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Research Article

Understanding Indirect Speech in Frontotemporal Dementia and Alzheimer's Disease Dementia: Validation of the Hinting Task – Dutch Version (HT-NL)

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Abstract

Objective: Impairments in social interaction are common symptoms of dementia and necessitate the use of validated neuropsychological instruments to measure social cognition. We aim to investigate the Hinting Task – Dutch version (HT-NL), which measures the ability to infer intentions behind indirect speech to assess Theory of Mind, in dementia. **Method:** Sixty-six patients with dementia, of whom 22 had behavioral variant frontotemporal dementia (bvFTD), 21 had primary progressive aphasia, and 23 had Alzheimer's disease (AD), and 99 healthy control participants were included. We examined the HT-NL's psychometric properties, including internal consistency, between-group differences using analyses of covariance with Bonferroni-adjusted post hoc comparisons, discriminative ability and concurrent validity using the area under the receiver operating characteristic curve (AUC), and construct validity using Spearman rank correlations with other cognitive tests. **Results:** Internal consistency was acceptable (Cronbach's $\alpha = 0.74$). All patient groups scored lower on the HT-NL than the control group. Patients with bvFTD scored lower than patients with AD dementia. The HT-NL showed excellent discriminative ability (AUC = 0.83), comparable to a test of emotion recognition (ΔAUC = 0.03, $p = .67$). The HT-NL correlated significantly with a test for emotion recognition ($r = .45$), and with measures of memory and language ($r = [.31, .40]$), but not with measures of information processing speed, executive functioning, or working memory ($r = [.00, .17]$). Preliminary normative data are provided. **Conclusions:** The HT-NL is a psychometrically sound and valid instrument and is useful for identifying Theory of Mind impairments in patients with dementia.

Keywords: Social Cognition; Theory of Mind; Assessment; Neuropsychological Tests; Psychometrics; Neurodegenerative Diseases

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Statement of Research Significance

Research Question(s) or Topic(s): The psychometric properties, between-group differences, and concurrent and construct validity of the Hinting Task – Dutch version (HT-NL), a measure of Theory of Mind, in dementia. **Main Findings:** The HT-NL has sound psychometric properties. Patients with behavioral variant frontotemporal dementia (bvFTD), primary progressive aphasia (PPA) and Alzheimer's disease (AD) dementia performed worse on the HT-NL compared to control participants. Additionally, patients with bvFTD performed worse than patients with AD dementia. The HT-NL measures social cognition, but is also at least partially dependent on memory and language. **Study Contributions:** This study shows that the HT-NL has sound psychometric properties, is able to detect group differences, and demonstrates concurrent and construct validity. The results support the use of the HT-NL as a measure of social cognition for the diagnostics of dementia.

Introduction

Changes in social behavior frequently occur as a result of neurodegenerative diseases (Setién-Suero et al., 2022). Social and behavioral changes are particularly prominent in the behavioral variant of frontotemporal dementia (bvFTD; Henry et al., 2016), but they also occur in primary progressive aphasia (PPA; Fittipaldi et al., 2019; Magno et al., 2022) and Alzheimer's disease (AD)

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dementia (Ossenkoppele et al., 2022). Social behavior is essential to human interactions and requires intact sociocognitive abilities (De Jaegher et al., 2010). Social cognition is defined as the cognitive processes that are involved in processing social information, which underlie social interactions (Green et al., 2008). These cognitive processes comprise multiple components, as social signs need to be recognized, understood, and interpreted within their context (Adolphs, 2003; Henry et al., 2014; Kennedy & Adolphs, 2012). The sociocognitive process of understanding social information is referred to as Theory of Mind (ToM) - that is, the ability to infer and understand mental states in oneself and others, and to understand that mental states in others can differ from one's own (Henry et al., 2016; Premack & Woodruff, 1978). Impairments in ToM have been reported in different types of dementia, including bvFTD, PPA, and AD dementia (Bora et al., 2015; Henry et al., 2014; Magno et al., 2022), and pose a burden on patients and their caregivers (Brioschi Guevara et al., 2015; Formica et al., 2020).

Despite the importance of measuring ToM and the recognition of social cognition as one of the six core components of neurocognitive functioning (American Psychiatric Association, 2013), social cognition is not routinely assessed in clinical practice (McDonald et al., 2023). An important reason is that few neuropsychological tests aimed at social cognition, and in particular ToM, are found to be psychometrically sound instruments. Developing and validating neuropsychological tests for ToM, and social cognition in general, is fundamental for ensuring a reliable and accurate diagnostic assessment of sociocognitive functioning in dementia.

To this end, the Hinting Task (Corcoran et al., 1995) is a promising neuropsychological instrument. The Hinting Task measures the ability to infer intentions behind indirect speech. Originally, the Hinting Task was developed to assess ToM in patients with schizophrenia and has since been investigated primarily in patient groups with various neuropsychiatric disorders, showing sensitivity to impairments in ToM (e.g. Bora et al., 2005; Pinkham et al., 2018). In these clinical populations, the Hinting Task has demonstrated adequate to good results concerning discriminative ability, test-retest reliability, internal consistency, and construct validity (Halverson et al., 2022; Klein et al., 2020; Morrison et al., 2019; Pinkham et al., 2018; Tsui et al., 2024). However, ceiling effects have been reported (Davidson et al., 2018; Frøyhaug et al., 2019), though not consistently (Pinkham et al., 2018).

Limited research has been performed on the Hinting Task in dementia (Braak et al., 2022; Van 't Hooft et al., 2024). Differences have been found between patients with AD dementia and control participants (Braak et al., 2022), albeit not invariably (Van 't Hooft et al., 2024). Despite the profound impairments in social cognition in frontotemporal dementia (FTD) spectrum disorders, only one study investigated the Hinting Task in the FTD spectrum and found that patients with bvFTD performed worse compared to control participants and patients with AD dementia (Van 't Hooft et al., 2024). A psychometric evaluation of the Hinting Task in dementia, however, has not been performed, leaving important questions on the validity of its use in memory clinics unanswered.

The aims of the present study are 1) to examine the psychometric properties of the Hinting Task – Dutch version (HT-NL), 2) to evaluate differences in HT-NL scores between patients with bvFTD, PPA, and AD dementia and control participants, and to investigate the discriminative ability of the HT-NL in patients with dementia compared to control participants, as well as to compare the discriminative ability to another test of social cognition to assess concurrent validity, and 3) to examine the associations between the HT-NL and other cognitive tests to assess construct validity. Preliminary normative data based on the control group are also reported to support the use of the HT-NL in research and clinical practice.

