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Cerebral dominance and its implications for education: A look at hemisphericity

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Cerebral Dominance and Its Implications for Education: A Look at Hemisphericity

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Introduction

The teacher of tomorrow may come to be regarded as a "neuroeducator." After decades of study on teaching styles, student-teacher interaction, and countless other aspects in the educational process, we only now are beginning to discover the bases of "good teaching." In the past, theories of learning have been based primarily on behavioral observation. Not until recently have educators considered the role of the brain in learning.

In an attempt to better understand the implications of neuroscience research, specifically as it relates to the function of the left and right hemispheres of the forebrain, this paper will discuss the functioning of the brain as applied to learning, consider some research in the area of cerebral functioning, and draw conclusions as to the impact of cerebral dominance upon education. The paper will close with implications for consideration by educators when developing curriculum.

An Overview of Research

There has been an awareness of the functional differences associated with the two hemispheres of the human brain since 1865 when Broca first described aphasia associated with damage to the left hemisphere of a patient's brain (Hines, 1985). Luria (1976) noted and described three brain functions or systems as (a) the hindbrain or attentional system, which functions as the monitor of stimuli; (b) the midbrain or sensory system, which deals with stimuli on an emotional level; and (c) the forebrain, which surrounds the two earlier brains and is responsible for thought and language. This forebrain is divided into two hemispheres which are connected by the corpus callosum, an intricate network of nerves which serves as a passageway between the two hemispheres. These hemispheres have been labeled the left and right brain because of their location. Though the two hemispheres appear to be equal in mass and similar in function, autopsies on patients who had lost their power of speech determined that the left hemisphere was primarily responsible for language activities.

In the 1960s neurosurgeons began performing surgery (commissurotomies) which severed the corpus collosum. This surgery was performed on epileptic patients with advanced, life threatening convulsions. Following surgery the seizures stopped and the patients' behavioral patterns appeared normal. Dr. Roger Sperry (Levy & Sperry, 1968) followed the case histories of these patients and examined the activities of the independent halves of their brains and found that (a) the left hemisphere sequentially processes and analyzes incoming information; (b) though the operation disconnected the patient's right hemisphere from the centers in the left that control speech, over time the right hemisphere assumed some speech responsibilities; (c) information was transmitted from one hemisphere to the other; and (d) the right hemisphere could understand concrete language such as nouns.

Each hemisphere performs entirely different mental operations on imput. Gazzaniga (1968), following up on the research of Sperry and Levy, found that in surgically separated hemispheres each hemisphere had its own sensation, perception, thoughts and ideas. Further, one hemisphere influences the other when the connection between them remains intact.

Our Western culture holds high regard for language, and as a result it was long held that the right hemisphere was a lower order brain and that the left hemisphere was a superior and dominant brain (Webb, 1983). This idea has been refuted by the knowledge that each hemisphere has immense but different capabilities (Stevens, 1971). The right brain is primarily involved with spatial tasks while the left brain deals with verbal and language tasks (Ornstein, 1978).

While treating epileptic patients with electrical stimulation and anesthetization of one half of the forebrain, researchers found that there was a lateralization of speech in the left hemisphere and a lateralization of nonverbal activities in the right hemisphere for most right handed persons. For the left handed population, the picture was unclear (Springer & Deutsch, 1981).

Levy (1979) developed a way of conceptualizing hemispheric skills. She organized the skills by the manner in which the information was processed and concluded that the left brain is analytic--finding patterns in words, discovering attributes in groups, putting parts into wholes, and using language to express what is understood. By contrast, she concluded that the right hemisphere is holistic in its approach to reasoning, deducing from the whole how things are assembled. She found that each of the hemispheres reasons, but by different strategies (Levy, 1979).

Research has given attention to the right brain/left brain specialization, particularily the relationship of handedness to hemispheric asymmetry. It was found that those who write using either the typical right-hand writing style or hooked left-handed writing style (used by over 60% of left-handed writers) have primary language housed in the left brain. People who write using the typical left-hand writing styles and hooked right-hand writing styles have primary language housed in the right hemisphere of the brain (Wonder & Donovan, 1984).

Ornstein (1978) also found that right brain functioning predominates in only 20% of the population and that people who favor one hemisphere over the other process data in that hemisphere regardless of the nature of the task being performed.

