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Shedding Light on the Link between Neurolinguistics and Second Language Acquisition (SLA)

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ABSTRACT

In the study of language, different fields have been developed including psycholinguistics, sociolinguistics, and Neurolinguistics, each one trying to elucidate a certain aspect of language acquisition. As such, Neurolinguistics as the study of the relationship between language and brain should be considered as an important field in the study of language. Neurolinguistics is the study of the neural mechanisms in the human brain that control the comprehension, production, and acquisition of language. Knowing about the human's brain, its physical and neurological structure, as well as its functions seems vital to understanding, for they provide a better picture of the processes involved in second language acquisition. This paper tries to take a critical look at the main literature on Neurolinguistics. Also, it can bear important implications for language instructors. Teachers should have an adequate knowledge about the brain structure and its functions, because this familiarity helps them much in designing materials and activities appropriate to the students.

Keywords*:* Neurolinguistics, Lateralization, Localization Hypothesis, Sensitive/Critical Period Hypothesis

1. What is Neurolinguistics?

In the first place, to reach an adequate understanding of the scope of Neurolinguistics, its functions as well as its role and relationship with second language acquisition, presenting a definition of the term seems vital. According to Lothmann (2005), Neurolinguistics is the branch of linguistics that is concerned with the cerebral-physiological prerequisites of language. In other words, it studies the neurological bases of the mental processes which were, traditionally, studied in psycholinguistics. Because of this similarity between the two fields, some scholars view Neurolinguistics as a linguistic companion to psycholinguistics.

Neurolinguistics shares similar objectives with cognitive linguistics but draws on neuropsychology rather than cognitive psychology as the main source of psychological knowledge. The term Neurolinguistics was first used by a French neurologist Henry Hecaen in the late 1960 to explain a discipline that was to bridge a gap between the neurosciences and human communication. Kopke (2004) defines Neurolinguistics in this way: Neurolinguistics studies the relation of language and communication to different aspects of brain function, that is, it attempts to explore how the brain comprehends and produces language and communication. In fact, Neurolinguistics tries to combine theory from neurology/ neurophysiology (how the brain is structured and how it functions) with linguistic theory (how language is structured and how it functions). According to Kopke (2004) Neurolinguistics is a branch of Cognitive Neuroscience that, on its turn, together with Systemic, Movement, Sensory and Cellular, is a branch of a larger domain named the Neurosciences. Neurolinguistics can still be divided into two areas: language acquisition and processing and language impairment.

2. Scopes of Neurolinguistics Inquiry

The main focus of Neurolinguistics is to find an answer to the following questions:

1. How is language physically represented in the structure of the brain?

2. How is language (or e.g. grammatical structure) factually processed?

3. What is the neurological make-up or development of the brain during language acquisition?

4. What happens to language and communication due to different types of damage to brain?

5. How do children learn to communicate and use language? How can we relate their acquisition of language to the development of their brains?

6. How can we measure and visualize processes in the brain that are involved in language and communication?

7. How can we make good models of language and communication processes that will help us to explain the linguistic phenomena that we study?

8. How can we make computer simulations of language processing, language development and language loss?

9. How can we make experiments that will allow us to test our models and hypotheses about language processing?

3. The Relationship between Brain and Language

In simple words, Neurolinguistics is the study of the relationship between language and brain. Different scholars have proposed different views to show the relation between language and brain each of which will be presented briefly below.

3.1 Localism

According to Paradis (2000) Localism stands for the differentiation of different "higher functions" that are localized in different centers of the brain, mainly the cortex. Either these centers can be seen as "sisters" being equally important or one center, e.g. the prefrontal area (to the front of the frontal lobes) can be seen as superordinate to the others.

3.2 Associationism

Associationism assumes that higher functions are dependent on the connections between different centers in the cortex. Linguistic ability is seen as the relation between images and words. Aphasia results from broken connections between the centers that are needed for linguistic function (Schumann, et. al. 2004).

3.3 Dynamic Localization of Function

As Paradis (2000) states, in this type of theory, different sub-functions are seen as localized in different parts of the brain. These sub-functions must be combined in order to achieve more complex functions, which can be "put together" in a number of different alternative ways. The relation between a localized lesion and the functions that are disturbed becomes more complex in this case.

