in part to a failure to engage in spontaneous semantic processing, and that this impairment can be reduced or eliminated by forcing patients to attend to semantic information during study.

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J. BLACKBURN & L. MURRAY. Language and Cognition in Healthy and Impaired Adults: Educational Influences.

This study examined the relationship between education level and the language, attention and memory test performance of three age-matched groups of elderly adults: 15 with depression, 13 with early Alzheimer's disease (AD) and 11 healthy controls. Subjects completed a battery of tests measuring (1) language, including basic (Arizona Battery for Communication Disorders of Dementia) and complex language skills (Test of Language Competence–Extended Version); (2) auditory and visual attention, including sustained, selective, and divided attention (Attention subtest of the Dementia Rating Scale; DRS and 7 Test of Everyday Attention

subtests); and (3) memory, including short-term (DRS Memory subtests) and working memory (Auditory Working Memory Task). There were significant correlations between education and basic and complex language skills, working memory, and sustained visual attention tasks when all subjects were analyzed. When individual groups were analyzed, only the depressed and normal groups continued to show significant correlations between education and language and working memory tests. Depressed subjects also showed significant correlations between education and both visual and auditory attention tasks. There were no significant correlations between education and test performance for the early AD group. These results indicate that education is strongly related to performance on language and working memory tasks, but less consistently to measures of attention among healthy and depressed elderly adults. In contrast, even in the early stages of AD, education level does not appear to influence outcomes on basic or complex tests of language, memory, or attention. Clinical implications of these findings will be discussed.

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J. PAXTON, G. PEAVY, C. JENKINS, V. RICE, & D.P. SALMON. Deterioration of Visual Organization Ability in Alzheimer's Disease.

Although deterioration of higher-order visual information processing abilities occurs in Alzheimer's disease (AD), few cross-sectional or longitudinal studies have systematically examined this deficit. The performance of 155 AD patients (M MMSE = 22.49; SD = 3.44) and 100 matched normal control (NC) subjects were compared on a structured test of visual organization ability, the Hooper Visual Organization Test (VOT). Both the raw VOT score [$t(255) = 11.74, p < .01$] and a derived score that corrected for anomia [$t(255) = 10.56, p < .01$] were significantly lower for AD patients than for NC subjects, but neither score was particularly effective at distinguishing between the groups (best score: sensitivity = 81%; specificity = 80%). The derived VOT score proved a more effective measure of visuospatial functioning than the VOT raw score as it loaded with other visuospatial tests in a principal components analysis while the raw score loaded with language tests. The VOT was sensitive to severity of dementia in the AD patients (derived score vs. Mattis DRS: $r = .48, p < .001$). Longitudinal assessment of 38 AD patients and 48 NC subjects revealed significant decline over 1 year in the VOT scores of AD patients, but not NC subjects [Group \times Year interaction for derived score: $F(1, 84) = 15.64, p < .01$]. These results indicate that higher-order visual information processing is impaired in patients with AD and gradually deteriorates with disease progression. However, this deficit may not be a particularly salient early marker of the disease.

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N. RIEFFEL & A. BERARDI. Executive Functions in Early Dementia of the Alzheimer Type and Healthy Aging.

The objective of this study was to determine whether different aspects of executive function are affected in mild DAT. Three aspects of executive function were evaluated within the same subjects: concept formation, planning and cognitive flexibility. Eighteen mild DAT patients (MMSE range: 17–29) and 21 healthy elderly controls, matched on age, education, overall health and depression, participated in this study. Executive functions were evaluated using Raven's Coloured Progressive Matrices, Porteus Mazes and Stroop Color-Word tests. Results were analyzed using ANOVAs with one between-group factor (mild DAT vs. healthy elderly controls) and one within-group factor (the score on each test). Mild DAT patients had lower scores than healthy elderly controls on all tests of executive function, namely concept formation (Raven's Progressive Matrices Correct Responses, $M \pm SD$: 18.83 \pm 5.15 vs. 26.81 \pm 4.07, $p = .0001$), planning (Porteus Mazes Age: 10.69 \pm 3.53 vs. 15.52 \pm 2.18, $p = .0001$) and cognitive flexibility (Stroop Words: 81.77 \pm 13.5 vs. 89.75 \pm 12.36, $p = .18$; Stroop Colors: 50.44 \pm 9.95 vs. 65.83 \pm 13.58, $p = .009$ and Stroop Interference: 16.44 \pm 8.17 vs. 28 \pm 7.67, $p = .003$). The findings show that different aspects of executive function are impaired in mild DAT

relative to healthy elderly controls and suggest that the evaluation of executive functions may be useful in the early diagnosis of DAT.

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T. GORANSON & R. GRAVES. Assessing Analogical Reasoning and Abstract Thinking in Alzheimer's Dementia.

A series of abstract thinking and reasoning tasks was administered to patients with Alzheimer's disease (AD) and a sample of nondemented older adults matched on age, education, and gender variables. The performance of the AD patients was inferior to control participants on all verbal and nonverbal reasoning tests, including a newly developed test of analogical reasoning, the Goranson Analogy Test (GAT). Preliminary psychometric analyses of the GAT revealed very high internal consistency, good convergent and divergent validity, and adequate predictive validity. Further analyses revealed that reasoning with pictures was just as easy as reasoning with words for AD patients, indicating that modality of presentation has little effect on reasoning performance. Taken together, the findings suggest that abstract thinking and reasoning abilities decline with the onset of Alzheimer's dementia. A neurocognitive model of analogical reasoning is proposed to account for the study findings.

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J.B. RICH & T. LUBINSKY. The Relation of Visual Form Discrimination Performance and Attention in Aging and AD.

Alzheimer disease (AD) patients' impairments on the Visual Form Discrimination Test (VFDT), a visuo-perceptual matching task, has been attributed to attentional inefficiency because the task makes no demand on episodic memory or construction. One would predict, therefore, that scores on attention and VFDT would be related. Conversely, if visuo-perceptual impairment is itself an early symptom of AD, then performance on the VFDT should be related to other aspects of mental status. We administered the VFDT and MMSE to 20 patients with probable AD (M age = 75; M educ = 11) and 140 healthy participants (M age = 73; M educ = 12). Two scores were derived for the MMSE: an attentional score, based on orientation, registration, and serial 7s (max = 18), and a nonattentional score based on the other items (max = 12). The patients were impaired on both tests, $ps < .001$. Total MMSE scores were significantly related to VFDT scores in both groups (AD: $r = .422$; NC: $r = .228$). Attention was related to VFDT performance in the AD group, $r = .442, p = .05$, but only the nonattentional MMSE subscore correlated with VFDT performance among the controls, $r = .211, p = .013$. Visuo-perceptual matching appears unrelated to attention in healthy aging but is significantly associated with higher-order aspects of mental status. In contrast, impaired VFDT performance in mild–moderate AD is associated with attentional impairments. Rehabilitation of basic attention skills may ultimately benefit visuo-perception and other abilities in AD patients.

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J. HIGGINS, R. McGLINCHEY-BERROTH, & W. MILBERG. Early Attentional Processing in Patients with Alzheimer's Disease.

Spatial orienting was investigated in patients diagnosed with Alzheimer's disease (AD) and healthy older adults (OA). A modified version of the target detection task employed by Stuss and colleagues was employed. There were three conditions: facilitation, interference, and negative priming. In the facilitation condition, the target appeared in the same location as on the previous trial; in the interference condition, participants were asked to locate the target in the presence of a distractor; and in the negative priming condition, the target appeared in the same location occupied by the distractor in the previous trial. To date, data have been collected from 15 OA's and 6 AD patients. Compared to the OA group, the AD group showed less of a facilitation effect (AD = 7 ms, OA = 17 ms), less

interference (AD = -23 ms, OA = -46 ms) but approximately equal negative priming (AD = -28 ms, OA = -30 ms) than the OA group. These data suggest that selective attentional processes involved in spatial orienting may be impaired in AD.

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E. FESTA-MARTINO, R. INSLER, D.P. SALMON, J. PAXTON, J. HAMILTON, & W. HEINDEL. Impaired Sensory Integration in Alzheimer's Disease.

Alzheimer's disease (AD) is associated with higher-order cognitive deficits due in part to the systematic disruption of corticocortical connections within neocortex. This study investigates whether this functional disconnection extends into the lower-level perceptual domain by comparing AD patients' ability to integrate visual information both within and across distinct sensory channels. In a global motion coherence paradigm, AD patients, age-matched normal control (NC) subjects, and dementia-matched Huntington's disease (HD) patients were shown dynamic dot stimuli consisting of coherent leftward or rightward motion of variable strength embedded within random visual noise. We examined the differential effect on direction discrimination of 2 surface feature cues processed within distinct neural pathways: (1) *luminance contrast*, processed within the same magnocellular pathway mediating motion perception; and (2) *hue*, processed separately within the parvocellular pathway. Both AD and NC groups exhibited enhanced discrimination when signal and noise dots were distinguished by luminance contrast polarity, indicating both groups were able to integrate information within a single sensory channel. In contrast, only the NC but not the AD group displayed enhanced discrimination when signal and noise dots were distinguished by hue, indicating that the NC but not the AD group was able to integrate information across sensory channels. The HD group displayed enhanced discrimination in both cue conditions, similar to the NC group, indicating that this deficit is not attributable to dementia generally but is specific to AD. These findings suggest that AD patients are unable to integrate visual information located in physically and functionally discrete cortical areas. Correspondence: *William Heindel, Department of Psychology, Brown University, 89 Waterman St., Box 1853, Providence, RI 02912. E-mail: William_Heindel@Brown.Edu*

S. LANDRY, T. ATCHISON, & P.J. MASSMAN. Two Measures of Anosognosia in Alzheimer's Disease: Relationship to Caregiver Burden, Patient Depression, and Function.

Family at home cares for most AD patients, thus caregiver burden is important. The patient's level of anosognosia is believed to impact caregiver burden, though support has been inconsistent for this finding. The difficulties measuring anosognosia may account for this inconsistency. The Anosognosia Questionnaire-Dementia (AQD) employs a discrepancy between patient and caregiver report of function to determine awareness. The dual prediction paradigm is a theoretical measure of anosognosia derived from memory testing (HVLt-R Delayed) and quantifies anosognosia using a statistical ratio (CPAd). Twenty-eight subjects from the ADRC at Baylor College of Medicine diagnosed with probable AD and their primary caregivers were assessed. Patient functioning was measured using the MMSE, Physical Self Maintenance Scale (PSMS), Instrumental Activities of Daily Living (IADL), and Geriatric Depression Scale (GDS). Caregiver burden was assessed using the Caregiver Burden Questionnaire (CGBQ). The AQD score was found to correlate significantly with MMSE, PSMS, and IADL scores, but not with CGBQ or GDS. The CPAd statistic showed a significant relationship with the CGBQ scores and a trend with GDS scores, but was not associated with MMSE, PSMS, or IADL measures. These findings suggest that the AQD may be influenced by the caregiver's assessment of the patients general cognitive and physical functioning rather than awareness. CPAd is unrelated to general cognitive function and is related to increasing caregiver burden and decreasing patient depression as would be expected for an awareness measure.

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T. ATCHISON & P.J. MASSMAN. Anosognosia for Memory Deficits in AD Patients: Measurement Issues and Neuropsychological Correlates.

Anosognosia is a commonly occurring condition in Alzheimer disease (AD) patients. However, researchers are in disagreement as to the neuropsychological correlates of anosognosia with deficits having been found in right hemisphere function, frontal lobe function, and procedural learning in varying studies. In these studies measurement of the construct anosognosia has been conducted with differing measurement procedures and little is known about how these differences affect the findings. Twenty-eight patients with probable AD and their primary caregiver were enrolled in the study. Patient anosognosia was measured by the discrepancy between the patient and caregiver report of patient function and by a dual prediction paradigm at immediate and delayed recall, where both the patient and the caregiver's prediction and actual memory performance are considered. Patients classified as unaware varied according to the method of measurement. Only 2 significant group differences in neuropsychological function were found. On the Graphic Pattern Generation (perseveration score) patients considered unaware on the dual prediction paradigm at immediate recall produced more perseverations than aware patients. Second, on a procedural learning task (pursuit rotor), patients considered unaware on the dual prediction paradigm at delayed recall exhibited less efficient learning. Only the second finding remained significant when variance accounted for by general cognitive impairment was removed. It appears more work is needed to understand the measurement of anosognosia before any firm conclusions can be drawn about how it relates to neuropsychological function. Without reliable measurement of the construct it is difficult to draw firm conclusions about relationships with neuropsychological measures.

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G. ARNOLD, J. CAOILE, J.G. BUCKWALTER, & S. MCPHERSON. Association Between Apathy and Executive Dysfunction in Alzheimer's Disease.

Apathy is a common neuropsychiatric disturbance in Alzheimer's disease (AD). Although both apathy and deficits in executive functioning are associated with frontal lobe dysfunction, few studies have explored the relationship between apathy and executive dysfunction in AD. Seventeen AD patients and 18 healthy older adults were matched for age and education and assessed for apathy and executive dysfunction using the Neuropsychiatric Inventory (NPI) and standard neuropsychological measures. Only AD patients showed symptoms of apathy, [$\chi^2(1, N = 16) = 6.56, p = .01$]. Patients with apathy had more difficulty benefiting from feedback [Wisconsin Card Sorting Test: $t(14) = -2.57, p = .02$], and inhibiting automatic responses [Stroop Color Interference Test: $t(13) = -2.39, p = .03$]. Performance on a measurement of self-monitoring (Ruff Figural Fluency perseverations) was associated with apathy severity [$r(15) > .56, p < .02$]. There was no significant difference in depression scores on the NPI or the Geriatric Depression Scale between patients with and without apathy. Anterior cingulate dysfunction may be implicated in the association between apathy and specific executive functioning deficits.

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J. MACOIR, T. AUDET, X. SERON, & J. BERNIER. The Breakdown of Number Transcoding in the Early Stages of Alzheimer's Disease.

