Brain Research Sheds Light on Language Learning

Language development seems to depend on integration of the right (spatial) and left (verbal) hemispheres.

RICHARD SINATRA

Elliot Eisner (1981) maintains that sensory deprivation is a glaring cause of illiteracy in our nation's schools. He contends that children who have not learned to see and mentally explore the forms of nature, art, and science will not be able to write; not because they can't spell, but because they have nothing to say.

Indeed, having "nothing to say" may reside at the very neural level, which should prompt educators to take a hard look at what they do to promote early written literacy. In the effort to emphasize the three Rs, educators have greatly narrowed their horizons. Those entrusted with the cognitive growth of youngsters may have forgotten how they themselves learned—through active sensory exploration and manipulation of the environment. In cutting back curriculum "frills" and intensifying time-on-task for written literacy, curriculum leaders may be cutting the real basics from the curriculum, especially in the primary grades.

Forming "Blueprints" in the Brain

According to Piaget, children learn by doing, by interacting with their environment, and constructing mental schema of how the physical world operates. They discover life-governing rules by actively using their own intelligence. They learn, for instance, that changes of physical appearance—such as pouring milk from a bottle to a glass or dividing a rolled-out piece of clay into smaller segments—do not result in a loss of volume.

Thus, the environment must provide a field of experimentation for young children to actively learn. They must manipulate materials and get visual/motor feedback regarding the outcome of their behavior. In so doing, they learn how to adapt and accommodate themselves to changes in the environment, some of which may have been self-induced. In effect, they construct mental schemata of past experiences. According to Piaget, a schema is a mental image or a pattern of action that becomes a way of representing and organizing all of the child's previous sensory-motor experiences.

Richard Sinatra is Coordinator of Graduate Reading Programs, St. John's University, Jamaica, New York.

Photo: Richard Sinatra

We see young children rapidly enlarging their schemata during the early years of life. At first, all four-footed animals may be called either a dog, a cat, or a cow. Then, as the youngster comes into more and more physical contact with each animal, the schema for each begins to take on a clearer focus. The child has accommodated his or her previous perceptions and adjusted to a new view. Later in life, when language develops, the words "dog," "cat," or "cow" can call to mind the schema of each type of four-footed animal. Schemata, then, are mass representations of all of life's experiences that become the basis of the child's conceptual filing system.

It is through such activities as cooking, cleaning and sorting dishes, modeling with clay, finger painting, building with blocks, playing house, and hundreds of other visual/motor activities that children form schema and learn the cognitive skills of comparing, contrasting, categorizing, sequencing, and evaluating. As suggested by Piaget and Eisner, a conceptual base for words and verbal expression needs to be developed before children come to the experience of reading and writing. We do not really teach children such skills as sequencing and classifying through paper-and-pencil activities. In most cases children bring these conceptualization skills to the task on the printed page and we merely provide another mode to practice those particular skills.

The younger the child, the more likely that language experiences, and later literacy experiences, will have meaning based on concrete happenings. When words and sentences are used to describe concrete experience, nonverbal, right-hemisphere conceptualizations provide the referents, the "blueprints," for the language meaning. Therefore, right-hemisphere stimulation during the early years of child development and primary grade schooling may be the cornerstone for later literacy learning in verbal modes during the higher grade levels.

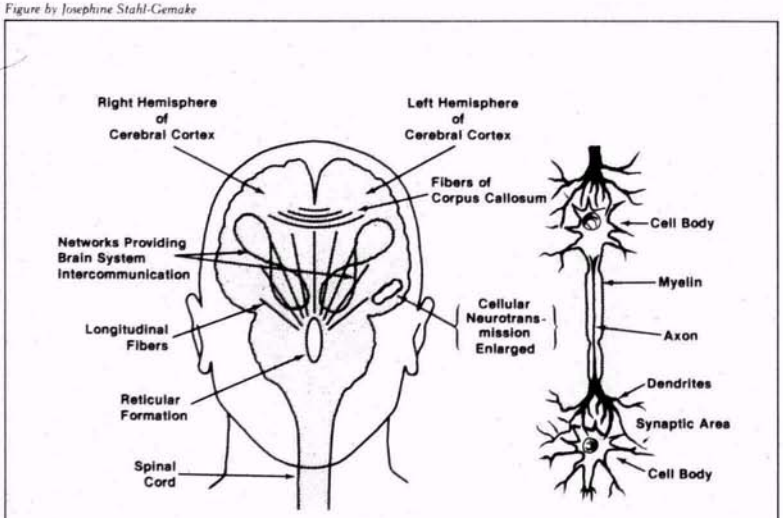
This is a highly important concern today because the accent in preschool, kindergarten, and early primary education seems to be toward earlier and earlier reading and writing ability. There is nothing wrong with this emphasis *if* youngsters have had the life experiences that form the basis of the ideas and conceptualizations they will be reading and writing about. However, the early push for letter, number, and written word knowledge may actually be detrimental to many youngsters if it uses time that may be better applied to sensory exploration of the environment.

