A Time Frame of Critical/Sensitive Periods of Language Development

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Abstract
By a focus on three essential elements of language, phonology, semantics, and syntax, a time frame for critical/sensitive periods of language development is presented as a model of central auditory nervous system flexibility. Several studies support the hypothesis that the critical/sensitive period of phonology is from the sixth month of fetal life through the 12th month of infancy. Data indicates that the critical/sensitive periods for syntax runs through the fourth year of life, and for semantics through the 15th or 16th year of life. The data indicate that there is a time dependent series of functions in sequence that is based on responsive adaptations made by the CNS to psychophysical and electrophysiological stimuli.

Key Words
Language development, critical/sensitive periods, phonology, semantics, syntax.
The view that language was an innate function, dissociated from ideas of plasticity, prevailed from ancient times to the beginning of the 19th century. From that time on, cases were reported that challenged the view of language as being an entirely inborn capacity. Starting with Itard's case of the "wild boy of Aveyron, reported in 1801 (1), numerous cases (2,3,4) catalyzed a modification the conceptualization of language as innate, a product of "nature," and pointed to the significance of the role of sensory input provided by the particular environment, "nurture," and the concomitant dimension of plasticity, in the development of language.

Although awareness of environmental factors in language development has a considerable history, scientific definition of the process has been slow. The current view of critical/sensitive periods for language acquisition is based primarily upon psychophysical observations, many of which are anecdotal, and only a few of which include quantitative data and/or have been reproduced. I will present a summary of the evidence for critical/sensitive periods in language development, and will suggest that the data indicates that there is a time dependent series of functions in sequence which is based on responsive adaptations made by the CNS to acoustic stimuli.

Language can be conceptualized as a communication system consisting of three fundamental elements. These are 1) phonology, the physical structure of the stimuli (specific sound in an auditory-based language); 2) semantics, the meaning assigned to specific stimuli (words); and 3) syntax, the organization of stimuli for the production of complex meanings (grammar).

The awareness of the critical/sensitive periods with regard to these elements in language development has come to the fore in the last twenty-five years. Most studies have examined effects of auditory stimuli and, thus, the development of language in the aural/oral modality. Research has been centered on the development of aural receptive skills in the normal human fetus, neonate, infant and toddler, and on the acoustic properties of the speech stimulus.

Reception of auditory stimuli has at least two dimensions. The first is detection, whether or not the stimulus is received. The second, identification, requires the differentiation among the auditory signals, implying a categorization of stimuli. This categorization includes assessment of factors such as intensity, frequency and timing, as in a word, and the capacity to discriminate is in part dependent upon the shaping of the central nervous system (5,6,7,8,9,10,11,12). This capacity enables the detection of phoneme, and is the basis of auditory language reception and utilization.

Several studies have shown that the 26-week human fetus has the auditory ability to detect sound (5,6). This has been demonstrated, for example, by changes in ECG and fetal position in response to sound transmitted in utero. Data obtained (7) from neonates indicate that these infants have a preferences for a female voice, that is, the voice most like that to which they were mainly exposed in utero, suggesting some level of discrimination has developed by the time of birth. The report noted that in utero exposure to specific sounds, such as the music of Prokofiev's "Peter and the Wolf," and the fly over noise at the Osaka airport, resulted in a neonatal preference for those sounds -- remarkable evidence for human adaptability and plasticity!

Jusczyk et al, (8) and Meher et al. (9) tested two-day old infants of French-speaking mothers by exposing them to stimuli which contained prosodic elements of either French or Russian. The stimuli were generated by having the same woman, who was fluent in both French and Russian, speak and read about an event of her life in both languages. The utterances were recorded and speech samples broken down and selected so as to reflect the particular prosodic aspects of the native language in which they were spoken. The two-day-old infants of the French speaking mothers, when exposed to these prosodic stimuli, responded positively, with high amplitude sucking, to the French prosodic elements but not to the Russian ones. A similar study (10) carried out in older infants in the United States using American English and Italian produced comparable results. These data demonstrate that, by at least two days of age, the neonate has an ability to discriminate language specific acoustic distinctions. It seems reasonable to infer that some, if not much, of this learned ability developed during fetal life, which would place the beginning of the critical/sensitive period for phoneme recognition originates at and before birth.