

both. Yet their hope is not in men but in the Lord of the covenant, who has entrusted them with the precious children of that covenant to nurture and instruct. Can they do anything less than provide a school where the instruction of church and family will be reinforced, and indeed, developed?

Tom Reid
(Treasurer, A.C.E.I.)
Creevagh Manse
Ballybay, Co. Monaghan, Eire

P.S. All correspondence should go to the Secretary, T.C. Donachie,
429 Cregagh Road, Belfast BT6 OLG Northern Ireland. ■ ■

LANGUAGE AND BRAIN LATERALIZATION

by David M. Harbach

*Mr. David Harbach teaches third grade at the Adams Street
Protestant Reformed Christian School in Grand Rapids, Michigan.*

Lateralization of the brain is an important aspect of our every day life and yet, we often are not aware that there is an important connection between lateralization of the brain and our ability to acquire language, to speak our language, to read our language, and to understand our language. In addition, there is a time in our life that is the most important for learning another language, which of course has a tremendous pedagogical impact for teachers and students. This report is divided into three major areas: the historical research of speech aphasias and epileptics, the critical age for language lateralization, and the pedagogical implications of lateralization of the brain. This report is to be open ended because new findings in brain lateralization will change our understanding of this important aspect of our daily life.

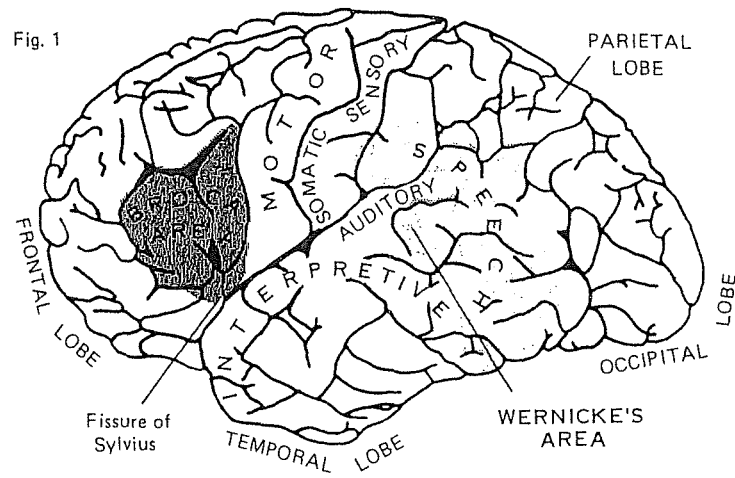
Let us begin with the first major area, the historical research. In order to help you to visualize the left hemisphere of the brain, I have provided two drawings, the first drawing (fig. 1, p. 18) is for the identification of the names of places in the brain that are most important for language acquisition, while the second drawing (fig. 2, p. 18) shows

two possible neural paths; one neural path is for speaking a written word and the other neural path is for speaking a heard word. I will be referring to these two drawings repeatedly throughout this report.

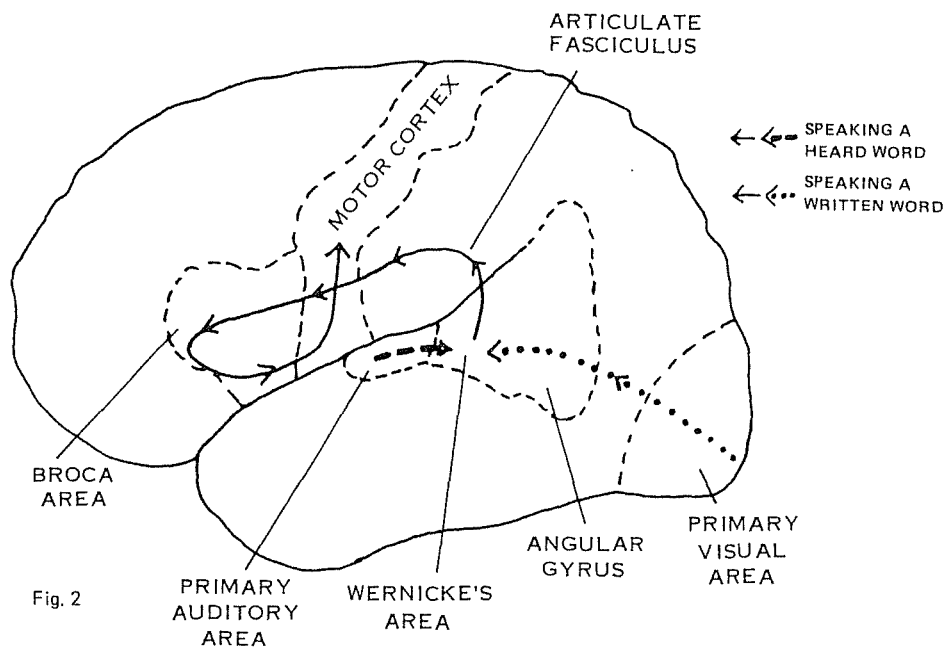
The left and right hemispheres of the brain make up the major part of the cerebral cortex. The cerebral cortex can be divided into four lobes (fig. 1) in each hemisphere: the frontal lobe, this lobe controls voluntary motor movements, eye movements, and the motor elements in speech; the parietal lobe, this lobe receives signals of somatic sensation from the skin, bones, joints, and muscles; the temporal lobe, this lobe receives auditory (hearing) stimuli, recognizes and understands meaningful sounds, and is concerned with memory; the occipital lobe, this lobe recognizes and integrates visual stimuli. If you desire a more clinical explanation of the cerebral cortex, consult *Clinical Anatomy* by Harold Ellis, 1971, p. 335-. The left hemisphere, the most important area of the brain for language acquisition, we will study more closely later in this report, along with how we speak a language. Now that we are familiar with the brain, let us consider brain damage.