Brain Growth in Young Children

In the young child, each hemisphere of the brain reacts to and sorts out the world with equal success until about the age of formal schooling. Up to approximately the age of four, the right hemisphere is about as proficient at handling language as the left (Gazzaniga, 1967). The more the language itself assumes a commanding role in guiding the young child's thoughts and actions, the more likely that full lateralization will occur. That is, the left hemisphere will dominate in language expression while the right hemisphere continues to excel in Gestalt, holistic, visual/spatial processing.

The key to how the left and right hemispheres eventually achieve coordinated verbal and nonverbal interchange appears to be in the maturation of the connecting fiber systems passing between the two brain hemispheres and among the major brain systems, particularly from the reticular formation in the lower brainstem to the cortex. The reticular formation is primarily responsible for our state of alertness and wakefulness. According to Restak (1979), wakefulness is the state of optimal "cortical tone" necessary for all organized mental activity. When that tone is out of step with the conscious, goal-directed behavior of the cortex, we often see evidence of such learning disabilities as distracta-

Figure by Josephine Stahl-Gemake



Human Brain and Neural Cell

bility, impulsivity, and hyperactivity. The fiber system extending from the reticular formation to the hemispheres matures even more slowly than the corpus callosum connecting the two hemispheres. The point is that maturation of these fiber systems appears to relate to the maturation of the youngster's cognitive powers.

The process of nerve fiber maturation is called myelination. Gazzaniga (1974) and Galin (1976, 1979) believe that because the connecting nerve systems, especially the corpus callosum, are the last to myelinate during childhood, the young child may be considered to have a functionally split brain with each thinking system developing independently. This means that preschoolers and some older children may not have the physiological capability to perform certain tasks that require hemispheric integration. This may occur for some youngsters when they are asked to name or decode the printed form of words before they know the words' meanings.

Myelination is the development of a fatty sheath around the nerve fibers, particularly the nerve axons. The axons conduct impulses from the cell body to threadlike projections called dendrites, which transmit the coded message to adjoining cell bodies. The myelin sheath facilitates electrical transmission through the neuron since its axonal fiber is insulated, just as an electrical cord is insulated for the transmission of electricity. Yakolev and Lecours (1967) have indicated that myelination of the horizontally and vertically arranged fiber systems is hardly noticeable until about two years of age. Then, the corpus callosum and other commissures between the two hemispheres myelinate rapidly from two until seven years of age, while the fibers from the reticular formation to the hemispheres myelinate rather rapidly from two until twelve and continue maturing until old age. Schnitker (1972), also a neurologist, indicates that by 18 to 20 months of age, myelination will have been complete in some areas of the cortex so that the young tot will have gained sufficient perceptions from what has been seen and heard to begin to talk. This time period roughly corresponds to the age when commissural myelination begins to be noticed (Yakolev and Lecours, 1967).

Matching Curriculum with Brain Development

Both Galin (1967) and Kraft and others (1980) have reasoned that these physiological myelin stages correspond with Piaget's landmarks in cognitive development. In other words, succession through the many growth stages noted by Piaget may parallel the growth of myelin maturation. Even more critical for educators of young children is the probability that visuospatial, manipulative activities stimulate myelin growth, thereby advancing nonverbal/verbal integration of the hemispheres.

Once maturation of the corpus callosum has begun, children can use speech to describe experiences recorded by the nonverbal right brain. Through the early preschool years, it is especially important to allow young children to explore their environment and to provide them with kinesthetic, tactual experiences that call for communication between the hemispheres. Since the commissures continue to myelinate well into the elementary school years, concrete, visual/motor activities should also be a regular ingredient of the daily curriculum at higher grade levels. Thus, as curriculum leaders and teachers continue to tie language to sensorimotor schema, they will assist youngsters in integrating nonverbal and verbal modes of learning.

Two landmark studies using the electroencephalograph (EEG) showed that hemispheric interchange of verbal and nonverbal processing modes does occur during reading (Kraft and others, 1980) and writing (Glassner, 1980).

