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Author for correspondence:
Bruce Eldine Morton,
Email: bemorton@hawaii.edu

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Brain executive laterality and hemisity

Bruce Eldine Morton

Department of Biochemistry and Biophysics, John A. Burns School of Medicine, University of Hawaii, Honolulu, Hawaii

Abstract

Brain laterality refers to the asymmetric location of functional elements within the bilateral brain of animals and humans. Thus far, five lateralized functions have been recognized in humans: handedness, language ability, spatial skills, facial recognition, and emotion recognition. Recently, a sixth asymmetric functional element bearing on personality has been discovered. It is the larger side of the split bilateral anterior cingulate cortex (ACC). This appears to be the final output element of the executive system of which, by logic, there can be only one. Which side is somewhat larger varies among the general population in a seemingly idiosyncratic manner, yet with a genetic basis because true-breeding lineages exist. Here, hemisity is binary measure where a person is inherently born *either* right brain or left brain oriented. This is determined by nine statistically robust sets of four biophysical tests, none of which depend upon personality, and five behavioral questionnaires. Crucially these hemisity methods have been validated by the Magnetic Resonance Imaging (MRI)-based discovery that the larger side of the ACC is on the same side as one's hemisity, making MRI the primary standard for hemisity determination ($r = 0.96$). There are at least 30 measurable differences in individual characteristics and behaviors between those persons whose hemsity is on the right compared to those with it on the left. The hemisity of 2929 individuals was determined by these methods. Large groups included 1428 junior and senior high schools students both in Hawaii and Utah. There were somewhat comparable numbers present for both types of hemisity. Hemisity of individuals was found stable from infancy to old age. There was no relation between hemisity and handedness. Larger corpus callosum (CC) size of male or female subjects was larger in right brainer that in left brainers. Twin studies demonstrate that CC size is inherited. Thirty-eight percent of individuals of both sexes were right brain oriented, while 62% of individuals of both sexes were left brain oriented. In pairings, there were more than twice as many couples with opposite hemisity. Of these couples, the right brain male and females were dominant. Reproductive outcomes of these were "Like father like son, Like mother like daughter."

Brain lateralization refers to the asymmetric location of functional elements within the bilateral brain of animals (Corballis, 2017) and humans (Wey, Phillips, McKay et al., 2014). Thus far, five lateralized functions have been recognized in humans. These are handedness (Kencht, Drager, Deppe et al., 2000), language ability (Knecht, Deppe, Drager et al., 2000; Stroobannt, Buijs, & Vingerhoets, 2009), spatial skills (Badzakova-Trajkov, Haberling, Roberts, & Corballis, 2010; Kang, Herron, Ettlinger, & Woods, 2015), facial recognition (Morita, Saito, Ban et al., 2017), and emotion recognition (Innes, Burt, Burch, & Hausmann, 2015).

Often, several of these specialized processing elements have been found to be parceled to the right hemisphere, while others can independently appear in the left hemisphere (Corballis & Haberling, 2017). Individuals vary greatly in the brain laterality of these functions, which appear to be genetically set independently at a very young age (Yamazaki, Easwar, Polonenko et al., 2018). For example, although people more commonly have their language skills located in the left hemisphere and spatial abilities in the right, this often can be reversed. Occasionally, some people are found with both language and spatial functions in the same hemisphere (Haberling, Badzakova-Trajkov, & Corballis, 2011). Handedness is now known to be sorted independently of the language function (Mazoyerr, Zago, Jobard et al., 2014).

Based upon the surprisingly different responses obtained from each of the isolated hemispheres of split-brain subjects (Bogen, 2000; Gazzaniga, 2000; Gazzaniga, Bogen, & Sperry, 1962; Geschwind, Iacoboni, Mega et al., 1995), it was early proposed by investigators that the right and left cerebral hemispheres are characterized by inbuilt, qualitatively different and mutually antagonistic modes of data processing, separated from interference by the major longitudinal fissure of the brain (Levy, 1969; Sperry, 1982). In this model, the left hemisphere specialized in top-down, deductive, cognitive dissection of local detail (Fink, Halligan, Marshall et al., 1996), while the right hemisphere produced a bottom-up, inductive, perceptual synthesis of global structure (Floegel & Kell, 2017; Gazzaniga, 2000; Sperry, 1982). This context has been reinforced by known laterality differences between them. That is, there are striking differences in input to each hemisphere, differences in internal neuronal-columnar architecture, and differences in hemispheric output (Hutsler & Galuske, 2003; Jager & Postma, 2003; Kosslyn, Chabris, Marsolek, & Koenig, 1992; Kosslyn, Koenig, Barrett et al., 1989; Schuz, & Preissl, 1996; Stephan, Fink, & Marshall, 2006).

Supporting the above global view is a large body of detailed evidence that the left cerebral hemisphere in most right-handed individuals manifests facilities for language (Broca, 1863), has an orientation for local detail (Robertson & Lamb, 1991), has object abstraction-identification abilities (Kosslyn, 1987), and appears to possess a hypothesis-generating, event "interpreter" (Gazzaniga, 1989, 2000; Wolford, Miller, & Gazzaniga, 2000). In contrast, the right hemisphere has been demonstrated to excel in global analysis (Proverbio, Zani, Gazzaniga, & Mangun, 1994; Robertson & Lamb, 1991), object localization (Kosslyn et al., 1989), facial recognition (Milner, 1968), and spatial construction (Sperry, 1968).