Method

Participants

This study included 66 patients with dementia, being bvFTD (n = 22), PPA (n = 21; semantic variant PPA = 8, nonfluent variant PPA = 6, logopenic variant PPA = 7), and AD dementia (n = 23), who visited the outpatient memory clinic of Alzheimer Center Erasmus MC in Rotterdam, the Netherlands, between June 2022 and April 2024 for a standardized diagnostic assessment, including a neurological examination, neuropsychological assessment, laboratory testing, and structural magnetic resonance imaging. Results were discussed in a multidisciplinary consensus meeting by neurologists, geriatricians, radiologists, and neuropsychologists in which a clinical diagnosis was made based on the international clinical criteria for bvFTD (Rascovsky et al., 2011), PPA (Gorno-Tempini et al., 2011), and AD (McKhann et al., 2011). Participants were included in the present study only if they had intact comprehension of the test instructions.

Control participants (n = 99) were healthy, community-dwelling adults recruited through word of mouth in the greater areas of Rotterdam and Groningen in the Netherlands. Control participants were included if they had no self-reported history of neurological or psychiatric disorders, scored below cutoff (< 11) on the anxiety and depression subscales of the Hospital Anxiety and Depression Scale (HADS; Bjelland et al., 2002), and scored above 25 points on the Mini-Mental State Examination (MMSE; Folstein et al., 1975).

This research was approved by the Medical Ethics Review Committee of the Erasmus MC University Medical Center (MEC-2022-0546) and was completed in accordance with the Helsinki Declaration. All participants gave written informed consent for their data to be used for scientific analysis.

Measures

The Hinting Task

The Hinting Task is a verbal test that measures the ability to infer intentions behind indirect speech in order to assess ToM. Ten passages describing an interaction between two characters are read aloud to the participant. In each passage, one character makes an indirect inquiry and participants are asked to infer the meaning of this hint. If the initial answer is incorrect, a continuation of the passage with a more obvious hint is provided. A correct response yields a score of 2, a correct response after providing the extra hint yields a score of 1, and if the response remains incorrect after the extra hint, a score of 0 is given. These are the original scoring criteria as reported by Corcoran et al. (1995). Total scores range from 0 to 20, with higher scores suggesting better ToM ability. An example of an item is: *George arrives at Angela's office after a long, hot trip on the motorway. Angela immediately begins to talk about some business ideas. George interrupts Angela to say: "Ugh, it has been a long, hot trip on the motorway."* The question asked is: *What does George really want to say when he says this?* If an incorrect response is given, the following hint is provided: *George continues to say, "I am thirsty." What does George want Angela to do?*

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The Hinting Task – Dutch version (HT-NL) was developed with permission of the authors of the original version of the Hinting Task (Corcoran et al., 1995). We translated and adapted the Hinting Task to the Dutch language and culture. Changes in the HT-NL relative to the original version were minor, such as names of the characters (e.g. *Gerard* for *George*). The translation from English to Dutch was performed by two independent raters (EB and HB) and the resulting translation was back-translated by a native English speaker. Differences in translations were minor and were resolved by consensus.

Cognitive assessment

All participants in this study completed a set of neuropsychological tests, but the test batteries differed slightly between patient groups as the neuropsychological assessment was part of the clinical diagnostic assessment. The MMSE was used as a measure of global cognition and as an estimator of disease severity (Folstein et al., 1975).

The Trail Making Test (TMT; Corrigan & Hinkeldey, 1987) part A was included to measure information processing speed and TMT part B and the TMT B/A index were included to measure executive functioning. The 60-item Boston Naming Test (BNT; Kaplan et al., 1983) was included as a measure of language, specifically confrontation naming. The category (animal) and letter (D-A-T) fluency tests (Schmand et al., 2008) were included as measures of language and executive functioning. Verbal episodic memory was measured using the immediate recall (sum score of trials 1–5) and the delayed recall of the Dutch version of the Rey Auditory Verbal Learning Test (RAVLT; Van der Elst et al., 2005). The Digit Span test from the WAIS-IV (Wechsler, 2012), including the forward, backward, and sequencing conditions, was included as a measure of working memory. Social cognition was assessed using the Emotion Recognition Test (ERT; Kessels et al., 2014) as a measure of facial emotion recognition. Control participants did not perform the BNT, RAVLT, and Digit Span test.

Level of education was recorded using seven categories in line with the Dutch educational system, in which 1 corresponds to having completed less than primary school and 7 corresponds to having an academic degree (Duits & Kessels, 2014). These levels were converted to years of education in accordance with the Anglo-Saxon educational system.

Statistical analysis

To examine the sample characteristics, we evaluated between-group differences using analyses of variance, except for the categorical variable sex, for which a chi-square test was performed.

In the first step, we examined the psychometric properties of the HT-NL in the total sample (n = 165). After exploring the data distribution of the HT-NL, we assessed the internal consistency using Cronbach's alpha and Pearson inter-item correlations. Associations with age, sex, and level of education and the HT-NL were assessed using multiple linear regression.

In the second step, between-group differences in HT-NL scores were examined using analysis of covariance controlling for age. Estimated marginal means were reported and partial eta squared (η^2) was used as a measure of effect size. Post hoc pairwise comparisons were adjusted using the Bonferroni correction. In a secondary analysis, the aforementioned analysis was additionally adjusted for MMSE score as an estimator of disease severity. In the few cases in which a patient had completed the Montreal Cognitive Assessment (MoCA; Nasreddine et al., 2005) instead of the MMSE, the MoCA score was converted to an equivalent MMSE score according to Van Steenoven et al. (2014). Power analyses were performed using G*Power 3.1.9.7, selecting the statistical test 'ANCOVA: Fixed effects, main effects and interactions' within the family of F-tests. Our sample size was sufficient to detect medium to large effects with a power of .80 and the alpha-level set at .05.

The discriminative ability of the HT-NL was assessed using receiver operating characteristic (ROC) analysis, with the area under the curve (AUC) calculated for the contrast of patients with dementia (n = 66) and control participants (n = 99). No analyses with subgroups of patients with dementia were performed due to small sample sizes. Additionally, we compared the discriminative ability of the HT-NL with the ERT (serving as a reference test for social cognition) as a measure of concurrent validity by comparing the AUCs of the two tests for the contrast of patients with dementia and control participants using a paired-sample design. An AUC below .70 was considered poor discrimination, between .70 and .80 was considered acceptable discrimination, between .80 and .90 was considered excellent discrimination, and above .90 was considered outstanding discrimination (Hosmer & Lemeshow, 2000).

