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ABSTRACT

Research has suggested that the two hemispheres of the brain serve specialized functions, with the most recent studies portraying the left hemisphere as processing information in a linear, serial, or sequential manner and the right hemisphere as processing information in a holistic, concrete, or visual mode. Although few systematic studies have attempted to integrate cognitive and neurological points of view, Paivio's (1971) portrayal of two distinct, yet interactive memory systems may be consistent with established hemispheric differences in functioning found in the human brain. Research examining the learning of individual words supports this dual processing theory. To extend this research, the degree to which the concreteness of prose materials would interact with a learner's hemispheric processing was investigated in 96 normal adult learners. Subjects were assigned to a control, imagery instructed, or hemispheric interference condition and were auditorily presented an abstract and a concrete expository passage. A second study examined this bimodal/dual processing integration with normals and with neurologically impaired learners. Results from these two studies suggest that while both hemispheres were efficient at learning concrete verbal material, the left hemisphere was better at processing abstract verbal information. These results can be interpreted as favoring a dual processing theory which operates along hemispheric lines. It can be further hypothesized that difficulties in the recall of text information may relate in part to difficulties in the integration of visual and verbal coding strategies. (Author/NRB)

Implications of Neuropsychological Research for School Psychology[a]

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Running Head: NEUROPSYCHOLOGICAL RESEARCH

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Abstract

Implications of Neuropsychological Research

for School Psychology

The implications of an integration between cognitive and neuropsychological theories of information processing were examined. The two distinct, yet interactive memory systems portrayed by Pavio (1971) were thought to be consistent with established hemispheric differences in functioning found in the human brain. Data supporting such a cognitive/neuropsychological approach to learning illustrated this process. The results were interpreted as favoring a dual processing theory which operates along hemispheric lines. Specifically, the results suggested that while both hemispheres were effecient at learning concrete verbal material, the left hemisphere was better at processing abstract-verbal information. Similar hemispheric differences were found for both individual words and prose passages. Importantly, it would seem that individual differences in cortical specialization interact with the abstractness of text materials. Thus, for individuals with more mixed patterns of specialization, the visual encoding system seems to offer a less potent representative mode of learning. With this in mind, it was hypothesized that difficulties in the recall of text information may relate inpart to difficulties in the integration of visual and verbal coding strategies. The results of these investigations have obvious implications for both school psychologists and educators.

Cognitive-Neuropsychological Aspects of School Learning

During the past 20 years, cognitive psychologists and neuroscientists have begun to examine the storage and retrieval of information in long-term memory. However, few systematic studies have attempted to integrate cognitive and neurological points of view. With this in mind, the purpose of the following paper was to examine the theoretical similarities between cognitive and neuropsychological positions in the processing and learning from prose. In support of a cognitive/neuropsychological approach to reading and learning recent data from our laboratory will be offered to illustrate the process.

Recent research suggests that the two hemispheres of the brain serve specialized functions. This Bimodal Theory of processing has historical roots in the study of diseased brains during the nineteenth century. Moreover, based on his clinical observations of brain-injured patients, Jackson (1874) proposed that two different, yet coexisting, modes of cognitive processing exist and follow hemispheric lines of the brain. These conclusions were congruent with Broca's (1865) earlier observations that control of many aspects of speech and language were localized in the left hemisphere of the brain. Although localization of functions to very small areas of the brain has been rejected by most neuroscientists, broad organizational principles and notions of hemispheric differences in functions have gained respectability during the last 30 years (Dean, 1978).

On the basis of investigations of patients who had undergone surgery which severed the major nerve connections between hemispheres, Sperry, Gazzaniga, and Bogen (1969) concluded that complex, linguistic functions are served by the left hemisphere of the brain, while the right cerebral hemisphere corresponds more closely to visual-spatial reality. Consistent with Reitan's (1955) work with brain damaged patients, it is generally agreed that the left hemisphere is superior for speech, language, and calculation. It seems, then, that verbal information is more efficiently processed by the left hemisphere. In contrast, the right hemisphere of the brain seems better able to process visual-spatial transformations and analyze complex visual patterns. Some problems with these early conclusions (Reitan, 1955, etc.) occurs when applyed to the functioning of normal individuals. This is true because samples with known cortical lesions may function quite differently from normal subjects.

More recent attempts to refine the Bimodal Theory of cerebral processing have involved investigations employing non invasive methods with subjects without neurological difficulties. From some twenty-five years of extensive study it can be concluded that while a good deal of communication occurs between hemispheres of the brain, each cerebral hemisphere selectively serves independent cognitive functions. Indeed some 1,000 investigations have been reported since the early 1960's (Dean,1984). Present

empirically based refinements of the Bimodal Theory originally articulated by Jackson (1874) and Broca (1865) allow one to conclude that the observed hemispheric differences may be more heuristically considered as differences in cognitive processing than specialization for specific types of stimuli (i.e., verbal/non-verbal).