Recently, a *sixth* asymmetric functional element bearing on personality has been discovered (Morton & Rafto, 2010, 2017). It is the larger side of the split bilateral anterior cingulate cortex (ACC). This appears to be the final output element of the executive system, of which in the bilateral vertebrate brain, by logic there can only be one ("The buck stops here"). Which side is the larger varies among the general population in a seemingly idiosyncratic manner, yet with a genetic basis because true-breeding lineages exist.

Earlier, executive laterality had been unwittingly approached by the popular topic of right brain, left brain personality differences, called hemisphericity. This had been stimulated by laterality findings of split-brain subjects (Bogen, 2000; see also, Gazzaniga, 2000; Gazzaniga et al., 1962; Sperry, 1982). However, due to poor definitions and weak measurement instruments, after hundreds of publications, the intuitively correct preliminary idea of hemisphericity was statistically debunked (Beaumont, Young, & McManus, 1984). This placed a pall on brain laterality research for decades.

Recently, right brain or left brain personality differences have been more accurately determined. This was done by replacing the original flawed definition of brain laterality. That definition consisted of a 10 step gradient between right and left extremes. As a result, subjects mainly gave intermediate values for their answers. This resulted in poor statistics and the ultimate rejection of the idea of hemisphericity. Here, the gradient idea has been replaced with a binary measure where a person is inherently born *either* right *or* left brain oriented. This binary executive laterality construct has been named *hemisity* (Morton & Rafto, 2010, 2017).

The binary definition has facilitated the development of a statistically robust set of nine binary biophysical assays and behavioral questionnaires. The four biophysical tests were the Dichotic Deafness Test (Morton, 2001, 2002), Phased Mirror Tracing Test (Morton, 2003a), the Two Hand Line Bisection Test (Morton, 2003b), and the MRI Hemisity Assessment Method (Morton & Rafto, 2010), none of which depend upon personality. The four behavioral questionnaires were the Polarity Questionnaire (Morton, 2002), the Asymmetry Questionnaire (Morton, 2003c), the Binary Questionnaire (Morton, 2012a), and the Hemisity Questionnaire (Morton, 2012a), plus the earlier less accurate Zenhausern's Preference Questionnaire (Morton, 2002; Zenhausern, 1978).

Crucially, these hemisity methods have been validated by the MRI-based discovery that the larger side of the bilateral ACC is on the same side as one's hemisity, making MRI the primary standard for hemisity determination ($r = 0.96$) (Morton & Rafto, 2010). The asymmetric sides of the ACC are separated by the midline fissure of the brain. The larger side in Areas 24 and 24' appears to contain the element producing the final output of the executive system. The relative sizes of the two sides of the ACC vary in a seemingly idiosyncratic manner (Huster, Westerhausen, Kreude, Schweiger, & Whittling, 2007). There are at least 30 measurable differences in individual characteristics and behaviors between those persons with a larger executive final output element on the right compared to those with it on the left (Morton, 2013).

1. Materials and Methods

1.1 Nomenclature of hemisity

R = right brain-oriented hemisity, L = left brain-oriented hemisity, M = male, F = female, P = person, RM-LF = patripolar couple, RF-LM = matripolar couple. RM-RF and LM-LF are hybrid couples. Handedness is irrelevant.

1.2 Subjects

The hemisity of a total of 2929 subjects was determined by methods described here.

These groups were as follows: 1089 were volunteers from the University of Hawaii community, ranging in age from 7 to 75 yrs, 44.0 yrs mean age, +/- 14.5 yrs S.D. In a subset ($n = 399$), 47.3% (189) were female, 11% (45) claimed left-handedness, and 77% (309) were Caucasian, the rest being predominantly Asian. Based upon an earlier MRI study (Morton & Rafto, 2010) with 399 subjects, there were 45.1% (180) right brain-oriented persons (RPs) and 54.9% (219) left brain-oriented persons (LPs). The above RPs were composed of 48.3% (87) right brain-oriented females (RFs) and 51.7% (93) right brain-oriented males (RMs). The LPs consisted of 47.9% (105) left brain-oriented females (LFs) and 52.1% (114) left brain-oriented males (LMs)].

For the hemisity pairing study, the 412 members of long-term couples (>5 yrs), the majority were recruited from members of the University of Hawaii at Manoa community. Others were obtained from families participating in children's soccer leagues in Honolulu and from those waiting for flight connections at the Honolulu International Airport. The 191 children of 96 couples also came from these groups.

The hemisity of 1428 individuals was determined in later studies (Morton, Svard, & Jensen, 2014). These consisted of 1049 junior and senior high school students from Kapolei High School on Oahu in Hawaii and Provo School District in Provo, Utah, in addition to 379 professional musicians.

1.3 Hemisity measurement methods

The following nine independent hemisity methods of Table 1 are described in greater detail elsewhere. They are as follows:

1.3.1. The four biophysical assays for hemisity

1.3.1.1 The Dichotic Deafness Test (Morton, 2001, 2002; Morton & Rafto, 2006). The "Tonal and Speech Materials for Auditory Perceptual Assessment," Disc 1.0 (1992), purchased from the Long Beach Research Foundation, was used to measure minor ear deafness of 115 pseudo-randomly selected subjects during simultaneous, and 90 ms-separated, presentations of dichotic consonant–vowel syllables. Attention bias (Iaccino & Houran, 1989) was reduced by instructing subjects to write the syllables heard in each ear.