Using the EEG procedure, it is possible to measure and study the actual engagement of the two hemispheres during a wide variety of natural cognitive tasks (Galin, 1979). Glassner looked at the process of composition with older students to determine which hemisphere was engaged during two modes of writing—one focusing on the ability of the writer to convey a message, and the other focusing on the writer's ability to express his or her thoughts and feelings about a closely felt personal experience. He noted that while the writing product is in a linear form, its processes incorporate nonlinear, nonverbal forms of thought.

Kraft and others (1980) recorded individual EEGs of 18 six-to-eight-year-old children during three types of tasks. The first task involved watching the visuospatial transformation of material based on Piaget's conservation paradigm; the second involved using oral language to logically explain what happened during the physical transformation; and the third involved reading about what had happened and then answering four questions about the reading passage. Greater right-hemisphere activity was recorded during the transformation of material tasks, which required a physical change of concrete form, and during the silent reading of the passage. Furthermore, there was greater left-hemisphere activity when children had to talk about and justify what occurred during the physical change stage and when they had to think about and answer the questions related to the reading passage.

It is especially revealing that the children's right-hemisphere activity was greater during their silent reading than when answering questions about the content. Since the children read a passage about an experience they had just witnessed, they were undoubtedly engaged in imagery, a visual re-representation of that experience. When reading involves a spatial thinking component—as when information is recalled through the process of imagery—the right hemisphere is apparently activated. While answering questions the mind has to logically reformulate the information to answer what was specifically asked and then orally express the answer. That is when the left hemisphere comes into play.

The Importance of Nonverbal Learning

This knowledge of brain functioning helps us see why right-hemisphere stimulation is important for language learning and in overall conceptual development. However, the curriculum in thousands of schools across America does not employ the strengths of the right hemisphere in learning and memory. Most language arts curricula in particular are strongly left-hemisphere-bound, although holistic process-oriented approaches to reading and writing (Goodman, 1979; Shuy, 1981) offer a real opportunity for dual hemispheric involvement in language learning. During language involvement in whole pieces of discourse—as occurs in composition writing, theme and poetry readings, and experience-language stories—stored sensory experiences and nonverbal schemata are aroused in the form of imagery.

The implication of research is that interhemispheric integration can be facilitated when the right hemisphere is given a commanding role in stimulating the verbal. The less nonverbal experience a child has had, the less schemata

will be formed, and by extension the less the verbal re-enactment of those experiences. The more the nonverbal experiences are associated with all the varied ways those experiences are represented (drawing and painting, body movement, music, sculpture, pictures, maps, flowcharts, and so on), the more schemata will be developed, and undoubtedly the richer the verbal accounting of those experiences.

Brain researchers point out other limitations of a confining, nonsensual curriculum. If a youngster whose talents lie in visuospatial conceptualization is forced into a curriculum that emphasizes a verbal mode to solve conceptual problems, frustration and hostility toward the teacher and the learning process may result (Gazzaniga, 1975). This may be just the plight for many of the so-called learning disabled. In this vein, Geschwind (1972) notes:

> We happen to live in a society in which the child who has trouble learning to read is in difficulty. Yet we have all seen some dyslexic children who draw much better controls; i.e., who have either superior visual-perception or visual-motor skills. My suspicions would be that in an illiterate society such a child would be in little difficulty and might do better because of his superior visual-perception talents, while many of us who function well here might do poorly in a society in which a quite different array of talents was needed to be successful . . . As the demands of society change, will we acquire a new group of "minimally brain-damaged"?

That children have differing styles of learning has been supported by research. When the curriculum is modified to adapt to learners' preferences, significant increases can occur in the learning of school disciplines (Douglas, 1979; Trautman, 1979; Dunn and others, 1981) or in school attendance (Lynch, 1981). We must accept that a wide range of individual differences exists for both the verbal and nonverbal modes. Roger Sperry (1973), one of the 1981 Nobel Prize recipients for his work on the brain hemispheres, noted that the differential strengths between left and right-hemisphere processing modes in different individuals would account for quite a spectrum of variations in human intellect—from the mechanical or artistic geniuses on the one hand who have difficulty expressing themselves in speech or writing, to the highly articulate who can almost "think aloud."

However, even in today's jargon, individualization generally means representing the written word in a variety of subskill guises to youngsters. In our teaching of the language arts, we continue to cultivate verbal growth and weed out verbal deficiencies; but we do not particularly cultivate or reward the nonverbal mode. We praise and reward the inventors, the artists, the composers, and the architects long after their schooling has ended. We may not reward them during their schooling years, nor do we particularly esteem their nonverbal strengths, which can be exhibited in a number of ways in and out of the classroom. Symmes and Rapoport (1972) give an interesting account of 54 high-I.Q. youngsters, all of whom showed superior ability for the visuospatial mode. Although these youngsters had demonstrated their skills in model building and visual classification early in life, they were failing in school because they lacked reading and writing skills.