Support for an early impairment of calculation abilities and numerical knowledge in the early stages of dementia of the Alzheimer's type (DAT) has recently been provided. A few single-case and group studies also reported that DAT patients frequently show problems in number transcoding, a cognitive activity that transforms a numeral presented in 1 numerical code (e.g., Arabic code 25) into another code (e.g., written verbal code TWENTY-FIVE). In transcoding tasks, these patients produced various error types, among which intrusions were the most striking. These errors consisted in the intrusion of the input code into the response (e.g., one

hundred and fourteen → one hundred 14). In the present study, we investigated number processing abilities in 26 patients with a mild form of DAT and compared them to the performance of 26 healthy control subjects (CS). DAT patients performed lower than CS on all tasks exploring number comprehension and production, calculation and numerical judgement. They were severely impaired in number transcoding tasks, particularly when they were required to transcode written verbal numerals into their corresponding Arabic form and *vice versa*. As compared to CS, the proportion of lexical and syntactic errors in these tasks was significantly greater. More interestingly, they also frequently produced intrusion errors, an error type almost absent in the CS group. These results confirm that number transcoding was affected early in DAT and suggest that the introduction of number transcoding tasks in neuropsychological evaluation protocols should be of great diagnostic value.

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M.F. DULAY, P.J. BARR, D.P. SALMON, & C. MURPHY. Assessment of Independent and Common Effects of Alzheimer's Disease on Cognition.

Research suggests that a single common factor may explain the pattern of deficits in neuropsychological test performance associated with Alzheimer's disease (AD); however, other studies suggest that the pattern may reflect the direct effects of AD on independent cognitive domains. While neuropsychological tests presented in the visual and auditory modalities have been used to address this question, use of the olfactory modality has not been investigated. Olfaction is particularly pertinent because tests of olfactory functioning are highly sensitive to neurodegeneration associated with AD. The present study used structural equation modeling to examine the extent to which there were independent or common effects of AD on cognitive tasks presented in the olfactory, visual and auditory modalities. Cross-sectional data from 123 patients with AD and 132 nondemented older adults were analyzed. Longitudinal data (retest ranged between 12–35 months) from a subset of patients with AD ($N = 57$) were analyzed to determine whether the pattern would change as a function of time. Cross-sectional analyses indicated that a single common factor accounted for the pattern of deficits among most of the cognitive variables, but AD also had a direct effect on memory independent of a common factor. The direct effects associated with AD were consistent across measures of visual, verbal and olfactory episodic memory. Longitudinal analyses indicated that pattern of independent and common effects of AD on cognitive functioning remained constant as a function of time.

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K. YAMAMOTO, J.D. EVANS, K.E. JOHNSON, & F.W. UNVERZAGT. Clinical Utility of IU Token Test in the Diagnosis of Dementia.

Background: Neuropsychological tests are critical for the early detection of cognitive decline associated with Alzheimer's disease (AD). We report on the utility of IU Token Test (IUTT) as part of the CERAD neuropsychological battery. *Method:* Participants were drawn from the database of the Indiana Alzheimer Disease Center and included 50 mild AD patients and 50 healthy controls individually matched to the patients on age and education. The IUTT is a multidimensional measure of working memory, language comprehension, and visual-motor-spatial integration. Subjects are read a series of 12 commands varying in complexity that require pointing to figures that vary in shape, size and color (score range: 0–24). *Results:* AD patients and controls did not differ in age and education ($p > .10$). Patients averaged 73.9 years of age, 13.1 years of education, and 23.2 on the MMSE. Patients performed significantly below the controls on all CERAD subtests (all $ps < .01$) and the IUTT [$M = 20.9 \pm 3.1$ vs. $M = 23.3 \pm 1.1$; $t(98) = -5.0, p < .001$]. The sensitivity of each subtest was determined using the 7th percentile of controls as a cut-off. IUTT had the second highest sensitivity (46% of patients correctly classified) after Word List Delayed Recall (100% correctly classified). *Conclusions:* The IU

Token Test had fair sensitivity to AD, being 2nd only to the memory measure of the CERAD battery. The results demonstrated clinical utility of the IU Token Test in the differential diagnosis of memory loss in the elderly.

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D.F. REXROTH, S. GAO, M.R. FARLOW, & F.W. UNVERZAGT. Incremental Validity of CERAD Constructional Praxis Recall in Diagnosing Alzheimer Disease.

Background: Previous research has shown the Consortium to Establish a Registry of Alzheimer's Disease (CERAD) Constructional Praxis Delayed Recall (CPDEL) to be a significant predictor in the diagnosis of Alzheimer disease (AD). We report on the incremental diagnostic utility of CPDEL over the currently known best single indicator, Word List Delayed Recall (WLDEL). *Method:* Participants were AD patients and healthy controls over age 65 with a complete CERAD and CPDEL data from the Indiana Alzheimer Disease Center. CPDEL is free delayed recall of the 4 geometric figures of CERAD Constructional Praxis, scores range from 0–11. *Results:* The AD patients ($n = 90$) were significantly older ($M = 76.1$ vs. 71.9 years) and less educated ($M = 12.2$ vs. 14.8 years) than controls (both $ps < .001$). As a group, the patients were mildly to moderately affected ($MMSE = 18.4 \pm 6.2$). Logistic regression was used to determine the incremental validity of CPDEL. Age and education were entered in a block as a first step. In a second step, WLDEL and CPDEL were entered using forward selection with likelihood-ratio. CPDEL independently predicted diagnostic status after accounting for age, education, and WLDEL ($\chi^2 = 4.2, df = 1, p = .04$). The inclusion of CPDEL increased the correct classification from 96.3 to 98.1%. *Conclusions:* Constructional Praxis Delayed Recall contributes unique information in the differential diagnosis of Alzheimer disease and normal aging. This study supports the incremental validity of Constructional Praxis Delayed Recall in the CERAD battery. Correspondence: *D.F. Rexroth, Department of Psychiatry, Indiana University School of Medicine, 550 N. University Boulevard, Suite 3124, Indianapolis, IN 46202. E-mail: drexroth@iupui.edu*

M. KNOX, M. CULLUM, L. LACRITZ, K. SAINÉ, A. LIPTON, M. WEINER, & R. ROSENBERG. Neuropsychological Algorithms in the Diagnosis of Alzheimer's Disease.

Memory dysfunction is a hallmark feature of Alzheimer's disease (AD), although the clinical presentation of the disorder varies, involving deficits in a variety of cognitive domains. Whereas no single neuropsychological test can be sensitive to all cognitive phenotypes, combined qualitative and quantitative features within and across tests may be most useful for diagnostic purposes. To test this hypothesis, we examined a diagnostic neuropsychological algorithm derived from selected scores of 8 common tests/domains: Dementia Rating Scale, Verbal Fluency, Trail Making Test–B, Boston Naming Test, WAIS–3 Digit Span (forward and backward), CVLT (various scores), WMS–3 Logical Memory, and WMS–3 Visual Reproduction. Cut points to determine *impairment* for each test or combination of tests were established based upon existing literature. Subjects included 46 patients with a diagnosis of probable AD (M age = 72, education = 14 years) and a group of 168 healthy controls (M age = 69, education = 14 years). Using the criterion of impairment on 3 or more of the 8 test scores resulted in correct classification of 97.83% of AD subjects and 98.8% of controls. No controls showed impairment on more than 3 indices, and none of the AD subjects showed impairment on less than 2. Results support the utility of a neuropsychological algorithm approach in the diagnosis of AD.

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K.L. MEDINA, R.M. BUSCH, K.M. FARRELL, M. SHIDLER, & R. KRİKORIAN. Neuropsychological Predictors of Dementia in Community-Dwelling Older Adults.

The Clinical Dementia Rating Scale (CDRS) is a widely used instrument for categorizing dementia status that has prognostic value with respect to

progression of neurodegenerative disorders. The CDRS assessment is based on everyday functional capability as opposed to mental status testing. The purpose of this study was to examine the relationship between performance on neuropsychological tests of cognitive abilities and scores on the CDRS. Fifty elderly men and women (M age = 72; range = 57–85) were recruited from the community through print advertisements. None of the participants was living in assisted living or nursing home settings. Twelve percent of the participants were categorized as mildly demented, 68% as questionably demented, and 20% as not demented according to the CDRS. Significant bivariate relationships were observed between the CDRS scores and verbal attention ($p < .01$), word fluency ($p < .04$), and verbal memory ($p < .05$). Multivariate predictors of CDRS category scores included age ($p < .03$), gender ($p < .05$), verbal attention ($p < .09$), semantic fluency ($p < .006$), spatial construction ($p < .002$), and verbal memory ($p < .02$). Thus, performance on the overall neuropsychological protocol and several specific tests predicted dementia status as assessed by the CDRS among community-dwelling older adults. These results provide support for the use of the CDRS as a brief and valid evaluation and staging instrument for dementia in the elderly and suggest that it can be used in lieu of more comprehensive neuropsychological testing in less impaired individuals.

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C. ROSS, B. HALLAM, J.G. BUCKWALTER, E. BIGLER, & W.S. BROWN. Regional Callosal Changes in 3 Forms of Dementia.

The corpus callosum (CC) has been shown to degenerate in Alzheimer's disease (AD). However, most of the previous research has used small subject groups, did not compare AD with other forms of dementia, and/or identified CC subregions based on geometric proportions. This study investigated regional morphology of the CC in differing types of dementia: AD, vascular dementia (VaD), mild ambiguous (or mild cognitive impairment; MA/MCI), and healthy elderly controls. The participants were 189 individuals from the Cache County, Utah study. Ninety-nine width measures were derived, and a factor analysis was used to determine subregions. Results demonstrated that overall CC area was significantly smaller in AD ($t = 2.10, p < .001$) and VaD ($t = 2.10, p < .04$) when compared to the control group. For the AD group, the CC was significantly smaller than the control group in the 3 most anterior subregions (the genu), and 2 of the 3 most posterior subregions (the splenium), but not significantly different throughout the midbody. Similarly, in the VaD group the CC was significantly smaller in the 2 most anterior, and 2 of the 3 most posterior regions. While the CC of the MA/MCI group was not significantly different from the controls in overall area, the CC was significantly smaller in 2 regions of the genu and 1 region of the splenium. These data confirm CC degeneration in AD, focus attention on CC fibers from frontal and temporal-parietal cortex, and demonstrate similar forms of degeneration in AD, VaD, and MA/MCI.

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C. CLASON, B. HALLAM, J.G. BUCKWALTER, & W.S. BROWN. Regional Callosal Size: Visual Construction and Mental Control in Dementia.

This study examined the relationship between the size of subregions of the corpus callosum (CC) and neurocognitive performance in Alzheimer's disease (AD). AD presents a unique opportunity for studying structure-function relationships in callosal channels due to the nonuniform decline that occurs both morphologically and cognitively. MRI's of 18 right-handed AD patients (MMSE > 13) were analyzed. In this report, sizes of 7 callosal subregions were correlated with performance on a measure of visuoconstructive functioning and the Weschler Memory Scale–Mental Control. The 7 subregions of the CC were summations of subsets of 99 midsagittal width measures based on the subregions identified by Cowell et al. from a factor analysis of a similar set of 99 widths. It was hypoth-

esized that functional channels mediating cognitive performance would be detectable in correlations between neurocognitive performance and callosal subregion size. Strong trends suggested that a larger size of the second anterior CC region is related to better performance on both the visuoconstructural ($r = .342, p = .179$) and mental control tests ($r = .416, p = .086$). These results are particularly important when taken in conjunction with results from the same study reported by Hallam et al. indicating that performance on the Boston Naming Test was negatively correlated with the most anterior region of the CC and verbal fluency was positively correlated with the anterior midbody. Thus, specific domains of cognitive decline in AD are associated with regional changes in CC size.

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M. FEARING, C.R. HANNAN, J. WHITE, J. MORTENSEN, S. RICE, D. TATE, & E.D. BIGLER. Dementia, Cerebral Atrophy, and Neuropsychological Performance: Relationship to APOE- ϵ 4.

Background and objectives: In the Cache County epidemiological study of memory and aging, presence of the ϵ 4 allele of the apolipoprotein E (APOE) was found to be a significant risk factor for Alzheimer disease (AD) and earlier onset of the disease. In the current study we examined subjects from this population with known APOE genotypes to determine if presence of ϵ 4 was related to any unique patterns of brain atrophy, with particular emphasis on the temporal lobe. **Methods:** MRI volumes of the total brain, parahippocampal gyri, fusiform gyri, and hippocampus were obtained in 169 subjects with AD, vascular dementia (VaD), a mild ambiguous group, and a group with mixed neuropsychological disorders. Right, left, and total volumes were examined. **Results:** Based on partial correlations controlling for total intracranial volume, age, sex, education, and level of cognitive impairment using the Mini-Mental Status Exam, a significant difference was found in total hippocampal volume ($F = 4.87, p < .05$) comparing all subjects with at least 1 ϵ 4 allele to those without. However, no significant differences were found that related to ϵ 4 presence between different diagnostic groups nor with cognitive performance on an expanded CERAD neuropsychological battery. **Conclusions:** While presence of ϵ 4 was associated with smaller hippocampal volume across all subjects, it was not specific to a diagnostic group. The relationship between quantitative neuroimaging findings in dementia with and without the ϵ 4 allele and cognitive deficits will be discussed.

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J. WHITE, J. MORTENSEN, C.R. HANNAN, M. FEARING, D. TATE, & E. BIGLER. Performance on the Logical Memory Measure and Temporal Lobe Atrophy.

Background: The LM subtest of the Weschler Memory Scale–Revised is a measure of memory for stories. While impaired performance is associated with dementia, how poor LM performance relates to structural changes with dementia is not yet fully understood. **Method:** MRI analysis was conducted on 20 control, 62 Alzheimer's disease, 16 vascular dementia, 30 mild ambiguous, and 32 mixed neuropsychiatric subjects. Diagnoses were established by a consensus diagnostic approach. Structures measured included the total temporal horn volume (an indication of general temporal lobe atrophy), total hippocampal volume, and volumes of the parahippocampal gyri, and the fusiform gyri. **Results:** Based on the total information recalled, hippocampal volume was positively correlated with both the immediate ($r = .24, p = .002$) and delayed recall ($r = .25, p < .002$), and the total temporal horn was negatively correlated with immediate ($r = .15, p = .023$). Moreover, immediate and delayed recall was positively associated with the combined volume for the right and left side of the parahippocampal gyrus, hippocampal volume, and fusiform gyrus ($r = .26, p = .001, r = .25, p = .003$, respectively). **Conclusion:** In cases of dementia, these findings indicate LM performance is associated to the degree of temporal lobe atrophy, where atrophy of the hippocampus and mesial temporal lobe demonstrated the most robust relationships.