3.3 Hierarchical or Evolution-based View

Evolution based theories emphasize the layered structure of the brain from inner/lower and more primitive structures to the later developed and superimposed cortical layer and the role of all of these layers in language and communication. Jackson is an early representative, Brown a contemporary one. Evolution based theories stress the relation between how brain and language evolved over time in different species, how they develop in children and how adults perform language functions.

3.5 Holism

Holism is the opinion that the brain, at least concerning higher functions, works as a whole. The cortex is said to handle, for example, "higher cognitive function", "symbolic thinking", "intelligence" or "abstraction" and aphasia is a sign of a general cognitive loss, not a specific language loss. This view has also been called "cognitivism" (Schumann, et. al. 2004).

3.6 Unitarism and Equipotentiality

According to Jacyan (1999) "unitarism" refers to one unitary function of the brain, the view that the soul is one and cannot be divided, and "equipotentiality", means that all parts of the cortex have the same functional potential and that the size of a brain lesion determines the extent of the aphasia.

4. The Neural Bases of Language Learning

Human brain has been considered by Psychologists, neuroscientists, and linguists as the final arbiter of hypotheses concerning language acquisition and pedagogy. If an understanding of the neural processes underlying language learning is achieved through science, it is believed that programs of instruction can be designed to facilitate language learning by taking advantage of the neural mechanisms involved. As Paradis (2004) states, Paul Broca was the first scientist who explored the neural basis of language learning. He identified the area in the brain which was devoted to language production known as Broca'sarea. Some years later Karl Wernicke (1848-1905) found out the area in the brain which was responsible for language comprehension known as Wernicke's area. These two discoveries paved the way for further investigations into the neural bases of language processing. These investigations have revealed that the neural processes in the brain are much more complex than can be accounted for just by Broca's and Wernicke's areas. For example some investigations resulted in the discovery of another area known as dorsolateral prefrontal cortex. Holtzheimer, Fawaz, Wilson, and Avery (2005, cited in Stowe, 2006) documented unexpected incidents of language switching between the L1 and L2, suggesting that this area may play a role in code-switching and inter-language interference prevention. Furthermore, the work of neurosurgeon George Ojemann (2004, cited in Dornyei, 2009) has shown that the neural network of language processing is so complex that it differs on an individual basis. This is true for second language representations as well. For example, one person's primary cortical area for noun production may serve an unrelated function for another person. Recently, a lot of research has been done using neuroimaging techniques which have provided a great deal of insight into the neural representation of second languages. As an example, in studies conducted by Kim, Relkin, and Hirsch (1997, cited in Birdsong, 2006), it has been concluded that the native and second languages show different patterns of neural activation for subjects who had acquired proficiency in the L2 after 10 years of age, whereas the patterns are comparable in childhood bilinguals. The results of this study are interesting in that they show neural evidence that L2 acquisition in adults differs greatly than that in children. Accordingly, it is understood that a lot of research has been done to shed light on the neural processes involved in the brain in acquiring L1 and L2. These investigations have led to interesting and sometimes differing results. Therefore, it seems reasonable to suggest that more caution should be taken before confirming the existence of difference between the neural representation of the L1 and L2 and if so the causes of such differences have to be accounted for through meticulous research.

5. Lateralization

The role of laterality in language processing is another area of investigation that provides clues to the organization of language within the brain. As Gordon (1980) mentions for a long time, research in this area has just concentrated on brain injury. However, according to Lust (2006, cited in Abutalebi, 2008) recent investigations have focused on brain function in normal subjects while they perform tasks that involve language.

The study of language aphasia has led to the view that the left cerebral hemisphere (LH) is specialized for language, specially grammar and phonology. It has also been theorized that the right hemisphere is responsible for the control of semantic and pragmatic aspects of language (Hull, 2003 cited in Abutalebi, 2008). Language lateralization which is also referred to as the Cerebral Functional Asymmetry according to Paradis (1990) refers to the condition wherein one hemisphere rather than the other is relatively more active during performing a specific task. Although some scholars have considered left-hemisphere as the key in the process of language acquisition, the observations made during a great deal of studies have resulted in the view that the right hemisphere is necessary for language processing and that trauma to this side of the brain could result in severe linguistic discrepancies.

