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## CRITICAL PERIOD IN SPEECH AND LANGUAGE DEVELOPMENT

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*The speech and language development occurs in early childhood. Giving the neurobiological bases for function development we discuss when the critical period ends, and is it more properly to speak of the existence of a sensitive period instead of critical period in speech and language development. An important prerequisite for normal speech and language development is the exposure of children to the speech encouraging environment. The paper considers does the language normally and fully develop only when one starts with learning the first language in early childhood and can one adopt the first language entirely in functional terms when language learning starts later, after the critical period? The aspects and views of several authors regarding the hypothesis of a critical period for acquisition of speech and language are discussed in the paper. This approach to the critical or sensitive period in speech and language development allows a better understanding of application the procedures and techniques for early detection, diagnostics and treatment of children with speech and language disorders and points the importance of early sensory stimulation.*

*KEY WORDS: language acquisition, critical period, speech and language development*

### NEUROLOGICAL BASES FOR CRITICAL PERIOD IN SPEECH AND LANGUAGE DEVELOPMENT

The huge differences between human abilities and behavior are caused by the uniqueness of human brains. Important neurobiological differences between humans derive from environmental and heritable factors. The period of neurogenesis has an important role in forming the basic conditions

for ability acquisition. The all stages of neurogenesis: proliferation, migration, differentiation (includes the growth of axons and dendrites, synaptogenesis and the formation of myelin) and apoptosis lay in the base for creating the basic capacity for speech and language development. During neurogenesis huge number of neurons is generated, but the number of synapses which they create as well as their functionality and activation depend on environmental factors. Stimulation has a great role in making new synapses and rich neural network. Neural activity in interaction with environmental activity after the birth makes mechanism by which environment can influence the brain structure and function. This important influences that environmental factors may have on developing brain are most noticeable during the *critical periods* for acquisition of certain abilities and speech and language ability as well.

The onset of receptive and expressive language occurs at about the age at which synaptic density in the corresponding language areas (Wernicke and Broca) approaches the maximum, that is to say at about the age of 1 year. Synaptogenesis in Wernicke's area slightly precedes that in Broca's area, which perhaps reflects the earlier onset of receptive versus expressive language. Synapse elimination in language areas occurs normally in late childhood and is complete by mid-adolescence. This time course corresponds closely to the age at which plasticity for language decreases. By late adolescence, the right hemisphere has lost the ability to process most language functions. In general, the emergence of competence in the basic functions of a cortical area appears to coincide with the age when cortical synapses show rapid proliferation. The period during which synaptic density in language areas is above adult levels coincides with a period of increased plasticity (Huttenlocher, 2002).

Positive sensory stimulation is an important predictor of typical psychophysiological development of the child, including the development of speech and language (Dobrijević, 2011). If the positive effects of the environment fail at the critical periods of development, the nervous system will not be formed normally, what will affect its function. Blum (1998) defined the first period of human development which is characterized by the greatest plasticity of brain structure as proto-developmental period. Stimulation in this period in most cases has irreversible effect on all subsequent stages of human cognitive and emotional maturation. It speeds up the process of maturation and enhances the special skills, while inadequate stimulation and early deprivation can leave behind a series of deficits in the individual's life. Cortical changes brought by sensory stimulation are: the increase in cortical weight, increase in cortical neurons, the increase in synaptic

density, increased cortical glial cells (Blum, 1998). Taking into account the effects of harmful environmental factors for the human development during prenatal and postnatal period as well as the possibility of overcoming the lack of function development or functional recovery in the early developmental period, the importance of early detection of developmental and other disorders, as well as the need for early stimulation of the entire child development is emphasized. The overall result is an improvement of preventive child health care activities in order to ensure their proper psychophysiological development (Dobrijević, 2011).

### ***Hypothesis of critical period for language acquisition***

Considering the existing literature dealing with the subject of a critical period for language acquisition, different views about the level in which the biological basis for speech and language acquisition is linked to age are discussed.

