Left Brain, Right Brain: Who's on First?

This critical review shows there's little evidence supporting the current vogue for left-brain/right-brain pop psychology and its use in training and performance improvement.

By TERENCE HINES

Research on the differences in function between the left and right sides of the human brain once was discussed only in professional medical and psychology journals. Now, neuroscience research has captured the popular imagination. References to it appear regularly in the popular press. Further, claims are made frequently that the differences between the two sides of the brain have important practical implications. This seems to be especially true in the area of training and personnel development. Several articles have appeared in this *Journal* over the past few years claiming that understanding left-brain/right-brain differences is important for people in the field of training and development. The basic thesis of these articles is that the two hemispheres of the human brain differ greatly in their mode of cognitive processing or thinking, that Western society emphasizes "left brain" modes of thought, that the left brain represses the right brain and its natural mode of thought and that, if only the right brain could be better trained to express its mode of thought, we'd all be better managers, salespersons, artists or whatever. Kaminski-da-Roza lists the different characteristics of left-brain and right-brain cognition as they are usually dichotomized in these articles.[1] The left brain is said to be "Conscious, inductive, logical, linear thinking and questions why and how." The right brain is said to be "Subconscious or even unconscious, deductive, intuitive and non-linear thinking."

All this may sound very scientific, especially when presented with the patina of modern neuroscience. However, it is an astonishingly uninformed and simplistic view of the brain. None of this left-brain/right-brain "mythology" is supported by the actual research on the differences between the left and right human cerebral hemispheres.[2] In fact, the research literature flatly contradicts most of the mythology.

Left-brain/right-brain mythology

That there are differences between the two sides of the human brain in the way they process information has been known since 1865, when Broca first described an impairment of speech (aphasia) associated with damage to a certain part of a patient's left hemisphere.[3] Research on these differences has shown them to be of a totally different character than those claimed by left-brain/right-brain mythology. The actual differences in the way that information is processed in the hemispheres are much smaller and much less dichotomized than the mythology claims.

In the 1960s and early 1970s, most researchers in this field felt that the left hemisphere was the "verbal" hemisphere and the right hemisphere was the "nonverbal" hemisphere. That is, regardless of the sensory modality used for stimulus

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presentation, the left hemisphere processed linguistic stimuli such as printed and spoken words and the right hemisphere processed non-verbal or "visual-spatial" stimuli such as unfamiliar faces, environmental sounds that could not easily be named and complicated shapes that also had no clear verbal label. Results soon appeared that showed that this dichotomy was far from absolute and not even terribly accurate. For instance, studies showed that, while the left hemisphere was somewhat better than the right on tasks involving linguistic stimuli, the right hemisphere, according to Searlman, *could* perform such tasks. It simply performed them more slowly.[4]

In a typical experiment designed to examine hemispheric differences in normal subjects, strings of letters are presented for a very brief period (usually less than 200 milliseconds) to either the left or right visual field. Because of the anatomy of the human visual system, stimuli presented in the right visual field are projected to the visual cortex of the left hemisphere and stimuli presented to the left visual field are projected to the visual cortex of the right hemisphere. In this type of experiment, the subject must decide as quickly as possible whether a given letter string is or is not a real word. The reaction time from the appearance of the letter string to the subject's response is measured. In such experiments, it is found that words presented to the right visual field (left hemisphere) are responded to more quickly than words presented to the left visual field (right hemisphere). These differences are real, theoretically important and exciting. But they are also very small. Rarely do they exceed 60 or 70 milliseconds. This same type of experiment can, of course, be done with non-verbal visual stimuli and, using the two ears rather than the two visual fields, verbal and non-verbal auditory stimuli. In all cases the results are the same—small but theoretically important differences that require rather specialized equipment to detect.

Day examined the ability of the left and right hemispheres of normal subjects to make decisions about words presented visually.[5] He found that *both* hemispheres were equally good when it came to making judgments about concrete nouns, but that the left hemisphere was better at making judgments about abstract nouns. Further, he demonstrated that the right hemisphere has the ability to "detect semantic relationships between concrete nouns and their superordinate categories". That is, the right hemisphere can correctly judge that "bread" is a "food" and that "cat" is not a "metal." This and other experiments like it demonstrate that the right hemisphere possesses a much greater ability to understand linguistic input than was previously thought or accorded to it by hemisphere mythology. What was thought to be a dichotomy of function between the hemispheres, then, turns out to be a gradient of abilities. Both hemispheres possess linguistic skills (with one major exception noted below), but the left hemisphere is superior to the right at these skills.

Little distinction

Very recent research by Sergent and Bindra suggests that, at least for visual stimuli, the verbal vs. non-verbal distinction may not be the basic one as far as hemispheric differences in information processing are concerned.[6-8] Using visual stimuli, Sergent has been able to obtain either a left *or* a right hemisphere superiority for *either* verbal (words) or non-verbal (random shapes) stimuli. She does so by varying the spatial frequency characteristics of the stimuli. It is possible, using the appropriate mathematics, to break down any pattern (visual or auditory) into a number of component sine waves of differing amplitude and/or frequency. This is called Fourier analysis.[9,10] Some patterns have an abundance of high spatial frequency sine waves when subjected to a Fourier analysis. A grating made up of thin lines spaced close together is an example. A grating of thick lines spaced rather far apart is an example of a pattern with an abundance of low spatial-frequency sine waves. Complex visual patterns, of course, are characterized by sine wave components at numerous frequencies. It turns out that the neurons in the primate visual system perform what is essentially a Fourier analysis on the pattern of light and dark falling on the retina.[11] Briefly, detail in a visual image is carried in high-frequency information in the image, while gross features such as overall outlines are carried by low-frequency information.