1.3.1.2 Phased Mirror Tracing (Morton, 2003a). Mirror tracings of pentagonal stars were produced by both hands of 131 subjects with the aid of a Lafayette Instruments, Mirror-drawing apparatus,

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Table 1. Overall correlations and reliability of preference questionnaire scores and biophysical measurements regarding predetermined subject hemisity subtypes

Prefrence Questionnaires (fast,easy) (upper half) vs. (lower half) Biophysical Methods (slow, difficult)	*r* (Pearsons)	*p*	*n*	% yield*	Alpha Cron-bach's
Correlations of MRI preassigned hemisity subtypes with:					
Zenhauserns Preference Questionaire	0.24	0.008	119	35	0.37
Polarity Questionnaire	0.57	0.000	132	82	0.57
Asymmetry Questionnaire	0.48	0.000	111	60	0.64
Binary Questionnaire	0.43	0.000	112	30	0.66
Hemisity Questionnaire	0.53	0.000	79	48	0.65
Best Hand Test (R-L)	0.37	0.000	143		
Mirror Tracing Test (R/L)	0.50	0.000	116		
Dichotic Deafness Test (R-L/R + L)	0.34	0.000	109		
vgACC laterality determined by MRI	**0.93**	0.000	149		

* = % yield refers to the percentage of questionnaire statements that were significantly associated with subjects neuroanatomical hemisity.

Model 31010. Competitive mean elapsed time outcomes between hands were phase adjusted by use of the Affective Laterality Test (Morton, 2003a).

1.3.1.3 Best Hand Task (Morton 2003b, 2003d). Forms containing 20 horizontal lines for each hand to bisect were completed by 142 subjects, measured, phased, and scored according to Morton (2003b).

1.3.1.4 MRI Hemisity Determination (Morton, 2010). The largest side of the ACC in Areas 24 and 24' was identified as the right or left brain hemisity orientation of the subject.

1.3.2 The five questionnaire measurements of hemisity

Sensitive topics were sought by posing hundreds of contrasting items to subjects and excluding those not causing sorting. Target comparisons causing sorting were then packaged into preference questionnaires. The questionnaire statements had little or no relationship to psychological or neurological theory.

1.3.2.1 Zenhausern's Preference Questionnaire (Morton, 2002; Zenhausern, 1978). A preexisting laterality instrument was used here. It was the best of the earlier generation hemisiphericity assays, albeit quite weak, as demonstrated here. Subjects ranked 21 statements *on a ten-point gradient* from "strongly agree to strongly disagree."

1.3.2.2 The Polarity Questionnaire (Morton, 2002). This is a binary questionnaire of 11 neutral statements, which were assessed by each subject, using true or false answers. For example: "Given the opportunity, I am more of an early morning than a late night person," or "I would rather maintain and use good old solutions than find new better ones," or "I am comfortable and productive in the presence of disorder and disorganization."

1.3.2.3 The Asymmetry Questionnaire (Morton, 2003c). Subjects selected between 15 binary statement pairs as to their preference.

1.3.2.4 Binary Preference Questionnaire (Morton, 2012a). It is a questionnaire consisting of 40 either-or preference choices, neither choice is wrong, just a personal preference or lack of such.

1.3.2.5 Hemisity Questionnaire (Morton, 2012a). This is another questionnaire of 21 either-or preference choices regarding personal orientation.

1.4 MRI corpus callosum cross-sectional area determinations

1.4.1 MRI assessment of corpus callosum thickness

MRI assessments employed a General Electric Signa 1.5 Tesla MRI instrument. A midsagittal plane setup calibration protocol was run for 3 minutes using a T1 weighted spin echo sequence (TR = 400 msec, TE = 1/Fr) to image 5 mm slices from the midline plane and two adjoining sagittal planes 6 mm on either side. Whole-head photographic images were prepared from these three planes, and additionally, a 2.3x enlargement of the most medial plane, centering on the corpus callosum (CC). These four exposures were printed on a single 35 cm x 43 cm film sheet for each subject.

Sagittal corpus callosal cross-sectional areas were determined by tracing the corpus callosal outline of the 2.3x midline enlargement upon computer printer paper (Weyehauser 1180, 20 lb stock) of predetermined weight per unit area. The 8 ½ x 11 inch pages varied in weight by +/- 0.6%. Corpus callosal cutouts weighed on a microbalance varied in weight by +/- 35%. These data were converted to absolute CC cross-sectional areas by use of predetermined magnification and paper weight constants. Subject corpus callosal areas ranged from 4.5 to 10.1 cm^2.