Several studies conducted by other neuroscientists have supported the data developed by Levy. Using dichotic listening, Kimura (1967) discovered the right ear (left hemisphere) was generally superior for verbal material and the left ear (right hemisphere) for melodies and environmental sounds. In studying eye preference and its relationship to the opposite brain Erlichman and Weinberger

(1978) found left eye preference (right hemisphere) for numbers, depth perception, line shapes, and facial recognition, while the right eye (left hemisphere) appeared superior for visual materials. Using cyclic electric impulses which map brain activity, researchers found that the left brain favors speech and reading and that the right brain favors music and geometric figures. "Both brains together pair visual-verbal association...and dyslexia involves both hemispheres at rest" (Webb, 1983, p. 515).

As a result of neurological research, considerable interest shifted to the implications these findings held for education and brain compatible instruction. Mawn (1985) followed up on research begun by Epstein (1978) and posited a parallel between Piagetian theory and brain research. She asserted that brain growth spurts and hemispheric specialization may explain why some students do not have the mental capacity to perform left brain activities. She also contended that this is compounded by brain incompatible instruction.

In discussions centered on the "back to basics" movement, Elliot (1980) pointed out that this trend was counter to research on hemispheric specialization and urged the use of brain compatible instructional methods. Likewise, Kitzen (1983) suggested that many learning disabilities in math could be traced to children being forced into left brain tasks too early. Lord (1984) noted that academic success is often influenced by the student's ability to use both hemispheres, and he contended that most instruction is directed to the left hemisphere only. In the same vein, Young (1978) and Woelfl (1984) both asserted that the use to which the young brain is put influences later development of the brain.

Brain hemisphere preference has also been linked to genetic, cultural, and environmental influences. Testosterone plays an important role in brain development, and as a result males are more likely to be right dominant than females. Maturation rate also is a key; late maturing individuals are more likely to develop a laterality imbalance than early maturing individuals (Leong, 1980). It has also been found that parents can influence brain development by altering the stimuli in an infant's environment via toys, conversation, and activity levels.

Culture has an impact on the development of lateral dominance. As an example, the Japanese have two writing systems, one phonetic and the other pictorial. If the pictorial system is selected by the student, then language is experienced in the right brain (Wonder & Donovan, 1985).

A research investigation supported by ESEA Title IV C in Glendora, California with elementary age children, led to the development of one of the first tests to study the educational implications of hemisphericity. Though the results were mainly geared to the testing procedure, it was noted that "the methods of instruction employed do have an impact on the learning of young children" (Dumbrower, Favero, Michael, & Cooper, 1981, p.119).

Conclusions from Research

The research suggests the following general conclusions concerning the functioning of the human brain:

1. The two hemispheres of the forebrain have differing functions and neither brain is more able than the other.

2. The left hemisphere is superior in language. It operates in a sequential, symbolic, analytic, and logical manner. The right hemisphere is superior in visual-spatial and nonverbal functioning along with holistic reasoning.

3. The right hemisphere performs some concrete language tasks, and the left hemisphere performs some concrete visual-spatial tasks. There is no convincing evidence for absolute control of any complex psychological process by either hemisphere. It appears there may be

relative, rather than absolute, contributions from the two hemispheres.

4. There is a need for both hemispheres to function in concert, tapping the strengths of both hemispheres so that the brain may operate at the optimal level.

5. The development of both hemispheres of the brain can be enhanced through activities and programs developed by knowledgeable parents and teachers.

Research has caused a move from the nineteenth century concept of equal hemispheric functioning to a twentieth century concept of left/right brain functioning (Webb, 1983). A model now exists that posits a division of labor for each hemisphere and cooperation between the hemispheres for optimal functioning. Levy (1979) stated that the "human cerebral hemispheres exist in a symbiotic relationship. Each side finds certain tasks difficult or distasteful or both. The right brain for all its competencies lacks a phonological analyzer while the left brain for all its abilities lacks a Gestalt synthesizer" (p. 222).

Implications for Educators

Educators can not be party to an educational system that develops only half of the brain and therefore are obligated to consider cerebral lateralization in their daily planning and working with students. Levy (1983) emphasized that brain research to date "is only the initial step...yet knowing the goal, perhaps it will be possible for teachers with sensitivity to find a way long before scientists can supply specific recommendations" (p. 71).

To clarify the findings of research, it is important to note the functions of the two hemispheres and the academic specialization of each hemisphere. Some of the academic specializations of the left hemisphere include handwriting, understanding symbols, reading, phonics, locating details and facts, following directions, listening to language, and auditory association (Wonder & Donovan, 1985).