In the third step, construct validity was assessed using exploratory Spearman rank correlation analyses between the HT-NL and other cognitive tests in the patient group (n = 66). The correlation between the HT-NL and the ERT was examined for convergent validity. Correlations with the TMT, BNT, category and letter fluency tests, RAVLT, and Digit Span test were examined for divergent validity.

Preliminary normative data were calculated as percentiles based on the distribution of HT-NL scores in the control group (n = 99), after investigating the effects of age, sex, and level of education using multiple linear regression.

All analyses were performed with IBM SPSS Statistics 28.0 (IBM Corporation, 2021), with alpha set at .05.

Results

Characteristics

The participant characteristics are shown in Table 1. Patients with bvFTD, PPA, and AD dementia and control participants differed in age (F (3, 161) = 4.88, p < .01, η^2 = .08). Patients with bvFTD were younger than patients with AD dementia (p < .001), patients with PPA (p < .05), and control participants (p = .01), and control participants were younger than patients with AD dementia (p = .04). No differences were found between the groups in the distribution of sex (χ^2 (3, N = 165) = 1.89, p = .60) or in years of education (F (3, 161) = 0.61, p = .61, η^2 = .01). Months since symptom onset did not differ between the patient groups (F (2, 62) = 0.35, p = .70, η^2 = .01). MMSE scores differed significantly (F (3, 156) = 60.67, p < .001, η^2 = .54). All patient groups (p's < .001) scored lower than the control group, and patients with AD dementia scored lower than patients with bvFTD (p < .001).

Psychometric properties of the HT-NL

Patients with dementia (n = 66) had a mean HT-NL score of 14.2 ± 3.8, with scores ranging from 1 to 19. Control participants (n = 99) had a mean score of 17.7 ± 1.5, with scores ranging from 13 to 20.

Overall, none of the patients and 12 (12.1%) control participants obtained a maximum score of 20. At the item level, item 8 (unpacking shelves) had both the highest proportion of patients (50.0%) and control participants (10.1%) scoring zero points. Most patients obtained the maximum score on item 5 (no

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Table 1. Characteristics of the control group and patient groups

	Control	bvFTD	PPA	AD dementia	*p*-value for between-group difference
n	99	22	21	23	
Age	67.9 ± 7.7	62.7 ± 8.2	67.7 ± 7.3	71.9 ± 10.3	< .01 (bvFTD < PPA = control < AD dementia)
Male sex, #*n* (%)	44 (44)	11 (50)	12 (57)	13 (57)	.60
Education, years	12.2 ± 3.0	12.9 ± 4.0	12.9 ± 3.3	11.8 ± 3.8	.61
Months since symptom onset	–	38.6 ± 21.1	33.2 ± 17.1	33.7 ± 28.9	.70
MMSE (30)	29.2 ± 1.1	25.3 ± 3.5	24.2 ± 3.8	22.6 ± 4.0	< .001 (control > bvFTD = PPA > AD dementia)
Neuropsychological tests					
Trail Making Test part A, seconds	41.1 ± 15.6	57.7 ± 30.1	68.9 ± 34.9	87.8 ± 41.2	< .001 (control < bvFTD = PPA < AD dementia)
Trail Making Test part B, seconds	92.2 ± 40.9	170.6 ± 78.2	189.0 ± 152.1	244.1 ± 90.7	< .001 (control < bvFTD = PPA < AD dementia)
Trail Making Test B/A index	2.3 ± 0.6	3.1 ± 0.9	2.9 ± 1.0	3.6 ± 1.5	< .001 (control < PPA = bvFTD < AD dementia)
Boston Naming Test (60)	–	43.7 ± 8.1	31.5 ± 17.9	41.2 ± 9.1	.01 (bvFTD = AD dementia > PPA)
Letter fluency test (D-A-T)	36.3 ± 11.6	19.0 ± 11.1	20.3 ± 12.1	25.0 ± 14.1	< .001 (control > AD dementia = PPA = bvFTD)
Category fluency test (animals)	23.4 ± 5.8	14.8 ± 6.4	11.3 ± 6.5	12.0 ± 5.3	< .001 (control > bvFTD = AD dementia = PPA)
RAVLT immediate recall (75)	–	28.2 ± 11.8	–	21.6 ± 8.3	.10
RAVLT delayed recall (15)	–	5.1 ± 3.6	–	1.4 ± 2.0	< .01 (bvFTD > AD dementia)
Digit Span test	–	17.6 ± 5.9	16.6 ± 6.6	17.0 ± 5.5	.94
Emotion Recognition Test (96)	54.7 ± 9.3	41.9 ± 17.1	42.1 ± 6.4	47.2 ± 7.4	< .001 (control = AD dementia > PPA = bvFTD)

Note: Data are represented as mean ± standard deviation, unless otherwise specified. Abbreviations: MMSE = Mini-Mental State Examination; RAVLT = Rey Auditory Verbal Learning Test; Control = control participants; bvFTD = behavioral variant frontotemporal dementia; PPA = primary progressive aphasia; AD = Alzheimer's disease.

Table 2. Inferential statistics and adjusted means of the Hinting Task – Dutch version

	Control	bvFTD	PPA	AD dementia	Statistic
HT-NL, age-adjusted	17.7 ± 0.3	13.1 ± 0.6	13.7 ± 0.6	15.5 ± 0.6	F (3, 160) = 26.71, p < .001, η_p^2 = .33
HT-NL, age- and MMSE-adjusted	17.1 ± 0.3	13.8 ± 0.6	14.0 ± 0.6	16.9 ± 0.7	F (3, 154) = 12.45, p < .001, η_p^2 = .20

Note: Data are reported as estimated marginal means ± standard error, which are adjusted for age and for age and MMSE. Abbreviations: HT-NL = Hinting Task – Dutch version; MMSE = Mini-Mental State Examination; Control = control participants; bvFTD = behavioral variant frontotemporal dementia; PPA = primary progressive aphasia; AD = Alzheimer's disease.

money; 81.8%), while most control participants obtained the maximum score on item 10 (heavy luggage; 94.9%).

Based on the total sample (n = 165), internal consistency was acceptable (Cronbach's α = .74). None of the items were removed, as doing so would have resulted in a lower internal consistency. Inter-item correlations ranged from small to moderate (r = [.07, .41]) with a mean inter-item correlation of .24 ± .08.

The overall model including age, sex, and level of education as predictors of HT-NL score was insignificant in the total sample (F (3, 161) = 0.68, p = .56, R^2 = .01). None of the individual predictors, age (B = 0.01, SE = 0.03, t = 0.26, p = .80), sex (B = −0.64, SE = 0.49, t = −1.29, p = .20), and years of education (B = −0.04, SE = 0.08, t = −0.54, p = .59), were predictive of HT-NL score.