1.4.2 MRI assessment of ACC laterality (hemisity primary standard)

MRI assessments (Morton & Rafto, 2010) were obtained employing a General Electric Signa 1.5 Tesla MRI instrument. A midsagittal plane setup calibration protocol was run for 3 minutes to image 5 mm thick slices from the midline plane and two adjoining sagittal planes 6 mm on either side. Whole-head photographic images were prepared from these three planes. These three exposures were printed on a single film sheet for each subject. This procedure enabled both cortical walls on either side of the midline fissure to be visualized and measured, thus allowing sub-element lateralities of the ACC to be evaluated directly from the film. At two ACC sites on each side of the brain, one in Area 24 and the other at Area 24' (Vogt et al., 1995), estimations of the relative thickness of the ventral gyri (vgACC) there were made. This abbreviation and these four ACC locations within Areas 24 and 24' are not to be confused with the more frontal ventral region of the perigenual ACC. The vgACC locations where these relative thickness estimations were made are illustrated by the arrows in Figure 4. Two lines were extended outward perpendicularly from the inner edge of the CC, ending in one case at a more frontal point in Area 24 and in the other at a more dorsal point in Area 24'. Both points were in the plane of the cingulate sulcus and arbitrarily selected, based upon the sites in the region giving the largest vgACC thickness for each brain side involved. The average of these two lateral relative thickness estimates from the vgACC of each side was then used to determine upon which side of each subject's brain the vgACC was thicker.

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1.5 Statistical analysis

The Statistica 6.0 package was used to assess the strength of these data and their associations with the various hemisity methods, as illustrated in Table 1.

1.6 Ethics and safety

The Committee of Human Studies of the University of Hawaii Institutional Review Board approved all appropriate elements of this unfunded research which was conducted in compliance with the Code of Ethics of the World Medical Association and posed no significant risks to participants.

2. Results

The above nine methods were used earlier to determine the hemisity of 143 subjects, as shown in Table 1 (mean number of methods/subject was 7.3). As may be seen, each method was able to determine the hemisity of a subject to some degree. The MRI method was superior ($r = .93$) and became the primary standard against which the others were validated. The average of the seven non-MRI hemisity tests, excluding Zenhausern's Preference Questionnaire, was $r = .46$; that of Zenhausern's Preference Questionnaire (1978) was $r = .24$.

Clearly, all eight of the questionnaires were superior to the earlier hemisphericity standard, Zenhauser's Preference Questionnaire (1978). Although the MRI method is most accurate, it was costly, time consuming, and intensely scheduled. The three other biophysical methods were also time consuming. However, it was found that combining three of the preference questionnaires for a given subject gave hemisity concordance values ($r = 0.89$, 91% accurate) comparable to the MRI method alone. This breakthrough allowed the rapid and accurate hemisity determination of large numbers of subjects.

Thirty significant behavioral contrasts of hemisity are shown in Table 2. These hemispheric asymmetries subtly, but measurably, influence the person's personality and behavioral orientation, depending on the side of his or her executive output.

2.1 Ten properties of hemisity

2.1.1 Stability of hemisity

Regarding the stability of one's hemisity over time, it has been found that brain laterality is present at very young ages and develops further in adolescence (Yamazaki et al., 2018). This lateralization completes with final maturation. It is inconceivable for laterality of the ACC to reverse itself, requiring the rewiring of the entire brain. Thus, one's hemisity can be considered permanent and unchangeable.

2.1.2 Relationship of hemisity to handedness

No relationship was found between hemisity and handedness in 113 subjects (Morton & Rafto, 2006), or 1049 subjects (Morton, Svard, & Jensen, 2014). Left brain-oriented, right-handed individuals commonly exist, as do right brain-oriented, left-handed individuals.

2.1.3 Hemisity in the general population

Among 703 students at Kapolei High School near Honolulu, Hawaii, we found a nearly even split between RPs (328) and LPs (355) (Table 3). The same relationship was found among 346 students attending high schools in the Provo School District in Provo, Utah: an even distribution of RPs (175) and LPs (171). Finally, among the summated population of these two public high school juniors and seniors ($n = 1049$), we found an even distribution of RPs (523) and LPs (526) (Morton, Svard, & Jensen, 2014). Since these high school students were unsorted, it may be concluded that in the general population, there are approximately equal numbers of RPs and LPs.

2.1.4 Hemisity and corpus callosum size

Individuals differ in the number of CC nerve fibers interconnecting their cerebral hemispheres by about threefold. Using quantitative MRI, we found the midline CC area of 113 subjects was significantly correlated, not with handedness or sex, but with hemisity (Figures 1 and 2) (Morton, 2006). That is, right brain-oriented individuals of either sex had significantly larger CCs than left brain-oriented persons.

2.1.5 Evidence that hemisity is inherited

Twin studies clearly show that corpus callosal size is inherited (Tramo, Loftus, Stukel et al., 1998). Since hemisity is tied to callosal size, and corpus callosal size does not change over time, it would appear that hemisity is inherited. Hemisity of offspring results also support this.

2.1.6 Hemisity distribution by sex

Although the right and left hemisity distributions were equal; interestingly, the distribution of hemisity subtypes between the sexes was quite different ($n = 1049$). Instead, in Figure 3, it may be seen that among the Hawaiian students, we found a reciprocal complementary relationship between RMs (37%, $n = 132$) and LFs (38%, $n = 133$) and correspondingly between LMs (62%, $n = 216$) and RFs (63%, $n = 222$). This same reciprocal complementary relationship was also found among genders in the Utah population between RMs (44%, $n = 74$) and LF (43%, $n = 77$) and correspondingly between LM (56%, $n = 94$) and RF (57%, $n = 101$). These paired numbers appear to be too close to be coincidental. Rather, it appears that they somehow reflect the hemisities of future couples, as follows.

