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Critical periods for second language acquisitions: An analytical review of developmental models

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Timing of exposure to an L2 is critical for maximizing language acquisition. Research from behavioral and brain studies has given rise to 4 main hypotheses regarding the L2 critical period. The hypotheses are as follows: (1) The critical period of L2 is equal to that of L1; (2) The first year of experience is decisive for acquiring L2 sounds; (3) Plasticity is progressively lost as one gets older, and; (4) Language sub-processes are differentially sensitive to biological time. The current paper reviews studies on these four lines of research within the framework of Greenough's and O'Connor's developmental models. Based on the present review, we suggest that earlier exposure to L2 is desirable for the second language acquisition. However, the length and the onset of the language ability was debatable according to the four topics of the research area. Elaboration of task-specific timetables in L2 acquisition was suggested to draw fuller educational implications.

Keywords: critical period, second language acquisition, behavior, brain, development

Timing is an important element in obtaining a good education along with other educational elements such as educator, learner, learning environment, and teaching method. Human language, as with other human cognitive capacities, develops spontaneously and shows a

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certain profile over time. Clarifying the developmental period for language acquisition is essential because one may acquire or fail to acquire a language depending on when exposure to that language occurs. Previous research has supported the decisive role of early postnatal experience on language acquisition. For example, the first 4 to 6 years of life are critical for the acquisition of language. There have been cases of feral children, who have grown up without communication with other people, failing to acquire spoken or sign language in their later lives (Newton, 2002; Uylings, 2006). This example offers a broad picture of how early experience is crucial in language learning. However, the specific time window and the degree of experience necessary for language acquisition is still in question.

Studies of the early experience effect on psychological development fall under three main models: the sensitive period model, the developmental programming model, and the cumulative model (O'Connor, 2003). The sensitive period model places humans in the most passive position of the three approaches. In this model, experiences produced by a normal environment determine a normal developmental process. Thus, a developmental deficit that arises from a lack of experience during an important stage, called the "critical period" or "sensitive period," is not reversible and cannot be recovered. The developmental programming model accepts people's gradual adjustment to an environment and the risk of early deprivation to the developmental process. However, it also allows for the reversibility of the effects of early deprivation, which is an important deviation from the sensitive period model. The cumulative model is possibly the most positive view of the three developmental models, claiming the importance of nurture over nature in the developmental process. Early experience maintains its impact on later development only when it is "reinforced by subsequent events" (O'Connor, p. 671). Various language-associated phenomena can be framed within these three models depending on the impact and maintenance of the early experience.

The role of critical periods and early language exposure on language acquisition has drawn public attention due to an increase in second language (L2) acquisition. As a consequence of globalization, it has become very common for people to migrate to a different country and learn a new language later in life. In the natural environment, it is rare to miss early exposure to a first language (L1), but it is very common to lack early exposure to an L2. Acquisition of L2 later in life raises many questions, including how similar are the L1 and L2 acquisition processes, and whether L2-specific, but not L1-specific, problems exist. Special attention has been paid to the age range during which exposure to an L2 environment would be most critically influential in acquiring L2 proficiency. This age range is the critical period for L2 acquisition, and it has been examined over the past several decades through various fields of research, including education, psychology, linguistics, and neuroscience.

As with other types of situated domain learning, L2 acquisition is a complex phenomenon which is difficult to interpret in the context of a single variable. Social factors such as family background, socioeconomic status, prior education, required task types and personal characteristics come into play. Assuming a tight relationship between experiences and neuronal development, social and psychological factors may speed up or delay L2 critical periods. For example, several researchers have reported how critical periods can shift as a function of education level and ethnicity using 1990 U.S. census data (Hakuta, Bialystok, Wiley, 2003; Stevens, 2004). Due to such complexity, researchers continue to debate the critical period length for L2 acquisition.