The hypothesis of a critical period which was popularized by Lenneberg (1967) has opened a long-lasting debate in linguistics: in which extent language acquisition is biologically related to the age. The hypothesis states that there is ideal time frame or ~window~ for language acquisition in a language rich environment, after which language acquisition is not possible.

Evidences for this hypothesis are limited and ongoing support comes from the theoretical arguments related to critical periods in biology. The good example is specific development of vision in cats and the development of singing in some species of birds. If the cats are exposed only to the horizontal lines in the first few weeks after birth, they will never be able to see other patterns such as vertical lines (Baxter, 1966). The critical period which is thought to be most similar to the critical period for language acquisition is learning songs in the zebra finch (*Taeniopygia guttata*) or whitecrowned sparrows (*Zonotrichia leucophrys*). If these birds do not hear a specific song for their species in a certain period after birth, they will learn to sing but never really learn to sing that particular song of their species, unlike the example of canaries that can learn new songs during any period in their lives. These critical periods are probably influenced by hormone levels because they can be manipulated by adding hormones or castration (Marler, 1970).

Although there are differences between different types of critical periods in many aspects, they share certain geometric features, which distinguish them from other types of development. In general, critical periods have an onset, a peak of heightened sensitivity, an offset and a terminus with a flattening after the terminus (Bornstein, 1989).

During the onset, there is a gradual rise in sensitivity to the critical stimuli. The onset is maturationally determined, but can in some cases be postponed (thus postponing the whole period) when no stimuli are presented, for example when cats are reared in the dark for a number of weeks. During the peak, exposure to the critical stimulus is most effective. This peak can be very short (for example for certain kinds of visual development in cats). The terminus indicates the end of the critical period of heightened sensitivity. After this point, the relevant behaviour should no longer be correlated with age and should stay at approximately the same level. Note that this level of ability (for example the ability to discriminate different visual patterns) should be lower than levels attained before the terminus. For some critical periods, the onset and/or peak can start so early (e.g. before birth for auditory stimuli) or be so short that they do not (seem to) play a role. In order to prove that there is a critical period for a certain ability (e.g. language acquisition), however, one must prove that an offset and flattening are present, and that after the terminus age is no longer correlated with this ability. This means that, under normal circumstances, late learners with the same amount (and quality) of input should behave significantly differently from early learners and not significantly differently from other late learners.

Some scientists have proposed sensitive or optimal period for language acquisition instead of the critical period. The difference between the terms sensitive and critical period for the language acquisition are used to distinguish periods, after which there is no more brain plasticity and the further development of normal function is no longer possible (critical period), and the period after which a certain degree of plasticity remains and the recovery (to a certain degree) is still possible and under special circumstances (optimal or sensitive period). Despite these differences, most researchers use the term critical period for all such approaches as we will in this paper.

The duration of this critical period is also subject to debate. Steven Pinker argues that language acquisition in children is guaranteed under 6 years and is compromised from 6<sup>th</sup> year to late adolescence, and very difficult after this period (Pinker, 1994).

The critical period hypothesis was first proposed in 1959 by neurologist Wilder Penfield and Lamar Roberts, who were co-authors in a paper "Speech and Brain Mechanisms", and in 1967 it was popularized by Eric Lenneberg, with the paper "Biological Basis of Language". Lenneberg spoke about the lateralization in puberty as of a mechanism that prevents the language acquisition. The critical period for language development is related to the

plasticity and lateralization of brain. Plasticity refers to how the brain is flexible in learning and lateralization of different functions is related to the specialization of function by the two cerebral hemispheres. In no area of cortical function is age-related plasticity as evident as in language. It seems that after puberty, the brain loses its plasticity to learn speech.

