

The Critical Period Hypothesis: A Review of Current Research

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Resumen

La hipótesis del período crítico, hipótesis que postula la existencia de un período limitado y determinado biológicamente para la adquisición del lenguaje luego del cual resulta imposible o extremadamente difícil aprender un idioma, es uno de los asuntos más controvertibles y debatidos en el estudio de la adquisición del lenguaje. Investigaciones recientes presentan hallazgos contradictorios, algunos que apoyan y otros que niegan la existencia de dicho período, particularmente en la adquisición de un segundo idioma. Sin embargo, la información en contra del período crítico está ganando terreno. En este trabajo se examinan estudios recientes sobre el período crítico y se presentan los hallazgos más significativos.

Descriptores: período crítico, hipótesis del período crítico, procesamiento de lenguaje, adquisición de un segundo idioma, período sensible.

Abstract

The Critical Period Hypothesis (CPH), the belief that there is a biologically determined period for language acquisition which ends around the time of puberty, after which time language is extremely difficult or impossible to acquire, remains one of the most controversial and highly debated issues in the study of language acquisition. Although current research both supports and negates the existence of a critical period, especially concerning second language acquisition (SLA), data against it seem to be gaining ground. This paper examines current studies on the critical period and summarizes relevant findings.

Keywords: critical period, Critical Period Hypothesis, Fundamental Difference Hypothesis, language processing, second language acquisition (SLA), sensitive period.

The Critical Period Hypothesis (CPH) remains one of the most controversial and highly debated issues in the study of language acquisition, and although current research both supports and negates the existence of a critical period, especially concerning second language acquisition, data against the CPH seems to be gaining ground. The CPH is the belief that there is a biologically determined period for language acquisition which ends around the time of puberty due to maturational changes in brain structures used to learn and process languages, after which time language is extremely difficult, if not impossible, to acquire. The CPH was suggested by Penfield and Roberts, who in 1959 proposed that children's apparent ease in learning a new language might be due to greater cerebral plasticity (Hamers and Blanc 2000, p. 74), and formulated by Lenneberg in 1967 (Moskovsky, 2001, p. 1; Marinova-Todd, Marshall, & Snow, 2000, p. 10; Hakuta, Bialystok, & Wiley, in press, p. 3).

The strong version of the Critical Period Hypothesis predicts that second language (L2) learning results in different language processing patterns (Friederici, Steinhauer, & Pfeifer, 2002, p. 529) and "claims that an authentic accent is not available unless SLA begins before the critical age" (Nikolov, 2000, p. 109). One problem with the strong version of the theory is that there is no consensus on when the critical period ends. Krashen claims it ends at the age of 5, Pinker at 6, Lenneberg at 12, and Johnson and Newport at 15 (Hakuta et al., in press, p. 5). According to Marinova-Todd et al. (2000, p. 11), as early as 1977, Lamendella considered that the concept of a critical period was overemphasized and introduced the term "sensitive period" to convey the idea that although children are considered more successful language learners than adults, it is not impossible for adults to attain native-like proficiency in a second language.

Although most researchers acknowledge the existence of a critical period for first language (L1) acquisition (Marinova-Todd et al., 2000, p. 9; Moskovsky, 2001, pp. 1, 2; Friederici et al., 2002, p. 529), the real controversy concerns its application to second language acquisition (SLA). Hakuta et al. call the critical period "a popular way of explaining differences between the apparent success of children and failure of adults at second-language acquisition" (in press, p. 14). Although children have traditionally been perceived as acquiring second languages with ease, whereas adults have been perceived as incapable of learning second languages with native-like proficiency, the existence of adult learners who have achieved native-like competence contests the hypotheses (Moskovsky, 2001, p. 1; Marinova-Todd et al., 2000, p.10). A number of current studies support the CPH; others present empirical evidence that casts doubts on the existence of a critical