The current paper aims to reviews analytically four research topics in the second language acquisition research area. The first views L2 acquisition processes as exactly the same as L1 acquisition processes. The second sheds light on the importance of the first-year experience, and is therefore similar to Greenough's experience-expectant development model (Greenough, 1987). In the third section, the importance of early exposure to an L2 retains, but the critical period was viewed as lasting for five years. The fourth is a more recent investigation that claims critical periods vary depending on the L2 tasks that are presented. These arguments can be interpreted within the context of biological development theories, as discussed by O'Connor, or the experience-expectant versus the experience-dependent theories, as discussed by Greenough. Theoretical interpretations are incorporated into each section.

The critical period of L2 is equal to that of L1

A group of researchers believe that the acquisition process of L2 would resemble that of L1 (unless L2 is an entirely different domain of knowledge from L1). With regard to acquisition processes, Krashen has sustained the input hypothesis model, assuming similarity between L1 and L2 (Krashen, 1985). Krashen's argument for L2 acquisition is a result of his distinctive conceptualization of "acquisition" and "learning." According to him, "the 'acquired system' or 'acquisition' is a product of subconscious processes very similar to the process children undergo when they acquire their first language" (Krashen, 1982, p. 10). On the other hand, "'learned system' or 'learning' is a product of formal instructions and it comprises a conscious process which results in conscious knowledge 'about' the language." In many cases, L2 performance follows the "learning" system, while native-like ability of L2, as with L1, depends on the "acquisition" system.

One can find earlier mention of the critical or sensitive period for L1 acquisition in the works of several developmental psychologists such as

Montessori and her followers (Vygotsky, 1966). According to them, "During sensitive period an influence that has little effect earlier or later may radically affect the course of development" (Vygotsky, 1966, p.104). Montessori viewed birth to 3 years of age as the most critical age for language acquisition. Montessori and her followers' semi-biological theory of critical periods were later reviewed by Vygostky, who added a social and cultural perspective on the development. School years as a whole were viewed as the "optimum period" for instruction and for further development. Meanwhile, Lenneberg later argued that 2 to 14 years of age were the most critical for normal language experience (Lenneberg, 1967). Like other the early pioneers of the biolinguistic enterprise (e.g., cited in Jenkins, 2000, 2004; Di Sciullo & Boeckx, 2011), Lenneberg approached "language as a species-specific mental organ with non-trivial biological properties" (Boeckx & Longa, 2011, p. 256). Although Lenneberg agreed upon the special mechanism of language development, his perspective has followed Generative Grammer, insisting that key mechanisms of language can be related to very ancient animal capacities. This very geno-centric position led Lenneberg to strike the process of internal maturation of language and to reduce the importance of human language acquisition in his/her later life.

So far, the debates upon the sensitive periods in the context of L1 acquisition is mostly relied on the behavioral studies. More contemporary investigations based on brain imaging techniques have been performed to study L1 and L2 acquisition and/or language deficits in earlier life. These will be presented in the next sections of this paper.

The first year of experience is decisive for acquiring L2 sounds

Many phonological maturation studies have established that the earliest period of language exposure determines the linguistic capacity over the remaining life course. Special attention has been paid to the maximum age at which an L2 learner can be exposed to the L2 environment and still obtain a similar level of phonemic competence as their L1 counterparts. Modern neuronal technology such as functional magnetic resonance imaging (fMRI) and event-related potential (ERP) have helped provide neurological evidence about the profound effect of first year experience on later life (Kuhl, 2010).

One of the earliest works on the importance of first-year experience was performed by Cheour and his colleagues using mismatch negative (MMN) analyses (Cheour et al., 1998). MMN is a type of ERP where brain activity is recorded and the response depends on a subject's familiarity with the stimulus. In order to see "the development of language-specific 'memory traces' in the brains of the same group of infants between 6 months and one year of age (p. 351)," the researchers recorded the brain responses of Finnish and Estonian infants (Cheour et al., 1998). The study results indicated that language-dependent memory traces (i.e., the MMN amplitude increases for native phonemes and decreases for non-native phonemes) in the human brain emerge before the age of 12 months. This result suggests that infants develop their ability to discriminate native speech sounds, while they lose the ability to discriminate non-native speech sounds, at an early age (Cheour et al., 1998, p.352).