The left hemisphere plays the leading role in speech and language in most right-handed persons. However, functional testing of hemispheric asymmetry of the brain has shown that language functions are not entirely related to the dominant hemisphere and that the right hemisphere has a certain linguistic competence. The right hemisphere has a dominant role in the metaphorical aspects of understanding the meanings of words and language. The right hemisphere is also dominant for the understanding of the affective components of speech, facial expressions, gestures and the musical abilities. Due to the damage of left, the right hemisphere takes the lead role in the control of language skills (Vuković, 2002).

There has been a great debate about when is the end point of functions lateralization. Molfese (1977) for example suggests that the lateralization of certain functions, such as for example phonetic/ phonological, could be completed by the end of the first year, while the sensorimotor cognitive structures that underlie the early use of syntax and semantics in children can be represented in both hemispheres, which would mean that children's meaningful statements will be mediated by both hemispheres, although not to the same degree. This approach suggests multiplicity of critical period.

Other researchers point out the earlier end of phonetic/phonology critical period. Seliger (1978) points out that just as there is a lateralization of function there is also a localization process for a specific function in the dominant hemisphere. He suggests that the phonetic/ phonological features are localized by the adolescence and that syntactic functions are localized subsequently and thus will remain available in later periods of life.

Another advocate of the critical period multiplicity, Diller (1978) suggests that the pyramidal cells, which he associates with the phonetic/phonological adoption, develop up to 6-8 years, whereas stellate cells, which he associates with higher order functions, mature over two or three decades.

Johnson and Newport (1989) concluded on the basis of their research that there is a specific stage of maturing until 7 years which is especially important for language acquisition and the second phase from 7 years until puberty, during which the capacity for language acquisition decreases gradually and then abruptly reduces in capacity.

Rubén (1977) takes a more radical stance. Based on the studies of the effects of very early temporary hearing impairment he has concluded that

the critical period for phonetics / phonology ends around 12 months of age. Further notes that critical period for syntax ends in the fourth year and for semantics ends in the fifteenth or sixteenth year of life.

### ***Evidence of a critical period for language acquisition***

Critical period for language acquisition ends between 4-5 years. If the language is not adopted before this period, one can never learn it in a functional sense. This is the ***Critical Period Hypothesis*** (CPH) for language acquisition (Lenneberg 1964).

CPH was based on evidence from:

(1) feral children and victims of child abuse who were reared without exposure to human language and thus were unable to fully acquire the ability to produce it;

(2) deaf children who were unable to develop spoken language after puberty;

(3) evidence that children with aphasia have a better chance at recovery than aphasic adults.

Cases of so-called. deprived children and abused children provide evidence of the biological determination of the critical period for language acquisition. Deprived children are those who were not exposed to any speech after birth because they were raised in the wild or isolation. The classic example is the Genie. Genie was a girl who was kept in a locked room by her schizophrenic father from her 18<sup>th</sup> month of life. Her mother was blind and was also abused by her husband so that she could not help to their daughter. After her father died, Genie was finally free, at that time she was thirteen. Even after intensive speech therapy she has failed to develop speech. Her voice production was limited to nouns, some verbs and adjectives. The sentence had a maximum of three words hard to understand.

Another case is Isabella that has been sealed with her deaf mother by her six years. When she was found she didn't have developed speech, but unlike the Genie she has quickly adopted the normal language skills through systematic speech therapy. But these examples are problematic because long-term isolation can result in general retardation and emotional disturbances that may lead to the wrong conclusions of the language skills.

Supalla and Newport (1987) studied the adoption of the sign language of deaf children who differed by age at the time of the beginning of learning the sign language. It was observed that children who have been exposed since birth to sign language were better at all tested levels compared to those children who started learning later (by fourth year). Their study

provided direct evidence of the declining capacity for language acquisition with increasing age. They have however proved that the decline in ability to learn languages is rather linear than sudden as it suggests the strong CPH.