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R.S. MACKIN, D.M. MUNGAS, J.H. KRAMER, B. BETZ, & B.R. REED. Volumetric MRI Measures Correlate With Intrusion Errors on Memory Testing.

Intrusion errors (nontarget responses word list recall) are associated with Alzheimer's disease (AD). Their pathogenesis, and what factors may modify or predict their presence, are not clear. One account is that AD patients exhibit reduced inhibitory processing. However, patients with vascular dementia appear to produce fewer intrusion errors than AD patients despite hypothesized frontal lobe dysfunction. We analyzed relationships between structural brain pathology, specifically hippocampal volume (HV), cortical gray matter (CGM), volume of lacunes (LV), and white matter lesions (WML), and intrusion errors. The sample consisted of 313 individuals, of whom 48% were cognitively normal, 19% cognitively impaired not demented, and 32% demented. Subjects came from a prospective study of vascular contributions to dementia; cortical strokes and non-AD or vascular causes of cognitive impairment were excluded. MRIs were research studies, obtained under a single protocol. Intrusions errors (IE) were defined as the total count of intrusions across short and long delay, free and cued recall trials (4 trials total) of a 12-word list, normalized to total correct recall across those same trials. As expected, IE was higher in the demented group than the other groups ($p < .0001$), which did not differ from each other. Neither age, education, nor gender was significantly correlated with IE. Regression analyses of MRI data found significant univariate relationships between IE and CMG ($R^2 = .06$), WML ($R^2 = .03$), and HV ($R^2 = .19$). Multiple regression revealed that only HV had an effect that was independent of the other MRI variables. Although IE correlated moderately with initial learning (total acquisition) on the memory list, the effect of HV on IE was unchanged when total acquisition was added to the model. These results suggest that IE may be a marker for hippocampal atrophy (which is likely associated with AD); we found essentially no evidence that cerebrovascular disease, as measured by WML and LV, directly affects the production of intrusion errors.

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K.K. ZAKZANIS, S.J. GRAHAM, & Z. CAMPBELL. Structural and Functional Imaging of Alzheimer's Disease: A Meta-Analytic Review.

We conducted a quantitative review of the imaging literature using meta-analytic methodology to characterize further the magnitude of hippocampal deficit in probable Alzheimer's disease (AD) and to determine whether other neuroanatomic structures in AD can better discriminate the disease from normal aging. Additionally, we parceled the discriminability of neuroanatomic structures by duration of disease to determine those structures most sensitive to AD in its early and late stages. One hundred twenty-one studies published between 1984 and 2000 met criteria for inclusion in the present analysis. In total, structural (i.e., CT and MRI) and functional (i.e., SPECT and PET) neuroimaging results from 3,511 patients with AD, and 1,632 normal healthy controls were recorded across meta-analyses. Our results include neuroimaging profiles for both early onset and longer duration patients with AD. In sum, these profiles yield a signature of diagnostic markers in both cortical and subcortical neuroanatomic areas. This signature is consistent with the clinical phenomenology of Alzheimer's dementia and should aid in the positive identification of AD.

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S. DUFF CANNING, R.H. SWARTZ, F.Q. GAO, & S.E. BLACK. A Standardized, Reliable MR Measurement of Medial Temporal Lobe Thickness Predicts Episodic and Semantic Retrieval in AD Patients.

MRI-based measurements of medial temporal lobe (MTL) volume, including hippocampal volume, are useful for detection of AD. However, MTL volumetry is time-consuming and labor-intensive, limiting its utility as a biomarker for AD. Linear measurement of MTL thickness (MTLT) on T-1 weighted MRI scans is rapid and user-friendly. We developed a reliable measure of MTLT at its narrowest point, which is sensitive and specific

for discriminating AD patients from normal elderly. The present study investigated the clinical validity of our measure by examining relationships between neuropsychological performance and MTLT in possible and probable AD patients ($N = 144$). For comparison, we examined correlations between cognitive performance and a measure of global atrophy, ventricular volume (VENT). Separate regression analyses with age, sex, education, and MTLT or VENT as independent predictors showed that VENT correlated with performance on memory (CVLT; Visual Reproduction, WMS-R), attention (Digits Backward), fluency (FAS), visuospatial perception (Benton Line Orientation), and problem-solving (WCST, $R^2 = .11-.24$, $p \leq .001$). In contrast, MTLT correlated only with performance on tests of episodic (CVLT, DRS-MEM, VR-WMS-R) and semantic retrieval (Boston Naming; $R^2 = .13-.20$, $p < .001$). With both measures included as predictors in the same analysis, however, only MTLT significantly contributed to prediction of CVLT, DRS-MEM and Boston Naming, suggesting that our MTLT measure selectively correlates with cognitive functions affected early in AD. We conclude that the simple *in vivo* measure appears to have clinical validity and may be useful in diagnosis and monitoring AD.

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COGNITIVE INTERVENTION

J. GUNSTAD & J. GRACE. Efficacy of a Brief Cognitive Screening in Reducing Rehabilitation Unit Falls.

Although patient falls are prevalent throughout hospital settings, they are especially likely in rehabilitation settings. Numerous patient factors have been associated with increased fall risk, with cognitive impairment receiving increased attention in recent years. The present study examined the possibility of reducing patient falls by identifying cognitively impaired patients early during their course of treatment. To this end, a Clock Drawing Test, Animal Naming, and a question tapping patient awareness were added to the standard nursing intake assessment for a general medical rehabilitation unit. Nursing staff was also asked to rate patient fall likelihood on a 10-point Likert-type scale. The fall rate of 50 patients receiving the screening was compared to 50 controls that were matched for age, gender, diagnosis, and functional impairment from previous quarters. Results showed screened patients were less likely to fall than matched controls [$\chi^2(1) = 5.26$, $p = .02$] and that fall likelihood ratings were closely related to Clock Drawing ($r = .49$), Animal Naming ($r = .45$), and degree of functional impairment at admission ($r = .34$). This reduction in patient falls emerged without an increase in use of safety alert status or one-to-one sitter use. However, compliance with the screening was relatively low, highlighting the difficulty in developing screening instruments that are both effective and likely to be used in clinical situations.

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J. KIXMILLER, W.J. COLLINS, C. MATHIESON, K. GODFREDSEN, & J. GARDNER. Modified DBT Skills Training With Cognitively and Psychiatric-Impaired Patients.

Psychosocial skills training is a common therapeutic approach for use with patients with psychiatric and neurologic impairments. However, skills training approaches are often atheoretical and are relegated to use with either psychiatric issues or cognitive/functional deficits, but not both. We are reporting on preliminary outcome findings from a group-oriented treatment for patients with both psychiatric and cognitive/neurologic problems. Treatment consisted of teaching psychosocial skills according to modified Dialectical Behavior Therapy training: (Mindfulness, Interpersonal Effectiveness, Emotion Regulation, Distress Tolerance). Patients attended twelve 90-min sessions consisting of multimodal lectures, homework, demonstrations, role-plays, relaxation, and group discussion and inter-

actions, as well as completing pre- and post-neuropsychological testing and symptom checklists. Preliminary findings reflect positive results in terms of inter-session awareness of deficits, increased use of new skills within session exercises, reported functional independence, and completion/success of homework assignments. However, neuropsychological testing (targeting attention, concentration, and executive abilities), as well as structured neuropsychological symptom reporting by patients and families failed to demonstrate any consistent positive changes. Further, while patients and families/caregivers reported improved mood overall following training, these subjective ratings were not consistently reflected in patients' overall pre/post mood ratings on self-report depression and anxiety self-report inventories. Initial implications are discussed as they relate to this complex patient population and recommends alternative outcome measures based on these pilot DBT groups.

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Z. CAMPBELL, D.A. YOUNG, K.K. ZAKZANIS, M.G. FREY-SLINGER, & D.H. MEICHENBAUM. The Efficacy of Scaffolding as a Cognitive Rehabilitation Technique for Chronic Schizophrenics.

This study compared the efficacy of 2 instructional techniques, scaffolding and direct instruction, with a practice control condition in the remediation of Wisconsin Card Sorting Test (WCST) deficits among 45 highly chronic schizophrenic patients. The extent to which learning of the WCST generalized to other cognitive tests, including an object sorting task, the Short Category Test, Trail Making and Stroop tests, was also examined. The affective experience of the subjects was assessed via Rosenberg's Self-Esteem Scale and the Positive and Negative Affect Schedule (PANAS). Subjects who received scaffolded instruction improved significantly in the number of WCST categories achieved. The improvement was sustained a month later. Generalization to other cognitive tests was encouraging but limited. The scaffolded group improved in their self-esteem and maintained a high positive affect. These findings have implications for psychosocial and cognitive rehabilitation.

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L. MURRAY, R. BALDWIN, & L. KARCHER. Treating Attention in Mild Aphasia: Evaluation of Attention Process Training–II.

This study examined the effects of Attention Processing Training–II (APT–II) on the attention and other cognitive abilities of R.W. a 56-year-old male with chronic, mild conduction aphasia. Attention rather than aphasia treatment was selected because (1) previous research has documented the negative effects of attention impairments on language comprehension and production, and vocational outcomes in aphasia, (2) R.W. displayed both basic and complex attention deficits, and (3) prior aphasia treatments had not improved R.W.'s concentration and auditory comprehension problems during daily work and home activities. Accordingly, APT–II was applied in the context of a multiple baseline ABA design. Each week, R.W. received a 60-min therapy session at a university clinic, and a 20–60-min home session with the aid of his spouse. Paragraph listening and rapid naming probe tasks were used to measure changes in language abilities that were related (i.e., auditory comprehension accuracy and speed) and unrelated (i.e., naming speed), respectively, to APT–II activities. R.W. showed improvements on trained attention tasks, increased speed and accuracy on both probe tasks, and modest gains on standardized tests of auditory comprehension, working memory, and attention. The results of questionnaires completed by R.W. and his spouse both pre- and post-treatment indicated, however, that neither he nor his spouse observed noticeable positive changes in his daily communication or attention abilities. Discussion will focus on failure to evoke functional changes and thus, on whether APT–II represents a viable or efficient approach to training attention in aphasia.

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M. ZACHAREWICZ & S. SCHMITZ. Using a CPT to Assess the Efficacy of Psychostimulants in the Treatment of MTBI.

Psychostimulants have been found to be beneficial in treating the sequelae associated with traumatic brain injury including memory difficulties, attention/concentration abilities, processing speed difficulties, and anger. Continuous Performance Tests (CPTs) have long been shown to be sensitive to brain damage and dysfunction, and have been shown to be valuable means of assessing the therapeutic response of psychostimulants. This paper will present data on a model utilizing a CPT, the Test of Variables of Attention (TOVA), as a means for assessing the efficacy of psychostimulant trials when attempting to treat attention and processing speed difficulties in a sample of patients diagnosed with mild traumatic brain injury (MTBI). Baseline and psychostimulant challenge testing data from 35 patients diagnosed with MTBI will be presented. The implications of evaluating and treating patients in this manner will be discussed, including how it may impact upon the patient's treatment and recovery. This data is presented as part of an ongoing study assessing the utility of psychostimulant titration trials on the treatment of the sequelae associated with MTBI. Future research directions will also be discussed.

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L. PENKMAN & C. MATEER. The Rehabilitation of Attention Deficits in Traumatic Brain Injury.

This study investigated the question of whether there is a specific effect of formal attention retraining above and beyond a supportive, adjustment-oriented approach in improving attentional and working memory functioning in individuals with traumatic brain injuries (TBI). A second objective was to determine if neurophysiological correlates of attention change after attention retraining in individuals with TBI. Neuropsychological and neurophysiological measures (event-related potentials) were collected for 4 participants in a single case modified multiple baseline cross-over design. Each participant underwent a 6-week baseline, 6 weeks participation in Attention Process Training (APT) and 6 weeks participation in an Active Control (AC) condition. Dependent measures were collected at 2-week intervals throughout the study. Data were analyzed using graphing and visual inspection. Results indicate that attention retraining was associated with more improvement on measures of working memory than the AC condition. ERP results varied somewhat across participants but all showed differences from baseline in either the amplitude and/or latency of the P300 or N200 components after participation in APT, regardless of order of exposure to condition. Only 1 participant showed a change in ERP components after the AC condition only. Data provide additional support for attention retraining in improving neuropsychological functioning, and further indicate that underlying change in neuronal activity may occur as a result of participation in attention retraining.

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T. NOVACK, J. BAÑOS, & J. SCHNEIDER. Significance of Decreased Orientation Performance During Rehabilitation.

Assessment of orientation following neurological insult is an effective means of documenting progress early in the course of recovery. Typically, improvement is evident across time. The significance of diminished performance is unclear, however. Using the Orientation Log (O-Log), 540 people were examined a minimum of twice and up to 10 times, each assessment separated by at least 1 day, but not more than three days. A range of disorders was represented, including traumatic brain injury (72%), vascular disorder (10%), intracranial tumor (7%), anoxia, infectious disease, and dementia (each 3%). The average age of the sample was 44, with a range of 10 to 93. Males predominated (66%) and most (60%) had achieved a high school education or better. The average time since event onset (when it could be computed) was 37 days. It was determined that decrease in O-Log performance of 5 or more points (out of a maximum of 30) from one administration to the next was an infrequent occurrence, ranging from 3% to 5.9% of the cases. Decrease in O-Log performance on

2 consecutive administrations occurred in less than 1% of the cases. These results indicate that a drop of 5 or more points on the O-Log from one administration to the next is a matter of concern and that a further drop in performance on the subsequent administration should generate major concern. To demonstrate this, 2 cases are presented in which consecutive drops in O-Log performance indicated significant change in neurological status (increased intracranial pressure and recurrent subdural hematoma). Correspondence: Tom Novack, 5258 Overland Trace, Birmingham, AL 35244. E-mail: novack@uab.edu

E. HEEREY, K. GODFREY, C. RANDALL-WALKER, & J. KIXMILLER. Training Prospective Memory: Decoupling of Prior Functioning and Performance.

