BRAIN THEORY AND MINIMAL BRAIN DYSFUNCTION *

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Introduction

Ever since the National Institutes of Health labeled the diffuse problems of learning disabilities in children as results of minimal brain dysfunction, a variety of research efforts have been made to explain the syndrome. To a large extent, these efforts have met with only limited success because of disagreement over whether, in fact, there is organic involvement. Even if there had been agreement on this point, however, the problem of determining the psychological dimensions of the disorder would still exist. Inattention, perceptual difficulties, impaired cognitive functioning, motor clumsiness, slow reaction time, and all the rest are commonly mentioned as aspects of the syndrome; all these problems and more surely exist.

Rather than adding data to the studies of the problem, I would like to offer another perspective from which to view it. In particular, insights on cerebral functions offered by studying the bisected brain may apply to specific problems seen in some cases of minimal brain dysfunction (MBD).

It seems fair to say that one of the clearest syndromes seen in clinical neurology results from brain bisection.[1] After observing cases with midline cerebral commissure section and studying the resulting deficits over a long period of time, one becomes convinced that the normal functioning of this information system is very important—especially during development. My own suspicion, moreover, is that when it does not function normally, it either produces or coexists with problems in the natural establishment of cerebral dominance and lateral specialization. Failure here may in turn be responsible for many of the problems seen in MBD: some aspects of MBD may reflect problems in the normal dynamics of cerebral activity, i.e., the shuttling of information between various specialized processing centers in the brain. It may well be that MBD reflects problems in this kind of neural integration more than it does neuronal disorders *per se*. Put differently, to some extent MBD may be the result of subtle software programming abnormalities that occur in the presence of poorly established cerebral dominance.

New View of Cerebral Dominance

For the following analysis, the meaning of cerebral dominance must be clear. When the term is used here, it does not mean that the hemisphere is dominant merely because it is mainly involved in language and speech process-

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ing and the like. A far more basic and important feature of cerebral dominance seems to be the function of the dominant hemisphere as the central processing site in the brain. According to this concept, if dominance is not clearly established, there is no central point through which various cognitive acts are channeled, where their relative importance is ranked and proper commands for motor responses are programmed. In other words, this theory states that there must be a final cognitive path. One can easily imagine that the lack of a central processing and control system—especially for the subtle and fragile processes of language learning and reading—would lead to great confusion, of the kind seen in MBD.

For a number of reasons, we believe that this aspect of the problem of cerebral dominance is real and crucial. It now appears that the dominant hemisphere gathers information from all over the brain for the analysis of linguistic information. For example, we have recently shown that in normal subjects, the right hemisphere is superior to the left in deciding whether words are the same or different.[2] In these quick flash perceptual tests, it was seen—much to our surprise—that word matches were carried out with greater accuracy when the information was flashed exclusively in the left visual field.

In addition to these studies of normal subjects, recent testing of global aphasic patients underlines a similar point.[3] In particular, in an ongoing project we have developed a language assessment procedure for testing the remaining natural language capacity in these patients, as well as their remaining conceptual talents. These tests are preliminary to establishing training procedures for the inculcation of an artificial language system.

The studies have been remarkably successful, but for present purposes their most interesting aspect is the clear evidence that at a very early stage in the processing of linguistic information, a judgment is made as to whether a printed group of letters is a member of a class, i.e., a word. To our surprise, these largely languageless subjects were able to sort out a deck of cards containing both words and nonwords into two appropriate piles. The subjects were subsequently examined for their semantic knowledge. Even though they had made the word/nonword distinction, they were able to demonstrate semantic knowledge of only some of the words they had distinguished. Although we cannot say with complete certainty that the right hemisphere performs this classifying activity, we are urged to suggest this conclusion as a strong probability. It must be remembered that these cases have all experienced heavy left hemisphere damage as a result of cerebral-vascular accidents.

This kind of data suggests that in language-related behaviors—in particular, reading—there may be a direct and immediate need for the transfer of information between the cerebral hemispheres. One can begin to see that if this system is not operating normally, obvious deficits would result in both acquiring and utilizing reading skills. Additionally, if there were a concomitant lack of dominance, one can imagine how a multibased decision system in one behaving organism could confuse and confound almost all behavioral sequences. Let me make this more explicit.

Following brain bisection, each hemisphere is independently capable of deciding upon a response hierarchy, of making decisions, and of carrying out an entire mental life outside the awareness of the other hemisphere.[4] Thus, in the case of brain bisection, in which the interactivities of one half-brain are not communicated to the other, we see separate decision centers at work. There is no really dominant hemisphere for decision making. Even in this state, however, we have been able over and over again to demonstrate, by using subtle measuring techniques, that the mere preparation for response emanating from one half-brain interferes with the responding of the other.[5] In some ongoing monkey experiments, we have shown that when one hemisphere is about to respond to a visual discrimination, the other, even though it is in no way involved in that response, initiates a response readiness that has the effect of interfering with the overall efficiency of the first hemisphere. A similar situation has been reported in our series of patients.[6]

Here again, we encounter a problem that may result from the poor establishment of a central processing system. In the bisected brain, consolidation of information through a central decision system is not possible. As a result, bilateral or double decisions initiate motor activities that cannot be coordinated normally. At some point, the conflicting signals (subcallosally) interfere with one another, causing slow performance.

The foregoing underlines a possible importance in establishing cerebral dominance in the sense we have described it. In the following, we will describe how such dominance can be established in the monkey. We can only infer, of course, that if similar procedures were used on children, a dominance could emerge that might alleviate some of the problems seen in some of the children suffering from MBD.

Changing Dominance by Changing Probability of Reward

Following brain bisection in the monkey, it is commonly observed that one hemisphere takes the lead and tends to control behavior.[7] If, for example, each hemisphere has fair access to a visual discrimination array, the leading hemisphere tends to learn the problem before or even instead of the other.[1] Although the dynamic forces leading to the establishment of this kind of dominance and to its maintenance are not completely understood, it has been generally maintained that hand and eye use play important and interrelated roles. Recently, we have shown that such manifested dominance can be changed by varying the possibility that a given hemisphere will receive a reward for having controlled a response. Thus, if the left hemisphere-right hand combination has dominated response, control can be switched to the right hemisphere by lowering the probability of reward. The initially preferred hemisphere will be rewarded if it responds.

Why can't a similar procedure be adapted for children? If there is one observation that occurs with any kind of frequency in the learning disability literature, it is that poor dominance is manifested. For all the reasons outlined above, this lack of dominance could be extremely costly to the child. We are thus suggesting that by manipulating dominance experimentally, clear hemisphere priority may be established with possible beneficial effects for children suffering from MBD.

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