period and attribute the differences between child and adult L2 acquisition to other factors. Some researchers hypothesize the existence of separate critical periods for different aspects of language (Moyer, 1999, p. 2; DeKeyser, 2000, pp. 501, 515-517; Liskin-Gasparro, 1999, p. 592). These researchers assume the modularity of language (syntax, vocabulary, grammar, etc.) and claim that there is not a single critical period, but rather several critical periods, and each module is affected differently. Some even claim that there are different critical periods for different structures within the different aspects. DeKeyser calls this the hypothesis of multiple critical periods (2000, p. 503). Traditionally pronunciation and phonology are the two areas that are considered most susceptible to critical period effects (Liskin-Gasparro, p. 593); recently, however, more attention has been directed towards morphosyntax (DeKeyser, 2000, p. 501).

In recent years research on the Critical Period Hypothesis has expanded to include the use of modern technology. In addition to traditional methods, researchers are now using brain imaging and electrophysiological techniques to provide neurophysiological (event-related brain potential) measures. This has opened a new window in the research on how the human brain processes language and provides information that sheds light on whether a critical period exists for language acquisition. However, both traditional research and technologically advanced research provide contradictory views concerning the critical period for language acquisition.

Marianne Nikolov and Alene Moyer both studied L2 attainment in phonology in an effort to challenge the CPH. In order to test the strong version of the Critical Period Hypothesis, Marianne Nikolov studied 33 highly successful adult Hungarian learners of English and learners of Hungarian with a variety of first languages to determine whether they had achieved a native accent and could be misidentified as native speakers on a tape. She also examined the strategies these successful adult L2 learners used and their motivations. The participants in Nikolov's study ranged in age from 20 to 70 and all had learned L2 after the age of 15. Participants were interviewed, asked to describe an embarrassing or a happy moment in their lives, and asked to read aloud a passage in the target language. Finally they were asked to tell a story in L2. Their production was recorded, and tapes were made incorporating the L2 speaking samples with native speaker samples. Native speakers of Hungarian evaluated the Hungarian segments and native speakers of English evaluated the English segments on the basis of whether the speakers were native or non-native speakers of the language. Out of 20 learners of Hungarian, two were generally and four were often identified as native English speakers by native speaking judges. Out of 13 learners of English, one was

generally and four others were often mistaken for native speakers. In terms of motivation and strategies used to acquire the language, Nikolov found that the successful L2 learners wanted to sound like natives and consciously and actively worked on developing their language proficiency by reading and listening extensively and by finding opportunities to communicate with native speakers of the target language. Nikolov concludes that her findings challenge the Critical Period Hypothesis in terms of phonological production in L2.

Alene Moyer's study (1999) examined the phonological performance of 24 highly motivated adult learners of German who had been immersed in German language and culture, taken courses in German, used the language as graduate student instructors at a Texas university and whose professional success depended on accurate production of the language. She hoped to demonstrate that motivational and instructional variables could overcome the impact of age on phonological production. Subjects completed a questionnaire that grouped items into three categories: biological variables, affective variables, and instructional variables. They were then asked to read a list of 24 words, eight sentences, and a paragraph of text chosen to include typically difficult phones for native English speakers. They also participated in a free-response section in which they chose one of five possible topics to talk about for several minutes. In addition to the twenty-four L2 learners, four native-speakers of German participated as controls in the study. Four native speaker judges evaluated each speech sample using a rating scale that varied from "definitely native" (1 point) to definitely "nonnative" (6 points), and a mean rating was assigned to each speaker. Descriptive statistics were then computed for the ordinal and categorical variables.