Tasks that tap prospective memory, memory for events that must be performed at a future time such as remembering to make a phone call, rank among the more challenging of memory problems. In particular, individuals with Alzheimer's dementia (AD) experience difficulty with such tasks. We tested the efficacy of a training program incorporating errorless learning to improve prospective memory performance among patients with early-stage AD. Participants were taught to either make a phone call at a particular time each day or to return postcards after receiving phone calls. Recall was tested for 20 trials during 4 of the 8 post-training weeks. Relative to a comparison group ($N = 4$) statistically matched on age and level of functioning who received general memory practice, trained participants ($N = 7$) missed significantly fewer trials ($p < .05$). An index of prospective memory functioning (PMF) was calculated from three items on the Rivermead Behavioural Memory Test: remembering to ask for the return of a belonging; remembering to ask the tester a question; remembering to deliver a message. We used PMF in a hierarchical regression analysis to predict the percentage of missed trials. For participants in the comparison group, PMF was a strong predictor of percentage of missed trials, after controlling for level of functioning ($\beta = -.93, p < .05$). Interestingly, for participants who received training, PMF did not predict percentage of missed trials during testing ($\beta = .003, p > .05$), demonstrating that training incorporating errorless learning improves AD patients' ability to complete a prospective memory task, despite initial level of PMF.

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T. HOPPER & S. BOND-MOORE. Errorless Learning in Alzheimer Disease.

Recent research findings indicate that some individuals with Alzheimer disease (AD) can learn information and behaviors, despite significant memory deficits. Two techniques, spaced-retrieval training and errorless learning, have potential for improving the functioning of AD patients possibly because they involve reducing demands on impaired memory systems while capitalizing on spared ones. However, few data are available from experimental studies regarding the effects of minimizing errors during learning, cognitive factors that influence response to errorless learning procedures and the utility of errorless learning when combined with spaced-retrieval training with individuals who have AD. The specific aim of this project was to evaluate the effects of spaced-retrieval training and errorless learning techniques on the learning and retention of new associations by individuals with AD who vary in cognitive-linguistic ability. Five individuals with a diagnosis of probable AD participated in the study. Several well-known measures were used to stage severity and characterize mental status and standardized test batteries were used to characterize cognitive-linguistic functioning. A single-subject design across behaviors was used to study the effects of constraining errors during learning trials. Novel face-name associations were taught under 2 conditions: 1 in which the participants' responses were constrained through a forced-choice recognition task and 1 in which the participants' responses were not constrained. Results were variable and will be discussed in relation to cognitive functioning and learning condition (errors constrained or not). The nature

and frequency of errors made during learning trials and clinical implications will be discussed.

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M.E. O'CONNELL, C. MATEER, & K. KERNS. Implementation of a Cognitive Prosthetic for a Client With Adynamia and Amnesia.

We address the practical considerations for rehabilitation of problems with initiation using a case example of a 48-year-old ex-economics professor with severe anterograde amnesia and adynamia. Of the rehabilitation strategies available for clients who have problems with initiation, we recommend the use of an external cueing system. We review available external cueing systems, and identify important factors involved in selecting a particular external cueing device. For our client, we considered his neuropsychological strengths and weaknesses, his premorbid knowledge and learning, his available hardware resources, his goals, and the ease with which the system could be programmed and maintained. In collaboration with our client, we chose to use an alphanumeric pager with reminders programmed into a free, web-based calendar (i.e., Yahoo.com). We also present guidelines for training and evaluation of a client's response to and ability to independently program external cues. As the client had concomitant difficulties with problem-solving and anterograde amnesia, we employed principles of error-free learning for skill acquisition. After six 1-hr sessions the client was able to correctly program the device. Investigation of the efficacy of this cognitive prosthetic revealed that, in his daily life, the client responded appropriately to most of the programmed external cues, helping to alleviate his problems with prospective memory and adynamia.

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M.F. DULAY & B.K. SCHEFFT. Evaluation of Different Memory Encoding Strategies for Self-Generated Words in TBI.

Healthy adults and patients undergoing rehabilitation for memory problems have improved memory for words generated by themselves (i.e., the generation effect). A *depth of processing* approach would predict that the level of elaboration used to encode words would impact memory performance. For example, words encoded from the same category may be better remembered than words that rhyme. The present study compared the effectiveness of different encoding strategies in improving memory for self-generated words in a within-subjects paired associates (PA) recall paradigm. Twenty individuals with moderate-to-severe traumatic brain injury (TBI; Glasgow Coma Scale $M = 4.3$) used the following rules to generate and remember the second of 2 words: associate (*coat-hanger*), category (*hammer-tool*), opposite (*all-none*), synonym (*street-road*), and rhyme (*sell-bell*) strategies. A control PA task was used where the 2nd word to be remembered was presented. Results indicated a modest but significant 12% increase in recall of self-generated words ($p < .01$) compared with the control task. Unexpectedly, repeated-measures ANOVA indicated that use of the opposite and synonym strategies significantly improved performance compared to the other strategies. Further exploration of the data indicated that time since TBI (range: 65–218 days) was differentially related to type of strategy. Fewer days since TBI was only associated with poorer performance for the associate ($r = .49, p < .05$) and category ($r = .57, p < .01$) strategies. Results suggest that encoding strategies that require more elaborate processing may be perceived as unsuccessful when used too early after injury.

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J. LENGENFELDER, N. CHIARAVALLI, & J. DELUCA. The Generation Effect: Comparisons Between MS and TBI to Improve New Learning.

The generation effect (GE) is the observation that items self generated by individuals are better remembered than information provided to them. The

GE is well documented in healthy controls (HC) and is a consistent phenomenon demonstrated under a variety of conditions. While the GE is robust within the normal population, few studies have examined the usefulness of the GE to improve learning and memory in neurological populations. This study compared the utility of the GE in 2 groups of clinical populations that have difficulty in learning and memory, multiple sclerosis (MS) and traumatic brain injury (TBI). GE protocol was administered to 31 MS, 18 TBI and 22 HC subjects. Subjects remembered a word from 32 sentences they had read aloud. In half of the sentence the target word to remember was already provided for them while in the other half of the sentences the word to be remembered was generated by the subject to complete the sentence. Recall and recognition of GE stimuli was tested immediately, 30 min and 1 week following presentation. Recall and recognition of generated stimuli was significantly higher than provided stimuli across testing sessions ($p < .01$). MS and HC groups benefited equally from the GE. Although TBI subjects did benefit from the GE, the effect was somewhat attenuated, likely due to level of overall cognitive impairment. This verification of the GE in neurologically impaired samples may have implications for improving the cognitive rehabilitation of learning and memory in populations such as MS and TBI, where learning new information is compromised.

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S. RASKIN. Cognitive Rehabilitation of Memory for Intentions With Individuals Who Have Mild Traumatic Brain Injury.

Previous studies have demonstrated the efficacy of cognitive remediation of memory for intentions in individuals with brain injury. Most of these studies, however, were performed with individuals with severe impairments in memory for intentions. Given the frequency of complaints about difficulty with this function, this study investigated the efficacy of training memory for intentions in individuals with mild traumatic brain injury (MTBI). Subjects with MTBI according to the definition of the American Congress of Rehabilitation Medicine ($N = 10$) and a normal control group were administered the Memory for Intentions Screening Test and a battery of standardized neuropsychological measures of attention, memory, executive functions and time estimation. The group with MTBI then participated in a multiple baseline *A-B-A-B* crossover design where the *A* condition was training in memory for intentions and the *B* condition was a retrospective memory task combined with brain-injury education. Training took place twice per week for 1-hr sessions. Generalization measures included self-report questionnaires and rating sheets in the community. All subjects were retested after the 26-week training period. Subjects with MTBI showed improvement on generalization measures compared to baseline ($p < .01$), although no greater change on standard neuropsychological measures than the control group. Subjects showed improvement only after the *A* condition. Tests of planning and time estimation showed the only significant correlation with memory for intentions performance ($p < .01$).

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FUNCTIONAL NEUROIMAGING OF COGNITION

L.S. SUSSKIND-WILDER, L.C. BAXTER, & S.C. JOHNSON. fMRI of the Stroop Interference Effect: Contrasting Congruent Versus Incongruent Stimuli.

Functional imaging has aided in identification of the neuroanatomic underpinnings of cognitive tasks such as Stroop color-word naming. Previous neuroimaging studies of the Stroop task have suggested the involvement of a number of cortical regions including anterior cingulate cortex (ACC), temporoparietal regions, frontal polar cortex, and other areas of prefrontal cortex. One explanation for these varied findings is that differences in activation patterns reflect differences in task design, particularly the choice of the baseline task. We predicted that dorsolateral prefrontal cortex

(DLPFC) rather than ACC activity would be more likely to appear in a task design structured to restrict differential activation to interference-related phenomena as opposite to basic attentional modulation, and to minimize differences in response mode, response-set adaptation and practice effects. To test this prediction, we employed a boxcar design alternating short, 8-item blocks of congruent-color and incongruent-color words. Eight healthy female subjects were scanned, and a fixed-effects, multisubject paradigm was employed. Results confirmed the prediction that differential activations in the incongruent condition would be found in regions other than the ACC. Most significant activations appeared in the left supplementary motor and DLPFC areas. These findings highlight the importance of the structure of the control task in designing cognitive fMRI experiments, and substantiate a role for the DLPFC in the executive process of response inhibition.

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J. PASKAVITZ, L. SWEET, J. WELLEN, K. HELMER, & R. COHEN. Dynamic Changes in Brain Volumes of Activation During Sustained Working Memory Observed with fMRI.

Published reports have shown regions of neural activation associated with working memory (WM) tasks. However, the temporal dynamics of brain activation associated with this task have not been determined. Since fMRI studies of WM often follow a blocked design, the purpose of this study was to determine if the volumes of brain activation change during the sustained task. We hypothesized that the volumes would increase over time with prolonged subject effort, even though task difficulty was constant. Eleven participants performed a 2-back verbal WM task. Consonants were presented every 3 seconds. The 2-back and letter vigilance control tasks alternated eight times over two six-minute runs. Whole brain image data was collected with GRE-EPI [TR/TE = 3000/60 ms, FOV = 24 cm (64 × 64)] and analyzed with AFNI. Cross-correlation analysis was performed with ideal waveforms created by dividing the 2-back periods into 4 subsets and maintaining the entire control epochs (*fourths analysis*). Individual subjects' correlation maps were thresholded ($p = .005$) and the number of active voxels was recorded along with their average correlation coefficient. Results from the fourths analysis indicate a statistically significant increase in the average correlation value between the 1st and 2nd fourths with no further increase at the later time points. The number of active voxels was also found to increase with time with increasing statistical significance. Increase in the correlation coefficient during the early portion of the sustained working memory task may reflect individual differences in the physiology of task engagement. In contrast, the increase in volumes of activation that occurred later in the 2-back task indicates the need for recruitment of more brain to meet prolonged task demands, sustain attention and maintain accurate working memory. Therefore, traditional blocked design fMRI studies may underestimate the dynamic changes in brain regions during a sustained task. This analysis method may be useful to demonstrate temporal changes of activation patterns in other neural network systems.

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S.P.A. DRUMMOND, J.S. SALAMAT, & G.G. BROWN. Cerebral Compensation Is Related to Word Difficulty Following Total Sleep Deprivation.

We recently reported cerebral compensation during cognitive performance following total sleep deprivation (TSD). Compensation manifested as recruitment of additional brain regions during task performance following TSD that were not involved (or as involved) after normal sleep, particularly regions within the bilateral frontoparietal working memory system. This pattern was seen during verbal learning and a divided attention task containing a verbal learning component. Here, we tested whether word difficulty during verbal learning influences the compensatory response. Eleven subjects (6F, age = 31.7 years) were studied with functional MRI (GRE, BOLD sensitive) while performing a verbal learning task after

normal sleep and following 35 hr of TSD. Based on recallability norms, half of the target words were *easy* (to learn) and half were *hard*. A compensatory response was defined as brain regions showing greater responses to *easy* or *hard* words following TSD compared to the same word-type following normal sleep. Easy words did not elicit a compensatory response in any brain region. However, compensation was seen during memorization of hard words, including in left temporal cortex, bilateral parahippocampal gyri, bilateral parietal lobes (including Wernicke's area), and right superior frontal gyrus. Furthermore, increased activation within several brain regions following TSD, including bilateral parietal lobes, was significantly correlated with better memory for the hard words. No such relationships were found with easy words. In sum, the cerebral compensatory response previously observed during TSD appears related to word difficulty, and the pattern of compensation exhibits similarities to the hemispheric asymmetry reduction seen in aging.

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T. HAMMEKE, S.J. SWANSON, E. POSSING, S. KORTENKAMP, & J.R. BINDER. Functional MRI Activation of the Anterior Temporal Lobe Using a Definition Naming Task.

A variety of language activation tasks in functional magnetic resonance imaging (fMRI) have successfully been used to establish cerebral dominance, including word generation, rhyme determination, reading, simple auditory or text comprehension, and semantic decisions to auditory or written stimuli. Still, none of these activation protocols reliably activate the anterior temporal lobe, the most common site of epilepsy surgery, making it difficult to use activation maps from these protocols to predict language morbidity following dominant anterior temporal lobectomy. In an effort to achieve better activation of the dominant anterior temporal lobe, a definition naming activation protocol was developed. The protocol involves auditory presentation of brief definitions, to which subjects generate a name orally. Accuracy and vocal reaction time are monitored during scanning. The stimuli include brief descriptions of people, places, animals and objects representing unique and common, living and nonliving categories. Activation from the definition naming task was contrasted with that from a nonverbal auditory discrimination task. A clustered image acquisition sequence was used to reduce movement artifacts associated with the oral responses. Preliminary findings from fMRI activation studies in healthy subjects and epilepsy surgery candidates show that, while language lateralization by the definition naming task is strongly correlated with that derived from a semantic monitoring task, the definition naming task produces stronger and more extensive activation of the anterior temporal lobes than does the semantic decision task. Task development and characteristics of activation maps generated by the definition naming protocol will be reviewed.

