IS LITERACY A FUNCTION IN DETERMINING THE HEMISPHERIC SPECIALIZATION OF LANGUAGE‡ ?

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Abstract

The authors of this paper have tried to discuss whether literacy has any emphasis in determining cerebral dominance for language. They discuss the possibilities of the same, taking evidence from the research works which have been done earlier.

Humm brain consists of two halves, which are called as cerebral hemispheres. Both the hemispheres are almost alike in appearance and controlling the opposite sides of the body in their functions. Each hemisphere is specialized in certain functions. It is this specialization that makes that particular hemisphere dominant or leading over its counterpart.

It is well established that the left hemisphere in dominant or specialised for language functions and the right hemisphere for spatial and non-linguistic functions in most of the normal individuals. That is, language functions are generally controlled and processed by the left hemisphere in most individuals. The evidence for this has been found since the days of Dax in 1836, through the studies of brain damaged individuals.

Dax (1836) first reported the association of aphasia and left hemisphere lesions in adults. Broca (1861) presented the first document that the lesions in the left hemisphere cause speech (language) disturbances. In 1876, Jackson observed the impairment of visual ideational and non-verbal mental processes in adults with right hemisphere lesions and described the left hemisphere as the "leading" hemisphere for language functions and the right hemisphere as leading in non-verbal and visual ideationtl functions.

In a similar manner, many studies which have been done with the brain damaged subjects, have reported left hemisphere dominance for language functions (Penfield and Roberts, 1959; Russel and Espir, 1961; Goodglass and Quadfasel, 1954; Luria 1964; Hecaen and Angelergues, 1964).

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Studies done, using electrical stimulation of different centers in the brain (Penfield and Jasper, 1954; Penfield and Roberts, 1959), by observing the temporal lobe and frontal lobe damaged patients (Milner, 1964, 1967; Luria, 1964; Kleist, 1934; Chase, 1967); sodium amytal test (Wada and Rasmussen 1960; Milner, Branch and Rasmussen, 1964; Rossi and Rosadini, 1967; using average evoked response method (McAdam and Whitaker, 1971); Callaway and Harris, 1974); by observing alpha rhythm of the brain (Robbins and McAdam 1974); using cortical blood flow method (Risberg and Ingvar, 1973); Carmon, Lavy, Gardon and Portnoy, 1975); using tests of perceptual asyrretry (Kimura, 1961a, b, 1964, 1967; Triesman 1964; Broadbent, 1954; Moray, 1959; Deutsch and Deutsch, 1963; Kumar, 1978; McKeever and Huling, 1971; Witelson, 1974 1976; Berlin and McNeil, 1976) and finally studies done using split brain subjects or commissurotomy patients (Milner, Taylor and Sperry, 1968; Sperry, Gazzaniga and Bogen, 1969; Sperry, 1968 a, b) indicate similar findings that the left hemisphere is leading and specialized in most of the normal individuals for language functions.

The notion that left hemisphere is specialised for all the functions of the language, that is for reading, writing, speaking and listening comes from the studies done with split brain subjects (Milner, Taylor and Sperry, 1968; Sperry, Gazzaniga and Bogen, 1969; Sperry, 1968 a, b). These studies observe that the right hemisphere cannot speak, read, write, and cannot do calculations, but the left hemisphere does.

Why is it language within the domain of left hemisphere of the brain?

Many researchers have tried to answer this question, assigning language to the domain of left hemisphere.

1. Hecaen and Albert (1978) write that it is essentially the left hemisphere that contains the neural subtrate necessary for language and systems those are necessary for non-verbal forms of communication, such as gestures, and those systems for perception of sensory stimuli that can be verbally labelled without any difficulty.

2. Hirsh (1967) emphasizes the fact that language and hearing differ so strikingly from other senses in their preoccupation with time. These temporal (time bound) activities are centered in the left hemisphere, hence the specialization of language functions within the domain of that hemisphere.

3. Masland (1967) comments that the left hemisphere serves as a trigger mechanism or as a primary initiator of activity. This initiated activity triggers a proprioceptive feed back into the non-dominant right hemisphere, which in turn leads to a locking system between the hemispheres, making the left hemisphere lead for language functions. It is this feed back mechanisms that gives the left hemisphere a superiority for control of language.

4. Neuroan atomic asymmetry between the hemispheres has also been observed.

An area in the superior surface of the temporal lobes that is, planum temporale is reported to be longer in the left temporal lobe than in the right temporal lobe, in most of the adults (Geschwind and Levitsky, 1968). Same finding has also been reported with the new born (Witelson and Pallie, 1973). Similar type of asymmetry has also been reported to be present in the Broca's area in the frontal lobe (Wada, 1974).

Witelson and Pallie (1973) attribute language functions to the domain of left hemisphere because of the above reasons of morphologic asymmetry and observe that it is this biological difference rather than subsequent environmental influences, which become the principal determining factor in explaining lateralization of language functions to the left hemisphere.