One of the great concerns of recent investigations has been the process of lateralization in bilinguals. Many researchers have dealt with this issue interested in finding out whether there is any possible different cerebral organization for each language in the people who know two languages. Grosjean (1989) presents two views about bilingualism-the monolingual or fractional view which holds that the bilingual is two monolinguals in one person, and the bilingual or holistic view which states that the coexistence of two languages in the bilingual has produced a unique and specific speaker-hearer.Grosjean (1985) maintains that the monolingual view of bilingualism has created some negative consequences. The first is that bilinguals (which we define as those people who use two or more languages in their everyday lives) have usually been described and evaluated in terms of the fluency and balance they have in their two languages. A second consequence of the monolingual view is that language skills in bilinguals have almost always been appraised in terms of monolingual standards. The tests used with bilinguals are often quite simply the tests employed with the monolinguals of the two corresponding language groups. As another negative consequence of the monolingual view, we can refer to the point that bilinguals rarely evaluate their language competencies as adequate. They often consider and encourage the monolingual view and, as a result, criticize their own language competence.

6. Localization Hypothesis

In addition to the theory of laterality, the language localization hypothesis must be taken into account when discussing the neural substrata of language processing. According to this hypothesis specific parts of the brain are specialized for specific linguistic functions. A lot of studies have been done which confirms this hypothesis. Almost all the studies have possessed an aphasic nature in which due to a certain lesion to a specific part of the brain a certain linguistic function has been distorted. As an example, Neininger and Pülvermuller's (2003, cited in Ingram, 2007) study of lesion patients found that subjects with lesions in the right frontal lobe showed severe deficiencies in the processing of action verbs and subjects with lesions in the right inferior temporo-occipital lobe showed similar deficits in processing visually-related nouns.

7. Sensitive or Critical Period Hypotheses

Knudsen (2004, cited in Dornyei, 2009) distinguished two types of developmentally decisive periods, sensitive periods and critical periods. A sensitive period refers to any duration of time when the neuronal connections within the brain are particularly susceptible to environmental input. The critical period is a special case of sensitive periods when the brain MUST receive certain stimulation or input in order to continue to function

normally. Lenneberg (1967, cited in Paradis, 2000) defines it as "a period of time with a specific onset and offset during which language can be acquired more easily than any other time" (p. 187). According to Lenneberg critical or sensitive period refers to a time when there is maximum brain plasticity during language development. During this period functional lateralization is thought to be mostly influenced by variations in the timing of exposure to language.

8. Critical Period for SLA

This question that whether there is a critical period for second language acquisition or not has been of great importance for language researchers. Most discussion about the critical period in language acquisition is actually related to learning that occurs in naturalistic SLA contexts rather than formal learning (Sarem & Hamidi, 2012). As long as L2 competence is assessed without regard for the learning mechanisms that produced it, it may appear that there is merely an optimal age for language learning. Birdsong (2006) states that strict either/or categorization of a true CP as defined in biology is inappropriate to be used when it comes to SLA. To solve this problem he prefers the term sensitive period as it allows for the existence of exceptions because it does not consider it critical to start learning the l2 in the specified bounded period. Some scholars even prefer the term 'age effect" to critical.

9. Multiple Critical Periods

Several scholars have suggested that since the different components of language- phonology, morphology, syntax, lexicon, and pragmatics are acquired relatively independently of each other, their development might follow different timetables, pointing to the possible existence of multiple critical periods for a person. Knudson (2004, cited in Dornyei, 2009) argues that language depends on a wide range of specialized sensory, motor, and cognitive skills that involve many neural networks and structures, and they are shaped differently by experience.