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R. THOMA, R. YEO, J. LEWINE, S. GANGESTAD, & K. PAULSON. MEG Localization of Individual Differences in the Speed–Intelligence Relationship.

More than a century of research has demonstrated an inverse relationship between intelligence and reaction time (RT), as measured on a wide range of tasks. This study used magnetoencephalography to examine the timing of the information processing stages that contribute to composite RT measures, with the goal of determining which of these processes are most closely associated with intelligence. MEG data were collected from 21 subjects responding to right/left randomly lateralized visual stimuli with a prespecified hand (e.g., respond with right hand only, a simple RT condition), or the hand contralateral to the presented stimulus (a choice RT condition). For each subject, the latency of the first visual evoked response localizing to calcarine cortex was taken as a time mark for visual processing. The difference between the peak latency of the calcarine response and the peak latency of the source dipole localizing to motor cortex was taken as an estimate visual–motor integration time. The difference

between the motor dipole latency and behavioral RT provided the time for preresponse motor preparation, and the latency between RT and post-response somatosensory activity was taken as an indication of sensori-motor integration time. Latency data were then evaluated with respect to performance on the Ravens Advanced Progress Matrices (RAPM) a measure of fluid intelligence. While none of the MEG assessed latency/processing time measures from the simple RT task correlated with RAPM scores, during the choice RT task, both visual–motor integration time and postresponse sensory–motor time showed significant negative correlations with RAPM scores.

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V. CESTONE, A.D. SCHWEINSBURG, E.C. CHEUNG, L.E. SANTERRE, C. PULIDO, M.J. MELOY, G.G. BROWN, S. KINDERMANN, & S.F. TAPERT. fMRI Response and Neuropsychological Performance in Adolescents.

The neuroanatomical correlates of common neuropsychological tests have not been delineated in adolescents. This preliminary investigation explores the relationship between neuropsychological performance and functional magnetic resonance imaging (fMRI) response to a spatial working memory task among healthy adolescents. Right-handed adolescent ($N = 24$) ages 13–17 with no history of substance or psychiatric disorders, head trauma, or neurological illness participated. Each was administered WISC–III, Rey–Osterrieth Complex Figure (ROCF), and California Verbal Learning Test–Children's Version (CVLT–C). Scores were standardized for age. fMRI response was measured in the brain as participants performed a spatial working memory task. Task accuracy significantly correlated with ROCF copy scores ($p < .05$). ROCF copy predicted increased bilateral superior frontal fMRI response to the task ($p < .025$). Better Block Design scores were associated with increased global brain response, particularly in bilateral inferior parietal, cingulate, and left superior frontal gyri ($p < .025$). Better Digit Span performance predicted increased activation in middle and superior frontal and supramarginal gyri but decreased bilateral response in the lentiform ($p < .025$). Good Arithmetic performance was linked to increased bilateral precuneus activation but decreased left inferior frontal gyrus response ($p < .025$). Higher CVLT–C recall predicted more response in right temporal regions ($p < .025$). In contrast, Vocabulary performance predicted few relationships with brain response to the task. These results demonstrate relationships between neuropsychological test performance and specific brain regions in the context of spatial working memory activity, and generally suggest increased fMRI response in those who perform well in cognitive testing.

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A.D. SCHWEINSBURG, E.C. CHEUNG, L.E. SANTERRE, V. CESTONE, C. PULIDO, M.J. MELOY, S. KINDERMANN, G.G. BROWN, S.A. BROWN, & S.F. TAPERT. fMRI Response to a Spatial Working Memory Task During Adolescent Development.

Recent studies have described processes of neuromaturation and cognitive development across the lifespan. However, few neuroimaging studies have explored alterations in brain activity during adolescence. We used functional magnetic resonance imaging (fMRI) to investigate brain response to a spatial working memory task throughout adolescent development. Participants were 10 girls and 14 boys ages 13–17 who were comparable on demographics. Exclusionary criteria were left handedness and history of head injury, psychiatric disorders, substance use disorders, or neurological problems. Participants performed a spatial working memory task during fMRI acquisition. No gender or age differences were found for task performance. However, brain response to the task correlated with age for both boys and girls. Older girls had somewhat more global activation than younger girls, particularly in the bilateral thalamus, right caudate, right superior temporal gyrus, and several frontal regions. In contrast, younger boys had substantially more brain response to the task than older boys, especially in bilateral inferior and superior parietal lobules, cingulate, left

superior temporal gyrus, and left frontal areas. Age and gender interacted ($p < .025$) such that younger boys showed more activation in the left superior parietal lobule, while older girls demonstrated more response in the left superior frontal gyrus. These findings indicate that fMRI response to a spatial working memory task varies with development during adolescence, which is consistent with neuromaturational changes. Specifically, boys demonstrated more widespread activation than girls in early adolescence, suggesting a less mature response pattern that corresponds to gender differences in brain efficiency during development.

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K. SCHENK, K.N. TIERNAN, M. SHIMONOVA, D. SWADBERG, D. SCHOLLAERT, P. BOORKMAN, & M. CHERRIER. Measurement of fMRI BOLD Response in Older Adults Performing a Spatial Memory Task.

Considerable work has demonstrated medial temporal lobe and hippocampal activation using functional magnetic resonance imaging (fMRI) in young adults for both verbal and spatial memory tasks. Previous work has also demonstrated that the hippocampus may be a critical structure for navigation and spatial memory. We explored fMRI blood oxygen level dependent (BOLD) response in healthy older adults using a unique spatial memory task. The environmental memory task has been shown to activate parietal, and medial temporal regions in young adults. The task was modified for use in older adults. Ten healthy older adults (age range 54–84 years) participated and were scanned twice, 5 weeks apart. Prior to scanning, participants were given a complete practice session that involved learning a virtual reality (VR) environment via a desktop computer followed by a test session in which recognition of the spatial layout of the environment was assessed. The recognition task was to determine if each scene was an accurate representation of the environment or inaccurate (shifted items). Participants underwent an identical encoding and recognition session in the scanner. Analysis revealed that older adults demonstrated hippocampal, parahippocampal, medial temporal and occipitoparietal region activation predominately on the right side. In addition, activation maps were very consistent across the repeated testing sessions. Results suggest that use of this spatial memory task may provide a more reliable method to assess and detect changes in hippocampal and medial temporal lobe function with age compared to a verbal task. Verbal tasks have demonstrated variable reliability with regard to hippocampal activation.

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L. SWEET, J. PASKAVITZ, R. COHEN, & J. WELLEN. A Functional Magnetic Resonance Imaging Study of Word Similarity Effects.

A modification of the N-Back verbal working memory (WM) paradigm was employed to determine if the word similarity interference was related to activity in brain regions associated with short-term memory buffering. Functional neuroimaging studies have used versions of the N-Back to localize components of WM networks; however, regions associated with short-term memory buffering have not yet been isolated. Standard and modified "similarity" versions of the 2-back, and a letter vigilance control task, were presented in a blocked design to eleven healthy participants during a functional magnetic resonance imaging (fMRI) procedure. A whole-brain, voxel-wise, subtraction procedure was used to identify clusters of significantly greater activity during each of the 2-back conditions compared to the control condition. A direct comparison of the 2 experimental tasks was also conducted. Successful performance of standard and "similarity" 2-back was associated with increased brain activity in bilateral supplementary motor and premotor areas, dorsolateral prefrontal cortex, and posterior parietal cortex. Additional activity near Broca's area and within the right cerebellum was observed during each condition. The direct comparison of the standard and similarity 2-back revealed several areas of greater activation during the similarity blocks. These included right medial and lateral frontal cortex and bilateral hippocampus. Task accuracy was significantly lower during the similarity condition. Word

similarity interference during this verbal WM task resulted in greater brain activity in regions associated with attention/executive functioning and memory consolidation, rather than regions associated with short-term memory buffering. Decreased verbal WM performance due to the word similarity effect may not be associated with the short-term memory buffer as has been suggested in the cognitive psychology literature.

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M. ROGERS, S. McLAUGHLIN, C. ANDERSON, & K. SPENCER. An fMRI Investigation of High and Low Syllable Frequency Using an Overt Speech Task.

A functional magnetic resonance imaging (fMRI) study was conducted to examine potential differences in the activation levels and location of neural activity when subjects produced nonsense syllables that maximally contrasted syllable frequency (frequency of occurrence in English). It has been hypothesized that high frequency syllables may be stored as whole phonological units, as *movement gestalts* and that the premotor processes preceding speech production may therefore require less brain activation (and possibly in a different set of locations) than low frequency syllables, which may instead require assembly of subsyllabic units such as articulatory features and phonemes. This study examined sagittal (to reduce the effects of head movement) BOLD fMRI images obtained from 12 individuals as they repeated aloud blocks of high and low frequency syllables and as a control task, listened to the same set of high and low frequency syllables in blocks without producing them. Movement artifact was controlled through padding placed to minimize subjects' head movements, obtaining multiple structural MRI images throughout the protocol, and through statistical analyses. The design permitted the use of event-related fMRI analysis (individual events averaged) and block design analysis (average over run approximately .30 s). The discussion compares block and event-related analyses, the effect of syllable frequency on activation levels and the location of neural activity, and the procedures for obtaining fMRI during speech production.

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IMAGING: STRUCTURE & FUNCTIONS

J. RISBERG, S. BORJESSION, & K. LJUNGGREN. A New Tomographic Technique for Absolute Measurements of White and Gray Matter Blood Flow.

Until now, interest has been focused on measurement of gray matter blood flow, while white matter blood flow has been rather neglected. The integrity of the white matter is, however, as important as that of the gray matter and white matter pathology is commonly reported in many developmental and acquired brain disorders. The aim of the present project is to develop and evaluate an improved method for reliable tomographic measurements of absolute white and gray matter blood flow. The new tomographic method (modified Xe-SPECT) implies an extension of the period of ^{133}Xe inhalation from 1 to 8 min followed by 22 instead of 4 min of breathing of ambient air. This results in a markedly stronger signal from the white matter with new possibilities to accurately quantify its blood flow. The arrival and clearance of the tracer is recorded by a 3-head gamma camera system that provides flow maps with a spatial resolution of about 1 cm. The new method has been evaluated in healthy subjects and in a pilot group of patients with different organic dementing disorders. The results obtained have shown gray and white matter flow levels with a similar magnitude as values obtained with other methods. Regional flow abnormalities, seen with the new method, have shown good agreement with relative results obtained by $^{99\text{m}}\text{Tc}$ -HMPAO-SPECT in the same group of patients. The scientific and clinical value of the absolute white and gray matter blood flow measures will be described and discussed.

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L. RIEMENSCHNEIDER & D. UMETSU. A Clinical Tale: Global Volume Loss on MRI and Neuropsychological Strengths.

A 32-year-old White male was admitted to a psychiatric ward after a minor motor vehicle accident. The patient had no history of psychiatric treatment, and yet recent events apparently exacerbated some longstanding persecutory beliefs. The accident was reportedly an attempt to draw the attention of authorities to his previously unheeded concerns. Examination revealed minimal physical injuries. MRI was ordered as part of the evaluation, with findings of diffuse volume loss of the cerebral cortex and the cerebellar vermis. These findings raised concerns regarding a possible degenerative disorder, infectious process, or toxic condition. The neurological exam did not reveal any pathology. In general, the patient's behavior on the ward was unremarkable. Neuropsychological evaluation was requested to determine the presence of an "early dementia" or other evidence of cognitive deficits. Evaluation did not reveal cognitive deficits. In fact, areas of significant strength were noted (FSIQ: 117, VIQ: 110, PIQ: 125). This patient decided against further diagnostic procedures, such as a lumbar puncture. In this case, the neuropsychological results promoted the understanding of this patient as functionally intact from a cognitive standpoint (albeit with circumscribed delusional beliefs), a view consistent with the neurological examination and the patient's comportment in general, in spite of the imaging results and the diagnosis of generalized brain atrophy. This case may serve to heighten our awareness of the range of variation of brain structure and neuropsychological function that may exist, as well as highlight the influence of the neuropsychological evaluation on the medical decision-making process.

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L.J. JULIAN, J.H. KRAMER, D.M. MUNGAS, B.R. REED, M. WEINER, & H.C. CHUI. An MRI Evaluation of Subcortical Brain Abnormalities and Patterns of Depressive Symptoms Among Nondemented Older Adults.

The *vascular depression* hypothesis is posited as a brain-based explanation for depressive illness among many older adults. Supporting evidence includes the co-occurrence of depression and cerebrovascular risk factors; lesions in frontal-subcortical structures associated with onset of depression, and increased white matter hyperintensities among older adults with depression. The specific role of subcortical brain changes relative to depressive symptoms remains unclear. In this study, the relationships among depressive symptoms (assessed by clinician-administered screening measure) and MRI measures of white (WV) and subcortical gray matter volume (SGV), white matter signal hyperintensities (WMSH), and lacunar infarcts were evaluated in a cohort of 157 nondemented elderly (M age = 73.7, SD = 7.73; M MMSE = 28.4, SD = 2.13). Affective symptoms were reported by 18.7% of the sample, and symptoms of "vascular depression" (e.g., apathy, anhedonia, decreased energy) were reported in 25.2% of the cohort. Depressed and nondepressed participants did not differ significantly by age, gender, education, ethnicity, or MMSE. Multiple regression analyses demonstrated that WMSH, SGV (adjusted for total intracranial volume) and lacunes in the white matter and basal ganglia, and thalamus, predicted approximately 36% of the variance of "vascular" depressive symptoms, but only thalamic lacunes predicted 6% of the variance of affective symptoms. These findings suggest that possible cerebrovascular brain changes in specific subcortical structures are uniquely associated with depressive symptoms in nondemented elderly.

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G. IVERSON, J. MOSELEY, J. BERNARDO, & M. FRANZEN. CT Abnormalities in Elderly Patients With MTBI Following Motor Vehicle Accidents.