2.1.7 Hemisity of reproductive pairs

Using a group of 412 paired individuals from the general population, the above seen distribution coupling of RMs to LFs and RFs to LMs was mirrored by the finding that these pairs actually formed the predominant marital partnerships of the RF-LMs and RM-LFs (Table 4). These pairing relationships also matched the larger number of related RF, LM, and RM-LF values of single high school students above (Figure 3). The abundance of the four naturally occurring heterosexual pairs was 40% RF-LM, 27% RM-LF, 20% LM-LF, 13% RM-RF. Of these, 67.5% consisted of opposite hemisity pairs (RM-LF, RF-LM), and 32.5% were composed of like–like (RM-RF, LM-LF) hemisity pairs. These observations support the hypothesis that in general twice as many opposite hemisity pairs bond to each other than like–like pairs and that "opposites attract" is the more common evolutionary pair-forming pattern.

2.1.8 RP hemisity dominance

Of the couples with opposite hemisities, the RP globally oriented partners were more dominant, and the LP detail-oriented partners were more supportive as shown in Table 5. This might be predicted from the observation that RPs are bold and outgoing, as compared to LPs who are more cautious and conservative. RPs also may be more cross-connected because their executive output often comes from the hemisphere opposite their language hemisphere. This

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Table 2. Thirty binary behavioral correlates of hemisity

Left Brain-Oriented Persons	Right Brain-Oriented Persons
1. Logical Orientation	
Analytical (stays within the limits of the data)	Sees the big picture: projects beyond data, predicts
Uses logic to convert objects to literal concepts	Imagines, concepts go to contexts or metaphors
Decisions based on objective facts	Decisions based on feelings, intuition
Uses a serious approach to solving problems	Use a playful approach to solving problems
Prefers to maintain and use good old solutions	Would rather find better new solutions.
2. Type of Consciousness	
Daydreams are not vivid	Has vivid daydreams
Does not often remember dreams	Remembers dreams often
Thinking often consists of words	Thinking consists of mental pictures or images
Comfortable and productive with chaos	Slowed by disorder and disorganization
Can easily concentrate on many things at once	Tends to concentrate one thing in depth at a time
Often thinking tends to ignore surroundings	Observant and in touch with surroundings
Often an early morning person	Often a late night person
3. Fear Level and Sensitivity	
Does not read other people's minds very well	Good at knowing what others' are thinking
Conservative and cautious	Innovative and bold
Sensitive in relating to others	Intense in relating to others
Tend to avoid talking about emotional feelings	Often talks about own and others feelings of emotion
Suppresses emotions as overwhelming	Seeks to experience/express emotions more deeply
Would self-medicate with depressants	Would self-medicate with stimulants
4. Social and Professional Orientation	
Independent, hidden, private, and indirect	Interdependent, open, public, and direct
Avoids seeking evaluation by others	Seeks frank feedback from others
Usually tries to avoid taking the blame	Tends to take the blame, blames self, or apologizes
Do not praise others nor work for praise	Praises others and works for the praise of others
5. Pair-Bonding and Spousal Dominance Style	
After an upset with spouse, needs to be alone	After upset with spouse, needs closeness, and to talk
Tolerates mate defiance in private	Finds it difficult to tolerate mate defiance in private
Needs little physical contact with mate	Needs a lot of physical contact with mate
Prefers monthly large reassurances of love	Likes daily small assurances of mate's love
Tends not to be very romantic or sentimental	Tends to be very romantic and sentimental
Thinks-listens quietly, keeps talk to minimum	Thinks-listens interactively, talks a lot
Does not read other people's mind very well	Good at knowing what others are thinking
Often feels mate talks too much	Feels my mate does not talk or listen enough
Lenient with their children	Strict with their children

may contribute to the observation that the medial CC area is considerably larger in RPs (Morton & Rafto, 2010).

2.1.9 Discovery of the neuroanatomical basis of hemisity

As mentioned above, ACC asymmetry is present in humans (Morton & Rafto, 2010), one side being larger than the other in a seemingly idiosyncratic manner (Figure 4). The larger side was congruent with hemisity subclass. If it was larger on the right, the person was found to be a right brain-oriented dominant male or female. If the ACC was larger on the left, the subject was determined to be a left brain-oriented supportive male or female.

2.1.10 Hemisity of offspring from parents of known hemisity

Table 6 portrays the hemisity of 191 offspring of 91 of the four possible heterosexual pairs. As may be seen, for the RM-LF and RF-LM pairs of opposite hemisity, there was a trend toward offspring of the

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Table 3. The apparent hemisity of 1049 high school students

Group	*n*	LP (%)	RP (%)	χ^2	*p*	Declared Left-handed
Pearl Harbor High School, HI	703	355 (**50**)	348 (**50**)	0.07	.79	11%
Males	354	222 (63)	132 (37)	22.88**	<.01	
Females	349	133 (38)	216 (62)	19.74**	<.01	
Provo District High Schools, UT	346	171 (**49**)	175 (**51**)	0.05	.83	13%
Males	168	94 (56)	74 (44)	2.38	.12	
Females	178	77 (43)	101 (57)	3.24	.07	
Total High School Students	1049	526 (**50**)	523 (**50**)	0.01	.93	12%
Males	522	316 (61)	206 (39)	23.18**	<.01	
Females	527	210 (40)	317 (60)	21.73**	<.01	

* indicates significance, $p < .05$, ** indicates significance, $p < .01$.