The right hemisphere is believed to be responsible for intuitive, holistic, non-judgmental thinking, which leads to expanded consciousness, increased awareness, divergent thinking and feeling, creative perception, and synthesis of experiences. Some of the academic specialization skills associated with the right hemisphere are haptic awareness, spatial relationships, shapes and patterns, mathematical computations, color sensitivity, singing and music, art expression, creativity, visualization, feelings, and emotions (Wonder & Donovan, 1985).

The research suggests the following implications for educators to consider:

1. When teachers deliver input to learners, the functions of the midbrain and the hindbrain must be taken into account (Luria, 1976). Educators must be able to gain the attention of the students in order for learning to take place, a hindbrain function. Likewise, the emotions of the student must be recognized as a critical aspect of effective learning. Emotions are controlled in the midbrain area.

2. There is strong evidence that there are individual differences among learners, to the extent that one hemisphere is more differentially aroused than the other (Stevens, 1971). These findings suggest that the student's individual learning styles should be recognized and that necessary adjustments be made so that the subject matter may be taught through methods that accommodate the varying styles of learning present in the classroom.

3. Simple, repetitive, dull tasks result in low levels of bilateral brain activation. In contrast, complex,

differentiated, interesting tasks result in increased activation of both sides of the brain (Oklahoma State Department of Education, 1983). Teachers should, therefore, augment the stimulus to the other hemisphere whenever students are not understanding the concepts or are bored with an approach. Practices that increase facility in the independent and joint use of each hemisphere of the brain should be adopted (Hunter, 1978).

4. Students need intense mental exercise to build up the total brain. They need teacher encouragement to create a solution to problems that have no one correct answer (Johnson, 1985).

5. Piagetian theory should be taken into account. It should be recognized that brain growth spurts and hemispheric development may have an impact on the student's comprehension and readiness for learning tasks. Modifications should be made as necessary so that the teacher may present brain compatible instruction (Mawn, 1985). Also, hands-on experiential learning should be provided during the concrete operational years of elementary and junior high school for most efficient learning (Johnson, 1985).

6. Activities should be aimed at both hemispheres of the brain with particular attention given to right brain

activities to compensate for traditional left brain biased teaching techniques (Lord, 1984). Effort should be taken by teachers to include many visual activities including the use of the chalkboard, pictures, charts, maps, artifacts, and realia. The effort should be away from using left brained language imput alone.

7. Labeling students as "right brained" or "left brained" is inappropriate and there is not a necessity to test children to determine their preference. Thinking, particularily creative and higher level thinking, involves the integration of both hemispheres of the brain (Shelby, 1985).

8. An effort is necessary to design programs for right brained learners. With proper curriculum planning and programming, many school failures may be averted. Teaching activities need to capitalize on both hemispheres' strengths. As an example, learning activities could be introduced visually and then translated to language to accommodate both left and right brained learners (Lord, 1984). This could be accomplished through the making of charts, maps, and graphs. Field trips, guest speakers, and other "hands on" experiences should be an important part of the curriculum. This allows for students to actually see how concepts fit into the real world.

9. Much curriculum development needs to be geared to student talking (Webb, 1983). Talking enhances learning for both the left and right brain preference learner and is particularily important for the right brain learner. Creative dramatics and other theatrical endeavors are also important. These activities allow not only for verbal experiences but also allow for emotional expression (Vitale, 1982).

10. Educators should realize that learners who use both brains cooperatively fare best academically and socially; the greater the differential between the left and the right brain functioning, the greater the emotional dissonance in the learner (Webb, 1983).

11. The left brain learner should not be forgotten. Since left brain learners do very well academically, there may be a tendency to ignore their need for right brain development. For example, as society moves further into the age of computers and computer graphics, left brain thinkers may come up deficient in visual-spatial skills so necessary in computer utilization. Left brain thinkers should be encouraged to draw, follow maps, and in general develop the right hemisphere of the brain (Johnson, 1985).

12. A concerted effort is necessary to cause test makers to revamp the measurement of student intellectual

abilities. Intelligence and basic skills tests rely almost exclusively on the measurement of left hemispheric functions. The tendency is to give more emphasis to the memorization of verbal facts and to ignore the more subtle and less easily tested effects of right brain knowledge. Little regard is given to the correlation of intelligence scores with the solving of insight problems, a right hemispheric function (Johnson, 1985).