Day-of-injury intracranial abnormalities are related to short-term and medium-term outcome following mild traumatic brain injury in the el-

derly. The purpose of this study was to examine the prevalence of abnormalities on day-of-injury CT scan results in a sample of 81 older adults, between the ages of 55 and 91, who were seen on a trauma service following a motor vehicle accident. All patients had Glasgow Coma Scale scores of 15 at admission. Day-of-injury CT scans were available for 39 patients. The remaining patients did not undergo scanning because the clinicians did not feel that it was necessitated by the injury, although it is possible that a small number were scanned and their results were not available at the time of data coding. Two subjects demonstrated cerebral atrophy that was not trauma-related. Of those who were scanned, 41.0% had a trauma-related abnormality. Of the total sample, 19.8% had an abnormality. Thus, the true prevalence of day-of-injury abnormalities in this sample was between 20% and 41%. Regarding specific abnormalities, 25% had a hematoma, 18.8% had a hemorrhage, 6.3% had a contusion, and 12.5% had a skull fracture as their only abnormality; 37.5% of the sample had 2 or more abnormalities. Removing those with skull fractures, the true prevalence of intracranial abnormalities ranged from 17.3% to 35.9%. This prevalence rate is considerably higher than the rates of day-of-injury abnormalities for younger adults, as reported in the literature.

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C.B. LEWIS, L.C. BAXTER, L.S. SUSSKIND-WILDER, N.E. ROUNDY, N.E. SAMPATACOS, M.N. SABBAGH, D.J. CONNOR, R. CASELLI, & S.C. JOHNSON. Neuropsychological Correlates of Gray Matter Density: A Voxel-Based Morphometry Study of Nondemented Elderly.

Recent developments in voxel-based morphometry (VBM) allow for a broader explanation of structural-functional relationships than do region of interest based approaches. This study used VBM to examine the relationship between brain gray matter density (GMD) and cognition in nondemented elderly participants. Twenty-eight subjects (M age = 77, SD = 6.6; education = 13.6 years, SD = 4.5; 17 female 11 male) were given the California Verbal Learning Test-II (CVLT-II), Trail-Making Test, and a T1-weighted 3D MRI exam. The average CVLT was 42.2 (SD = 11.9) while the average Trails-B time was 90.1 s (SD = 37.1). MRI images were processed using SPM99. The VBM procedure was performed in a similar fashion to that done in Good et al., and used the procedures of gray matter segmentation and spatial normalization and smoothing. Voxel-based statistics were used to correlate CVLT total recall (Trials 1-5) and Trails-B completion time with GMD. The CVLT-GMD correlation showed a significant positive mesial temporal lobe effect (Talairach coordinate 40, -11, -37; p = .000; t = 3.72). The Trails-B-GMD correlation map showed significant negatively correlated voxels more diffusely along the cortical surface, including medial and dorsolateral prefrontal, inferior temporal and medial parietal regions. The differing results in the 2 correlational analyses reflect the nature of the neuropsychological tests. Trails-B is a sensitive indicator of overall brain integrity, whereas the learning portion of CVLT-II may be more specific to mesial temporal integrity.

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J.G. CRAGGS, C.J. MILLER, J. SANCHEZ, & G.W. HYND. Topography and Classification of the Perisylvian Region Using MRI: Prevalence Rates and a Possible Link to Cognitive Processing.

Advances in neuroimaging techniques and rendering programs allow for *in vivo* study of cortical structures. The pattern of sulcal and gyral development are frequently used to guide surgical, radiological, and neuropsychological procedures and prognoses. Steinmetz devised a method for classifying the topography of the parietal operculum (PO) using 120 hemispheres. The PO can be classified into one of four morphological types based upon subtle shifts of the postcentral sulcus (POCS), posterior ascending ramus (PAR), and the presence of an intermediate opercular sulcus between the POCS and PAR. His results indicated Type I as most prevalent (74%) overall, with mixed results for the other types. Hiemenz

& Hynd also reported Type I as most frequent (82%), very low incidence of Type II, and no incidence of Type IV. Yet, controversy remains regarding the “typical” PO topography due to few studies and conflicting reports of Types II–IV prevalence. To help clarify this issue 248 hemispheres (124 left, 124 right) were classified using the Steinmetz system. Subjects were selected from a clinic-based sample of individuals suspected of having reading difficulty, but without neurological impairment. Surprisingly, results indicate Type IV as most prevalent overall (44%), followed by Types I, II, & III, respectively. Mixed prevalence rates were found between hemispheres, suggesting the topography of the PO might have an impact on information processing. Hiemenz and Hynd reported that Type III was associated with poor linguistic ability. Continued documentation of cortical topography and its affect on cognition is urged.

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J.G. CRAGGS, J. SANCHEZ, C.J. MILLER, & G.W. HYND. Sulcal/gyral Typology of the Perisylvian Region: Prevalence Rates and the Impact on Cognition.

Gross sulcal and gyral landmarks are frequently used to guide surgical and radiological procedures. Steinmetz devised a method for classifying the topography of the parietal operculum into 1 of 4 types to aid radiological and neurosurgical orientation. Unfortunately, the relevance of these morphological features to overall cognitive functioning has received little attention. Because Steinmetz reported that Type I was more prevalent in both hemispheres, it seems reasonable that Types II, III, and IV might represent cortical compromise. However, this has not been fully explored. Hiemenz and Hynd reported that Type III was predictive of low neurolinguistic performance. Yet, controversy remains due to the dearth of studies and historically low prevalence of Types II and IV. Toward this end, 150 hemispheres were typed (76 left, 74 right) using Steinmetz’s classification system and related to verbal and nonverbal neuropsychological test performance. Strikingly, results indicate nearly uniform distribution of the 4 typologies in the left hemisphere. Moreover, in the right hemisphere, Type IV, not Type I was the most prevalent. Types II and III appeared infrequently in the right hemisphere. Neuropsychological test performance indicated that only verbal skill varied significantly with typology in the left hemisphere. Further, no differences were found for verbal or nonverbal ability with respect to different typologies in the right hemisphere. Continued investigation relating cortical variations to cognitive processing is urged as variations in natural hemispheric asymmetries have been linked to cognitive deficits (e.g., developmental dyslexia).

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A.L. FOUNDAS, D.M. COREY, V. ANGELES, & J. ROUSE. Prefrontal and Occipital Asymmetries in Right-Handed Men: How Typical Is Typical?

One of the most consistent anatomical asymmetries in the human brain is a rightward prefrontal and leftward occipital asymmetry. These configurations are considered typical, whereas reduced or reversed asymmetries are considered atypical. Atypical asymmetries may be markers of atypical functional laterality, although atypical anatomy is found in some individuals with normal neural development and function. Because there is evidence that women and left-handers may be more atypical in terms of anatomy and function, we examined lobar asymmetries in healthy right-handed men ($n = 27$). Using volumetric MRI methods, prefrontal and occipital lobe volumes were measured as percent of total hemisphere volume. Results showed the expected larger right prefrontal ($p = .012$) and left occipital lobe ($p < .0005$) volume. Prefrontal AQs were left > right 7 (26%); left = right 2 (7%); right > left 18 (67%). Occipital volumes were: left > right 19 (70%); left = right 5 (19%); right > left 3 (11%). In 15 (56%) subjects, typical asymmetries were seen in both prefrontal and occipital regions, whereas completely reversed lobar asymmetries were found in 3 (11%) subjects. Some combinations were not present in any subjects. In summary, our sample of healthy right-handed men had the

expected rightward prefrontal and leftward occipital asymmetry. Consistent with the Geschwind-Galaburda theory on cerebral laterality, 25–30% of our sample had atypical anatomy. As postulated by Annett, anomalous anatomy in this subgroup of right-handed men may be linked to the absence of the right-shift gene. We speculate that atypical anatomy in healthy right-handed men might be associated with variations in cognitive–motor operations that are different but not functionally disruptive.

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NEUROPSYCHIATRIC DISORDERS

B.K. LEBOWITZ, D. FLECK, P.K. SHEAR, & S.M. STRAKOWSKI. Stroop Interference in Euthymic Patients With Bipolar Disorder.

Studies employing the Stroop task to assess inhibitory control (IC) in euthymic individuals with bipolar disorder (BPD) have reported mixed results. Although new color/word interference performance alone has been used as a measure of IC ability in some euthymia studies, others have employed interference calculation methods that take into account the impact of the word reading and color naming conditions of the Stroop task. In this study, we compared the interference scores of a group of euthymic individuals with BPD ($N = 22$) to those of a healthy comparison group ($N = 17$) using 3 different calculation methods. The patient group demonstrated significantly poorer color naming ($p < .03$) than the controls, and showed a trend towards significantly poorer word reading ($p < .07$). When examining interference scores using different calculation methods, we found that the groups differed significantly when we analyzed color/word ($p < .035$), there was a trend towards significance when we subtracted color/word from color naming scores ($p < .06$), and they did not differ in their scores based on the method recommended in the Golden Stroop manual that accounts for both word reading and color naming ($p < .35$). The findings of this study suggest that the discrepancy in the literature as to the presence or absence of IC deficits in euthymic BPD patients, as inferred from Stroop interference, may be the result of varying calculation methods, which control differentially for word reading and color naming components of Stroop performance.

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A. JAK, P. SHEAR, M. DELBELLO, H. ROSENBERG, & S. STRAKOWSKI. Verbal Learning and Memory in Children With Bipolar Disorder.

Previous research has demonstrated that adults with bipolar disorder (BPD) exhibit cognitive deficits during abnormal mood episodes, including deficits in verbal learning and memory. Only a few studies, however, have examined the neuropsychological status of children and adolescents with BPD. The aim of this study was to examine verbal learning and memory abilities in 26 children and adolescents with BPD (manic or mixed) in comparison to 15 demographically matched, psychiatrically healthy volunteers. Relative to the healthy volunteers, the BPD group demonstrated subtle differences in total learning ($F = 4.78, p < .04$) and delayed recall ($F = 4.98, p < .04$) on the Hopkins Verbal Learning Test (HVLT), although the rate of learning across trials was similar in the two groups. Even when subgroups of the sample were created that were equivalent in WASI IQ, regression analyses suggested Full Scale IQ was a stronger independent predictor of learning and recall than was group membership. Correlations between symptom severity (Young Mania Rating Scale and Hamilton Depression Rating Scale scores) and learning and memory indices were not significant ($r_s = -.24-.175, p > .2$ for all comparisons), suggesting that symptom severity did not significantly impact performance on the HVLT within the patient group. These results suggest that

children and adolescents with BPD may experience mild learning and memory deficits that are similar to those reported in adults with the disorder; however, their performance in this domain, like that of healthy individuals, shares substantial variance with their general level of cognitive functioning.

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R. ZIEGLER, D. DUSH, & D. SITZER. Social Support and Neuropsychological Dysfunction in an Acute Psychiatric Population.

The interrelationship of social support, psychiatric dysfunction, and neuropsychological dysfunction was examined in a sample consisted of 162 acute psychiatric patients who had recently presented for inpatient care. Social support was hypothesized as a possible buffer for the relationship between neuropsychological dysfunction and psychiatric dysfunction. Subjects were administered the Brief Psychiatric Rating Scale (BPRS), the Cognistat brief neuropsychological screen, the Craig Handicap Assessment Rating Technique (CHART) and the Social Provisions Scale (SPS). For the CHART, a 2×2 ANOVA showed significant main effects with lower level of functioning associated with lower availability of social support ($p = .001$) and higher levels of neuropsychological dysfunction ($p = .001$), and a buffering interaction effect ($p = .036$) such that level of function was not as low for those with neuropsychological dysfunction if higher levels of social support were present. For the BPRS, there were significant main effects ($p < .05$) but no buffering interaction of the 2 factors ($p > .05$). Individuals with lower social support demonstrated more psychiatric symptoms than individuals with more social support at the time of intake and at 2 weeks. Exploratory analyses indicated that subjects with more neuropsychological deficits demonstrated more severe psychiatric symptoms while those with less neuropsychological dysfunction demonstrated less psychiatric dysfunction at 2 weeks ($r = .212, p = .01$). In addition, analyses are discussed as in support of evaluating and increasing social supports available to acute psychiatric patients, especially patients with neuropsychological dysfunction.

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R. PETERSEN, B. MARCOPULOS, & J. MANLEY. WAIS-III Working Memory and Processing Speed Performance in Psychiatric Patients.

Deficient working memory, executive functioning, and psychomotor speed have long been noted in various psychiatric disorders. The Wechsler Adult Intelligence Scale-Third Edition (WAIS-III) includes new subtests and factor indices purportedly measuring these functions. Although the WAIS-III technical manual provides information (factor indices) for schizophrenic patients, these were well educated, clinically stable outpatients. The performance of 219 inpatients at a state psychiatric hospital, the majority of whom carried schizophrenic spectrum diagnoses, on the new WAIS-III subtests and their respective factor index scores was examined. On the Working Memory Index, patients obtained a mean score of 84.19 ($SD = 14.99$) and significant performance differences were observed between Digit Span ($M = 8.11, SD = 2.37$) and Letter-Number Sequencing ($M = 7.00, SD = 3.33$). This finding supports the notion of attentional impairments in this population, and suggests that differential performance reflects the increased attentional reserve required to perform successfully on Letter-Number Sequencing. Patients earned a mean Processing Speed Index score of 78.51 ($SD = 10.54$) and performed significantly better on Symbol Search ($M = 6.11, SD = 2.54$) than on Digit Symbol-Coding ($M = 5.73, SD = 2.24$), a finding consistent with previous research. This performance discrepancy is believed to be a function of the increased task demands of Digit Symbol-Coding above and beyond psychomotor speed. Educational level was lower in this sample than the sample reported in the WAIS-III technical manual and accounted for a statistically significant amount of variance in patient performance. The influence of this and other

variables (gender, comorbid substance abuse, neurocognitive risk factors) are discussed and implications for psychoeducational intervention and future research are presented.

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M. SHIKHMAN, J.G. KEILP, E. SCHORI, & G. BRUDER. Associations Between Working Memory Ability and Risk Factors for Psychopathology.