Only one of the 24 participants in Moyer's study was rated as having performed within the native speaker category. This person had not been exposed to the language until he was 22 and had had only five years of instruction in the language, the lowest among all the participants. However, Moyer categorized him as an "outlier," or exceptional participant, and excluded his score from the final data analysis. Once the outlier's score was excluded, the other participants evinced "a clear lack of native-level performance" (Moyer, 1999, p. 90), and data analysis indicated a highly significant correlation between the ages of immersion and instruction with the mean rating attained by each participant—the higher the age of immersion and age of instruction, the lower the accuracy in the use of the German language. This, she asserts, confirms that biological age plays a significant role in language learning outcome, thus confirming the CPH.

In terms of affect and motivation, the most significant variable Moyer detected was professional motivation. Participants in Moyer's study did not

consider pronunciation as important a factor as did the participants in Nikolov's study. Half of Moyer's participants indicated that "perfect pronunciation was neither realistic nor necessary for overall fluency" (p. 88). This contrasts greatly with the attitude of the one exceptional participant or "outlier" who, contrary to the other subjects for whom perfect pronunciation and sounding native was not crucial, indicated his fascination with the language and desire to acculturate and sound German. This finding is similar to Nikolov's findings regarding motivation. But, whereas Nikolov concludes that this variable refutes the CPH, Moyer does not.

Contrary to Nikolov, Moyer asserts that such exceptional "learners elude thorough description and explanation" (p. 98). She finds that the results of the study do not support her original hypothesis which stated that motivational and instructional variables can overcome the impact of age, and she concludes that her findings do not refute the CPH. Nevertheless, she asserts that the results of her study indicate that variables other than age influence language learning and suggests the CPH should be expanded to include socio-psychological influences such as motivational and instructional variables (p. 96). Although she does not accept it, once Moyer indicates that other variables in addition to age of immersion and instruction play a role in the successful acquisition of a second language, she is rebutting the CPH.

In another study, Flege, Yeni-Komshian, and Liu (1999) also tested the existence of the Critical Period Hypothesis for L2 acquisition. They analyzed English pronunciation and knowledge of morphosyntax of 240 native speakers of Korean who had arrived in the U.S.A. at different ages and whose mean length of residence was 15 years. Pronunciation was evaluated by having listeners rate the degree of "foreign" accent in sentences the participants read, and morphosyntax was evaluated through a 144-item grammaticality judgment test which required that participants evaluate sentences as grammatical or not grammatical. The participants also answered a language background and motivation questionnaire. The researchers used three separate tests to analyze the data: a discontinuity test, a pre/post correlation test and a matched subgroup test.

Data analysis indicated that foreign accents increased and scores on grammaticality judgment tests decreased as the age of arrival in the U.S.A. (age of exposure to English) increased. When other variables were considered, the effect of age of exposure to the language remained significant in terms of phonology and, although the researchers concluded that the effect of age of arrival on phonology may have been due to a critical period related to brain maturation, they also admit that it could result "more likely, from changes in how the L1 and L2 phonological systems interact as the L1 system develops"

(Flege, p. 100). The difference in morphosyntax scores was found to be related to the amount of education the participants had received in the U.S. (rule based aspects) and on how much they used English (lexically based aspects). As a result, Flege et al. concluded that their study failed to support the existence of a critical period for the learning of morphosyntax.

Kenji Hakuta et al. assert that there *is* an age-related decline in successful language acquisition. This is evidenced by “by personal anecdote and documented by empirical evidence” (Hakuta et al., in press, p.3). These researchers assert that “what *is* controversial is whether these patterns meet the conditions for concluding that a critical period constrains learning in a way predicted by the theory” (p.3). Hakuta et al. propose an alternative to the Critical Period Hypothesis. They hypothesize that L2 learning is related to age through factors not specific to language, such as social and educational variables and cognitive aging, which may interfere with the ability to learn a new language. Stating that education has been demonstrated to influence the acquisition of a second language, they concentrate on examining the effects of age on L2 learning. They hypothesize that older learners would find acquiring a new language more difficult than younger ones because of the fact that cognitive processes slow down with age, and this would not involve a critical period.