13. Teachers and parents of young children must realize the importance of their role in developing the total brain, for the use to which the young brain is put influences its later development (Lord, 1984).

14. Educators should follow the path of researchers, translating research findings into practice as soon as possible (Webb, 1983).

Conclusion

It appears that there is a need for widely diverse curricula and teaching methods. It is not necessary to know exactly what processing mode is being utilized for each bit of information or presentation as long as it is clear that both hemispheres are being encouraged and accepted (Brooks, 1980).

Rennels (1987) suggested that since 80% of the students prefer to process through the left hemisphere of the brain, the schools may have adapted to teaching predominantly to this hemisphere. He further recommended that children be given more experiences which would assist them in developing visualization, imagination, and/or sensory-perceptual abilities so that they may obtain a richer, fuller life through greater emphasis on right brain functioning.

Educators have a great responsibility. Only when they are aware and knowledgeable can they react to the needs of the learners in their charge. Although the human brain is complex, the basic knowledge to be assimilated for use by educators is relatively simple. Educators should resist being lulled into traditional teaching methods which reach only the left hemisphere language center. They should resist relying on traditional inputs of reading and listening with their expected outputs of discussion and writing. Rather, educators should use methods which challenge the right brain by offering inputs of observation, inspection, and imaging which call for outputs of demonstration, construction, and role playing. The educator's goal should be to have both hemispheres of the brain work as a team for most effective learning. Webb

(1983) offered an analogy for understanding this necessary interrelationship between the hemispheres. She stated,

> As a pair of horses hauls a wagon, so both our brains work to help us understand and get control of our worlds. In the case of the horse-drawn wagon, the wagon tips if one horse leaps ahead of the other. In like fashion, if one brain, as a poor team member, attempts to perform alone, the learner is put out of balance and becomes uncomfortable, irritable, and ineffective (p. 515).

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Appendix

To assist educators in developing curriculum that incorporates right brain activities with left brain activities the following suggestions are offered. The suggestions are meant to stimulate further development on the part of the reader.

1. When teaching language arts, all materials should be presented as a whole and as parts of a whole. Less material should be covered allowing students to approach the concepts using as many modalities as possible. Students should be allowed to explore new processes and ideas and to play with ideas. Reading and writing activities should be extended to include informal conversation, rhythmic and physical interpretations, and creative dramatics activities. New associations between ideas should be encouraged and their expression rewarded. Literature rather than basal readers should be the choice of materials for all language arts activities (McLendon, 1983).

2. At the preschool and elementary level, activities to develop letter and word recognition should associate general size and position of the letters with the letters themselves. Other activities at this level should include

songs, jingles, coloring, poetry, fables, proverbs, shaping, sequencing, and acting. All these activities develop hemispheric integration (Dumbrower, Favero, Michael & Cooper, 1981).

3. In science, during the concrete operational years of elementary and junior high school, "hands on" experiential learning is the best way to learn efficiently (Johnson, 1982). Several "hands on" text approaches to science are available. In the near future, The National Science Foundation will have available the latest recommended formats. In the meantime, curriculum developers might look at the programs receiving National Science Foundation support such as SAPA, SCIS, ESS, USMES, and Minnemast materials for concept development with a hands on approach.

4. In reading new material, "interactive reading" has been used to cause the activation of both hemispheres. This approach requires students to relate their concepts, knowledge and experiences to print and to practice language arts skills while creating an individual and personal picture book to share with classmates (Gemake, 1984). Following the reading of a passage, the students make a picture of, and write in their own words, their

interpretation of the printed matter. This follows a verbal exchange of ideas with a partner.

5. In mathematics with the preschool and elementary child, "hands on" activities that are many and varied should be included in the curriculum. This may include division with egg cartons, designing with coins, identifying shapes, creating flip books, developing time concepts around daily events such as lunch time, and teaching of fractions with food such as Hershey bars (Glendora Unified School District, 1982).

6. In all areas of the curriculum attention should be placed on imaging and haptic awareness. This differs from gross motor activity in that it involves the visualization of the environment or the symbol involved in order to accomplish the task (Vitale, 1982). Science and social studies areas of the curriculum lend themselves readily for such activities. An example of a haptic awareness, imaging activity for lower elementary children during a plant unit in science serves as an example. The purpose of this lesson is to have the children mentally image that they are going through the life cycle of a tree.