Kuhl et al.'s study (Kuhl, Williams, Lacerda, Stevens, & Lindblom, 1992) supports Cheour's critical period of 6 to 12 months of age. Kuhl and his colleagues conducted behavioral analyses which corroborate Cheour's developmental time window of speech-sound perception. Their initial investigation involved a cohort of English-speaking adults who had never been exposed to Swedish or Thai. It showed that the adults possess different speech perception levels for contrasting sounds (L1 sounds versus L2 sounds). More crucially, they proposed a time window of 6 to 12 months of age during which infants can obtain the ability to discriminate sounds. For example, those who were raised in an English-speaking home for the period of 6 to 12 months were able to discriminate contrasting English sounds, but failed to discriminate contrasting Swedish or Thai language sounds (Nelson, 2000, p. 117). In short, linguistic experience between 6 and 12 months of age shaped their phonetic perception capacity.

Kuhl has drawn a specified time chart for infants' development of language perception and production (Kuhl, 2004). This chart upholds the previous idea that infants' language-relevant maturation ends after their first year. Within this time period, various language capacities are formed and language-specific behaviors are produced: infants start to produce vowel-like sounds by 3 months, complete the acquisition of language-specific perception for vowel sounds by 6 months, detect typical stress patterns at 8 months, recognize language-specific sound combinations at 9 months, produce language-specific speech at 10 months, start to lose perception of foreign-language consonants and increase perception of native-language consonants at 11 months, and produce their first words at 12 months of age. Importantly, these developmental stages are observed globally across many languages.

Werker and Tees (Werker, 2002) have proposed a similar age range for language critical periods. They conducted experimental studies which provide evidence of infants' high level of competence in speech perception. The infants in the study were trained to respond to changes in auditory stimuli with the "head turn" (HT) paradigm (sometimes referred to as a "habituation" paradigm) within a specified time interval (4.5 seconds). Three age groups (6-8 months, 8-10 months, and 10-12 months of age) of trained Hindi and English infants were tested for their correct responses. The results, using the "the 8 out of 10 correct response criterion," showed a significant reduction in competency in the 10-12 month age group compared to the younger two groups. The findings from this study suggest that the ability to discriminate non-native phonetic contrasts emerges within the first year of life, specifically around 10-12 months of age.

Taken together, the evidence suggests that the first year of life is critical in language acquisition, particularly in acquiring the ability to recognize phonetic contrasts. Therefore, those who want to acquire native-like speech sound perception should be exposed to an L2-speaking environment within the first 12 months, or more conservatively, within ten months of age.

The results of infant studies is similar to those of adult studies. For example, Hindi- and English-speaking adults were less salient than infants in discriminating a pair of contrasting sounds that were not used in their L1 (Werker, 1981). These findings are consistent with Greenough's experience-expectant model and O'Connor's critical period model: the experience gained within 12 months of postnatal age determines the rest of the developmental process and the effect is not reversible.

Plasticity is progressively lost as one gets older

One of the earliest proponents of progressive plasticity is Krashen (1973), who argues that there is a critical period for language acquisition, and that this period terminates at five years of age in a natural environment. Krashen argues that adults, as well as infants, are "plastic" or malleable depending on institutionalizations. Although adults tend to acquire limited language capacity in a natural environment, this limitation is somewhat recovered through sufficient institutionalizations (i.e., compensation through institutionalization), such as taking speech classes and participating in academic activities using L2. Other researchers have expressed similar views of the critical period, including Pinker's 6 years (Pinker, 1994), Lenneberg's 12 years(1967), and Johnson and Newport's 15 years of age(1989).