To assess their theory, Hakuta et al. examined the effects of age of acquisition on second language proficiency by studying a large sample of native Spanish and Chinese speakers who were exposed to English over a wide range of ages. They analyzed data from the 1990 U.S. Census which asks respondents to assess their English ability according to the following scale: “Not at all,” “Not well,” “Well,” “Very Well,” and “Speak Only English.” The researchers’ analyses and a Census Bureau study to validate the aforementioned response categories against actual language proficiency show an acceptable level of correlation between the items and objective measures of proficiency (p.7). In their study they considered the respondents’ age, year of arrival in the U.S., length of residence, and educational background. They analyzed data from 2,016,317 Spanish speakers and 324,444 Chinese speakers. Using the ages of 15 and 20 as hypothesized cutoff points for the end of the critical period, they found no evidence of a change in language learning potential at those ages. They found that the degree of success in L2 acquisition declines throughout the life span (p. 14). The data they analyzed also pointed to the importance of socioeconomic factors in the acquisition of English as a second language, especially the amount of formal education.

An innovative approach to the controversy over the existence of a CPH for language learning is Robert Bley-Vroman’s Fundamental Difference

Hypothesis (1989) which asserts that L1 and L2 learning are “marked by fundamental differences which indicate that they are essentially two different processes” (Moskovsky, p. 3). Bley-Vroman assumes that a linguistic knowledge base and set of cognitive procedures are involved in first and second language acquisition, but they differ for the two types of acquisition. He hypothesizes that Universal Grammar (UG) is not available for second language acquisition and for this reason L2 learners use their first language as a knowledge base rather than UG (Moskovsky, 2001, p. 1). Moskovsky claims that this perspective accounts for some problematic issues concerning the Critical Period Hypothesis, such as the fact that some adult L2 learners can achieve native competence in a second language, and for a number of the differences between first and adult second language acquisition. Analyzing adult second language acquisition, Moskovsky notes:

...in [adult] SL acquisition there is very little uniformity; individual cognitive ability, motivation, social status, etc. play a significant role; learning involves a serious effort; SL learners are not ‘equipotential’ (Schachter 1996: 159) for any natural language: learners find languages which are typologically closer to their first language easier to learn, and generally achieve higher levels of proficiency in such second languages (in addition, the learner’s FL [first language] has been found to exert substantial influence on both SL competence and performance); results from recent experimental studies (e.g. de Graaf 1997) suggest that SL acquisition is sensitive to instruction and correction; very few (if any) SL learners manage to acquire competence in the SL. For an approach assuming that first and second language acquisition are essentially the same (i.e. both involving UG), such differences are rather unexpected” (pp. 3-4).

Moskovsky claims that a critical period for second language acquisition doesn’t follow from a critical period for first language acquisition (p. 2). The Fundamental Difference Hypothesis views second language learning as a manifestation of general cognition, and adult learners must rely on alternative problem solving and verbal analytic skills to learn a second language (DeKeyser, 2000, p. 501-2). Social and psychological variables, such as “educational level, intelligence, personality type, motivation, attitudes, learning strategies, learning goals... which have been found to determine the learner’s degree of success (or failure)” are also involved (Moskovsky, p. 4). The age-related decline in cognitive ability is one of the reasons older learners do not learn a second language as well as younger learners.

Robert DeKeyser designed a study to test the Fundamental Difference Hypothesis. If, as asserted by Bley-Vroman, children rely on innate language-specific mechanisms for language learning which are no longer available to adults, adults no longer have the ability to learn a language without reflecting on its structure and rely instead on alternative mechanisms, such as verbal-analytic problem-solving skills, for explicit learning. There are strong individual differences concerning these skills, and the Fundamental Difference Hypothesis implies that only adults with above-average analytical abilities will be successful L2 learners.