Between-group analyses and discriminative ability

Patients with bvFTD, PPA, and AD dementia and control participants scored significantly different on the HT-NL after adjusting for age (Table 2; F (3, 160) = 26.71, p < .001, η_p^2 = .33). All three patient groups scored lower than the control group (bvFTD: p < .001, PPA: p < .001, AD dementia: p < .01). Within the patient groups, patients with bvFTD scored lower than patients with AD dementia (p = .02). No differences were found between patients with bvFTD and patients with PPA (p = .99), nor between patients with AD dementia and patients with PPA (p = .14).

Additional adjustment for MMSE score as an estimator of disease severity yielded largely similar results (F (3, 154) = 12.45, p < .001, η_p^2 = .20), except that the difference between patients with AD dementia and control participants was no longer significant (p = .99). Patients with bvFTD (p < .001) and patients with PPA (p < .001) scored lower than control participants. Patients with bvFTD (p < .01) and patients with PPA (p < .01) scored lower than patients with AD dementia. No differences were found between patients with bvFTD and patients with PPA (p = .99).

The ROC analysis, to assess the ability of the HT-NL to distinguish between patients with dementia and control participants, yielded an AUC of 0.83 (SE = 0.03, 95% confidence interval (95%CI) = [0.77, 0.89]), indicating excellent discrimination. When comparing the AUCs of the HT-NL and the ERT (serving as a reference test for social cognition), no significant difference was found, indicating that both tests have similar discriminative ability and that the HT-NL demonstrates concurrent validity (Figure 1; ΔAUC = 0.03, SE = 0.32, 95%CI = [−0.09, 0.15], p = .67).

Associations between the HT-NL and other cognitive tests

The correlations between the HT-NL and other cognitive tests in the patient group are shown in Table 3.

The HT-NL had a moderate to large positive correlation with the ERT, indicating convergent validity. The HT-NL had moderate positive correlations with the BNT and the category fluency test, and a moderate to large positive correlation with the RAVLT immediate recall. No associations were found with TMT part A, TMT part B, TMT B/A index, letter fluency test, RAVLT delayed recall, and Digit Span test, indicating divergent validity.

Preliminary normative data

Preliminary normative data based on the control group (n = 99, age = 67.9 ± 7.7, male sex = 44 (44%), years of education = 12.2 ± 3.0)

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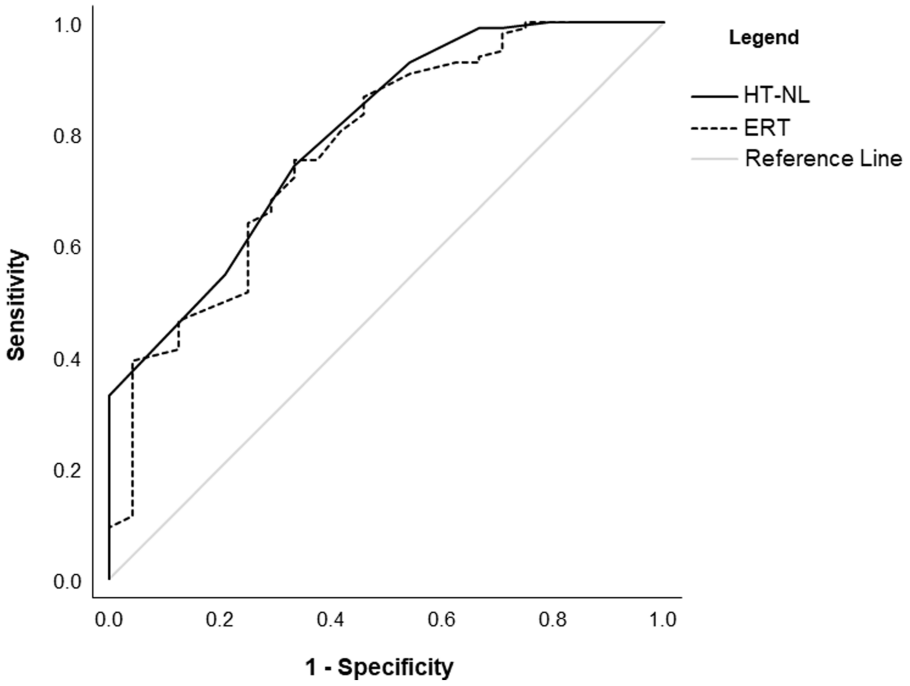

Figure 1. *The receiver operating characteristic curves of the Hinting Task – Dutch version and the Emotion Recognition Test. Note*. Abbreviations: HT-NL = Hinting Task – Dutch version; ERT = Emotion Recognition Test.

Table 3. Spearman rank correlations between the Hinting Task – Dutch version and other cognitive tests in the patient group (n = 66)

	HT-NL	*p*-value
Trail Making Test part A, seconds	.00	.99
Trail Making Test part B, seconds	–.03	.83
Trail Making Test B/A index	.02	.88
Boston Naming Test	**.32**	**.01**
Category fluency test	**.31**	**.02**
Letter fluency test	.11	.46
RAVLT immediate recall	**.40**	**.03**
RAVLT delayed recall	.17	.40
Digit Span test	.16	.34
Emotion Recognition Test	**.45**	**.03**

Note: Correlations in bold are significant at the .05 level. Abbreviations: HT-NL = Hinting Task – Dutch version; RAVLT = Rey Auditory Verbal Learning Test.

are presented in Table 4. The overall model including age, sex, and level of education as predictors of HT-NL score was insignificant in the control group (F (3, 95) = 1.20, p = .31, R^2 = .04). None of the individual predictors, age (B = −0.01, SE = 0.02, t = −0.27, p = .79), sex (B = −0.55, SE = 0.31, t = −1.78, p = .08), and years of education (B = 0.03, SE = 0.05, t = 0.67, p = .50), were predictive of HT-NL score.

Discussion

The current study examined the psychometric properties of the HT-NL, as well as group differences between patients with bvFTD, PPA, and AD dementia and control participants, the ability to distinguish between patients with dementia and control participants - also compared to a reference test for social cognition to assess concurrent validity, and associations between the HT-NL and other cognitive tests to assess construct validity. The results showed that the HT-NL has acceptable internal consistency and that its scores are not influenced by age, sex, or level of education. All patient groups performed worse than the control group, and patients with bvFTD performed worse than patients with AD dementia. The HT-NL could distinguish between patients with dementia and control participants, similar to a reference test for social cognition, thereby showing concurrent validity. The HT-NL showed convergent validity by its association with a test of facial emotion recognition. Significant associations with measures of memory and language were also found. Divergent validity was indicated by the absence of associations with measures of information processing speed, executive functioning, and working memory.

