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Odyssey

Harnad, S., and Doty, R. W. Introductory overview. In: S. Harnad, R. W. Doty, L. Goldstein, J. Jaynes, and G. Krauthamer (eds.), *Lateralization in the Nervous System*. New York: Academic Press, 1977.

by **Richard J. Davidson**

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Lateral specialization in the human brain: speculations concerning its origins and development. In their discussion of early signs of cerebral specialization, C & M argue that although current data clearly indicate that cerebral asymmetry is present at birth, it also undergoes progressive maturation over the course of ontogeny and, consequently, the asymmetry becomes accentuated with age. While the Wada, Clarke, and Hamm (1975 *op. cit.*) data on temporal planum structural asymmetries in infant and adult brains is consistent with this view, their data on asymmetry in the frontal operculum reveal no difference between infants and adults. Moreover, C & M failed to indicate that Molfese, Freeman, and Palermo (1975 *op. cit.*) found *larger* electrophysiological asymmetries in response to speech sounds than to musical chords and noise bursts in their infant subjects than in adults.

Similar age effects have been obtained in behavioral tasks. Kinsbourne and McMurray (1975) found that in children (mean age: 5.67 years) required to tap with either their right or left index fingers while reciting or repeating verbal material, their tapping speed was impaired significantly more for their right than their left hands. The asymmetry was found to be less pronounced in adults than in children (Hicks, 1975).

Despite the suggestions from the data reviewed above, it appears that certain aspects of asymmetry do mature with age, as C & M indicate. Lenneberg (1967 *op. cit.*) has reviewed a variety of data indicating that the capacity for recovery by an intact hemisphere of function previously subserved by a damaged hemisphere, declines with age. How might the findings on greater asymmetry in newborns and young children be reconciled with other data suggesting a maturation of asymmetry?

One possible resolution of this apparent contradiction lies in the consequences of maturation and myelination of the corpus callosum. Although estimates vary, it is agreed that myelination of the commissures is not complete at birth and probably continues until puberty (Yakovlev & Lecours, 1967). The structural development of the commissures also continues past birth. Not only is the corpus callosum proportionately thinner in neonates than in adults, but, in addition, the rostrum is not completely developed and the splenium is continuing to develop (Hewitt, 1962). These anatomical findings indicate that early in ontogeny, communication between the two hemispheres, as well as active inhibition of one by the other will be less pronounced. The Molfese et al. (1975 *op. cit.*) finding of greater electrophysiological asymmetry in neonates compared with adults can be explained on this basis. Increased callosal transmission may conceivably result in greater similarities in the responsiveness of the two hemispheres. Finally, the decrease in the plasticity of the hemispheres observed by many investigators (Lenneberg, 1967 *op. cit.*; Zangwill, 1960 *op. cit.*) may be in part a function of the development and maturation of the corpus callosum, which may serve an inhibitory as well as a facilitatory function. Thus, verbal processing in the left hemisphere may be associated with an inhibition of certain right hemisphere regions. The effects of such repeated right hemisphere inhibition may be to decrease its capacity to engage in verbal processing.

A direct implication of this hypothesis is that interhemispheric communication should be less pronounced and/or more degraded at earlier ages. Comparing ipsilateral versus contralateral tactile localization in children of various ages, Galin et al. (1977) have recently found evidence consistent with this suggestion. Their findings indicate that the maturation of the corpus callosum may lag behind that of the two cerebral hemispheres and this may account for many of the ontogenetic shifts previously ascribed to changes within the hemispheres.

The evidence that C & M consider to be critical to their view of hemispheric specialization concerns recovery of function following early unilateral lesions. They predict that the right hemisphere should be more readily disposed to take over left hemisphere functions than is the left to take over right hemisphere functions. This, they indicate, would argue for the "higher priority" of left hemisphere functions and for the "subordinate" nature of right hemisphere functions. It may in part be the case that certain aspects of linguistic processing, particularly language comprehension, do not require the focal neural organization of the left hemisphere for at least their rudimentary expression. Findings consistent with this suggestion have not only been observed in brain-injured patients but also in neurologically intact individuals (Searleman, 1977). Moreover, a variety of evidence indicates that certain aspects of speech comprehension are bilaterally represented (Zurif, 1974). In contrast to linguistic processes, some spatial activities may require right hemisphere mediation for their successful performance and may be less amenable to bilateral representation. Consistent with this notion are the recent data obtained by Furst (1976), who found a high correlation (.546) between successful visuospatial performance and relative right hemisphere EEG activation. We have recently replicated this finding with additional spatial tasks (Davidson, et al., in preparation). Thus, the pattern of evidence that C & M interpret as providing critical support for their right hemisphere equipotentiality hypothesis may be interpreted in a different framework. The present line of argument suggests that "left hemisphere functions" may be amenable to greater bilateral representation than "right hemisphere functions." However, adequate support for this hypothesis awaits future research.

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Reversible and irreversible lateralities in some animals. Based mainly on my observations on a few crustacean species, deer, molluscs, and others, the data presented here would serve as supplementary material to illustrate the theory of Corballis and Morgan that human handedness and cerebral lateralization are expressions of a general left-right maturational gradient.

Birgus latro, the coconut crab. Some aspects of the form and function of the coconut robber crab have relevance to the subject under review. This animal starts life as a larva with a bilaterally symmetric body (Reese, 1968). The young crab adopts a gastropod shell, like other pagurids, for its survival on land. As the great majority of shells available are dextrally coiled, the body of *Birgus* takes the form of the shell cavity and turns asymmetric; its left half, especially the walking legs, are conspicuously larger than those on the right half. The crab grows to an enormous size (males, which are heavier than the females, weigh up to 5kg), and when suitable shells are no longer available, it abandons shell-life. Even thereafter, the symmetry of the body is not restored. The size differences between the left and right pincers of adult *Birgus* are given in Table 1.

One of the causes for the great variation in pincer size between males and females is that in females there are three pairs of swimmerets developing on the left margin of the abdomen. These extra appendages help the females to

Table 1 (Davis). Birgus latro: *maximum girth of pincers*

Sex	No. of animals studied	Mean girth of pincers: Left	Mean girth of pincers: Right	% difference
Male	6	15.80cm	12.85cm	22.96
Female	5	13.16cm	9.90cm	32.93