Sergent's work suggests strongly that the left hemisphere is superior to the right in processing high spatial-frequency information while the right hemisphere is better than the left at processing low spatial-frequency components of a stimulus. In past studies visually presented words have been heavy in high-frequency information. That is, they have been made up of small letters which, in turn, are made up of small line segments. It is the high spatial-frequency information that permits one to decide that "slip" and "ship" are different words. The left hemisphere typically is somewhat better at processing these stimuli. Decisions about non-verbal stimuli, such as random shapes, can be made on the basis of the low spatial-frequency information in these stimuli. And these stimuli usually are processed faster or more accurately by the right hemisphere. The question, then, is which dimension, the verbal/non-verbal or high spatial-frequency/low spatial-frequency dimension, is responsible for the differences in processing between the hemispheres. Sergent constructed stimuli such that low spatial-frequency information had to be used to make decisions about words and high spatial-frequency information had to be used to make decisions about unnameable random shapes.[12] She found a reversal in the usual pattern of hemispheric differences. Now words were processed better by the right and shapes better by the left hemisphere. The crucial factor in determining which hemisphere processed a stimulus was not whether the stimulus was verbal or non-verbal, but rather whether high or low spatial-frequency information had to be used in making the decison. Again, these differences are of degree, not type. No absolute dichotomy exists in the spatial-frequency domain either: the right hemisphere *can* process high spatial-frequency information (it just takes longer to do so) and the left hemisphere can process low spatial-frequency information. The time differences in processing speed here, too, are measured in milliseconds. This is certainly a long way from the vague and nebulous assertions of the hemisphere mythologizers.

One skill, though, appears to be represented very strongly in the left hemisphere and very weakly, if at all, in the right hemisphere of most individuals. This is the ability to control the vocal musculature: speech. The finding that speech control is strongly lateralized to the left hemisphere is as close to an absolute dichotomy of function between the hemispheres as one will find in the literature. Yet, it offers no support to left-brain/right-brain mythology. The dichotomy here is a motoric one and similar lateralization of control of vocalization is probably due to evolutionary pressures for unilateral control of the highly precise motor acts found in human and avian vocalization requiring precise temporal control for fluent production.[13,14]

There are many ways to study differences between the two sides of the brain in normal human subjects. All involve at least fairly complex equipment and statistical analysis of data.[15] The hemisphere mythologizers claim that there are simple and effective methods for determining whether a given individual is "left brained" or "right brained." These claims are false.

One popular measure of whether an individual is left or right brained has been the predominant direction of his or her lateral eye movements. The claim here is that the left brain controls eye movements to the right and the right brain controls eye movements to the left. Thus, if an individual shows a preponderance of, say, rightward eye movements during some task, that person is left brained. A thorough review of this area of research concluded that lateral eye movements (LEMs) had nothing to do with hemispheric dominance. Specifically, "variables that ought to correlate with LEM patterns if the latter are indicators of hemisphericity tend not to, and variables that do correlate with LEM patterns are only tangentially related to hemispheric asymmetry."[16] Beaumont, Young and McManus have examined the studies of lateral eye movements that have appeared since Ehrlichman and Weinberger's paper and have found no new evidence to support a link between lateral eye movements and hemisphericity.[17,18]

Reliable or valid?

Various questionnaires also assess individual differences in hemisphericity. The authors of these questionnaires have consistently failed to provide evidence that they are either reliable and/or valid. Briefly, reliability refers to the degree to which a test will give the same result when given to the same individual at different times. Validity refers to the degree to which a test really measures what it claims to measure. A test or questionnaire must be both reliable and valid to be useful.[19]

One popular questionnaire used to assess hemisphericity appears to be reliable but gives no evidence to show that it measures anything at all related to hemispheric differences. It is not enough to *assume* creativity is a right-hemisphere function and then claim that the test is a measure of right-hemisphere function because it correlates with other measures of creativity. Nowhere is any direct link between scores on the questionnaire and right-hemisphere function presented or demonstrated. In fact, as noted above, even the idea that creativity is a right-hemisphere function is inconsistent with what is known about the real nature of hemispheric differences.

Another test claims to determine dominance partly through preferences for words and/or shapes but no published data exist to support claims that such preferences actually are related, in any way, to brain dominance.

The idea of "brain dominance" or "hemisphericity" grew out of a simplistic view of hemispheric differences. If functional differences between the hemispheres did exist, it might be reasonable to look for tests of individual differences in brain dominance and the like. However, given the actual nature of functional hemispheric differences, such a search is almost certainly futile. Concluding their extensive review of the concept of hemisphericity, Beaumont, Young and McManus state:

> On the basis of the review presented, it would seem prudent to abandon the notion of hemisphericity, at least in so far *[sic]* as it claims to make any reference to the lateral function of the cerebral hemispheres. Such a claim cannot be supported by current scientific studies of the cognitive functions of the cerebral hemispheres, and it is most unlikely that more thorough understanding of the relation between cognitive function and cerebral structural systems will lead to any changes in this state of affairs.

The real research findings on hemispheric differences have shown, in sharp contrast to the claims of left-brain/right-brain mythology, that differences in function between the hemispheres, while very real and extremely interesting are, with the exception of vocal control, rather small and matters of degree. There is no evidence to support the claims that, for example, the left hemisphere is "logical" and the right "intuitive" or that the left hemisphere is "conscious" while the right is "unconscious." Harnad and Steklis have pointed out that such simplistic dichotomies bear "about as much relation to the known facts about hemisphere functioning as astrology does to astronomy."[21] In view of this, attempts to improve performance and training by relying on nonexistent left-brain/right-brain differences are unlikely to be productive.

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