More recently, Kuhl has adopted a more flexible view of critical periods (Kuhl, 2004). In order to provide a functional description of the apparently linear language development during the first year, Kuhl has established a dynamic model called the native language neural commitment (NLNC) model. With the NLNC, Kuhl added the potential for a delay of language-learning plasticity induced by neuronal interference, although the timeline of language development seems to persist in a general form during the first year. Infants' perceptual, computational, social, and neural constraints have been found to affect language learning. Given the flexibility of the human experience, Kuhl argues that NLNC results support a phased developmental pattern, not an age-fixed pattern, and provides a "mechanism" for the critical period during the first year.

An event-related fMRI study provided

additional evidence for the argument that plasticity can be delayed in language acquisition. The crystallization hypothesis claims a progressive loss of plasticity over the lifespan, and expects "exposure to the L1 should leave long-lasting traces in the neural circuits sub-serving language processing" (Pallier et al., 2003, p.155). To confirm this hypothesis, Pallier and colleagues examined 8 adult subjects born in Korea and adopted by French families during childhood. The 8 participants ranged in age from 20 to 32 years old and had no contact with Koreans since their ages of adoption (3, 3, 5.5, 5.5, 5.5, 7, 7.5, and 8 years respectively). They were compared with a control group of monolingual French adults who had never been exposed to an Asian language. The study investigated the participants' language capacity using language identification tasks and word recognition tasks in conjunction with brain imaging. Due to the nature of fMRI comparisons, the study used two unknown languages (e.g., Polish and Japanese) for the baseline measurement and the other native languages (i.e., Korean and French) for the comparison.

The main finding of Pallier's fMRI study was that Korean adoptees and native French adults showed very similar patterns in their brain functioning. However, the study found two interesting differences between the two groups: (1) the extent of brain activation, when they listened to French relative to foreign languages, was larger in the French subjects than in the Korean adopted subjects, and; (2) Korean-Polish subtraction (i.e., Korean measured in comparison to Polish) showed stronger activation in the right superior temporal sulcus (STS) region of the French subjects than in the Korean adoptees. These results suggest the potential for long-lasting L1 traces in the neural circuitry.

This conclusion does not definitively support either the early exposure effect or late plasticity for L2 acquisition. The Korean subject groups had been adopted after 8 or fewer years of age and they showed equivalent French language capacity. Therefore, Pallier concluded that this study is not incompatible with Lenneberg's theory of a puberty critical period for L2 acquisition, where "puberty is associated with a biologically determined reduction in language learning ability" (Lenneberg, 1967; Pallier, 2003, p.160). In addition, traces from the brain-imaging studies support the idea that the replacement of L1 with L2 is not a single event, but rather a progressive change. However, what role the L1 traces play in L2 capacity in later life is still a matter of debate. The only certain conclusion that can be drawn is that the later an L2 is learned, the more the cortical representations of the L2 and the L1 will differ.

Language sub-processes are differentially sensitive to biological time

It has been convincingly argued that a window of opportunity for obtaining phonetic perception exists in early life and that the window closes after the first year (Kuhl, 2004) or, at the latest, during puberty (Lenneberg, 1967). Sound perception is fundamental to language listening capacity, and acquired listening ability in turn affects other language components such as speaking, reading, and writing. The existence of a critical period in sound perception was originally highlighted in the view of L1 acquisition, but also can be used to understand the process of L2 acquisition. The deterministic critical periods of sound perception seems negative for late L2 learners. In the mean time, it is also observed that some late L2 learners learn native-like accents as well as native-like speech fluency. Several studies have been conducted to uncover how the adult or late L2 learner can obtain a high language competency despite late L2 acquisition.