"In man brain damage is often caused by cerebral thrombosis or stroke: occlusion of arteries in the brain, which results in the death of the tissues the blocked arteries supply. This led to the fact that there were several functional areas of the brain, including language areas" (Geschwind, *Scientific American*, 1971, p. 180). Paul Broca, a French surgeon during the 1860s, discovered that "damage to specific areas of the left half (hemisphere) led to disorder of spoken language. . .while damage to the right side left language abilities intact. Out of 100 people with language disorder 97 will have left brain damage. However, these people can sing melodies without difficulty" (Geschwind, *Scientific American*, 1972, p. 76). The Broca area, as it is now called, refers to an area in the left hemisphere, that when damaged, gives rise to aphasia or speech disorder. The characteristics of a Broca type aphasia would be slow speech with poor articulation, the loss of verb inflections and pronouns, the inability to form a complete syntactic sentence, the ability to understand spoken and written language, and the presence of paralysis to the right side of the body. Although these characteristics seem difficult to explain and understand, Broca was able to point out that damage to a particular area in the left hemisphere of the brain caused similar characteristics in each patient.

Carl Wernicke, a German professor at the University of Breslau, in the 1870s found that a lesion (damage) in the temporal lobe of the left hemisphere between the primary auditory area and the angular gyrus (fig. 2) causes a person to have difficulty in the semantic area of language output: the person is able to speak fluently, the spoken sentences are syntactically correct, but the spoken sentences lack meaning.



LEFT CEREBRAL HEMISPHERE



"The Wernicke's aphasic. . . shows a profound failure to understand both spoken and written language, although he suffers from no elementary impairment of hearing or sight" (Geschwind, *Science*, 1970, p. 941). The area in the temporal lobe that lies between the primary auditory area and the angular gyrus is called Wernicke's area. Wernicke also "pointed out that Broca's area was located just in front of the cortical region in which lay the motor representation for the face, tongue, lips, palate, and vocal cords — that is, the organs of speech. It seemed reasonable to assume that Broca's area contained the rules by which heard language could be coded into articulatory form. . . . By contrast, Wernicke's area lies next to the cortical representation of hearing, and it was reasonable to assume that this area was somehow involved in the recognition of the patterns of spoken language" (Geschwind, 1970, p. 941).

We know now that there is a connection between Broca's area and Wernicke's area by means of the articulate fasciculus (fig. 2). This means that information is transferred from Wernicke's area to Broca's area, and this is confirmed by the characteristics we see in the described above aphasias.

We can produce a basic model of language from the preceding information. Geschwind has not disappointed us in this desire. Geschwind proposes that "when a word is heard, the output from the primary auditory area of the cortex is received by the Wernicke area. If the word is to be spoken, it is transferred from the Wernicke area to the Broca area where the articulatory form is aroused and passed on to the motor area that controls movement of the muscles of speech" (1972, p. 76-). Similarly, Leonard Small proposes this model for how a visually perceived object is named: the visual cortex is stimulated producing a stimulation of the visual association cortex which transfers the impulse to the angular gyrus that arouses the name in the Wernicke area; the name is transferred by means of the articulate fasciculus to the motor association area of Broca, where the motor pattern associated with the sound form is aroused in the motor cortex thereby producing speech, (1973), (see fig. 2). These two models of language give us the main pathways of language in the left hemisphere. The brain is far more complex in organization and function than we can realize, even when we focus on a model of language which is only one area of brain function, and which is also a clear testimony of God's handiwork in the creation of man, separating him from the rest of creation, but we must examine the other half or part of man's brain to have a more complete picture of our being fearfully and wonderfully made.

