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Sex differences in human brain asymmetry: a critical survey

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Abstract: Dual functional brain asymmetry refers to the notion that in most individuals the left cerebral hemisphere is specialized for language functions, whereas the right cerebral hemisphere is more important than the left for the perception, construction, and recall of stimuli that are difficult to verbalize. In the last twenty years there have been scattered reports of sex differences in degree of hemispheric specialization. This review provides a critical framework within which two related topics are discussed: Do meaningful sex differences in verbal or spatial cerebral lateralization exist? and, if so, is the brain of one sex more symmetrically organized than the other? Data gathered on right-handed adults are examined from clinical studies of patients with unilateral brain lesions; from dichotic listening, tachistoscopic, and sensorimotor studies of functional asymmetries in non-brain-damaged subjects; from anatomical and electrophysiological investigations, as well as from the developmental literature. Retrospective and descriptive findings predominate over prospective and experimental methodologies. Nevertheless, there is an impressive accumulation of evidence suggesting that the male brain may be more asymmetrically organized than the female brain, both for verbal and nonverbal functions. These trends are rarely found in childhood but are often significant in the mature organism.

Keywords: asymmetry; human brain; sex differences

It would appear that the tendency to symmetry in the two halves of the cerebrum is stronger in women than in men. J. Crichton-Browne, *Brain*, 1880.

Introduction

The notion that the structure or function of the human brain may be sexually dimorphic is not entirely new. Previous work in nonhuman species clearly links the difference between male and female patterns of reproductive behaviour to sex differences in neural control centres (Goy 1970; Levine 1966; Reinish 1974). A fresh approach to this topic, however, is reflected in recent publications suggesting that nonreproductive functions in humans may also be organized differently in male and female brains. Thus, it has been suggested that the cerebral representation of cognitive functions such as linguistic and visuospatial abilities may vary according to sex (Landsell 1961; McGlone 1977b; 1978; McGlone and Kertesz 1973).

Functional brain asymmetry refers to the idea that, for most individuals, the left cerebral hemisphere is specialized for language functions as well as for the execution of learned manual activities. By comparison, the right cerebral hemisphere is less involved in subserving speech functions but more critical than the left hemisphere for the perception, construction, and recall of stimuli that are difficult to verbalize (Kimura 1973; Milner 1971). Recently, the possibility of sexual variation in the degree of brain lateralization has attracted attention from researchers investigating sex differences in overall psychological abilities. According to many psychologists, there are reliable group differences between males and females in those functions that have previously been described as being represented in opposite sides of the brain. Males, particularly after puberty, surpass females in visuospatial skill, such as the alignment of a rod to the vertical, left-right discrimination, disembedding figures,

mental rotation, and point localization (Bakan and Putnam 1974; Sandström 1953; Stafford 1961; Thurstone 1938; Wilkin 1949). In contrast, there appears to be a female advantage in certain executive speech tasks such as speed of articulation, fluency, and grammar, but not in other language tasks such as verbal reasoning (Hutt 1972). Several authors have speculated that these sex differences in overall cognitive patterning may be biologically influenced by underlying differences in lateralized brain organization (Harris 1978; Hutt 1972; McGee 1979; Maccoby and Jacklin 1974; Sherman 1974).

The 1970s produced several reviews dealing with the topic of sex differences and functional brain asymmetry (Bryden 1979; Buffery and Gray 1972; Fairweather 1976; Harris 1978; Harshman and Remington 1974; Hutt 1979; McGlone 1977a). Consensus has been reached on at least two points: First, there has been an inadequate data base on which to form conclusions. This is because most normative studies have tended to ignore the sex of the subject in the data analysis, and clinical investigations of psychological deficits after unilateral brain damage contain predominantly male patients, thus precluding cross-sex comparisons. The second point of agreement is that findings accruing from immature organisms must be considered separately from those derived from adults.

Opinions are more divergent regarding the existence of meaningful sex differences in the cerebral lateralization of verbal and spatial functions, and, if such differences exist, regarding whether the brain of one sex is more symmetrically organized than the other. Two opposing points of view have emerged with respect to the latter question. Buffery and Gray (1972) posit that the male brain is more symmetrically organized than the female brain for both speech and spatial representation. Most reviewers find very little support for this model and instead favour just the reverse pattern, albeit with reservations. That is, the adult male brain is more asymmetrically organized than the female brain for verbal functions (Harshman et al. 1974; McGlone 1977b), spatial functions (Harris 1978; McGee 1979; Witelson 1976, 1977b), or both

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