One line of debate argues for an extended biological timeline for sound perception: "people who begin learning L2 later in life can sometimes achieve native-like pronunciation" (Caudery, 1999). Theo Bongaerts and colleagues are among the scholars who claim that there is a late or no critical period for native-like accent acquisition (Bongaerts, Mennen, van der Slik, 2002). In several of their studies, late second language learners' accents were rated by native speakers of Dutch, and the researchers found the L2 learners' accents were as good as that of the L1 speakers. The results showed a combination of input, motivational and instructional factors are probably compensatory for the "neurological disadvantages of a late start" (Bongaerts, Mennen, van der Slik, 2002, p.298). Bongaerts et al.'s studies are meaningful in that they demonstrate a compensatory mechanism for critical periods. However, a direct comparison between Bongaerts' argument and Kuhl's critical period argument on the importance of the first year is difficult because the research measurements were different. Bongaerts' study was based on observational data, while Kuhl's study primarily relied on brain imaging data. Considering the nature of inner speech (i.e., thought) and that of verbal speech (i.e., behavior) (Vygotsky, 1966), participants' observable behavioral performance (oral speech) may not always reflect their thoughts (inner speech), which are in part measurable by brain imaging. In that sense, Bongaerts' study only displays the pattern of verbal speech, while Kuhl's brain imaging study examines inner speech plus verbal speech.

Brain imaging studies showing more flexible critical periods for L2 acquisition blossomed in the late 1990's. One line of studies in the adult brain was aimed primarily at revealing major differences in the cortical representations of L1 and L2 (Dehaene-Lambertz & Dehaene, 1994; Kim, Relkin, Lee, & Hirsch, 1997; Perani, et al., 1996). The study results show a similar degree of lateralization of language pathways across L1 and L2, but also reveal significant differences between L1 and L2 in different functional areas in the brain (Neville & Bavelier, 1998). Likewise, lesion and deficit data suggest a subprocess-specific critical period in infants. For example, early damage to the left temporal regions results in lifelong grammatical and retrieval problems. Prenatal damage to the right hemisphere is associated with deficits in vocabulary size between 10- and 17-months of age. Taken together, findings from the existent literature show that language sub-processes exist and that these processes differ in terms of task-specific maturational time sensitivity.

Task-specific development for L2 was also confirmed by Birdsong (1999) and Weber-Fox (2001). While their argument is not incompatible with the classical critical period theory, the main point was that the patterns of change vary for different language tasks. Indeed, "the findings are consistent with the hypothesis that the development of at least some neural subsystems for language processing is constrained by maturational changes, even in early childhood (Caudery, 1999; Birdsong, 1999; Weber-Fox, 2001)."

One example of a task-specific neural study is Weber-Fox and Neville's investigation regarding open- and closed-class words (Weber-Fox, 2001). Aiming to test the hypothesis that neural processes for language are heterogeneous in their adaptations to maturation and experience, they examined the interaction between delays in L2 immersion and the neural processing of closed- and open-class words in English. "Open-class words" are those that primarily convey referential meaning, including nouns, verbs, and adjectives, whereas "closed-class words" are words that primarily have grammatical functions in sentence processing, including articles, determiners, prepositions, and conjunctions. Due to the functional distinctions between them, revealing the developmental time courses across these two class levels of English words was presumed to uncover the task-specific critical periods in L2 acquisition. To this end, the researchers recorded ERP data on ten monolingual English speakers and 53 Chinese-English bilingual speakers who were grouped according to age of immersion in English: 1-3, 4-6, 7-10, 11-13, and >15 years of age. The subjects were asked to push a button, either "yes" for correct sentences or "no" for incorrect sentences, while looking at the sentence presented on a computer screen. As hypothesized, the findings indicated considerable heterogeneous growth patterns between closed-and open-class words. These results suggest that "the neuronal subsystems for grammatical processing appear to be more sensitive to delays in L2 immersion compared to processes mediating semantic interpretation" (p.1351).

