Sex Differences in Neural Organization

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In the last ten years or so, experimental research has been conducted concerning the possibility of sex differences in neural organization. I would like to review this research and speculate on the theoretical and clinical implications of sex differences to areas of interest in our field.

In general, investigators of sex differences in cortical organization have argued that females tend to be less lateralized than males. That is, the hypothesis is that cerebral asymmetry is greater in males than in females. Let me emphasize that the issue is one of degree. It is still accepted that the left or right hemisphere may be dominant for certain functions, but the ability of the nondominant hemisphere to perform the task is greater in females than males. Stated another way, the idea is that the hemispheres have greater equipotentiality in the female, and certain abilities may be bilaterally represented to a greater degree in the female than in the male.

Evidence for this position can be found in several studies of cerebral asymmetry. I'd like to begin by looking at the findings of S. Witelson's (1976) study of the course of specialization of the right hemisphere for the nonlinguistic function of spatial processing. She used a tactual perception test developed to assess the participation of the two hemispheres in spatial processing. The test required the subjects (N=220, 25 boys/25 girls--all right handed-- in each two year interval from 6 to 12) to palpatate simultaneously, out of view, two different meaningless shapes for 10 seconds with the index and middle finger and then choose the shapes from a visual display containing 6 such shapes.

There were several critical features of this test: 1) it required tactile shape discrimination, which is thought to be dependent on the right hemisphere; 2) stimuli were designed to be meaningless shapes; not readily labeled, therefore hindering linguistic encoding; 3) different stimuli were presented simultaneously, termed "dichhaptic." It was expected that this procedure would produce competition in the neural system, so that any superiority of the right hemisphere for the required cognitive processing would be reflected in superior perception of the contralateral (left) hand stimuli. The results showed that the left hand score of boys was significantly better than the right; for girls, no difference between hands was noted.

This is not the only study suggesting that the right hemisphere may be more specialized for nonlinguistic abilities in males. McGlone and Kerteze (1973) reported that spatial impairments following right hemisphere lesions are greater in males than in females. Kimura, in 1973, found that males performed better in spatial perception tasks. McGlone and Davidson (1973) administered a standard test of spatial perception in which the subject must identify a design after it has been rotated. They found, as is usual in this task, that males usually performed better than females.

A second area of investigation of cerebral asymmetry that has yielded information relevant to this discussion has been the study of conjugate lateral eye movements as indicators of hemisphericity. This type of research

has been popularized through articles in Psychology Today and has served as a conversation topic at many a cocktail party. Essentially, the notion is that individuals tend to move both eyes in a characteristic direction, either right or left, when attention is shifted from a passive to active role. The direction of movement is related to hemisphericity--leftward eye movements indicate that the right hemisphere is active and rightward eye movements indicate that the left hemisphere is being called on for processing.

In the few studies that have looked at lateral eye movements in males and females, it has been noted that women are less consistent in eye movements, and consequently, are more difficult to classify as right or left movers than males. Experimenters have found that males make about 75% of CLEM's (conjugate lateral eye movements) in one direction. Females are more likely than men to move their eyes in both directions. The suggestion from these studies is that women shift from one hemisphere to the other in cognitive processing with greater facility than males. Unfortunately, few studies have pursued the investigation of sex differences in CLEM's. Rather, as so frequently happens, those subjects who do not perform in a manner necessary for study are eliminated from the study. Consequently, experimenters have gone on to studying males only and consequently many of the findings from CLEM studies are generalizable only to males.

However, one study, by Gur and Gur (1977), did assess male/female differences. Their findings suggested that hemisphere bias as measured by CLEM's was correlated with certain personality traits, task performances and classroom seating preferences. (The personality characteristics that they looked at were hypnotizability, scores on a defense mechanism inventory and manifest symptom questionnaire.) The pattern of relations among these variables appeared to be different for males and females (i.e., leftsided seating preference [right movers] was associated with higher MSQ scores in males, whereas the opposite was true for females). Now, let's go on to consider the "biggie" for us--the notion of sex differences in cerebral specialization for language.

Several dichotic listening studies have been done and have been virtually unanimous in showing greater laterality effects in men than in women. For example: 1) Bryden (1962) found 73.6% of males while only 62.2% of females to have a REA in a free recall digit task; 2) Using CV's, Bryden (1966) found a REA for 74% of right-handed males and 57% for right-handed females; 3) Remington, Krashen, and Harshman (1973), using CV's, found a significant REA only among males; and 4) Lake and Bryden (1976) found 84% of the males to have REA, while only 63% was noted among females. These findings have suggested that there are sex differences in cerebral organization for language.

While dichotic data do show sex differences, one must remember that dichotic tasks permit only an indirect inference about speech lateralization. Any conclusions about the relation of sex to language and speech lateralization should be supported with clinical data.

Unfortunately, the data on the relationship between sex and language lateralization from studies of aphasia are very unsatisfactory (equally unsatisfactory are studies assessing cerebral dominance with the Wada Sodium Amytal Test). Few authors consistently report the sex of their subjects or analyze the data to permit assessment of sex differences. Also, much of our knowledge of language lateralization has come from aphasia studies which have tapped substantially male populations such as veterans.

