A bright future for the study of multiple cerebral asymmetries?: Comment on "Phenotypes in hemispheric functional segregation? Perspectives and challenges" by Guy Vingerhoets

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A bright future for the study of multiple cerebral asymmetries? Comment on "Phenotypes in hemispheric functional segregation? Perspectives and challenges" by Guy Vingerhoets.

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Before neuroimaging, scientists interested in asymmetry of the brain tended to resort to long-term studies of neurological cases with unilateral brain damage, charting intact versus disrupted processes with standardised tests. The only other option was administration of perceptual experiments tests to groups of right and left handers. The left handers need to be over-recruited in such experiments for two reasons: they are rare (so random sampling only gives you about 10% of them), but they also are more likely, in theory, to contain individuals with the relatively rare type of hemispheric specialisation. There is, at least, plenty of evidence that ~15% of left handers would possess right hemispheric specialisation in speech and language, in comparison to ~5% of their right-handed counterparts.

The "in theory" caveat above is crucial for lateralised functions that are not language or speech, as there is rather little evidence one way or another that shows that left handers are more likely to have an underlying atypical asymmetry for these functions. Finding these atypicals, we argue, apparently a "specialist sort of worry" has considerable implications (see [1]). Here, Vingerhoets [2] does the field a great service, by describing the proportions of right handers and left handers who show typical and atypical lateralisation for a host of different functions in addition to speech and language. His table 1, which provides these data for several non-language skills, is fascinating and provocative. It indeed suggests that all of the asymmetries are reduced in the left handed group. Where this is most surprising is for praxis (the supraordinate control of movements on both side of the body), as many left handers use their dominant hand for skilled tool use, such as writing, cutting and hammering. Yet Vingerhoets shows data suggesting that nearly 80% of them have *left* hemisphere dominance for the recognition of tools. These types of asymmetry deserve much more detailed study, given this paradox of left speech and praxis dominance in individuals' whose dominant hand is

controlled by the other hemisphere. Partial explanations of this unusual arrangement that depend on greater interhemispheric connectivity in the majority of left handers are not as of yet particularly convincing [3,4,5,6].

A second provocative aspect from these fascinating proportions is that they could, in theory, speak to the likelihood of complementary hemispheric specialisations with language. Any non-speech/language asymmetry can be tested in right-handed and left-handed samples. The obvious prediction is, if it is related to language in a causal fashion, a 15-20 percent reduction in the breadth (i.e. frequency of occurrence) of typical dominance in the left-handed group. For example, right handers and left handers do not differ at all on one measure of right hemispheric dominance for spatial attention [7]. With a little digging, virtually identical right dominance estimates can be gleaned from recent neuroimaging studies ([8,9], in contrast with the data on attention summarised in table 1). Taken together, these data suggest that two stalwarts of cerebral asymmetry, language and visuospatial attention, are lateralised relative to one another by statistical accident.

Vingerhoets moves from these interesting data on the breadth of asymmetries and handedness to the crucial role that people with unusual cerebral dominance should play in testing models of complementary hemispheric specialisation (see also [1,10]). This point is worthy of re-emphasis. Claims regarding the natural constraints in hemispheric specialisation for multiple functions need to be tested in individuals with the rare forms of cerebral dominance. The use of the plural "forms" above is intentional: the recent, typically heroic attempts of this type usually focus on the unusual asymmetry in language and its consequences for the secondary function in question (e.g. [13]). Faces are the most frequent, due to their importance in recent models of how reading becomes left hemispheric which drives face and other types of visual processing to the right hemisphere [8,11,12].

One issue is worthy of further discussion and exploration: the definition of a "bilateral" category (discussed on page 3 in Vingerhoets; although different papers use different +/- cut-offs: .15 [13]; .50 [14], and .60 [15]). In response to our comments, Vingerhoets suggest one data-driven way of justifying a sensible cut-off. He notes the lack of clearly right lateralised right handed individuals when a sentence generation task was used in [16], supporting the theoretically huge idea that right brain dominance is only seen in left handed individuals. In other words, the threshold for bilaterality would be defined by an LI value that separates the most atypically lateralised left handers from all of the atypically lateralised right handers. The criteria for bilaterality in this paper was .50. We would argue that providing all the available

LIs calculated (as the authors mentioned do) and avoiding cut-offs (do not) for most analyses. When group composition is required by the analytic question, using a cut off of 0 is defensible (although some might argue, somewhat conservative). Models of hemispheric specialisation of more than one function need to be able to explain relationships in less strongly lateralised individuals just as much as in the strongly lateralised. In fact, the need is probably greater in the former case. A more pressing issue with the bilateral category is whether or not some individuals are actually bilateral (i.e. in a retest produce a similar LI not very different than 0) or if their asymmetry is indeterminate by that particular test and/or in that particular session.

An alternate approach could use a test-retest or split-half reliability analysis, wherein the range of uncertainty of categorical asymmetry can be established. For example, in some of our own data, verbal fluency LIs calculated with the laterality toolbox [17] produce more uncertainty the closer the average LIs from two runs are to zero: in the band of individuals with an average LI of ±.20 or less, disagreement in side of dominance between the two runs reached 40%. Several caveats apply here, including a split-half analysis versus a proper test-retest (hard to justify in MRI centres or the research grants that fund them), and a rather small number of people with mean LIs in the band around 0 (6 in our dataset of 90 individuals).

A final caveat about these very interesting and important proportions of typical and atypical dominance estimated using fMRI: 95% confidence intervals around these estimates are indeed large, even in the huge datasets painstakingly created by our colleagues in Ghent, Bordeaux, Oxford [18] and Auckland. This problem is in part generated by the highly skewed nature of the underlying data structures: atypical types of specialisation are rare, so certainty of their direction (let alone magnitude) will be higher in the rare forms of dominance. Nevertheless, these pioneering efforts point the way forward for several much-needed analyses of validity and reliability, performed across multiple centres using standardized tasks. Much remains to be done, but the future looks bright.

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