Similarly, Sakai's brain imaging study (Sakai, 2005) attempted to test task-specific critical periods on a categorical basis of linguistic tasks. The study hypothesized two contrastive types of language abilities: 1) primary language ability, such as speaking and signing, which are innate or biologically determined, and; 2) secondary language ability, such as reading and writing, which are acquired in later in life. According to Sakai, of the many linguistic elements, grammar shows significant functional changes when one is in a transition from primary language ability to secondary ability, or from L1 to L2. On such a basis, Sakai attempted to show how the "grammar center (domain special neural system for grammar processing)" (p.817) functions differently in two groups of twin L2 learners. One group was a set of 13-year-old twins who were exposed to English learning for less than three months and the other group was a set of 19-year-old twins who had learned English for six years. Test results using transcranial magnetic stimulation (TMS) of English past-tense and English verb-matching showed brain activation of the grammar center was related to English proficiency and to age. The more proficient the participant, the stronger the grammar center activation. The 13-year-old group's grammar center was more activated than the 19-year-old group's grammar center. Sakai concluded that the "left dorsal inferior frontal gyrus (IFG) activation increases with proficiency level improvements at the early stages of L2 acquisition and becomes lower when a higher proficiency in L2 is attained" (p. 818).

Krishnan and colleagues' work (Krishnan, 2005) is also suitable to this section (i.e., critical periods specified by language subtasks) since they have studied experience-dependent neural plasticity for language. Krishnan's study hypothesized that language experience shapes neural processes of pitch perception. In order to explore the influence of experiences on pitch processing in the human brainstem, they recruited 14 adult native Mandarin speakers and 13 native English speakers. The Chinese subjects were late English language learners who had grown up in mainland China and migrated to the U.S. in their early 20's. The Chinese subjects were exposed to a spontaneous English language-use environment for less than 4 years. Krishnan and et al. compared pitch perception for tone-language speakers and non-tone-language speakers. The frequency following response (FFR) from Krishnan's study results revealed contrasting activities within the rostral brainstem between the Chinese subjects and the English speakers. The Chinese group presented "stronger pitch" (Krishnan, 2005, p.161) (reflecting robustness of neural phase-locking at the pitch periods) and tracked pitches more smoothly than the English group. Since the Chinese subjects were those exposed to an English-speaking environment for less than four years, the contrasting results may be the result of their different language experiences. Consequently, the authors concluded that speech input might be enhanced by past language experience, which could cause neural plasticity at the brainstem level.

One could ask why the neuronal developmental system onsets or offsets would be different across language subtasks. The mechanisms of different linguistic sub-processes with different critical periods are well illustrated in Knudsen's review paper (Knudsen, 2004). According to Knudsen, an opening sensitive period requires three conditions: "(1) sufficiently reliable and precise information to the brain circuit, (2) adequate connectivity of the circuit, and (3) activation mechanisms such as the 'capacity for altering axonal or dendrite morphologies'" (p. 1414). Suppose the existence of the task-specific critical period, any of three conditions is understandably expected to be met at a different time point across the subtasks. For example, L2 learners who do not accomplish a certain level of speaking ability probably did not pass the lower level of linguistic capacity, such as the conceptualization of basic words. In such cases, the L2 learners have some kind of potentiality of speech, but do not hold a sufficient ability to open the sensitive period. The presented empirical study results support the idea that continuous and sufficient experience is necessary to extend or maintain the capacity for later L2 acquisition, and that this capacity is manifested at different times across language subtasks.

Discussion

Given the importance of the L2 critical period, the current paper aimed to review and incorporate various lines of previous L2 studies concerning early experience and/or critical periods. These prior studies were outlined in four sections: (1) The critical period of L2 is equal to that of L1; (2) The first year of experience is decisive for acquiring L2 sounds; (3) Plasticity is progressively lost as one gets older, and; (4) Language sub-processes are differentially sensitive to biological time. Of these, (2) to (4) can be framed in the more global developmental models of O'Connor and Greenough.

The first-year critical period model holds similar arguments with O'Connor's sensitive periods model and with Greenough's experience-expectant model. The critical period, which the models support, is finite and irreversible and occurs relatively early in life. These researchers believe the critical period is part of an innate biological and/or behavioral development process, and that the timing is associated with critical points in one's survival. For example, infants' sound perception may play an important role as in discriminating between risks and benefits in an infant's life. The phonetic perception ultimately arises as part of their language expression: they can present their needs. Therefore, acquiring a sound perception is crucial for their survival. Unfortunately, there is a limited window for obtaining such perception-the first year according to first-year critical period proponents. For most late L2 learners, the first-year critical period view seems quite negative.