DeKeyser studied the effect of verbal aptitude and age of arrival on ultimate attainment of L2 morphosyntax in 57 native speakers of Hungarian who lived near Pittsburgh by administering a grammaticality judgment test and a language learning aptitude test (the Hungarian Language Aptitude Test). The grammaticality test required that participants listen to pairs of sentences spoken by a native English speaker and identify the grammatically incorrect one. He also administered a questionnaire which gathered data on participants' language and educational background in addition to their age of arrival in the U.S. and their age. The participants' age of arrival ranged from 1 to 40 years. All had lived in the U.S. for at least 10 years, and the average length of residence was 34 years. The ages of the participants ranged from 16 to 81, and the average age was 55. None reported having been exposed to English before arriving in the U.S.

According to DeKeyser, this study provides evidence for Bley-Vroman's Fundamental Difference Hypothesis because it shows that the only adults who reached a native level of grammatical competence were the ones who relied on "explicit, analytic, problem-solving capabilities" (p. 518). And although aptitude does not appear to play a role in child L2 learners, it is a predictor of ultimate attainment in adult L2 learners. The study also shows that aptitude and age interact: age of arrival makes a clear difference for those who have average or below-average verbal ability and verbal ability makes a difference for those who start to learn an L2 as adults (p. 518). DeKeyser concludes that children are better at acquiring a language implicitly and adults must apply explicit learning processes in order to achieve a high level of competence. DeKeyser claims that his study suggests that there really is a critical period for language acquisition as long as it is restricted to *implicit* learning.

Friederici, Steinhauer, & Pfeifer (2002) and Christine Weber-Fox and Helen Neville (2001) used brain imaging and electrophysiological techniques to document neurophysiological, or event-related brain potential (ERP), measures produced by visual and auditory stimuli in their study of

how the human brain processes language. The results of the studies contradict each other in terms of the CPH.

Friederici et al. used an artificial language to study how syntax is processed and determined that early automatic and late controlled syntactic processes are similar and even a language learned in adulthood can be processed automatically. This led them to discard the strong version of the CPH which “predicts that L2 learning results in different language processing patterns” (2002, p. 530). Their experiments, which measure electrophysical activity while participants listen to syntactic errors and correct control sentences, indicate that the brain mechanisms involved in L1 and L2 processing are similar. The adult learners of a miniature artificial language called BROCANTO, reflected patterns of brain activation similar to those reflected by L1 speakers when processing natural languages. This challenges the view that late L2 learners process language in a different way from native speakers. The researchers conclude that late learners of an artificial language process the acquired language in the same way L1 is processed and that the strong version of the CPH, “based on maturational neural constraints, needs to be reconsidered” (2002, p. 534).

Christine Weber-Fox and Helen J. Neville (2001) also used event-related brain potentials (ERPs) to study the ways in which language processing differs for monolingual speakers and for bilingual speakers based on the age at which they were first immersed in a second language. Specifically, the study examined whether the neural processes for open- and closed-class words are differentially affected by delays in second-language immersion. Participants included monolingual English speakers and bilingual Chinese-English speakers who completed language history and self-assessment questionnaires, were given standardized tests to assess their English language skills, and underwent neural imaging of ERPs elicited by visual stimuli consisting of sentences, half which violated semantic rules and half which were semantically correct.

Weber-Fox and Neville found that the age of immersion effects differed for different aspects of language and for different parts of the brain. Neural processes used for open-class words do not exhibit a sensitive period for L2 acquisition, whereas “neural subsystems for grammatical processing appear to be more sensitive to delays in second-language immersion compared to processes mediating semantic interpretation” (2001, last ¶). In other words, neural processes used for grammatical functions in L2 may slow when language immersion occurs after the age of seven. They conclude that cerebral processing of grammar and semantics are differentially affected by critical periods and that this is consistent with the CPH that contends that language processes are differentially sensitive.