Procedure: After allowing time for each child to find an area where they have adequate body space to spread their arms, they will be taught a magic key word. Whenever they hear that word, they will stop what they are doing and freeze. The teacher then relates a story that they act out.

Story: Imagine you are an acorn hanging from a giant oak tree. The wind is blowing a bit briskly and your fragile stem breaks and you fall to the ground. A friendly squirrel spots you and grabs you and takes you to a secret hiding place where he buries you for his dinner later during the winter. He is a forgetful squirrel and one warm spring day, a funny thing happens. After a rainstorm, you feel a strange stirring. Your seed coat cracks open and you begin to send down a root to collect water from the soil. You begin to sprout a stem with tiny leaves. You break through the dirt the squirrel has placed on you and you discover you can feel sunshine. (This would continue with the tree growing over a period of years, experiencing the change of seasons, adverse weather conditions, children swinging on your limbs, and then being cut down to make way for a new highway.)

7. Use jig saw puzzles with all students. This activity allows the left brain to rest and provides learning experiences for the right brain (Gebers, 1985).

Puzzles may complement a story from literature, a period of time being studied in social studies, a topic from science, or any of several other learnings. Jig saw puzzles are not only fun, they are also a welcome relief from the usual worksheet.

8. Creative dramatics is a vital component at all grade levels when developing the right brain. Impromptu dramatizations of stories in texts or concepts in academic areas cause all the children to get a clearer idea of what words and concepts mean (Shelby, 1985). An example of the use of dramatics to develop a concept would be acting out a slave auction where the roles of the drama would be assigned and reactions and emotions shared by participants after the experience. Another example would be acting out story problems in math class or illustrating mathematics concepts such as multiplication by having three rows of four students acting out 3 X 4 = 12.

9. Encourage first drafts of stories even with grammatical or spelling errors. Give students many chances to show and read their work to classmates. This technique nurtures holistic and creative thinking along with the sequential and logical (Shelby, 1985).

10. Incorporate all the five senses into the curriculum. The left brain curriculum relies heavily on the sense of sight. By incorporating the sense of smell, taste, hearing, and touch, concepts can be more readily grasped and recall is enhanced (Vitale, 1982). As an example, when teaching the word "pear", have a pear available. Have the children touch it and describe its texture. Have them smell it and describe its odor; listen to its sound as they drop it on the table or take a bite of it. Have them taste it and describe its flavor. Then write the word, have them look at the configuration. By this point, their senses will have been activated to a point that the left brain learning will also be enhanced and "pear" will forever be a part of their vocabulary.

11. Incorporate the use of color in the teaching strategies used. Often concepts can be more readily communicated by use of color (Vitale, 1982). For example a row of three red shapes, next to a row of three blue shapes, and a row of three yellow shapes can dramatically illustrate the concept 3 x 3 = 9.

In spelling letters that cause particular trouble can be highlighted in color causing students to key in on trouble spots.

Children with trouble in directionality when writing can be given color clues to assist them; for example, begin at the green dot, stop at the red dot. Reluctant writers may be encouraged by writing on rainbow colored writing paper. When teaching colors to very young children consider making and eating finger jello in the color being presented.

12. Variety is necessary when keeping the right brain stimulated. Some ways of providing variety might include: (1) using lap chalk boards to write spelling words, do math practice or draw the ending to a story; (2) use highlighter pens to mark words in newpapers, magazines that are being studied. For example, the task might be to find ten nouns and highlight them in pink and five verbs and have them highlighted in yellow; (3) do air writing for new spelling words or new vocabulary words. To further enhance this activity, the children may be asked to write the words in the air with imaginary purple paint and a wide brush; (4) play music in the background. When soft music in 4-4 time is played while children are learning new material not only is information they already have received stabilized, but they are also able to think better and their focus of attention appears to be longer than most children's

(Ostrander & Schroeder, 1979); and (5) use movement to instill a concept. Movement can be incorporated into all the areas of the curriculum. For examples, children can pretend to be simple machines that join with other simple machines to become compound machines, they can show the spelling of words with their bodies, or they can depict the movement and/or emotions of characters from history or literature.

These ideas are by no means an exhaustive list of all the possible ways an educator can teach to the right brain. They are offered as suggestions from which educators might draw when developing a holistic approach to learning in various areas of the curriculum.