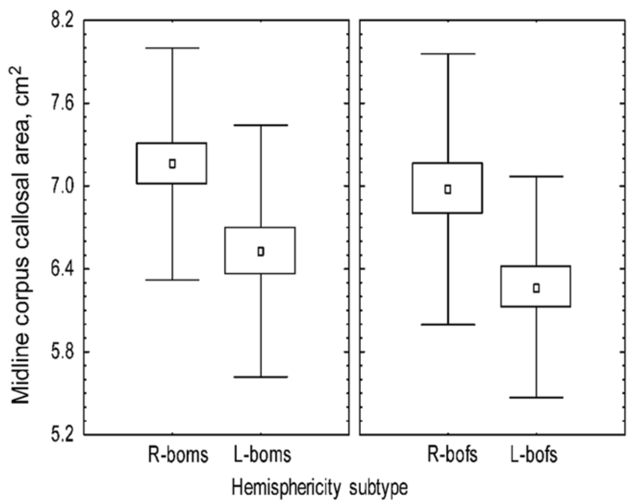

Figure 1. Effect of sex and hemisphericity upon corpus callosal area.

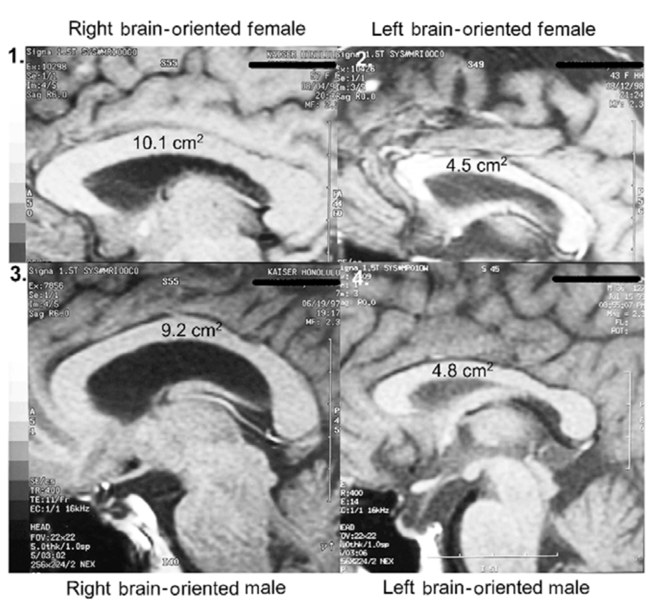

Figure 2. Hemisphericity vs. sex: size range of corpus callosal area.

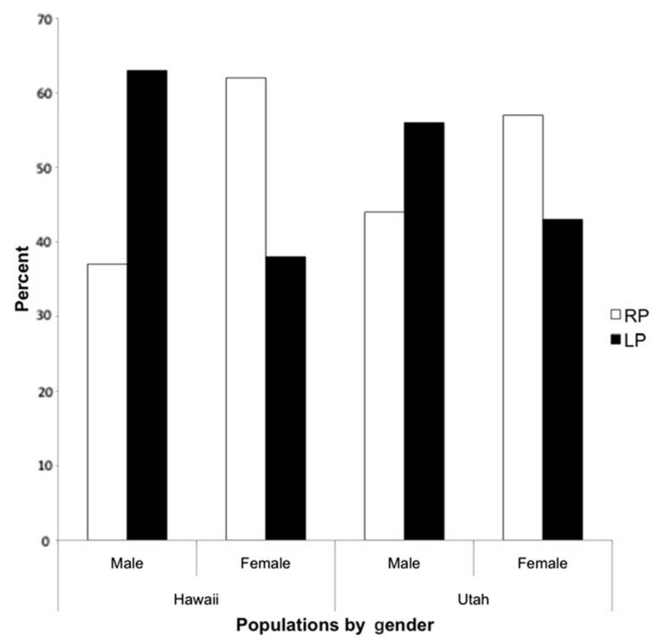

Figure 3. Reciprocal complementary relationship between hemisity and gender in both Hawaiian and Utahan populations of high school students, $n = 1049$.

same sex as the parent having the same hemisity, that is, "like father, like son and like mother like daughter." In contrast, the offspring of the RM-RF same–same pairs appeared to be sorted randomly. For those of the LM-LF pairs, percentage of RP was greatly reduced, in keeping with the high level of reproductive failure and childlessness of this pair due to partial sterility (Table 4). Offspring from both like–like parent pairs showed certain reproductive anomalies including dyslexia, bisexuality, and homosexuality. Pedophilia could not be assessed. The differences between the polarities at the human familial level are shown in Table 7, where the opposite behavioral roles are contrasted between the RM-LF and RF-LM reproductive pairs.