Marinova-Todd, Marshall, & Snow (2000) assert that a critical period for the acquisition of a second language does not exist. They explain that although adults are less likely than children to attain native-like proficiency in a second language, this is not evidence of a critical period. It is due to “differences in the situation of learning rather than in capacity to learn” (p. 9). In their article, they discuss some problems inherent in studies concerning language acquisition and place the blame for the controversy on researchers who they assert have committed “the same blunders as members of the general public:” misinterpretation of facts relating to speed of acquisition, misattribution of age differences to neurobiological facts and, especially, misemphasis on poor learners and underemphasis on adults who master second languages (p. 9).

Marinova-Todd et al. present some interesting facts to support their point. In terms of misinterpretation, they discuss several studies which refute the idea that children learn faster than adults and state that research shows that “older learners are generally faster and more efficient in the initial stages of L2 learning” and adolescents are better than children in the early stages of phonological acquisition (p. 12). They mention the re-evaluation of Johnson and Newport’s well-known 1989 study that is considered one of the best studies in support of the existence of a critical period, and explain that when these findings were reexamined by other researchers, it was determined that age-related effects apply only to some of the structures examined. They also claim that aging effects continue to affect the learning process well beyond when the critical period is supposed have ended.

Concerning misattribution, Marinova-Todd et al. refer to neuroscience and claim that neuroscientists often assume that “differences in the location of two languages within the brain or in speed of processing account for differences in proficiency levels and explain the poorer performance of older learners” (p. 14). Among the studies criticized are several by Weber-Fox and Neville. Marinova-Todd et al. assert that these studies, as well as others they mention, “fail to relate differences in brain activation patterns to differences in target language proficiency and thus are essentially irrelevant to any claim concerning a critical period” (p. 17). They add that different patterns in brain processing may indicate that adults are reacting to grammatical anomalies that children are not even aware of and, even if evidence in terms of brain patterning seems to be correct, it could be that the adults assessed were poorly selected and do not represent proficient bilinguals.

The third criticism Marinova-Todd et al. make is that of misemphasis. They claim that the most common error in studies concerning the existence of a critical period is that researchers have used too many participants who

are not proficient in L2 and have for the most part, ignored L2 speakers who have achieved native-like proficiency. The fact that so many adults do find it difficult to learn another language has led researchers to assume that all adults are incapable of mastering a second language and they have not made an effort to study proficient L2 speakers. They insist that past researchers have provided average scores for the age groups and have paid little attention to the degree of variation among learners tested. Furthermore, they claim that a study which concluded that older learners are less proficient than younger ones “actually contained a few examples of adolescent and adult learners who outperformed some of the early learners both in speed of language processing and in the number of correct responses in the L2” (p. 19).

The area of phonology is the area that is most closely associated with the Critical Period Hypothesis. Marinova-Todd et al. make an observation none of the other studies consider. They point out that native speakers have different accents that vary from the standard, but rarely have researchers defined what they consider a standard accent in the target language (p. 19). In addition, some studies on pronunciation ask participants to perform imitation and read aloud tasks that contain words beyond the users’ ordinary vocabulary which they do not know how to pronounce. Marinova-Todd et al. conclude that there is not a critical period for second language acquisition. Age influences language learning, not because of maturational constraints predetermined by a critical period, but because age is related to “social, psychological educational, and to other factors that can affect L2 proficiency (p. 28).

Current researchers have gathered interesting and varied data that appear to both support and negate the existence of a critical period for second language acquisition, but none of them has resolved the issue. However, the existence of a critical period for second language acquisition seems less plausible and harder to defend. Flege sums up the crux of the controversy relating to the validity of the Critical Period Hypothesis. He asserts that the Critical Period Hypothesis offers “an overly simplistic view of what is an inherently complex phenomenon, marked by various ‘conditions that co-vary with chronological age’” (in Moyer, 1999, p. 84). In other words, environmental factors, cognitive skill development, and sociopsychological concerns are interwoven with biological factors and all must be taken into account when examining the individual’s potential to acquire a second language.

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