The psychometric properties found in this study are overall in line with previous literature about the Hinting Task in different clinical populations (Halverson et al., 2022; Klein et al., 2020; Morrison et al., 2019; Pinkham et al., 2018; Tsui et al., 2024). Similar to Halverson et al. (2022), no item could be removed to increase the internal consistency, and we thereby find no strong support for a shorter version of the HT-NL. We applied the original scoring criteria instead of the more stringent scoring criteria as described by Klein et al. (2020), which have been found to be more sensitive and to reduce ceiling effects compared to the original scoring. In our sample, however, no clear evidence was found for ceiling effects on the total score of the HT-NL or on any of the items. This held for both patients and control participants and aligns with the absence of ceiling effects in the study by Pinkham et al. (2018), but further research could investigate whether the different scoring criteria yield significantly different results for the HT-NL. The absence of ceiling effects does suggest that the HT-NL is sufficiently challenging to capture the range of performances within dementia, perhaps more than in psychiatric disorders. However, the number of control participants who obtained the maximum score also appeared to be slightly lower compared to previous research in healthy control participants

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Table 4. *Preliminary normative data based on the control group (n = 99)*

Percentiles	HT-NL
2 – 5	15
10 – 20	16
30 – 40	17
50 – 60	18
70 – 80	19
≥90	20

Note: Based on 99 control participants (age = 67.9 ± 7.7, male sex = 44 (44%), years of education = 12.2 ± 3.0). Abbreviation: HT-NL = Hinting Task – Dutch version.

(Frøyhaug et al., 2019; Klein et al., 2024). This could perhaps be due to our control participants being older in order to match the patients with dementia. Additionally, we cannot exclude a difference in difficulty between the original English version and the Dutch version, potentially related to a cultural difference in (in)directness in communication style (Labrie et al., 2020). Our findings thus highlight the importance of the international validation of instruments for social cognition (Bourdage et al., 2024).

Our results showed that all patient groups performed worse than the control group. In line with these results, worse performance on the Hinting Task has been reported for patients with AD (Braak et al., 2022) and bvFTD (Van 't Hooft et al., 2024) compared to control participants. The results are also consistent with the broader literature on social cognition in dementia, which shows that patients with AD dementia and bvFTD score lower than control participants on other tests measuring ToM (Henry et al., 2014). Additionally, we found that patients with bvFTD scored lower than patients with AD dementia, which also aligns with a previous study using the Hinting Task (Van 't Hooft et al., 2024) and with overall findings on ToM in bvFTD and AD dementia (Bora et al., 2015; Henry et al., 2014). Within PPA, relatively few studies examined ToM, or social cognition in general. However, similar to our results, impairments in ToM have been found in patients with PPA compared to healthy control participants (Fittipaldi et al., 2019; Magno et al., 2022). Accounting for disease severity using MMSE scores affected the results only for the patients with AD dementia, who did not perform significantly different from control participants anymore. This could be due to broader cognitive impairments in AD dementia, in which impairments in social cognition generally occur later in the disease course than in bvFTD and PPA (Setién-Suero et al., 2022). Specifically, impairments in social cognition are a specific deficit in bvFTD, whereas impairments in social cognition are relatively less specific compared to other cognitive impairments in AD dementia (Bora et al., 2016). Of note, the MMSE is not an optimal estimator of disease severity in bvFTD and PPA (Bora et al., 2016; Premi et al., 2016), for which the MoCA may be more appropriate (De Boer et al., 2025). The HT-NL showed similar discriminative ability to the ERT, which served as our reference test for social cognition, thereby showing concurrent validity and underlining the diagnostic applicability of the HT-NL.

Our results in terms of construct validity indicate that the HT-NL shows convergent validity through a moderate to large association with a test for facial emotion recognition, which is consistent with previous studies (Braak et al., 2022; Frøyhaug et al., 2019; Mallawaarachchi et al., 2019). We also found significant associations with measures of memory and language, indicating that performance on the HT-NL is at least partly dependent on these cognitive functions, which corroborates previous findings (Deckler et al., 2018; Pérez-Flores et al., 2024). These associations are to be expected as the brief passages have to be understood and retained for a short period of time, after which a verbal response is required. These findings underline that designing tests for social cognition that solely measure a sociocognitive process is difficult. The results thus reflect the complexity of sociocognitive processes (Thibaudeau et al., 2020) and may call for the development of more direct measures of social cognition, such as gaze direction by means of eye tracking (Bueno et al., 2019; Singleton et al., 2023) or automated speech analysis including linguistic and acoustic features, such as the emotional intensity of words (Vonk et al., 2024). The HT-NL showed divergent validity through the absence of associations with tests of information processing speed, executive functioning, and working memory. Previous studies corroborate the absence of associations with measures of information processing speed and executive functioning, although an association with working memory was not replicated (Deckler et al., 2018; Kosutzka et al., 2019).

Strengths of this study include the large group of patients with dementia and the direct comparisons between patients with bvFTD, PPA, and AD dementia and control participants. Moreover, we report preliminary normative data to support the use of the HT-NL in research and clinical practice. A limitation of this study is the heterogeneity of the sample inherent to comparing different types of dementia. Disease onset and progression vary between dementia types, meaning that disease severity is not proportional to the time since disease onset, which complicates patient matching (Rascovsky et al., 2005; Rogalski & Mesulam, 2009). Another limitation is the cross-sectional rather than longitudinal design, which did not allow for evaluating the stability of test scores or the ability to measure decline in ToM – an aspect particularly relevant given the progressive nature of neurodegenerative diseases. In addition, we compared the HT-NL only to a measure of facial emotion recognition to assess convergent validity, whereas comparison with other tests measuring ToM would be preferable – these tests were, however, unavailable in the present study. Additionally, as social cognition is a multidimensional construct, investigating associations between the HT-NL and other sociocognitive components provides insights in the embedding of the HT-NL within the broader theoretical framework of social cognition and advances understanding of the interrelations among sociocognitive components (Van den Stock et al., 2021). Accordingly, the HT-NL could be compared to tests assessing higher-order sociocognitive components, such as emotion regulation, moral reasoning, and social knowledge, in addition to tests assessing ToM and emotion recognition (Eikelboom et al., 2025). Lastly, for a few participants only a MoCA score was available instead of an MMSE score. These scores were converted to MMSE scores according to Van Steenoven et al. (2014), but we acknowledge that using a single test is preferable over the use of conversions.