Working memory deficits have been documented in a wide variety of psychiatric disorders, including schizophrenia and depression. Working memory deficits have also been found in unaffected relatives of schizophrenic patients, suggesting it might be a phenotypic marker for the disorder. It is hypothesized that working memory ability in healthy adults is also related to social anhedonia and personality variables that reflect possible risk factors for schizophrenia and other disorders. A sample of 100 healthy adults, aged 18 to 40 was obtained as part of a larger ongoing study. Subjects were screened for current medical, neurological and psychiatric conditions that could impact working memory using self-report questionnaires (Symptom Check List-90 and Beck Depression Inventory). Personality traits were assessed using the Eysenk Personality Questionnaire and the Chapman scale was used to assess social anhedonia, which was previously shown to correlate positively with risk for developing schizophrenia. Measures of working memory were obtained using Letter-Number subtest of WAIS-III. Predicted negative correlation ($r = -.227, p < .05$) was found between scores on the Letter-Number subtest of the WAIS and scores on Chapman Social Anhedonia subscale, and negative correlation ($r = -.328, p < .01$) was also found between scores on Letter-Number span and Neuroticism scale of the EPQ. The results support the hypothesis that working memory ability is associated with risk factors for psychopathology.

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D. FLECK, P. SHEAR, M. ZIMMERMAN, G. GETZ, K. COREY, A. JAK, B.K. LEBOWITZ, & S.M. STRAKOWSKI. Verbal Memory Deficits in Bipolar Disorder: Effects of Clinical State and Symptom Severity.

Patients with bipolar disorder (BPD) exhibit selective deficits in verbal learning and memory, particularly following longstanding illness. However, there is little consensus about whether these deficits are present from illness onset, persist during euthymia, or involve a differential deficit in recognition versus recall. To examine these issues we administered the California Verbal Learning Test (CVLT) and symptom-rating scales to patients 1st hospitalized for manic or mixed BPD, patients with remitted BPD, and healthy subjects. An overall performance difference was identified between groups based on 7 CVLT variables. Both symptomatic and euthymic BPD groups performed more poorly than healthy subjects on recall measures. However, symptomatic patients performed more poorly than both euthymic patients and healthy subjects on recognition measures. Although manic symptom ratings were related to recognition performance, they were not associated with recall. The results indicated that verbal memory deficits in symptomatic BPD were present at illness onset, affected recognition and recall, and resulted, in part, from the nonlinear influence of symptoms on encoding abilities. The pattern of primary retrieval deficits during symptom remission was consistent with that expected for patients with subcortical frontal dysfunction, which is hypothesized to be present in BPD. Psychiatric symptoms may attenuate attentional/encoding abilities during acute affective states while subcortical dysfunction leads to persistent retrieval deficits.

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G. GETZ, P.K. SHEAR, D. FLECK, & S.M. STRAKOWSKI. Positive Emotional Labeling Bias in Mania.

Recent research indicates that patients diagnosed with bipolar disorder (BPD) exhibit impaired emotional processing. We have reported elsewhere that manic patients exhibit a facial affect recognition deficit when labeling emotions. Although it has been hypothesized that depressed patients have a tendency to label positive emotions less accurately (negative response bias), it remains unclear as to whether manic patients have a positive response bias. The goal of the present study was to re-examine data from the previously reported sample in order to determine if manic patients more accurately label positive emotions (happy and surprise) as compared to negative emotions (sadness, anger, fear, and disgust). Twenty-five manic patients were compared to 25 healthy participants (HV) on a task of facial affect labeling. The participants were shown photographs of different individuals displaying 1 of the 6 emotions. Eighteen stimuli, 3 of each emotion, were presented in the same order for each subject. The BPD and HV groups did not differ in terms of age ($M = 27, SD = 9$ and $M = 24, SD = 4$), education ($M = 12, SD = 2$ and $M = 12, SD = 2$), or ANART-estimated verbal IQ ($M = 104, SD = 8$ and $M = 109, SD = 5$). When examining accuracy on labeling the positive emotions, the BPD group performed similar to the HV group ($p = .8$). However, as compared to the HV group, the BPD group was less accurate when labeling the negative emotions ($p = .001$). Further, follow-up tests indicate that the BPD group labeled negative emotions more often as positive emotions than the HV group ($p = .002$). This study supports the notion that manic patients have a positive response bias, which may contribute to their risk-taking behavior. Correspondence: *Glen Getz, University of Cincinnati, Department of Psychiatry, PO Box 670559, Cincinnati, OH 45267. E-mail: getzg@email.uc.edu*

M.A. STEED, C. ADLER, P.K. SHEAR, S. HOLLAND, C.-Y. CHIU, B.K. LEBOWITZ, & S.M. STRAKOWSKI. Functional MRI Correlates of Facial Affect Recognition in Bipolar Disorder.

Several lines of evidence suggest that the internal emotional dysregulation characteristic of bipolar disorder (BPD) is accompanied by a deficit in the recognition and processing of external emotional cues, such as facial affect. We hypothesized that this impairment is related to the neuropathophysiology of the disorder and would be reflected in dysfunction of frontal-subcortical circuitry in BPD. In the current study, functional MRI scans were obtained at 3 T from 7 euthymic patients with BPD and 7 healthy individuals matched on the basis of age, sex, handedness, and years of education. Participants completed a novel facial affect matching task and a control task in which they were required to do facial gender matching. Reaction time measures were obtained for each task, and regional brain activation during the affect matching task was compared between groups using a voxel-by-voxel analysis without *a priori* constraints. We observed no difference in reaction time between groups on either facial affect matching or control tasks, but did observe significantly different patterns of brain activation. Bipolar patients showed decreased amygdala activation during performance of the facial affect task, and increased activation of the prefrontal cortex in Brodman area 10. These findings suggest that euthymic BPD patients experience decreased activation of subcortical brain structures involved in affect recognition but are disproportionately more likely to recruit prefrontal regions.

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M. KIM, S. KANG, K. SHIN, K. KANG, & J. KWON. ERP Study of Word Priming Effect in Patients With Obsessive-Compulsive Disorder.

Word priming effect in OCD patients was investigated using event-related potential (ERP) and lexical decision task, in which 200 words were repeated immediately (Lag zero), 200 were after 5 intervening words (Lag 5), 120 were never repeated, and 140 nonwords were presented. Five OCD patients and 10 normals participated. Word priming effect was analyzed in three conditions, i.e., old/new words in total (words repeated immediately

and after a delay vs. nonrepeated words + initial presentation of repeated words), old/new words in Lag zero and new/old words in Lag 5. Epoch was 1100 ms (including 100 ms prestimulus). Epoch was divided into 5 intervals (0–200, 200–400, 400–600, 600–800, 800–1000 ms). Mean amplitudes of each interval were analyzed by ANOVA, repeated measure, mixed design. Mean reaction time to old and new words was analyzed. For the control group, response times were significantly shorter to words repeated immediately [$t(9) = -7.582, p = .000$] and to those after a delay [$t(9) = -10.738, p = .000$], compared with words initially presented. However, response times to repeated words and initial presented words did not differ in OCD patients. In terms of ERP amplitude, old/new effect, i.e., priming effect was observed only in 400–600 ms interval [$F(1, 13) = 8.659, p = .011$] in all 3 conditions. Old words showed more positivity than new words. The group effect was also observed only in 400–600ms interval [$F(1, 13) = 11.575, p = .005$]. Control group showed more positivity than OCD group. The absence of priming effect in behavior and electrophysiology in OCD patients indicates the possible implicit memory deficit in these patients.

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T. YOUN, S.J. KANG, H. PARK, M. KIM, & J. KWON. Organizational Deficit Mediates Nonverbal Memory Impairment in OCD Patients.

This study investigated memory deficit in patients with obsessive-compulsive disorder (OCD) using Rey-Osterrieth Complex Figure Test (RCFT) and Korean version of California Verbal Learning Test (K-CVLT). The mediating effect of organizational strategy was analyzed. Thirteen controls (M age: 24.08) and 8 OCD patients (M age: 27.88) participated. Both groups did not differ on any measures of K-CVLT. Contrary to K-CVLT, control and OCD groups showed significant differences on recall accuracy [$F(1, 19) = 5.944, p = .025$], particularly, on the immediate recall [$t(19) = 2.508, p = .021$], and on organizational score during copy condition [$t(19) = 2.348, p = .03$]. The OCD patients recalled significantly less and inaccurately than the controls. The immediate percent recall (immediate recall score/copy score $\times 100$) was also different between two groups [$t(19) = 2.083, p = .05$]. OCD group showed lower percent recall than control group (52.78 vs. 66.83%). The mediating effect of organizational strategy on immediate percent recall was investigated using multiple regression, with group as independent variable, immediate percent recall as dependent variable, and organizational score in the copy as a mediator of group effect on percent recall. In regression analysis, group had a direct effect on the mediator (standard coefficient = $-.474, p = .03$) and on percent recall (standard coefficient = $-.431, p = .05$). However, in multiple regression, organization had a significant direct effect on percent recall (standard coefficient = $.57, p = .011$), but the direct effect of group on percent recall was reduced and did not reach statistical significance (standard coefficient = $-.161, p = .434$). These results indicate that impairment of immediate recall in OCD patients is mediated by organizational deficit during copy of RCFT figures.

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R. STERN, A. BENDER, M. FURMAN, K. SMITH, B. ROGERS, R. BROWNING, N. RAUFI, & D. SOLOMON. The Use of Aricept (Donepezil) in Electroconvulsive Therapy (ECT).

Electroconvulsive therapy (ECT) is a highly effective treatment for a variety of psychiatric disorders. However, cognitive deficits remain a significant side effect of ECT, including brief periods of confusion and disorientation, as well as temporary anterograde and retrograde amnesia. Clinical trials of adjunctive pharmacologic agents have been conducted to reduce the memory deficits, though none has resulted in robust effects or has been replicated successfully. Converging evidence suggests that ECT-related memory deficits may be due to alterations of central cholinergic functioning, implicating a potential role of cholinergic agonists in protect-

ing against these impairments. The current preliminary study examined the use of Aricept (donepezil; 5–10 mg) in a group of 25 patients with major depressive disorders receiving ECT. Patients were examined with several anterograde and retrograde memory tests at baseline and following their last ECT treatment. The results of this double-blind, placebo-controlled clinical trial indicated no significant effect for Aricept (all $ps > .1$). Moreover, Aricept did not impact the duration of skeletal muscle relaxation induced by succinylcholine, a drug commonly used as part of the anesthesia regimen used in ECT and other procedures (all $ps > .1$). Effect sizes were very small ($\eta^2 < .01$), indicating that the negative findings in this study were not due merely to small sample size or inadequate power. In conclusion, these preliminary results suggest that Aricept does not protect against the amnesic side effects of ECT, though the use of Aricept in patients undergoing ECT is not contraindicated because of an interaction with succinylcholine.

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D. SITZER, D. DUSH, & R. ZIEGLER. Stability of Neuropsychological Deficits Following Acute Psychiatric Treatment.

Stability over time of neuropsychological dysfunction following acute psychiatric treatment was investigated. A sample of 98 acute psychiatric patients who had recently presented for inpatient care were identified for the current study. All participants were administered the Cognistat, a brief neuropsychological screening device; the Brief Psychiatric Rating Scale (BPRS), a clinical rating scale of psychiatric symptoms; and the Health Concerns Questionnaire (HCQ), a brief self-report checklist related to clinically diagnostic criteria, at 2 weeks post intake and again at 6 months post intake. Overall, 56% of the sample showed at least minor impairment on one or more subscales of the Cognistat at pretest. Paired-sample t tests indicated improved psychiatric status over time on both clinical rating ($t = 3.61, p < .01$) and self report ($t = 3.12, p < .01$), while neuropsychological status remained unchanged ($t = -1.07, p = n.s.$). Nonetheless, greater correlations between neuropsychological and psychiatric status (BPRS) were observed at 6 months post intake ($r = .34, p < .01$) than at 2 weeks post intake ($r = .21, p < .05$), suggesting that despite the passage of 6 months and general psychiatric improvement, neuropsychological deficits continued to be predictive of those with greater psychiatric disturbance. Results support the use of neuropsychological assessment as part of a standard intake battery for psychiatric inpatients. Many of these patients maintain stable neuropsychological deficits following presentation for inpatient psychiatric care. Addressing these impairments may help to identify continued psychiatric risk or perhaps, if treated, improve psychiatric status.

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S. REMY & A. BERARDI. Mental Imagery Abilities and Sensation Seeking in Female Suicide Attempters.

The aim of this study was to determine whether mental imagery abilities are associated with sensation seeking in suicide attempters and controls. Thirteen female suicide attempters and 44 healthy female controls matched on age and education were studied. Subjects were administered the Vividness of Visual Imagery Questionnaire (VVIQ), the Mental Rotations Test (MRT) and the SSS (with subscales of Disinhibition, Thrill and Adventure Seeking, Experience Seeking and Boredom Susceptibility). Results were analyzed using Pearson correlations and one-way ANOVAs with 1 between-groups factor (suicide attempters vs. controls) and 1 within-group factor (the scores on the tests). In suicide attempters, the VVIQ was positively correlated with the Boredom Susceptibility subscale of the SSS suggesting that subjects with higher self-reported vividness of mental imagery had higher boredom susceptibility ($r = .71, p < .005$). In controls, the correlation between the VVIQ and Boredom Susceptibility was not significant ($r = .24, p = .12$). No other significant correlations were found and ANOVAs did not reveal any significant differences between

groups. The results indicate that vividness of mental imagery is correlated with at least 1 factor of sensation seeking in female suicide attempters. However, spatial imagery ability (MRT) was not related to sensation seeking. This finding may suggest that only specific aspects of mental imagery are related to sensation seeking in suicide attempters.

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J.G. KEILP, G. LOWE, E. SCHORI, H.A. SACKEIM, & J.J. MANN. Screening for Attempt-Related Brain Damage in Neuropsychological Studies of Suicidal Behavior.

