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## T-13. Handedness and Eye-Dominance: Explaining the Association

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Although handedness has been much investigated by neuropsychologists, there has been little interest in recent years in eye dominance, or eyedness, with about two-thirds of the population being right-eye dominant (''sighting dominance'') and one-third left-eye dominant. Although the relationship between handedness and eyedness was particularly investigated in the 1920s and 1930s, with particular emphasis being placed on crossed eye–hand dominance as an explanation of reading difficulties, there has been little interest in the association in recent decades.

Since eyedness is part of a broader set of lateralities (e.g., handedness, hand-clasping, arm-folding, earedness, etc.), a general theory of laterality should be able to explain associations between these measures. In the case of measures such as hand-clasping or arm-folding, which seem to be independent of each other and of handedness, then the theory simply postulates independent mechanisms, in the form of independent genes. This is what we call a no-association model.

Eyedness is straightforwardly measured, but can nevertheless be contaminated by measures of handedness, as in tasks such as sighting a rifle, in which manual dexterity is also required, or in unimanual tasks such as pointing, in which subjects inadvertently use their dominant hand. Our initial hypothesis was therefore that the association of hand and eye dominance may only occur in studies using biased measures of eye dominance. Elsewhere (INS, 1995, Seattle) we have presented data from a meta-analysis of the association be-

tween handedness and eyedness in 54,087 subjects from 54 populations, in which even in studies using unbiased measures of eyedness, left-handers were 2.53× more likely than right-handers to be left-eyed. For a population with typical values of 9.3% left-handedness and 36.5% left-eyedness this means that 34.4% of right-handers and 57.1% of left-handers are left-eyed. The no-association model therefore fails. The present paper therefore assesses alternative explanations for the very significant association.

A phenotypic association model assumes that at some stage during development, the presence of one laterality, presumably handedness since it is the more extreme lateralization, causes in some sense eyedness. Such a model fails since it predicts a higher proportion of left-eyedness in left-handers than is found in the data. A variant of the model in which eyedness is caused by language dominance also fails because it predicts that the majority of left-handers should be right-eyed. We conclude that phenotypic association models also fail.

A genotypic association model assumes that handedness and eyedness are pleiotropic consequences of two alleles at a single genetic locus (as the association of handedness and language dominance can adequately be explained). Such a model also predicts that the majority of left-handers should be right-eyed and therefore fails.

A genotypic–phenotypic association model states that in individuals with a DD genotype handedness causes ipsilateral eyedness, but that in DC and CC genotypes there is an increasingly random association of handedness and eyedness, so that in the CC genotype both handedness and eyedness are consequences of fluctuating asymmetry, and hence are uncorrelated. Such a model is capable of explaining the association of handedness and eyedness. However, it also predicts that there should be little tendency of eyedness to run in families, whereas most published studies find a fairly strong familial trend. We therefore conclude that this model is also flawed.

In summary, no existing model can adequately explain the clear association of handedness and eyedness, and such data provide a challenge to existing theories of lateralization.

### T-14. Relation between Spatial Performance and Laterality on an Embedded Figures Task

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The present study examined how the choice of a cognitive measure affected the detection of a level of spatial ability by laterality interaction on an embedded figures task (EFT). Forty-eight right-handed subjects (24 females, 24 males) completed a lateralized EFT and three pencil-and-paper spatial tests. Results showed improved accuracy on the lateralized EFT as levels of spatial ability increased. An interaction between spatial ability and visual field was found only for one of the tests used to