Our results underline the importance of measuring social cognition in different types of dementia, even in those with relatively mild sociocognitive symptoms (Quesque et al., 2024). The HT-NL has been found to be a clinically useful test to recognize ToM impairments and can therefore facilitate the routine assessment of social cognition in dementia (McDonald et al., 2023). Preliminary normative data based on the control group (Table 4) are reported to support the use of the HT-NL in research and clinical practice, although these should be used with caution until further validation in larger samples.

In conclusion, the HT-NL has sound psychometric properties and shows adequate construct validity. The HT-NL is able to

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distinguish between patients with dementia and control participants, but more caution is warranted when differentiating between types of dementia. Altogether, the HT-NL is a useful test to identify impairments in ToM in patients with dementia as part of a comprehensive neuropsychological assessment.

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References

Adolphs, R. (2003). Cognitive neuroscience of human social behaviour. *Nature Reviews Neuroscience*, *4*, 165–178.

American Psychiatric Association (2013). *Diagnostic and Statistical Manual of Mental Disorders* (5th ed.). Arlington, VA, United States, American Psychiatric Association Publishing. https://doi.org/10.1176/appi.books.9780890425596.

Bjelland, I., Dahl, A. A., Haug, T. T., & Neckelmann, D. (2002). The validity of the Hospital Anxiety and Depression Scale. An updated literature review. *Journal of Psychosomatic Research*, *52*, 69–77.

Bora, E., Vahip, S., Gonul, A. S., Akdeniz, F., Alkan, M., Ogut, M., & Eryavuz, A. (2005). Evidence for theory of mind deficits in euthymic patients with bipolar disorder. *Acta Psychiatrica Scandinavica*, *112*, 110–116.

Bora, E., Velakoulis, D., & Walterfang, M. (2016). Meta-analysis of facial emotion recognition in behavioral variant frontotemporal dementia: Comparison with Alzheimer disease and healthy controls. *Journal of Geriatric Psychiatry and Neurology*, *29*, 205–211.

Bora, E., Walterfang, M., & Velakoulis, D. (2015). Theory of mind in behavioural-variant frontotemporal dementia and Alzheimer's disease: A meta-analysis. *Journal of Neurology, Neurosurgery & Psychiatry*, *86*, 714–719.

Bourdage, R., Narme, P., Neeskens, R., Papma, J., & Franzen, S. (2024). An evaluation of cross-cultural adaptations of social cognition testing: A systematic review. *Neuropsychology Review*, *34*, 1048–1094.

Braak, S., Su, T., Krudop, W., Pijnenburg, Y. A. L., Reus, L. M., van der Wee, N., Bilderbeck, A. C., Dawson, G. R., Winter-Van Rossum, I., Vieira Campos, A., Arango, C., Saris, I. M. J., Kas, M. J., & Penninx, B. W. J. H. (2022). Theory of mind and social functioning among neuropsychiatric disorders: A transdiagnostic study. *European Neuropsychopharmacology*, *64*, 19–29.

Brioschi Guevara, A., Knutson, K. M., Wassermann, E. M., Pulaski, S., Grafman, J., & Krueger, F. (2015). Theory of mind impairment in patients with behavioural variant fronto-temporal dementia (bv-FTD) increases caregiver burden. *Age and Ageing*, *44*, 891–895.

Bueno, A. P. A., Sato, J. R., & Hornberger, M. (2019). Eye tracking - the overlooked method to measure cognition in neurodegeneration? *Neuropsychologia*, *133*, 1071–1091.

Corcoran, R., Mercer, G., & Frith, C. D. (1995). Schizophrenia, symptomatology and social inference: Investigating "theory of mind" in people with schizophrenia. *Schizophrenia Research*, *17*, 5–13.

Corrigan, J. D., & Hinkeldey, N. S. (1987). Relationships between parts A and B of the Trail Making Test. *Journal of Clinical Psychology*, *43*, 402–409.

Davidson, C. A., Lesser, R., Parente, L. T., & Fiszdon, J. M. (2018). Psychometrics of social cognitive measures for psychosis treatment research. *Schizophrenia Research*, *193*, 51–57.

de Boer, L., Poos, J. M., van den Berg, E., De Houwer, J. F. H., Swartenbroekx, T., Dopper, E. G. P., Boesjes, P., Tahboun, N., Bouzigues, A., Foster, P. H., Ferry-Bolder, E., Adams-Carr, K., Russell, L. L., Convery, R. S., Rohrer, J. D., Seelaar, H., & Jiskoot, L. C. (2025). Montreal Cognitive Assessment vs the Mini-Mental State Examination as a screening tool for patients with genetic frontotemporal dementia. *Neurology*, *104*.

De Jaegher, H., Di Paolo, E., & Gallagher, S. (2010). Can social interaction constitute social cognition? *Trends in Cognitive Sciences*, *14*, 441–447.

Deckler, E., Hodgins, G. E., Pinkham, A. E., Penn, D. L., & Harvey, P. D. (2018). Social cognition and neurocognition in schizophrenia and healthy controls: Intercorrelations of performance and effects of manipulations aimed at increasing task difficulty. *Frontiers in Psychiatry*, *9*, 356.

Duits, A., & Kessels, R. (2014). Schatten van het premorbide functioneren [Estimating premorbid functioning]. In *Neuropsychologische diagnostiek: De klinische praktijk [Neuropsychological assessment: Clinical practice]*. Boom.

Eikelboom, W. S., van den Berg, E., Beauchamp, M. H., Bray, K. O., Kumfor, F., MacPherson, S. E., McDonald, S., Spikman, J. M., & Kessels, R. P. C. (2025). Providing a taxonomy for social cognition: How to bridge the gap between expert opinion, empirical data, and theoretical models. *Journal of Psychiatry and Neuroscience*, *50*, 157–161.

Fittipaldi, S., Ibanez, A., Baez, S., Manes, F., Sedeno, L., & Garcia, A. M. (2019). More than words: Social cognition across variants of primary progressive aphasia. *Neuroscience & Biobehavioral Reviews*, *100*, 263–284.

Folstein, M. F., Folstein, S. E., & McHugh, P. R. (1975). "Mini-mental state": A practical method for grading the cognitive state of patients for the clinician. *Journal of Psychiatric Research*, *12*, 189–198.

Formica, C., Bonanno, L., Todaro, A., Marra, A., Alagna, A., Corallo, F., Marino, S., Bramanti, A., & De Salvo, S. (2020). The role of mind theory in patients affected by neurodegenerative disorders and impact on caregiver burden. *Journal of Clinical Neuroscience*, *78*, 291–295.