Wayne Sage says that Roger W. Sperry, a neurobiologist, "was intrigued by the fact that each of the hemispheres of the cerebrum has

always seemed oblivious to each other's existence. . .each side of the brain learned independently and had a separate memory" (1976, p. 24). Drs. Phillip J. Vogle and J.E. Bogen sought a way to control epileptic seizures. They reasoned that if electrical discharges which caused the epileptic seizure were confined to either side of the brain, the other hemisphere not affected by the seizure could serve to provide normal body control. The only way this could be accomplished would be by disconnecting most of the neural connections between both hemispheres, thereby preventing any seizure from transferring over to the other side. In sixteen intractable epileptics, they cut the corpus callosum, the nerve system that exists between both halves of the brain and which serves to carry neural information between hemispheres, enabling the unaffected side to control the body during seizures. The operations worked and Sperry began his study by performing several experiments using photographs, objects, and word displays.

There is not enough space in this report to allow a detailed study of the setup of Sperry's experiments, but it will suffice to say that he sought to present different visual and tactile stimuli to each side of the brain, so that the left side would receive a different stimuli than the right side was receiving, or he would present visual or tactile stimuli to just one side. Adams Smith quotes Sperry: "what is experienced in the right hemisphere seems to be entirely outside the realm of awareness in the left hemisphere" (1975, p. 63). What then were each of the hemispheres responsible for controlling? Sage reports that the left hemisphere is our rationality lobe, processing information bit by bit in a logical fashion, carrying on verbal and mathematical reasoning, and communicating with the outside world by the use of verbal language (1976). These facts suggest that the brain is somewhat specialized, depending on the particular process involved, so that each hemisphere does not carry on duplicate functions, but rather separate functions, that are at times integrated with both hemispheres. We know that the eyes and ears have neural connections that are contralateral (opposite side) and ipsilateral (same side). This led investigators to be more specific about auditory and speech perception.

Studdert-Kennedy and Shankweiler focused their investigation on lower-level speech sounds. They used a dichotic listening device which presents a different sound stimuli in each ear at the same time. Studdert-Kennedy and Shankweiler decided to test the components of a speech signal in order to determine which components of a speech signal are lateralized in the brain (1970). They found a right ear phonemic advantage for stop consonants and vowels. They concluded that "convergence of the two signals in the dominant hemisphere occurs before the extraction of linguistic features, and that it is for this

process of feature extraction that the dominant hemisphere is specialized" (1970, p. 590). In other words, the left hemisphere is truly the linguistic perceiver, separating the auditory stimuli into phonological features, while the right hemisphere perceives more general non-linguistic auditory sounds, such as environmental sounds.

Knox and Kimura have found through dichotic presentations that "verbal stimuli such as digits, nonsense syllables, or words, were more correctly identified from the right ear than from the left ear. Conversely, nonverbal stimuli such as melodic patterns or environmental sounds were identified more in the left ear than in the right ear" (1970, p. 227). We conclude that there is lateralization in the brain, so that the left hemisphere is the center of our linguistic perception and control, while the right hemisphere is specific for musical and environmental perception and control. However, lateralization is not fixed at birth. We now turn our attention to the critical age of brain lateralization.

Lenneburg fixes lateralization of speech function at puberty, whereas Krashen and Harshman fix lateralization of speech function by age five. Let us examine these two viewpoints.

Lenneburg states that "during the first two years of life, cerebral domination is not yet well established. . ." during "the age of language acquisition left sided cerebral dominance is manifest" (1967, p. 151). However, "if a child had a lesion in infancy, regardless of side, speech function was eventually confined to the healthy hemisphere, so that when the diseased hemisphere had to be removed later in life, it caused no aphasia" (1967, p. 152). This means that the right hemisphere is capable of and has the potential for assuming linguistic perception and function during childhood. This ability "for speech — specific physiological adjustment ceases to function at puberty" (1967, p. 150), which can be verified by the severe loss of speech of those past puberty who have their left hemisphere removed due to brain damage. Obrador seems to agree with Lenneburg when he says "transference of speech from one hemisphere to the other appears to be the rule rather than the exception up to about the age of fifteen" (1964, p. 141).

Krashen and Harshman used the dichotic listening device with children between five and ten years of age. They found no difference in lateralization in those children. They also found the "aphasia in children resulting from localized lesions revealed that right sided lesions do not cause more cases of speech disturbance after five than in adults, indicating that the involvement of the right hemisphere in the language function in children older than five is the same as in adults" (1972, p. 174). This means that we would expect to see a greater speech loss in children before puberty, than in adults after puberty, due to right hemisphere damage. Since there is no difference, lateralization must

already be complete in the left hemisphere by the age of five years. Krashen and Harshman conclude "the completion of lateralization by five implies that lateralization reflects the maturation of some essential component of the language faculty, rather than the termination of organizational plasticity" (1972, p. 174). Even though linguistic speech function cannot be established in the right hemisphere after puberty, maturation of the speech function occurs in the left hemisphere by the age of five years. Sage agrees with Krashen and Harshman when he states that "two hemispheres develop at an equal rate albeit along separate paths and are equipotential in all functions until around age five, when the hemispheres lose their ability to act interchangeably, each moving into its own specialty. . ." (1976, p. 28).