Such is the prestige of written literacy. If children do not attain it early and at the same rate as their peers, we may label them disabled and subject them to analytic, parts-specific remediation. We thus curtail their powers of nonverbal and analogic thinking and minimize opportunities to cultivate the creative mode in which they may excel.

Our educational horizons should be broadened to readmit the nonverbal mode of thought that is an essential part of youngsters' lives. By so doing we will reestablish the influential role of the right hemisphere in creativity and in language development.□

References

Douglas, Claudia. "Making Biology Easier to Understand." *The American Biology Teacher* 41 (May 1979): 277–299.

Dunn, R.; Carbo, M.; and Burton, E. "Breakthrough: How to Improve Early Reading Instruction." *Phi Delta Kappan* 62 (May 1981): 675.

Eisner, Elliot. "Mind as Cultural Achievement." *Educational Leadership* 38 (March 1981): 466–471.

Galin, David. "Educating Both Halves of the Brain." *Childhood Education* 53 (October 1976): 17–20.

Galin, David. "EEG Studies of Lateralization of Verbal Processes." In *The Neurological Bases of Language Disorders in Children: Methods and Directions for Research* (NINCDS Monograph No. 22). Edited by C. Ludlow and M. Doran-Quine. Bethesda, Md.: U.S. Department of Health, Education and Welfare, 1979.

Gazzaniga, Michael. "The Split Brain in Man." *Scientific American* 217 (1967): 24–29.

Gazzaniga, Michael. "Cerebral Dominance Viewed as a Decision System." In *Hemisphere Function in the Human Brain*. Edited by S. J. Dimond and J. G. Beaumont. New York: Wiley and Sons, 1974.

Gazzaniga, Michael. "Brain—Corpus Callosum." *Journal of Learning Disabilities* 8 (November 1975): 35–36.

Geschwind, Norman. "Disorders of Higher Cortical Functions in Children." *Clinical Proceedings, Children's Hospital National Medical Center* 28 (1972): 270–271.

Glassner, Benjamin. "Preliminary Report: Hemispheric Relationship in Composing." *Journal of Education* 162 (Spring 1980): 74–95.

Goodman, Kenneth. "The Know-More and the Know-Nothing Movement in Reading: A Personal Response." *Language Arts* 56 (September 1979): 657–663.

Kraft, R. H.; Mitchell, O. R.; Languis, M. L.; and Wheatley, G. H. "Hemispheric Asymmetries During Six-to-Eight-Year-Olds Performance of Piagetian Conservation and Reading Tasks." *Neuropsychologia* 18 (1980): 637–643.

Lynch, Peter. "Time Preference Affects Attendance Significantly." *Learning Styles Network Newsletter* 2 (Spring 1981): 1 (St. John's University, Jamaica, New York).

MacLean, Paul. "A Mind of Three Minds: Educating the Triune Brain." In *Education and the Brain*, 27th Yearbook of the National Society for the Study of Education. Edited by J. Chall and A. Mirsky. Chicago, Ill.: University of Chicago Press, 1978.

Restak, Richard. *The Brain: The Last Frontier*. Garden City, N.Y.: Doubleday, 1979.

Schnitker, Max. *The Teacher's Guide to the Brain and Learning*. San Rafael, Calif.: Academic Therapy Publications, 1972.

Searleman, Alan. "A Review of Right Hemisphere Linguistic Capabilities." *Psychological Bulletin* 34 (1977): 503–528.

Shuy, Roger. "A Holistic View of Language." *Research in the Teaching of English* 15 (1981): 101–111.

Sperry, Roger. "Lateral Specialization of Cerebral Function in the Surgically Separated Hemispheres." In *The Psychophysiology of Thinking: Studies of Covert Processes*. Edited by F. J. McGuigan and R. A. Schoonover. New York: Academic Press, 1973.

Symmes, J., and Rapoport, R. "Unexpected Reading Failure." *American Journal of Orthopsychiatry* 42 (1972): 82–91.

Trautman, Paul. "An Investigation of the Relationship Between Selected Instructional Techniques and Identified Cognitive Style." Ed.D. dissertation, St. John's University, 1979.

Yakolev, P., and Lecours, A. "The Myelogenetic Cycles of Regional Development of the Brain." In *Regional Development of the Brain in Early Life*. Edited by A. Minkowski. Symposium, Blackwell, Oxford, 1967.