Neuropsychological deficits found in past suicide attempters may be a product of severe self-injury rather than a precursor. Clinical MRI data were used to evaluate the incidence of structural brain abnormality in past attempters, and its association to cognitive performance. Seventeen nonpatients (CON), depressed nonattempters (NA), 9 low-lethality attempters (LL), and 15 high-lethality attempters (HL) received a neuropsychological battery and MRI scans (SPGR and T2-weighted; standardized, blinded clinical reading by a single radiologist). Minor focal abnormalities were found in 41.2% of CON, 35.3% of NA, 22.2% of LL, and 46.7% of HL ($\chi^2 = 1.56, p = .67$). Atrophy was found in 11.8% of CON, 29.4% of NA, 22.2% of LL, and 20.0% of HC ($\chi^2 = 1.63, p = .65$). Rating of cerebral atrophy did not differ among the groups [$F(3, 54) = 1.48, p = .23$]. Across all groups, those with focal abnormalities performed more poorly on the Buschke SRT [$t(56) = 2.41, p = .02$], and WMS-R Verbal Memory [$t(56) = 1.71, p = .09$]. The cerebral atrophy rating correlated with performance on Choice Reaction Time ($rs = .34, p = .01$), WAIS-R Digit Symbol ($rs = -.27, p = .04$), WAIS-R Block Design ($rs = -.42, p = .001$), Trail Making Part A ($rs = .43, p = .001$), and WMS-R Visual Memory ($rs = -.26, p = .05$). Adjusting neuropsychological scores for the presence of focal abnormalities and severity of atrophy, however, did not significantly affect previously observed differences among the groups. Clinically rated MRI abnormalities were no more common among past suicide attempters than among nonattempters or nonpatients. Though aspects of memory, motor, and psychomotor performance were associated with these abnormalities, they did not account for previously observed performance differences among these subject groups.

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E. TWAMLEY & J. WELLER. Executive Dysfunction in Inpatient Suicide Attempters.

The elevated risk of suicidal behavior in patients with depression, bipolar disorder, psychotic disorders, and borderline personality disorder may reflect impulsivity and poor problem-solving ability, usually associated with orbitofrontal and dorsolateral-prefrontal functioning, respectively. It remains unclear, however, whether 1 domain is differentially affected, and whether suicide attempters are more impaired in either domain than are nonattempters with the same diagnoses. In the current study, 18 suicide attempters with the aforementioned diagnoses in an acute, inpatient psychiatric setting were administered a brief neuropsychological battery within one month of their suicide attempt. Participants (9 women and 9 men) represented a broad range of ages (19–60 years; $M = 33$), education levels (8–17 years, $M = 11.7$), and estimated IQs (92–125; $M = 106$). With impairment defined at a T score of < 40 , 39% of suicide attempters were impaired on Trails B and 44% were impaired on verbal fluency (FAS). On the Wisconsin Card Sorting Test–64, 39% were impaired on conceptual level responses and nonperseverative errors, 33% were impaired on total errors, 44% achieved zero to 2 category sorts, and 39% had 1 or more set losses. Most participants performed normally on a continuous performance test, but 50% were impaired on the Stroop Interference condition. These preliminary results support the notion of impairments in both dorsolateral-prefrontal and orbitofrontal functions. Further analyses will compare suicide attempters with nonattempters of the same diagnostic groups. Knowledge gained regarding the executive function deficits that

may be associated with suicidal behavior will be helpful in identifying potential targets of treatment to reduce suicidal behavior in at-risk groups. Correspondence: *Elizabeth Twamley, VA San Diego Healthcare System (116A-1), 3350 La Jolla Village Drive, San Diego, CA 92161. E-mail: etwamley@ucsd.edu*

D. EVERHART & H. DEMAREE. Low Alpha (7.5–9.5 Hz) Differences Among High and Low Hostiles During Affective Learning.

In this experiment the relationship between hostility and low alpha power (7.5–9.5 Hz) during affective verbal learning was examined. Fifty low and high hostile undergraduate students were identified using the Cook-Medley Hostility Scale (CMHS). Participants completed either the positive or negative word list from the Affective Auditory Verbal Learning Test (AAVL). One-minute electroencephalographic samples were recorded from 19 scalp-sites prior to administration, following Trials 3 and 5 of the AAVL, and 5 min post administration. Using the dependent measure of low alpha power, ANOVA revealed a Group \times Affect \times Scalp Site interaction [$F(6,258) = 2.741, p < .01$]. *Post-hoc* comparisons for this interaction yielded 2 findings. First, high hostile participants who learned the negative affective list evidenced significantly ($p < .05$) greater low alpha power at central (C3, C4) and occipital (O1, O2) scalp sites than did low hostile participants. No differences in low alpha power were observed between high and low hostiles who learned the positive affective list. Second, low hostiles who learned the positive affective list evidenced reliably greater low alpha power at central (C3, C4) and occipital (O1, O2) scalp sites in comparison to low hostiles who learned the negative affective list. No reliable electrophysiological differences were observed between high hostiles who learned the positive affective list and high hostiles who learned the negative affective list. These findings indicate differing patterns of neurophysiological activity for low and high hostiles during affective learning. The implications are discussed in terms of current neuropsychological models of hostility.

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S. BEZEAU & A.T. DUGBARTEY. Verbal and Nonverbal Abilities Among Adolescent and Adult Offenders.

The hypothesis that offenders tend to have better nonverbal (PIQ) abilities than verbal (VIQ) abilities was examined in both an adolescent and an adult forensic population. One hundred adolescents and 90 adults were administered either the Wechsler Adult Intelligence Scale (WAIS–III) or the Wechsler Intelligence Scale for Children (WISC–III). Results indicated that the young offenders who received the WISC–III displayed the expected pattern of superior PIQ over VIQ. Among adolescents who received the WAIS–III this pattern did not hold. In the adult population, the difference between VIQ and PIQ was nonsignificant, although the difference between the Verbal Comprehension Index (VCI) and the Perceptual Organization Index (POI) was significant. The PIQ–VIQ discrepancy tends to decrease with advancing age, and this is related to a decline in PIQ. VIQ, in contrast, appears to be relatively stable across age groups. The same pattern across age ranges is seen with POI and VCI. Consideration is given to the basis of the nonverbal–verbal discrepancy reported in the previous literature.

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P.L. EBERT, A.T. DUGBARTEY, & S. SIM. Measures of Executive Function as Predictors of Violent Offending.

Brain imaging and neuropsychological correlation studies have suggested a relationship between impaired executive functions/frontal systems and violent offending. This study examined the relationship between performance on common executive function tasks and the presence of violence in the index offence. Participants included 40 individuals consecutively referred for neuropsychological assessment in a community forensic men-

tal health clinic. The average age of the participants was 35 years (range: 19–75). There were 3 females and 37 males. Overall intellectual ability was in the low average range (M FSIQ = 87, FSIQ range: 57–120). Executive measures were broadly grouped according frontal systems: dorsolateral (Trailmaking Interference; COWAT; WCST categories, perseverative responses, FMS), orbitofrontal (Stroop interference), and medial frontal (i.e., working memory, WAIS–III letter–number). Violence in the index offence was based on HCR–20 (which is a scheme for predicting risk for future violence in criminal offenders) criteria. A forward stepwise multiple regression was used to predict violence in the index offence by using executive measures as predictors and FSIQ as a co-variant. Results indicated that WCST categories was moderately associated with the presence of violence in the index offence [$F(1,39) = 5.73, p = .02, R^2 = 14\%$]. Results are suggestive of dorsolateral mechanisms underlying violent offending, and are consistent with previous research implicating difficulties in set shifting in violent offenders. Further research is currently being undertaken to examine the relationship between executive functioning and clinician assessment of future risk of violent offending using the HCR–20. Correspondence: *Patricia Ebert, Forensic Psychiatric Services Commission, 2840 Nanaimo Street, Victoria, BC V8T 4W9, Canada. E-mail: pebert@uvic.ca*

S.A. CRUMP & J.A. OGDEN. The Impact of Executive Dysfunction on Recidivist Violent Offending.

Links between executive dysfunction and aggression and violence have been consistently noted in the research literature over recent years. Some research documents profound change and development of unsavory and antisocial traits after ablation or damage to various parts of the prefrontal cortex, whilst other research makes more tentative links using brain imaging and neuropsychological methods. This study uses a neuropsychological battery to examine the role of the executive functions in offending. It is hypothesized that problems with executive functioning may be linked to offending through impulsivity and disinhibition. Crimes offer immediate gratification; they are often simple and easy to commit requiring few formal skills or little academic education. Most crimes are spontaneous, and the obvious lack of planning is consistent with their being viewed as impulsive actions. An aim of this study was to see if prison inmates who commit violent crimes are more likely to have executive impairments, than those prison inmates whose crimes were not violent. Three groups of men were assessed on tests of executive dysfunction: inmates convicted of violent crimes; inmates convicted of nonviolent crimes; and a matched control sample of men in the community (conviction-free). Preliminary results provide some support for a relationship between executive dysfunction and participation in violent crimes. Rehabilitation strategies that might better serve offenders with executive difficulties will be suggested.

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T. WODUSHEK & E. HARRELL. Psychopathy and Neuropsychological Measures of Orbitofrontal Functioning.

Recent neuropsychological theories and empirical research studies have posited a link between cognitive measures of orbitofrontal functioning and the symptoms of psychopathy. The current study will provide an analysis of the relationship between the neuropsychological functioning of incarcerated offenders and their psychopathic symptoms. 100 inmates detained at a county jail for a variety of offenses were interviewed via the Psychopathy Checklist: Screening Version. Cognitive testing included an IQ screen (WASI), traditional frontal lobe tests (COWAT, WCST, Spatial Span), and purported measures of orbitofrontal functions (Gambling Task, Stop Signal Task, Cross Cultural Smell Identification Test, facial emotional expression identification). The study hypothesized a significant relationship between measures of orbitofrontal functioning and the Defective Affective Experience and Impulsive and Irresponsible Behavioral Style factors of the Cooke and Mieche 3-factor model of psychopathy. Furthermore, performance on orbitofrontal measures was hypothesized to account for a greater proportion of the variance in these factor scores than that which is

explained by age, educational level, IQ, or nonorbitofrontal related cognitive measures.

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K.D. HIATT & J.P. NEWMAN. Flanker Interference Among Psychopathic Offenders.

Psychopaths frequently fail to accommodate information that is peripheral or secondary to their current attentional focus. These failures are suggestive of *overselective* attention, such that information of immediate interest is processed to the exclusion of peripheral or contextual information. We investigated psychopaths' selective attention using a visual flanker paradigm in which participants were required to respond to a central target while attempting to ignore flanking distractors. If psychopaths' attention is overselective, they should be better able to ignore the distractors and should therefore experience less interference than controls from response-incongruent flankers. Contrary to the overselection hypothesis, primary (low-anxious) psychopaths demonstrated *greater* flanker interference than controls, indicating that they were actually less able than controls to selectively attend to the central target. This finding seems to contradict previous evidence that psychopaths are insensitive to interference from contextual cues. Together with evidence that psychopaths show facilitation, but not interference, on a spatially separated version of the color-word Stroop, these data reveal important limits of psychopaths' failure to use contextual cues.

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B.K. ENGELSEN & A. GRAMSTAD. Neuropsychological Performances in Norwegian Prison Inmates.

Compared to noncriminals, criminals with law violation of an impulsive or violent character generally have been found to show abnormalities on neuropsychological testing and on MMPI. More specifically, MMPI-2 scales F, 4, 6, 8 and 9 are elevated; PIQ > VIQ on Wechsler scales, and performance on neuropsychological test batteries are impaired. This study inspected whether these findings could be replicated among Norwegian prison inmates. Seven prisoners (6 male, 1 female, *M* age 24.7, *SD* 4.4) consecutively referred to neuropsychological testing were included in the study. One person was excluded because of known brain damage. Five had a history of drug abuse, and 1 had a previous psychiatric diagnosis, WAIS, WMS-R, WCST, Halstead-Reitan Neuropsychological Battery and MMPI-2

were administered. Neuropsychological abnormalities were found in all persons included. However, no characteristic group pattern of neuropsychological deficiencies could be identified. In particular, no PIQ > VIQ pattern was found. MMPI-2 profiles showed a pattern in agreement with the main findings in the literature. Results are discussed in relation to theories of cortical dyscontrol, defects in executive function and impaired strategy flexibility among criminals. These hypotheses were partially supported by this study, whereas theories of verbal skills deficiency were not supported.

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J. WALTERS, C. MATHIESEN, & L. BOLIN. Intelligence as a Moderator of Institutional Aggression Among Psychopaths.

Studies have found that higher levels of psychopathy (characterologically disordered, predatory social behavior) are a robust predictor of increased institutional and future violence. However, Heilbrun also suggested that intelligence might moderate this relationship: high psychopathy and low IQ further increases risk for violence. The goal of the current study was to determine whether IQ moderates the expression of institutional violence among psychopaths (if lower FSIQ correlates with increased aggression) and if this profile facilitates risk prediction. Subjects were drawn from a clinical database of patients referred to the neuropsychology service at a maximum-security forensic hospital, and were grouped according to Psychopathy Checklist-Revised score (PCL-R) as follows: *high* (*N* = 50; PCL-R = 27-40), *med* (*N* = 49; PCL-R = 21-26), and *low* (*N* = 42; PCL-R = 0-20). Groups did not differ significantly on demographic variables. However, there were significant differences between groups on IQ. The *low* group scored significantly higher than the *high* group on FSIQ [$F(2,75) = 4.044, p = .021$] and VSIQ [$F(2,83) = 3.083, p = .051$]. Further, negative correlations between patients' PCL-R scores and FSIQ and VSIQ scores were found. The most robust correlations were between PCL-R Factor 2 scores (impulsive and socially deviant behaviors) and FSIQ ($r = -.280, p = .009$) and VSIQ ($r = -.339, p = .009$). Consistent with our hypothesis, lower FSIQ/higher PCL-R scores correlated with increased institutional aggression. However, it was not statistically significant ($p = .095$), suggesting that the structured maximum-security facility in which patients currently reside limits aggression. Nevertheless, IQ—and thus, neuropsychological evaluations—may be clinically useful in identifying patients at higher risk for institutional aggression.

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