In sum, the left cerebral hemisphere may be portrayed as processing information in a linear (analytical), serial (temporal), or sequential (logical) manner, and as such language is an excellent strategy in these processes. Clearly, the bulk of the data indicate a holistic, concrete (visual) or simultaneous mode for cognitive operations of the right hemisphere. Thus, this side of the brain seems more suitable for the processing of spatial relations presented visually. Apparently, individuals have some control over the mode of processing (i.e., left or right hemisphere) that will be utilized. Moreover, Levy (1969) and Dean and Hua (1982) have offered data portraying hemispheric specialization as an active-constructive process in which information storage is dependent on consraints of attention and individual differences in the brain functions. Similarily, Das (1973) and Deifman (1973) have suggested that differences in hemispheric processes are complimentary and coexisting modes. That is to say, that the learner may use strategies which cause either the right or left hemisphere to process the same bit of information.

It should be emphasized that the majority of research in this area has focused on normal right handed individuals. In this regard, attempts have long been made to explain a number of language disorders for otherwise normal individuals in terms of failure to establish complete specialization of the hemispheres of the brain. Related to this notion, Luria (1966) argued that specialization of hemispheres may not only vary from individual to individual, but more importantly to the present discussion, for the individual as a function of the specific cognitive system under investigation.

The neuropsychological principles presented thus far hold distinct similarity to Paivio's (1969, 1971) dual coding theory of memory. Arguing from a cognitive perspective, Paivio offers data in favor of two distinct, yet interactive memory systems. These two qualitatively distinct systems are argued to be interconnected information processing modes. An imaginal mode is portrayed as specialized for the processing and representation of non-verbal material in a direct analog fashion. Essentially a more primative system, the most idiosyncratic expression of its function has been conceptualized as imagery (Dean & Kulhavy, 1981). A second system, or verbal mode, is hypothesized as representing, processing, and storing information abstractly in a sequentially arranged array with the aid of languge.

Evidence for such a dual coding notion comes from studies which indicate that visually presented material may be stored accoustically (Conrad, 1964), and verbally presented material may be represented as visual images (Paivio, 1971). Interestingly, learners store verbal information in memory on the basis of its verbal-abstract meaning as well as visual features regardless of the form (auditory or visual) of the original stimulus. Indeed, it seems that the learner's frame of reference is important in that both expectancy (e.g., Frost, 1972) and learning instructions (e.g., Paivio, 1971) influence the strategy (left vs. right hemisphere) used in learning.

In accord with this dual coding hypothesis, abstract material should be processed and stored in terms of verbal or semantic strategies. This mode of processing prevails because abstract materials do not have a readily available visual component and thus a low potential for the subject to generate an image (e.g., the word justice). As would be summarized by the foregoing, concrete information (e.g., the word dog) because of its potential for imagery could readily be coded and remembered in terms of either a visual or verbal mechanism or both. Indeed, one would expect, and several investigators have found, a greater recall of concrete material which would be interpreted and stored in both interconnected modes (Dean, Gray, & Yekovich, under review; Paivio, 1971; Rohwer & Ammons, 1971). Consistent with Paivio's hypothesis, concrete information should be

more easily remembered because it would be encoded or stored in both imaginal and verbal systems. In an attempt to examine the neuropsychological underpinnings of this dual coding modal, Sherman, Kulhavy, and Burns (1976) auditorilly presented learners with abstract and concrete word lists under various conditions meant to cause interference in the processing of either the right or left hemisphere. The data from a series of two experiments suggested that both hemispheres were efficient at learning concrete verbal material while, the left hemisphere was better at processing abstract-verbal information. More recently, Mc Farland, McFarland, Bain, and Ashton (1978) showed a left hemispheric advantage for abstract words. This was in contrast to concrete words in which it was shown that both left (verbally) and right (image) hemispheres stored this information. Seamon and Gazzaniga (1973) using visually presented stimuli have offered further support for the dual coding argument which followed hemispheric lines. They argue in favor of imagery as part of the visual processing system of the right hemisphere. In sum, the majority of the reported research supports a dual processing theory which operates along hemispheric lines. However, it should be noted that in each of these reported studies the information to be learned was individual words. Although one may hypothesize that similar hemispheric differences should occur concomitant with the concreteness of prose materials, little published evidence relates to such a hypothesis.

In an effort to examine the value of an integrated bimodal/dual processing theory, we recently investigated the degree to which the concreteness of prose materials would interact with learner's hemispheric processing. In this study, 96 normal adult learners were assigned to a control, imagery instructed, or hemispheric interference condition. Learners in each of six groups were auditorily presented an abstract and a concrete expository passage. Subjects in the imagerial treatment condition were asked to form relational images of the passages presented. In the interference conditions, on the other hand, learners were asked to track a rather complex maze task while listening to the passage which interfered with right hemispheric processing. Control subjects were asked simply to listen to the passage and try to remember it. As predicted , across conditions, subjects recalled a significantly greater number of ideas when the passage was concrete. This would be true if concrete information was stored via both hemispheres and thus, each processing mode. Interestingly, the abstractness of the passage was found to interact with subjects' inferred processing mode. It was found that right-hemispheric interference decreased concrete recall but had little effect on more abstract material. Clearly, these results favor a dual coding strategy which opperates consistent with hemispheric specialization lines. Apparently, visual encoding offers a less efficient mode of processing abstract

connected discourse than when the information in the passage was more concrete.