It is generally assumed in the linguistic community that children learn second languages more easily and quickly than adults. This difference in ability has been traced back to the existence of "sensitive (or critical) period," which ends at around 8-10 years of age. It is thought that the pre-mature brain has a higher degree of neural plasticity than the post-mature brain and that this directly relates to the neural bases of second language acquisition. However, there is great disagreement about the extent to which adult second language learners are inhibited due to these neural differences.

10. Moderating Variables Influencing Lateralization in L2

As it was mentioned previously, many investigations have been done so far that confirm laterality differences between monolinguals and bilinguals. These studies have disclosed that there are some potential moderating factors that affect the nature of cerebral lateralization. These studies have considered Sex, Task Demands and Complexity of Language, Distance/Relationship between First and Second Languages, and Language Environment as the most common variables accounting for this laterality difference. These factors will be discussed briefly as follows:

10.1 Sex

In a meta-analysis, Voyger (1996, cited in Paradis, 2000) evaluated the results of monolingual and bilingual studies of lateralization with regard to sex differences as an independent variable affecting laterality. Shanon (1982), on the other hand, reported that bilingual men showed more right hemisphere involvement for word processing in comparison with women.

10.2 Task Demands and Complexity of Language

The number and types of tasks used in laterality studies is another source of variation in the reported results from the previous studies. The tasks used in such studies are varied from single word recall to translation. According to Grosjean (1989) it has been suggested that brain involvement during sentence level processing differs depending upon the complexity of sentence structure. When sentences contained semantically rich word clauses, there was an increased right hemisphere (RH) activation, but words in isolation caused increased left hemisphere (LH) involvement **(**Schumann et al., 2004).

10.3 Distance/Relationship between First and Second Languages

Linguistic distance/relationship between L1 and L2 as a moderating factor of cerebral lateralization in bilinguals has been investigated by many studies. The findings of such studies revealed that languages that are structurally very dissimilar, tend to show greater differences in language laterality than those languages which are structurally related.

10.4 Language Environment

According to Ulman (2001) current models of language representations for language in bilinguals assume that there are functional differences between the L1 and L2; some theorists have suggested that environmental context in which first and second languages are used may lead to a different pattern of organization.

11. Final Remarks

The acquisition first language is an automatic task without awareness on the part of the children involved in developing their mother tongue (Rahmani, Alizadeh, & Hamidi, 2014). However, second language acquisition entails awareness and continuous efforts. Neurolinguistics as the study of the relationship between language and brain should be considered as an important field in the study of both first and second language acquisition. Knowing about the human's brain, its physical and neurological structure, as well as its functions seems vital to understanding, for they provide a better picture of the processes involved in second language acquisition. However, the neurological processes within the brain are so much complicated that make it difficult to generalize certain conclusions to both languages, L1 and L2, and to all individuals who are involved in the process of acquiring a language. The variety of the findings of many studies conducted in this realm confirms this complexity in the structure of brain and its neurological processes for different individuals in different contexts. As an example, studies on lateralization and critical period showed this difference in child and adult learners of a second language pointing out to the fact that their brain has different capacity and different neurological

processes for second language learning. Taking these points into account, we can extract certain implications for second language teachers and researchers. It is recommended that teachers and researchers take caution in utilizing and relating the neurologists' findings to the processes and procedures involved in the classroom and to what happens to language students within this context. Teachers should have an adequate knowledge about the brain structure and its functions, because this familiarity helps them much in designing materials and activities appropriate to the students. Individual factors like age and sex imply that language learners at different ages and with different sex would require different materials and tasks in the classrooms due to their different brain structure. It is also suggested that we have to look carefully at who the subjects are in studies available in the literature, what specific behavioral task the subjects are required to do, where in the brain we are looking for our neurological evidence, and whether teaching quantitatively more to one or another portion of the brain would somehow produce qualitatively better results. I conclude my arguments with pointing out to the shortcomings of Neurolinguistics studies as mentioned by Scovel (1982):

1) Neuropsychologists have studied competent bilingual, not language learners - the group we are concerned with.

2) Experimental tasks are often more complex than imagined.

3) The studies have dealt only with hemispheric lateralization and not with other dimensions of the brain.

4) Even if it were possible to teach primarily to one or more portions of the brain, quantity does not imply qualitative success at language learning.

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