Children who have had brain damage before puberty are recovering and re-adopt the language as opposed to adults after brain injury who rarely recover fully, and often fail to regain verbal abilities beyond the point that they achieve five months after the injury. What is the underlying anatomical substrate of the remarkable recovery of language functions in the young? Reorganization of language areas in the damaged left hemisphere, de novo organization of language in the normal right hemisphere, and initial bilateral representation of language in both hemispheres have all been suggested as possible anatomic substrates for preservation or recovery of language functions in children.

Children have a neurological advantage in language acquisition and puberty is highly correlated with the turning point in ability. Re-language acquisition occurs solely due to the high degree of plasticity of the brain during childhood, a period after which a brain loses its plasticity. It then becomes rigid and loses its capacity for adaptation and reorganization which makes language learning very difficult (Penfield and Roberts, 1959, Lennenberg, 1967).

## CONCLUSIONS

When it comes to language acquisition, the impact of the environment that is exposure of individuals to speaking encouraging environment is essential for speech and language development. The human development passes through stages that can not be found in any other species. This is primarily related to cognitive and language development in which language can not be compared to any other type of communication system because of its complexity that makes it qualitatively different from all of the systems of communication, (Vladislavljević, 1997).

A necessary condition for the child to master the speech is the existence of an organic basis for the development of speech and language, which is primarily related to good hearing, developed auditory perception and discrimination of the voices, well-developed visual perception, developed motor skills of speech organs, normal intelligence, the ability of organizing and directing attention and the presence of social conditions present during the early period of life, (Golubovic, 1998).

The language is adopted by imitation, practice and encouragement. If the child is not exposed to the speech during the critical period for the lan-

guage acquisition, it will never be able to adopt the speech fully in functional terms. On the other side, we point to the importance of different sensory modalities among which auditory and visual attention have a special role in language acquisition. According to this, auditory attention in its developmental context unavoidably leads to the major developmental issues of language acquisition, (Nenadović, 2011).

Among these facts, we also may point to the importance of early rehabilitation of speech and language which is clearly confirmed in the scientific research and practical work in the field of early rehabilitation of hearing and speech impaired children, but also from the neurophysiological aspects of CNS development, (Jeličić, 2007). The neurophysiological developmental potentials of the central auditory system are significantly higher in the first year of life than later, Moore and Linthicum (2004), which explains the significantly better achievements and results in the field of speech and language development and cognitive development if rehabilitation starts several months after birth.

Stimulation in the early developmental period in most cases would have an irreversible effect on all subsequent stages of development: speech and language, sensorimotor development, cognitive development and socioemotional development. It improves the process of maturation and enhances the special skills, while inadequate stimulation and early deprivation can leave behind a series of deficits in the individual's life.

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## KRITIČAN PERIOD U RAZVOJU GOVORA I JEZIKA

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### REZIME

Usvajanje govora i jezika se dešava u ranom detinjstvu. Prikazujući neurobiološku osnovu razvoja funkcija u radu se razmatra kritičan period razvoja, njegov završetak, kao i pitanje da li je pravilnije govoriti o postojanju senzitivnog umesto kritičnog perioda u razvoju govora i jezika. Važan preduslov za uredan govorno- jezički razvoj jeste izloženost dece podsticajnoj govorno-jezičkoj sredini. Stoga se nadalje diskutuje da li se jezik normalno i u potpunosti razvija samo kada se započne sa učenjem u ranom detinjstvu ili je jezik moguće usvojiti u potpunosti u funkcionalnom smislu i kada se sa učenjem prvog jezika započne kasnije, nakon kritičnog perioda? Diskutuju se aspekti i stavovi više autora po pitanju hipoteze o kritičnom periodu za usvajanje govora i jezika. Ovakav pristup sagledavanja kritičnog ili senzitivnog perioda za razvoj govora i jezika omogućuje bolje sagledavanje značaja primene procedura i tehnika rane detekcije, dijagnostike i tretmana kod dece za govorno jezičkim poremećajima, a ujedno ukazuje na značaj rane senzorne stimulacije.

KLJUČNE REČI: usvajanje govora i jezika, kritičan period, govorno-jezički razvoj