The asymmetries are considered to be the functional and anatomical factors those determining the specialization of language in one hemisphere, in particular the left. However, one cannot reject the influence of environmental factors on the structures in the nervous system of an individual. Evidence for this comes from the studies on animals. Hubel and Weisel (1962) demonstrated the presence of precise patterned connections from eye to the brain even before birth, in kittens. These patterned connections were irreversibly damaged when there was an absence of visual in put. Globus and Scheibel (1967) reported that visual deafferentation in rabbits resulted in deformation or loss of dendritic spines from neurons in the animal's visual cortex. Jones and Thomas (1962) observed a reduction in dendritic density of the animal's prepyriform cortex on olfactory deafferentation in rates. Electronmicroscopic studies of deafferented cerebellar-cortex demonstrated a degeneration of dendritic spines and climbing fibers (Hamori, 1973).

Malkasian and Diamond (1971) observed that after twenty eight days neonatal rats raised in an enriched environment having significantly greater cortical depths than those rats raised in an impoverished environment.

These few studies done on animals, reveal that environmental factors can produce microstructural changes in the neuronal connections of the brain" after their initial formation.

If these revelations in the animal experiments can prove that environment has certain effects on the nervous system, one can also expect the same to happen even with human beings. Hence, one can expect a difference in the performance of the hemispheres of a literate, who has acquired all the four skills of language functions, that is, reading, writing, speaking and listening, and an illiterate who has acquired just speaking and listening modalities.

There is only one study by Cameron Currier and Haerer (1971) and one case report by Wechsler (1976), to say that there are certain differences between a

literate brain and an illiterate brain, on language functions. Both the study and the case report are based on brain damaged subjects.

Cameron, Currier and Haerer (1971) studied 65 adults who had left hemisphere damaged. These cases were compared for the degree of literacy and language (aphasic) disturbances. They classified the degree of literacy based on the years of schooling their patients had. The literacy group had a 10.5 years, semi-literacy group had a 5.6 years, and illiterate group had a 2.5 years of schooling.

They observed language disturbances in 78 per cent of the literate group and in 64 per cent of the semi-literate group, whereas 64 per cent of the illiterate group did not have any language disturbances. This finding led Cameron, Currier and Haerer to suspect that the language is not well planted in the dominant (left) hemisphere. They conclude, that of the factors they analyzed, only one had a definite effect on the presence or absence of language disturbance in the dominant (left) hemisphere lesion, that is the degree of literacy. They suggested that literacy emphasizes cerebral dominance for language.

Wechsler (1976) reported a case of crossed aphasia in an illiterate right handed woman. That is, language disturbances with right hemisphere damage in a right handed woman. The patient acquired persistent non-fluent language disturbances following a right cerebral infarction in the right posterior frontal lobe. Based on this finding in this case, along with the presence of illiteracy, Wechsler (1976) suggested that the neural mechanisms involved in learning to read and write may become necessary and critical for the complete establishment and maintenance of language dominance in the left hemisphere. Wechsler (1976) concludes that it is the patient's failure to acquire reading and writing skills, that altered the normal evolution of language lateralization and resulted in the right hemisphere assuming the dominant role. Because of this role that right hemisphere acquired, damage to it caused aphasia, that is, language disturbance.

Observations in the above studies viewed along with the animal experiments, allow one to conclude that all the four modalities of language—viz., speaking, listening, reading and writing, help establish language in the domain of the left hemisphere. It is hypothesized here, that failure to acquire two of the skills of language modalities, reading and writing, allows for an alteration in the domain of hemispheric function for language, by channellising the language either to be in both the hemispheres for a bilateral representation or to be in the right hemisphere, due to decreased neural in put, when compared to a literate who receives the neural in put through all the four modalities.

There is a serious limitation in the study by Cameron, Currier and Haerer (1971). They have not studied occurrence of language disturbances in relation to literacy with right hemisphere lesion patients for comparison. Findings of

the case report by Wechsler (1976) does not allow one to draw definite conclusions, as it is only a single case with right brain damage with illiteracy.

There have been no studies done using normal illiterate and literates, for observing the differences in hemisphere dominance for language in them. This study can easily be done using tests of perceptual asymmetry which are available to us. The findings of the studies using tests of perceptual asymmetry corroborated with the findings in pathological subjects can lay a strong foundation for the statement that there is a difference in the hemispheric specialization for language functions in literates and illiterates.

*If the findings in such type of study indicate that there is a difference in the hemispheric specialization of language functions in literates and illiterates, one can study on the following lines :

Our Government has announced National Adult Education Programme (N. A. E. P.) for training the illiterates to become literates. The emphasis is laid to train the adults between the ages of 13 years and 25 years. The training between the ages of 13 and 35 years is almost after the maturity of an individual, physically as well as neurally. Hence, one has to see, whether this matured individual can accommodate these skills, which are taught after attaining maturity and even if he accommodates, can the nervous system store it neurally, after it has lost its plasticity to a greater extent ?

To explain this, a follow up study becomes necessary. Follow up study should be done to know the neural process involved in acquiring the reading and writing skills in children at different intervals of time and the same should be compared with adults who start acquiring the reading and writing skills and the same group should be followed up at different time intervals. If the results of this type of study imply that there is no difference between the groups of children and adults in acquiring these skills, then it may have further implications in rehabilitative measures of language in disordered language (aphasia) cases. Language can very well be reinstated through reading and writing modalities.

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