Frøyhaug, M., Andersson, S., Andreassen, O. A., Ueland, T., & Vaskinn, A. (2019). Theory of mind in Schizophrenia and bipolar disorder: Psychometric properties of the Norwegian version of the Hinting Task. *Cognitive Neuropsychiatry*, *24*, 454–469.

Gorno-Tempini, M. L., Hillis, A. E., Weintraub, S., Kertesz, A., Mendez, M., Cappa, S. F., Ogar, J. M., Rohrer, J. D., Black, S., Boeve, B. F., Manes, F., Dronkers, N. F., Vandenberghe, R., Rascovsky, K., Patterson, K., Miller, B. L., Knopman, D. S., Hodges, J. R., Mesulam, M. M., & Grossman, M. (2011). Classification of primary progressive aphasia and its variants. *Neurology*, *76*, 1006–1014.

Green, M. F., Penn, D. L., Bentall, R., Carpenter, W. T., Gaebel, W., Gur, R. C., Kring, A. M., Park, S., Silverstein, S. M., & Heinssen, R. (2008). Social cognition in schizophrenia: An NIMH Workshop on definitions, dssessment, and research opportunities. *Schizophrenia Bulletin*, *34*, 1211–1220.

Halverson, T. F., Pinkham, A. E., Harvey, P. D., & Penn, D. L. (2022). Brief battery of the Social Cognition Psychometric Evaluation study (BB-SCOPE): Development and validation in schizophrenia spectrum disorders. *Journal of Psychiatric Research*, *150*, 307–316.

Henry, J. D., Phillips, L. H., & von Hippel, C. (2014). A meta-analytic review of theory of mind difficulties in behavioural-variant frontotemporal dementia. *Neuropsychologia*, *56*, 53–62.

Henry, J. D., von Hippel, W., Molenberghs, P., Lee, T., & Sachdev, P. S. (2016). Clinical assessment of social cognitive function in neurological disorders. *Nature Reviews Neurology*, *12*, 28–39.

Hosmer, D. W., & Lemeshow, S. (2000). *Applied logistic regression* (2nd ed.). Wiley.

IBM Corporation (2021). *IBM SPSS Statistics for Windows, Version 28.0*. IBM Corporation.

Kaplan, E., Goodglass, H., & Weintraub, S. (1983). *Boston Naming Test*. Lea and Febiger, Philadelphia, PA, United States. https://doi.org/10.1037/t27208-000.

Kennedy, D. P., & Adolphs, R. (2012). The social brain in psychiatric and neurological disorders. *Trends in Cognitive Sciences*, *16*, 559–572.

Kessels, R. P., Montagne, B., Hendriks, A. W., Perrett, D. I., & de Haan, E. H. F. (2014). Assessment of perception of morphed facial expressions using the Emotion Recognition Task: Normative data from healthy participants aged 8–75. *Journal of Neuropsychology*, *8*, 75–93.

Klein, H., Springfield, C. R., & Pinkham, A. E. (2024). Measuring social cognition within the university: The Social Cognition Psychometric Evaluation (SCOPE) battery in an undergraduate sample. *Applied Neuropsychology: Adult*, *31*, 866–873.

Klein, H. S., Springfield, C. R., Bass, E., Ludwig, K., Penn, D. L., Harvey, P. D., & Pinkham, A. E. (2020). Measuring mentalizing: A comparison of scoring

methods for the hinting task. *International Journal of Methods in Psychiatric Research*, *29*, 1827.

Kosutzka, Z., Kralova, M., Kusnirova, A., Papayova, M., Valkovic, P., Csefalvay, Z., & Hajduk, M. (2019). Neurocognitive predictors of understanding of intentions in Parkinson disease. *Journal of Geriatric Psychiatry and Neurology*, *32*, 178–185.

Labrie, N., Akkermans, A., & Hample, D. (2020). A Dutch dose of dissent: Exploring the role of gender, education, and culture on Dutch students' argumentative predispositions. *Journal of Argumentation in Context*, *9*, 219–242.

Magno, M. A., Canu, E., Filippi, M., & Agosta, F. (2022). Social cognition in the FTLD spectrum: Evidence from MRI. *Journal of Neurology*, *269*, 2245–2258.

Mallawaarachchi, S. R., Cotton, S. M., Anderson, J., Killackey, E., & Allott, K. A. (2019). Exploring the use of the Hinting Task in first-episode psychosis. *Cognitive Neuropsychiatry*, *24*, 65–79.

McDonald, S., Wearne, T., & Kelly, M. (2023). Calling on clinicians to get social and emotional. *The Clinical Neuropsychologist*, *37*, 506–544.

McKhann, G. M., Knopman, D. S., Chertkow, H., Hyman, B. T., Jack C. R. Jr., Kawas, C. H., Klunk, W. E., Koroshetz, W. J., Manly, J. J., Mayeux, R., Mohs, R. C., Morris, J. C., Rossor, M. N., Scheltens, P., Carrillo, M. C., Thies, B., Weintraub, S., Phelps, C. H. (2011). The diagnosis of dementia due to Alzheimers disease: Recommendations from the national institute on Aging-Alzheimer's Association workgroups on diagnostic guidelines for Alzheimer's disease. *Alzheimer's & Dementia*, *7*, 263–269.

Morrison, K. E., Pinkham, A. E., Kelsven, S., Ludwig, K., Penn, D. L., & Sasson, N. J. (2019). Psychometric evaluation of social cognitive measures for adults with autism. *Autism Research*, *12*, 766–778.

Nasreddine, Z. S., Phillips, N. A., Bédirian, V., Charbonneau, S., Whitehead, V., Collin, I., Cummings, J. L., & Chertkow, H. (2005). The Montreal Cognitive Assessment, MoCA: A brief screening tool for mild cognitive impairment. *Journal of the American Geriatrics Society*, *53*, 695–699.

Ossenkoppele, R., Singleton, E. H., Groot, C., Dijkstra, A. A., Eikelboom, W. S., Seeley, W. W., Miller, B., Laforce, R. J., Scheltens, P., Papma, J. M., Rabinovici, G. D., & Pijnenburg, Y. A. L. (2022). Research criteria for the behavioral variant of Alzheimer disease: A systematic review and meta-analysis. *JAMA Neurology*, *79*, 48–60.

Pérez-Flores, J., Nieto, A., & Delgado, O. (2024). Relationship between semantic memory and social cognition in schizophrenia: A preliminary analysis. *Psychiatry International*, *5*, 424–433.