Lateralization in the brain is an awesome fact of life. We cannot suggest to someone that if he is going to have brain damage to the left hemisphere he should have it before puberty, or if he does have brain damage after puberty, then only the right hemisphere should be damaged. However, whether or not our brain is damaged, the kind of instruction we receive in our education may determine the extent to which we use our brain capability. The rest of this report will be my own pedagogical suggestions in the light of lateralization in the brain.

The area of educational instruction that has the most impact on a child's life would be in the reading process. When the child has reached school age and begins his schooling, the first area of great concern is that the child be able to read and write in a relatively short period of time. Experience has proven that, for many children, learning the reading process is a formidable task and may even lead to a turned-off attitude towards reading many books. I believe that as educators we must be acutely aware of the fact that lateralization in the brain does not occur for some children until they are older. These particular children will have a lot of difficulty in learning to read because neither hemisphere is assuming dominance in the reading process: in fact, each hemisphere will interfere with the other hemisphere while the child is trying to read. This does not mean that the child is retarded, or backward, or stupid, but it does mean that for that particular child the brain has not lateralized the control of the reading process into one side. The teacher will have to exercise patient understanding with a child with dyslexia (i.e., an impairment of the ability to read due to a brain defect), allowing the child the opportunity to read as often as possible with verbal representations of the words, with picture representations of the meaning. Many opportunities must be given the child so he can convey the meaning of what he has read. Our purpose as educators is not to force the brain to lateralize the control of the reading process but to encourage a positive reading atmosphere so that lateralization

can take place without undue harm to the child's attitude towards reading.

The question you may have in the back of your mind may be, "Is the human brain so created that the language process is lateralized to a specific side of the brain?" I bring this question up now because you may have the erroneous impression that the language process is an either-or situation in regards to the left or right hemisphere function. The preceding research is to point out the fact that one of the hemispheres, the left, assumes the major function of controlling the language process, but we must keep in mind that the other hemisphere, the right, is active in the language process, only with less control function, not because its role as a language processor is unimportant, but because it is working along with the left hemisphere in processing language, the left hemisphere being the linguistic organizer, the right hemisphere being a supplier of linguistic information. This means our brain is working as a whole organized unit, integrating the numerous functions it performs each second of our life, each half sending and receiving information from the other half along intricate neural pathways that connect both hemispheres of the brain. Language acquisition and the language process are two of the major functions of the brain as a whole, organized, interconnected unit; the reading process is inseparably connected to these other two functions of the brain and, therefore, we conclude that in learning to read, a rich variety of activities at every level of primary and secondary education must be presented to the reader, so that all of the associated functions of the brain in regards to the language process and reading process are repeatedly stimulated into coordinated and concordant activity.

In the reading process, many activities take place in the brain, such as the auditory perception of a written or spoken word or part of a word; the visual identification of letters, words, and groups of words; the coordination of this information into an understandable form; and the combination of this form with previous knowledge obtained in the reading experience, so that meaning, the main purpose of the reading process, is obtained. The brain integrates perceived stimuli received from many of our sense organs during the reading process for the purpose of getting meaning from the printed or spoken word. A child can have educational experiences that may emphasize the understanding of stimuli received from one of the sense organs, such as the phonics approach, the sight word identification approach and a linguistic approach; but the burden of education, in regards to the reading process, is *not* an emphasis on a particular part of the reading process but must be to teach covenant children so that they are able to get meaning from what they read and to understand that the main purpose

of reading is to understand what they read and to bring meaning to what they read. This makes sense from what we have learned about language and brain lateralization. God has created man so that he is capable of learning how to get meaning from what he reads, that is, God has created the brain of man so that, above all other creatures, man alone is capable of learning how to get meaning from printed words. This has even a greater importance to the teacher of covenant children, when we understand that reading is a means by which the covenant child gains a deeper understanding of God and of his purpose here on earth.

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WORDLESS PICTURE BOOKS

by Marilyn Decker

Mrs. Marilyn Decker, a veteran of many years, teaches kindergarten at the Hope Protestant Reformed Christian School, Grand Rapids, Michigan.

Wordless picture books are one of the major trends in children's literature today. The story in these books is told exclusively by means of pictures. These wordless books can fulfill a very important purpose in the classroom and the home. Perhaps the most important is using the wordless books to stimulate language development in our children. Through the wordless books children take an active part in the storytelling. It is the teacher's responsibility to provide many varied experiences to foster the development of oral language in each of her children.