3. Discussion

This is the report of a sixth lateralized brain function called hemisity. It is found to depend upon the idiosyncratic laterality of the

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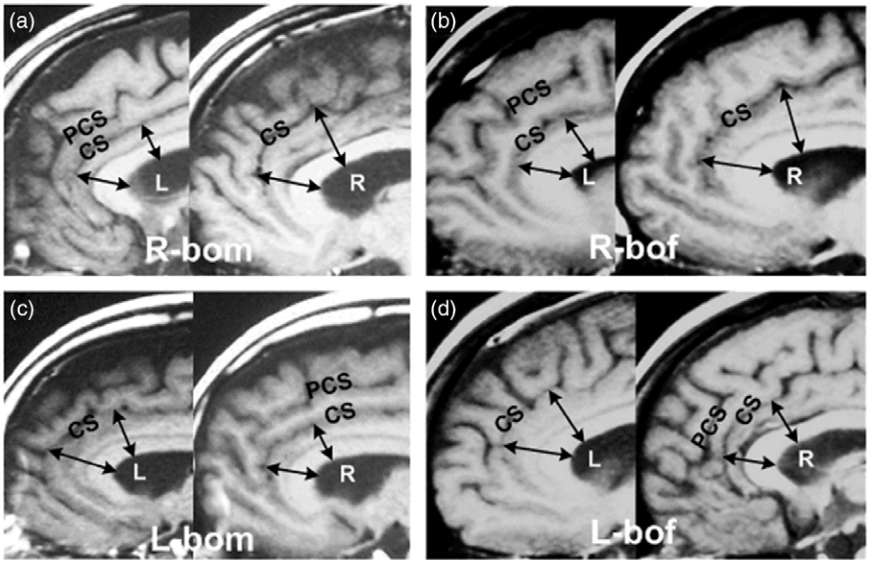

Figure 4. Asymmetries of the human anterior cingulate cortex. Three MRI sagittal images were taken for each of the 149 hemisity-calibrated subjects at midline, and 6 mm right and 6 mm left of the midline. (a) (R-bom or RM) right brain-oriented male subject with a larger right vgACC, (b) (R-bof or RF) right brain-oriented female subject with a larger vgACC, (c) (Lbom or LM) left brain-oriented male subject with a larger left vgACC, and (d) (L-bof or LF) left brain-oriented female subject with a larger left vgACC. Pairs of arrows reaching from the lower surface of the corpus callosum to the cingulate sulcus (CS) illustrate four measurements made for each subject. Corpus callosal thicknesses were also measured for each subject and subtracted from the four measurements to give thickness of the vgACC. The paracingulate sulcus (PCS), when present, is seen above the CS. Note that the distance to the cingulate suclus was shorter on the side of the brain where the paracingulate gyrus was present, while the relative vgACC thickness was greater on the opposite side.

larger, dominant side of the ACC. When the larger side of the ACC is on the right, the 30 behavioral traits of right hemisity (Table 2) were predominantly found. Correspondingly, when the larger side of the ACC is on the left, the person showed mostly left hemisity traits. That one's right or left hemisity can be determined by questionnaires based upon three biophysical, non-behavioral measures (dichotic deafness, mirror tracing, best hand test (not counting MRI)), which give strong support to the existence of hemisity, especially because their results are similar to those of the five behavioral questionnaires, each confirmed by MRI (Table 1).

The 30 binary behavioral correlates of hemisity (Table 2) are organized under the following five categories: logical orientation, type of consciousness, fear level and sensitivity, social and professional orientation, and pair-bonding and spousal dominance style. Each of the 30 binary choices has a probability of 80% for agreement in hemisity. Thus, the differences in hemisity are fairly obvious, L hemisity traits, for example: independent hidden, private, and indirect vs. R hemisity traits: interdependent, open, public, and direct. Or L hemisity traits: often an early morning person vs. R hemisity traits: often a late night person. It thus becomes very clear whether a person's hemisity is right or left.

3.1 Ten properties of hemisity

Hemisity supplies an important information packed missing factor in the categorization of individuals, of couples, and of groups. Ten properties of Hemisity are identified as follows:

1. It is irreversibly set by birth.
2. It is unrelated to handedness.
3. It is inherited.
4. In the general population, the numbers of RPs and LPs are approximately equal.
5. In RPs, the CC was up to three times larger than in LPs.
6. The numbers of both RMs and LFs have inexplicably been found to be similar, as were the more numerous LMs and RFs. That is, Both the RMs and LFs were about 40% of the LMs and RFs.
7. There were twice as many "opposites attract" RF-LM and RM-LF reproductive pairs than "same–same" RM-RF and LM-LF couples. This may have evolutionary significance.
8. In the "opposites-attract" mating pairs, RPs were the dominant partner. In the "same–same" pairs, dominance was random.
9. The side of the brain with the larger half of the split ACC determines whether a person will be an RP or LP.
10. Opposites-attract reproductive RF-LM and RM-LF pairs were true breeding, usually producing similar offspring. However, childlessness was high in L-L couples, whose remaining LP offspring were often homosexual. Offspring of R-R couples had many RP dyslexics and LP bisexuals.

3.2 Hemisity and corpus callosum size

It was found that those RPs with their final ACC executive output on the right side of the brain have significantly larger corpus callosi (Morton, 2006). This may be a consequence of their executive output module being on the opposite side of the brain from the commonly left hemisphere language module. Those LPs with their executive output on the same side as their language module would not be expected to need as much trans-hemisphere connectivity as RPs would. Thus, LPs would thus be expected to have smaller corpus callosi. Beyond this may be other factors that are related to the top-down, bottom-up specialization of the left and right cerebral hemispheres (Levy, 1969; Sperry, 1982).