The age-dependent plasticity model resembles in part O'Connor's developmental programming model and cumulative model, as well as Greenough's experience-dependent model. These researchers believe any part of language acquisition relies on the learner's age, but do not fix "the time of opportunity" as a one-time critical period for L2 acquisition. Rather, they believe that L2 learners have less of a biological opportunity to develop, change, and acquire new information. Although the developmental programming model highly emphasizes environmental factors in human development, and the cumulative model focuses on learner's active engagement, they are similar to the age-dependent plasticity model in that they agree on later plasticity. Likewise, the possibility of plasticity in L2 acquisition was sustained in Greenough's experience-dependent model. While they involve different time points, the cumulative study results suggest that puberty is a critical period in L2 acquisition, which needs to be reinforced to maintain a certain level of L2 competency.

The sub-processes model seems microscopic in scope compared to the other models. These researchers ask more detailed questions about which part of the brain, which subtask of L2 acquisition, and at which point in time these processes develop. Different developmental courses are assumed for subtasks, including vocabulary, grammar, sound, and semantic processes. Empirical studies indicate that the semantic process is less susceptible to early experience than vocabulary, grammar, and phonetic processes. In the same context, later intervention may work in acquiring the semantic processes of L2.

The gap between the findings from the current review and the general Korean situation supports development or adoption of new programs to allow early L2 acquisition. In general, the educational programs for L2 learners in Korea starts ages 3-5, and the age range has been believed statistically and empirically as significant (Park & Suk, 2007). However, the condition of the current English L2 education does not satisfy suggestions from the existent literature, that is one needs to be exposed to a target L2 early as possible (e.g., within 12 months).

Other conditions such as psychological environments also have been suggested as essential for effective L2 acquisition (Jeon, 2003). The length and the onset are still debatable (Knudsen, 2004) depending on sub-tasks of L2 acquisition. Elaboration of task-specific timetables in L2 acquisition, either through brain imaging or through behavioral analyses, is necessary to clarify remaining questions. Nevertheless, one convergent result from the L2 developmental studies is the existence of the critical period for L2 acquisition in the young age (Jeon, 2003). Educators and policy makers need to make efforts to develope programs that can be provided at the earlier times and periods for L2 learners.

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제2언어 습득의 결정적 시기: 발달학적 모델에 기초한 문헌 분석

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제2언어에 학습자를 '언제' 노출시켜야 언어 습득을 최적화할 수 있을지는 외국어 발달 연구에서 여전히 논란거리이다. 뇌과학, 행동과학, 발달학 연구를 살펴 본 결과 제2언어의 결정적 시기에 대한 네 개의 가설을 얻었다. 첫째, 제2언어는 습득 측면에 있어서 제1언어와 동일한 결정적 시기를 갖는다. 둘째, 제2언어 소리 습득에 생애 첫해 경험이 매우 결정적이다. 셋째, 학습자의 연령이 증가함에 따라 언어 학습에서의 가소성(plasticity)을 점차 잃게 된다. 넷째, 하부 언어 학습 영역에 따라 각기 다른 생물학적 발달 시기를 갖는다. 본 연구에서는 이 네 개의 가설을 Greenough와 O'Connor의 발달 모델을 바탕으로 해석하였다. 본 문헌 분석을 통해 제2언어에 가급적 빨리 노출되는 것이 해당 언어를 습득하는데 유리하다는 결론을 도출하였다. 그러나 이론에 따라 언어 습득의 하위 영역의 결정적 시기에 대해서는 여전히 명확한 답을 내리기 어렵다. 언어 하위 영역에 따른 결정적시기를 제시함으로써 영어교육 방향 설정에 도움이 되는 연구가 더욱 필요할 것으로 보인다.

주제어: 결정적 시기, 제2 언어 습득, 뇌, 행동, 발달