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Culture and Brain Organization

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The second half of the twentieth century has seen an explosion in research developments in the area of cognitive neuropsychology. One of the sources of this explosion are the spectacular findings showing the perceptual and performance asymmetries of the disconnected hemispheres of the split-brain patients from Roger Sperry's lab, which spawned enormous interest in hemispheric specialization. Studies of the laterality patterns in the physiological substrate and the behavior of brain-damaged and healthy participants have resulted in a general picture of hemispheric abilities—that is, we have a model of a modal brain with a map of its functional architecture. The study of individual differences in brain laterality has focused on specific biological factors such as handedness and sex and has begun to delimit their effects on the organization of cognitive abilities, performance asymmetries, and morphological differences in brain structures (e.g., Clarke, Lufkin, & Zaidel, 1993; Eviatar, Hellige, & Zaidel, 1997). In this essay I would like to argue that as a complement to biological characteristics, the study of the effects of learned behaviors that constitute culture on brain organization can be crucial in delimiting the manner in which higher cognitive processes are related to brain organization. This is a somewhat Whorfian view, in which the search is for crucial dimensions of culture that interact, or co-occur with systematic differences in functional architecture of cognitive functions in the cerebral hemispheres. Language is the most promising dimension, because linguistic and psycholinguistic models allow us to talk about both similarities and differences between languages in principled ways. Focusing on language is useful because it is the faculty about which we know the most, and it enables us to better delineate the seam between organizational principles that are or are not susceptible to different learning environments and strategies.

The problem with the modal model of the functional architecture of the

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brain is that it is a description of a steady-state system which is unable to capture the complexity of the brain–behavior relationship. The consensus now is that there are some design characteristics that are universal, such as left hemisphere (LH) specialization for speech, and others that are sensitive to patterns of learned behavior. For example, it has been suggested that the morphological structure of a language does not necessarily affect the LH advantage for reading tasks, but does affect *what* it is the hemispheres are doing in the task (Eviatar, 1999). More interestingly, some preliminary data from readers of Arabic suggest that the orthography of a language can interact with the inherent division of labor between the hemispheres in reading tasks. Studies based on the English language have suggested that the right hemisphere (RH) is involved in some stages of normal reading. It may be, however, that this can only be true if the orthography is of a type that allows RH abilities to come into play.

Both the convergence and divergence of performance patterns across different populations are relevant here. For example, findings with the split-brain subjects using both visual and auditory stimuli have suggested that the RH cannot process phonological information (e.g., Zaidel, 1983). Recent findings with the Hebrew orthography, in which vowel information is represented very differently than in English, as optional diacritical marks, supports the universality of this conclusion, by showing that diacritics are processed as visual information in the LVF, and as phonological information in the RVF of normal subjects (Smolka, 1999). On the other hand, Hellige and his colleagues (e.g., Hellige & Cowin, 1996) have suggested that the LH processes pronounceable nonwords in a parallel manner, while the RH processes them sequentially, and they have shown the consistency of data patterns supporting this interpretation in a large variety of presentation conditions. Eviatar (1999) has shown that these patterns do not occur for readers of Hebrew (even when they are doing the test in English). Thus, models of hemispheric abilities that are based only on English-speakers may not account for other possible schemes of brain organization.

More urgently, given that the majority of hemispheric research is based on interpretations of performance asymmetries, it has recently been shown that attentional habits developed as a result of reading direction can affect performance asymmetries for nonlanguage tasks. Vaid and Singh (1989) and Eviatar (1997) have suggested that scanning habits due to reading direction can affect the ubiquitous left preference in the Chimeric Faces task, where participants who read from right to left do not show this preference. The left preference found among readers of left to right languages in this task has been interpreted as reflecting RH specialization for the processing of faces and emotion. Given our current level of knowledge, it is more parsimonious to infer that the lack of asymmetry in readers of right-to-left languages in this task is due to the effects of scanning habits rather than to differential lateralization of these basic abilities. However, when the data from non-

English speaking participants depart from the patterns shown by English-speakers, this suggests that the original findings and interpretations are a specific, not a general description. The finding that a cognitive habit related to language (reading scanning direction), can affect performance asymmetry for a nonlanguage task believed to be subserved by the RH, might possibly reflect large-scale interactions between cognitive habits and hemispheric asymmetry which are not covered by the general model.

These data are relevant to our view of laterality in general, as they argue against a static and modular view of brain organization. The major task of a human child is to learn to function in the culture to which it has been born. It is generally agreed that the brain-cognition program must include a model in which specific learned behaviors modify and are subserved by the physiology-function model of the brain (Trevarthen, 1990). The examples described above all deal with language, but it is possible and necessary to define other skills, faculties, and belief systems together with their concomitant cognitive strategies that vary across human cultures, and in all probability interact with inherent patterns of hemispheric specialization.

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