There are a few studies, however, that suggest male/female differences in cerebral organization with specific reference to language. Lansdell (1973) studied the effect of neurosurgery on the ability to identify popular word associations. Both males and females served as subjects; each had had temporal lobe neurosurgical operations. Before surgery, there were no significant differences in scores, comparing either type or side of subsequent surgery or sex of patient. After surgery, the mean number of errors increased significantly only with male patients who had undergone surgery on the left hemisphere. Lansdell also found, in a subsequent study, that the effect of left temporal lobe operations on performance of an objective test of proverbs differed according to the sex of the patient. Women were unaffected and men dropped in score after the operation.

A most interesting study was conducted by Dennis and Whitaker (1976). In this study, the language development of three 9-10 year old children possessing only a right or a left hemisphere was studied. Surgical removal of one half brain antedated the beginning of speech, so each child had acquired speech and language with only one hemisphere. The authors were interested in assessing language acquisition in an isolated right or left hemisphere. Although Dennis and Whitaker limited their discussion to right and left hemisphere differences, inclusion of a male and a female left hemidecorticate subject permits assessment of differences related to sex. Not all of the test measures used in this study demonstrated differences between these two subjects, but some did. Specifically, the female achieved a percent correct score of 90.0 while the male achieved a percent correct score of 83.3 on the responsive naming subtest of the Boston Diagnostic Aphasia Test (Goodglass and Kaplan, 1972). The results of the token test are even more revealing, with the male achieving a total of 80.6% correct and the female achieving 91.9% correct. This finding is particularly interesting, since there were no differences in age of the two children.

Whitaker and Dennis concluded from the comparison of all three children that each hemisphere has an adequate substrate for phonemic and semantic abilities, but syntactic abilities were not acquired as well by the isolated right hemisphere as by the left. The data analyzed by sex supports this conclusion, but suggests that it may have to be qualified because cerebral asymmetry for males may be greater than for females. Certainly, the right hemidecorticate performed consistently better than the two left hemidecorticate children. But the female hemidecorticate performed, in some instances, better than the male. One must, of course, be extremely careful of any attempt to generalize from such a small number of subjects, but the findings are provocative and can be seen as supportive of the notion that females are less lateralized than males.

The studies of "Genie" by Fromkin et al. (1974) and Hillier's (1954) report bear on this question. Fromkin et al., report the language development of a 16 year old girl who for most of her life suffered social isolation and experiential deprivation. Hillier reported on the language abilities of a left hemispherectomized 14 year old boy. The studies may be compared, as dichotic listening tests on Genie demonstrated an extreme left ear advantage, suggesting right hemisphere dominance for language. Her language acquisition was greater than Hillier's subject. Again, a small number of subjects does not permit generalizability. But it is open to the suggestion that the difference between the two is a result of sex differences; that the female brain retains plasticity longer than the male and/or that there is, from beginning to end, less specialization of function in the female brain.

From this review, it appears that the evidence is at least suggestive that males demonstrate a greater degree of lateralization than do females in verbal, visuospatial and overall lateralization. To be sure, the differences are one of degree, but even so, they may have theoretical and clinical implications for speech pathology. What we are looking at is a possible sex difference in cerebral asymmetry. When one asks the question of specialization of function of the left and right hemisphere, the answer may vary according to sex. In consideration of gross differences in cerebral hemispheres, perhaps the model of cerebral organization may be more appropriately recognized as:

Males		Females	
Left Hemisphere	Right Hemisphere	Left Hemisphere	Right Hemisphere
Verbal	Spatial	Verbal Spatial	Spatial Verbal

There appears to be a need to evaluate language abilities of the male and female who have incurred unilateral cerebral lesions for additional information regarding language representation in the two hemispheres. This information would contribute to the basic question of cerebral asymmetry but also, and particularly relevant, would aid in delineating diagnostic and therapeutic procedures. Recall that the majority of studies on aphasia have sampled predominantly male populations. Several aphasia tests have been normed according to this sampling. Classification schemes have been developed, recovery profile curves have been derived. Could it be that with female populations, results could have differed? Take, for example, predictions of recovery. If, as suggested from the studies conducted, females are less lateralized than males, language recovery and/or residual abilities for females should differ, in favor of the female. Review of studies of recovery offer little insight into this question. In the studies conducted by Butfield and Zangwill (1946), Godfrey and Douglass (1959), Sands, Sarno, and Shankweiler (1969), Sarno, Silverman, and Sands (1970), no distinctions related to sex of subject were noted. Also, the subjects were presumably all male in Schuell, Jenkins, and Jimenez-Pabon's (1964), Luria's (1970), and Wepman's (1951) reports. Only two studies, Vignolo (1964) and Weisenburg and McBride (1935) included females. In Vignolo's study, "all but a few were male." In Weisenburg and McBride's study, 21 of the 60 subjects were females. Interestingly, the reported pattern of recovery was similar for males and females in this instance. A program of research needs to be conducted comparing female performance to male performance. Also, with reference to classification, the Dennis and Whitaker data and isolated child data indicate that the right hemisphere of the female (at least, the young female) has greater language abilities than the male. It follows that this cerebral organization difference may be reflected in incidence of types of aphasia. Could it be that there are fewer female fluent aphasics than males? Or, one might propose that there are fewer Broca's in the female population as the right hemisphere has some expressive ability.

In line with the notion of differential performance or differential recovery is that of differential therapeusis. If, indeed, females differ from males in cognitive strategies, should this difference not be reflected in therapeutic approaches? Would M.I.T. be more effective in females than in males as it "calls" on right hemisphere functioning?

The question of sex differences in neural organization is a provocative one. The value of this paper, then, is heuristic. I believe that those of us who are interested in aphasia are in the best circumstances to set about the task of providing the answer.

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