Pinkham, A. E., Harvey, P. D., & Penn, D. L. (2018). Social Cognition Psychometric Evaluation: Results of the final validation study. *Schizophrenia Bulletin*, *44*, 737–748.

Premack, D., & Woodruff, G. (1978). Does the chimpanzee have a theory of mind. *Behavioral and Brain Sciences*, *1*, 515–526.

Premi, E., Gualeni, V., Costa, P., Cosseddu, M., Gasparotti, R., Padovani, A., & Borroni, B. (2016). Looking for measures of disease severity in the frontotemporal dementia continuum. *Journal of Alzheimer' s Disease*, *52*, 1227–1235.

Quesque, F., Nivet, M., Etchepare, A., Wauquiez, G., Prouteau, A., Desgranges, B., & Bertoux, M. (2024). Social cognition in neuropsychology: A nationwide survey revealing current representations and practices. *Applied Neuropsychology: Adult*, *31*, 689–702.

Rascovsky, K., Hodges, J. R., Knopman, D., Mendez, M. F., Kramer, J. H., Neuhaus, J., van Swieten, J. C., Seelaar, H., Dopper, E. G. P., Onyike, C. U., Hillis, A. E., Josephs, K. A., Boeve, B. F., Kertesz, A., Seeley, W. W., Rankin, K. P., Johnson, J. K., Gorno-Tempini, M. L., Rosen, H., . . . Miller, B. L. (2011). Sensitivity of revised diagnostic criteria for the behavioural variant of frontotemporal dementia. *Brain*, *134*, 2456–2477.

Rascovsky, K., Salmon, D. P., Lipton, A. M., Leverenz, J. B., DeCarli, C., Jagust, W. J., Clark, C. M., Mendez, M. F., Tang-Wai, D. F., Graff-Radford, N. R., & Galasko, D. (2005). Rate of progression differs in frontotemporal dementia and Alzheimer disease. *Neurology*, *65*, 397–403.

Rogalski, E. J., & Mesulam, M. M. (2009). Clinical trajectories and biological features of primary progressive aphasia (PPA). *Current Alzheimer Research*, *6*, 331–336.

Schmand, B., Groenink, S. C., & van den Dungen, M. (2008). Letterfluency: Psychometrische eigenschappen en Nederlandse normen [Letter fluency: Psychometric properties and Dutch normative data]. *Tijdschrift voor gerontologie en geriatrie*, *39*, 64–76.

Setién-Suero, E., Murillo-García, N., Sevilla-Ramos, M., Abreu-Fernández, G., Pozueta, A., & Ayesa-Arriola, R. (2022). Exploring the relationship between deficits in docial cognition and neurodegenerative dementia: A systematic review. *Frontiers in Aging Neuroscience*, *14*. https://doi.org/10.3389/fnagi.2022.778093.

Singleton, E. H., Fieldhouse, J. L. P., van 't Hooft, J. J., Scarioni, M., van Engelen, M. E., Sikkes, S. A. M., de Boer, C., Bocancea, D. I., van den Berg, E., Scheltens, P., van der Flier, W. M., Papma, J. M., Pijnenburg, Y. A. L., & Ossenkoppele, R. (2023). Social cognition deficits and biometric signatures in the behavioural variant of Alzheimer's disease. *Brain*, *146*, 2163–2174.

Thibaudeau, E., Achim, A. M., Parent, C., Turcotte, M., & Cellard, C. (2020). A meta-analysis of the associations between theory of mind and neuro-cognition in schizophrenia. *Schizophrenia Research*, *216*, 118–128.

Tsui, H. K. H., Liao, Y., Hsiao, J., Suen, Y. N., Yan, E. W. C., Poon, L. T., Siu, M. W., Hui, C. L. M., Chang, W. C., Lee, E. H. M., Chen, E. Y. H., & Chan, S. K. W. (2024). Mentalizing impairments and hypermentalizing bias in individuals with first-episode schizophrenia-spectrum disorder and at-risk mental state: The differential roles of neurocognition and social anxiety. *European Archives of Psychiatry and Clinical Neuroscience*, *275*, 907–919. https://doi.org/10.1007/s00406-024-01830-y.

van 't Hooft J. J., Hartog W. L., Braun M., Boessen D., Fieldhouse J. L. P., van Engelen M. P. E., Singleton E. H., Jaschke A. C., Schaefer R. S., Venkatraghavan V., Barkhof F., van Harten A. C., Duits, F., H., Schouws, S. N. T. M., Oudega, M. L., Warren, J. D., Tijms, B. M., & Pijnenburg, Y. A. L. (2024). Musicality and social cognition in dementia: Clinical and anatomical associations. *Brain Communications*, *6*. https://doi.org/10.1093/braincomms/fcae429.

van den Stock, J., Sun, J., DeWinter, F. L., & Vandenbulcke, M. (2021). The interplay of social cognition sub-domains in frontotemporal dementia. *Brain Communications*, *3*. https://doi.org/10.1093/braincomms/fcab161.

van der Elst, W., van Boxtel, M. P. J., van Breukelen, G. J. P., & Jolles, J. (2005). Rey's verbal learning test: Normative data for 1855 healthy participants aged 24–81 years and the influence of age, sex, education, and mode of presentation. *Journal of the International Neuropsychological Society*, *11*, 290–302.

van Steenoven, I., Aarsland, D., Hurtig, H., Chen-Plotkin, A., Duda, J. E., Rick, J., Chahine, L. M., Dahodwala, N., Trojanowski, J. Q., Roalf, D. R., Moberg, P. J., & Weintraub, D. (2014). Conversion between Mini-Mental State Examination, Montreal Cognitive Assessment, and Dementia Rating Scale-2 scores in Parkinson's disease. *Movement Disorders*, *29*, 1809–1815.

Vonk, J. M. J., Morin, B. T., Pillai, J., Rolon, D. R., Bogley, R., Baquirin, D. P., Ezzes, Z., Tee, B. L., DeLeon, J., Wauters, L., Lukic, S., Montembeault, M., Younes, K., Miller, Z., García, A. M., Mandelli, M. L., Sturm, V. E., Miller, B. L., & Gorno-Tempini, M. L. (2024). Digital language markers distinguish frontal from right anterior temporal lobe atrophy in frontotemporal dementia. https://doi.org/10.1101/2024.08.29.24312807.

Wechsler, D. (2012). *Wechsler Adult Intelligence Scale - Fourth Edition - Nederlandse Bewerking. Technische handleiding en Afname- en scoring-shandleiding*. Pearson Assessment and Information BV.