3.3 Reproductive partner choice

When marital partners are chosen, the two complimentary pairs (RF-LM and RM-LF) result more than twice as often as pairs with similar hemisity partners (LM-LF, RM-RF). The opposite hemisity pairs would appear to be evolutionarily preferred over similar hemisity pairs. This is because, in terms of survival, opposite hemisity partners may logically contribute many more survival skills as a reproductive package, such as morning and evening orientations, than two partners of the same limited skills. Besides this, L-L and R-R pairs are not true breeding and produce reproductive anomalies, such as dyslexia and homosexuality.

3.4 Distribution of hemisity subtypes and sex subtypes

The distribution of hemisity subtypes between the sexes was not the same as the equal distribution of right and left brainers in the

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Table 4. Hemisities of 206 couples in the general population

Couple Hemisity	RM-LF	RF-LM	LM-LF	RM-RF
% of Total	40%	27%	20%	13%
% Childless	15%	9%	38%*	15%
Birth anomalies*	Few	Few	Many	Many
Pair patterns	Opposite +	Opposite = 67%	Similar +	Similar = 33%

n = 206 of couples > 5 yrs. 50-50 MF. 53%LPs, 47% RPs.
* = birth anomalies: dyslexia, bisexuality, homosexuality.

Table 5. Six partner dominance-oriented items from the preference questionnaires

Left Brain	Pair-bonding Style	Right Brain
Does not read other people's mind very well		Very good at knowing what others are thinking.
Avoids talking about their own and other's emotions.		Often talks about their and other's emotions.
Can tolerate it if their mates defies them in private.		Finds it intolerable if mate defies them in private.
Likes longer-term, larger rewards of mate's love.		Likes daily small reassurances of mate's love.
Often feels mate talks too much.		Often feels that mate does not talk/listen enough.
Not a very strict parent, kids tend to defy.		Strict, kids obey and work for his/her approval.

Table 6. Hemisity of 191 offspring from 95 parental pairs

Parental Pairs	RM Offspring	RF Offspring	LM Offspring	LF Offspring	Total Offspring
34 RM-LF	*27 (42%)*	11 (17%)	9 (14%)	*17 (27%)*	64
28 RF-LM	11 (18%)	*15 (25%)*	*22 (37%)*	12 (20%)	60
15 RM-RF	8 (27%)	8 (27%)	8 (27%)	6 (20%)	30
18 LM-LF	*1 (3%)*	*5 (17%)*	17 (57%)	14 (47%)	37

Table 7. Human personality trait comparisons between the two familial polarities

Trait	Patripolar	Families	Matripolar	Famlies
Parental sex	**Male**	**Female**	**Female**	**Male**
Hemisity	Right	Left	Right	Left
Corp.callos: size	Larger	Smaller	Larger	Smaller
Mental orientation	Big Picture	Important Details	Big Picture	Important Details
Verbosity, speech	Charismatic	Quiet, Articulate	Charismatic	Quiet, Articulate
Family leadership	Most Dominant	Most Supportive	Most Dominant	Most Supportive
Child's Hemisity	Boys are Rights	Girls are Lefts	Girls are Rights	Boys are Lefts
Parental love type	Conditional	Unconditional	Conditional	Unconditional
Parental function	Sets Standards	Prevents Excess	Sets Standards	Prevents Excess
Parental status	Role Model	Serves the Child	Role Model	Serves the Child
Mating behavior	He selects	She displays	She selects	He displays

population. That is, among the 1049 high school students there were more RFs and LMs than RMs and LFs. Furthermore, the numbers of the each of the two hemisity sets of high school individuals were almost identical. This suggests that there may somehow be a relationship between the unpaired high school student data and the later self-selected RM-LF and RF-LM reproductive pairs.

3.5 Hemisity subtype pair dominance

Among the "opposites attract" reproductive pairs, dominance between the partners almost always goes to the RP, whether male or female. This is not to say that LPs outside the home do not have a strong dominance hierarchies. They notoriously do, especially LMs. However, in the home, between partners, the

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RP almost always has the final word. Although one may be biased in judging the hemisity of others by one's own hemisity orientation, the existence within the home of either male dominant or female dominant families is readily visible to the educated eye. However, in homes of like–like hemisity marital partners, this can be confusing because they follow a more random pattern.

3.6 Correlation of ACC size laterality and hemisity subtype

The fortuitous finding of laterality size differences between the divided ACCs was the key unifying factor when it was discovered that the larger ACC side was very highly correlated with hemisity subtype. That is, RPs almost invariably had larger ACCs on the right and LPs on the left. This gave hemisity a neuroanatomical basis.

3.7 Breakthrough: the true breeding nature of opposite hemisity Pairs

A new chapter began when it was found that two complementary hemisity pairs (RM-LF and RF-LM) were true breeding, producing offspring identical in hemisity to their parents (like mother, like daughter, like father, like son). In contrast, the hemisity of offspring from parents of the RM-RF partners was of random hemisity with anomalies, such as dyslexia, bisexuality, and homosexuality common. For the offspring of L-L couples, there was a large amount of childlessness. It may be that most of the RPs of the LM-LF pairs were aborted leaving only homosexual and bisexual LP offspring.

The ability to determine the right- or left brain hemisity of individuals has opened doors to many significant previous inaccessible social and historical issues. These include not only the personality and dominance of individuals but also the identification of the hemisity of reproductive pairs, that of their offspring, that of their geographic distributions, with consequent historical insights. The integration of all the facts presented here begins to suggest the existence of two human species (Morton, 2012b). This topic will be developed in a future publication.

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Conflict of Interest. None present.

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