Subsequent to this experiment, we have attempted to examine this bimodal/dual processing integration with normals and neurologically impaired learners. In general, as would be predicted with an integration of the bimodal and dual processing notions, the recall of concrete prose for patients with right hemispheric damage (post-central lesions established with CAT Scan) is generally less facilitated by imagery instructions than normals or left hemispherically impaired patients. Thus, showing the right hemisphere's role in the processing of prose material in an imaginal fashion. Similar to those data reported by Bower (1970), for individual words, right hemispheric damage (in the area of the temporal lobe) reduces the facilitative effects for imagery in prose learning. Although this seems to be the case, such right hemispheric lesions had little significant effect on abstract prose. This outcome would be expected if concrete prose involves dual hemispheric encoding and more abstract materials are processed by the left hemisphere. Learners who fail to show significant facilitation of recall with imagery instructions showed more of a difficulty in the integration of visual-verbal information than a right-hemispheric deficit in isolation.

In summary, the results of these investigations and those conducted in other laboritories support a dual coding theory which follows hemispheric lines of the brain.

Apparently, concrete prose material may be stored in verbal or semantic terms simultaneously with a visual representation. Moreover, neither visual interference nor right hemispheric lesions affect learner's long term recall of abstract text materials. This outcome would seem logical if the left hemisphere is specialized for sequential abstract material. Additionally, individual differences in cortical specialization seem to interact with the abstractness of text materials. Thus, for individuals with more mixed patterns of handedness, imagery and the visual encoding system seem to offer a less potent representative mode of learning. It may be hypothesized that difficulties in the recall of text information may relate inpart to difficulties in the integration of visual and verbal coding strategies.

References

Bower, G. H. (1970). Analysis of a mnemonic device. American Scientist, 58, 496-510.

Broca, P. (1865). Remarks on the seat of the faculty of articulate language, followed by an observation of aphemia. In G. von Bonin (tr.). Some papers on the cerebral cortex, Springfield: Thomas.

Conrad, R. (1964). Acoustic confusions in immediate memory. British Journal of Psychology, 55, 75-83.

Das, J. P. (1973). Structure of cognitive abilities: Evidence for simultaneous and successive processing. Journal of Educational Psychology, 65, 103-108.

Dean, R. S. (1978). Cerebral lateralization and reading comprehension. Neuropsychologia, 16, 633-636.

Dean, R. S. (1984). Functional lateralization of the brain. The Journal of Special Education, 18, 239-256.

Dean, R. S., Gray, J. W., & Yekovich, F. R. (Under review). Journal of Experimental Psychology: Human learning and memory.

Dean, R. S., & Hua, M.S. (1982). Laterality effects in cued auditory asymmetries. Neuropsychologia, 20, 685-690.

Dean, R.S. & Kulhavy, R. W. (1981). Influence of spatial organization in prose learning. Journal of Educational Psychology, 73, 57-64.

Frost, N. (1972). Encoding and retrieval in visual memory tasks. Journal of Experimental Psychology, 95, 317-326.

Jackson, J. H. (1932). On the duality of the brain. Medical Press, 1:19. Reprinted in J. Taylor (Ed.), Selected writings of John Hughlings Jackson (Vol.II). London: Hodder and Stoughton.

Levy, J. (1969). Possible basis for the evolution of lateral specialization of the human brain. Nature, 224, 614-615.

Luria, A. R. (1966). Higher cortical functions in man. New York: Basic Books.

McFarland, K., McFarland, M. L., Bain, J. D., & Ashton, R. (1978). Ear differences of abstract and concrete word recognition. Neuropsychologia, 16, 555-561.

Paivio, A. (1969). Mental imagery in associative learning and thought, Psychological Review, 76, 214-263.

Paivio, A. (1971). Imagery and Verbal Processes. New York: Holt, Rinehart, and Winston.

Reitan, R. M. (1955). An investigation of the validity of Halstead's measures of biological intelligence. Archives of Neurology and Psychiatry, 73, 28-35.

Rolwer, W. D., & Ammons, M. S. (1971). Education training and paired-associated learning efficiency in children. Journal of Educational Psychology, 62, 376-383.

Seamon, J. G., & Gazzaniga, M. D. (1973). Coding strategies and cerebral laterality effects. Cognitive Psychology, 5, 249-256.

Sherman, J. L., Kulhavy, R.W., & Burns, K. (1976). Hemispheric laterality and verbal processes. Journal of Experimental Psychology, 86, 241-246.

Sperry, R. W., Gazzaniga, M. S., & Bogen, J. H. (1969). Interhemispheric relationships: The neocortical commissures: syndromes of hemisphere disconnection. In P. Vinken & G. W. Bruyn's (Eds.), Handbook of Clinical Neurology (Vol.4). New York: Wiley.