

How Childhood's Linguistic Critical Period Influences Adult English Language Acquisition Phonological Insights in Consonants for Chinese-English Bilingual Learners

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Abstract: The Critical Period Hypothesis (CPH) has always been a topic of continuous debate in second language acquisition. This paper reports on a study investigating the ultimate achievement in English consonant pronunciation of late second-language (English) learners whose native language is Chinese. The research aims to explore the impact of the CPH on the ultimate attainment in English consonant pronunciation by comparing scores of adult and child English learners. This study involves speech samples from three groups of learners: one group is native English speakers as a control group, the second is late Chinese learners of English who are highly successful in listening, reading, and writing, and the third group is Chinese native speakers who started learning English from a young age. Professional native English speakers and AI will be used to score their speech samples. Throughout the experiment, we hypothesize the critical period does affect the production of phonological consonants. In addition, the results of the study could offer an enlightening point for pedagogy and could provide some advice for phonetic English learning in second language acquisition.

Keywords: Critical period, English consonant, Language production, Second language acquisition, Bilinguals

1. Introduction

Speech production has always been one of the important areas of second language acquisition research since it directly affects the quality and fluency of verbal communication. A very common belief concerning second language acquisition (SLA) is that children are better and faster learners than adults, and this belief is especially strong about phonology [1].

Age of acquisition is also a very important determinant of L2 speech perception abilities [2]. Despite widespread acceptance that language-learning aptitude generally increases through late adolescence, there seems to be widespread agreement among L2 researchers that adults lose some

important aspect of speech-learning ability that children still possess. This belief has found expression in what will be referred to here as the 'Critical Period Hypothesis'[3]. Many studies have investigated the influencing factors of speech production, such as conflating acquisition rate with ultimate proficiency [4]; unreasonable participant selection, and disputes between L1 and L2[5], but there is still little research on the impact of children's speech learning during critical periods on consonant production in adulthood.

This article mainly explores the critical period of phonological learning. It discusses the rationality and limitations of the phonological critical period hypothesis by examining the impact of children's consonant learning during this critical period on the consonant production of Chinese native speakers. This article determines whether CPH has an impact on Chinese native speakers' learning of English phonetics by comparing the scores of three groups on consonant pronunciation by having participants read words aloud. This article uses the method of scoring the pronunciation samples of the subjects using judges, aiming to explore the impact of CPH on the final benefits of English consonant pronunciation through the scores of adult English learners and children's English learners in English pronunciation. By synthesizing critical period theory and its practical application, this paper aims to provide practitioners and researchers in the field of language education with important insights into second language acquisition in phonetic learning to facilitate the development of more effective teaching methods and resources.

2. Literature Review

2.1. The CPH and MCPH

The critical period hypothesis is the core concept in the debate on the age issue in second language acquisition, first proposed by Lenneberg in 1967. According to this hypothesis, once an individual surpasses the age range of 2 years to adolescence – the prime window for language acquisition – the ability to reach the language level to a native-like proficiency (NLP) diminishes due to the lateralization of the brain. Consequently, foreign language learning becomes more laborious. This hypothesis is characterized by six major features and offers explanations from biological and physiological perspectives regarding age constraints in second language acquisition [6].

Stemming from this, researchers introduced the Multiple Critical Period Hypothesis (MCPH), which argues that different linguistic modules have distinct optimal starting and ending ages for acquisition. For instance, the critical period for conceptualizing the world is limited to the infantile phase from birth to 69 months; the period from birth to 4-7 years is important for children in segmenting sound sequences, mastering phonology, and acquiring lexical collocations; and up to about age 10 is considered the optimal period for vocabulary and syntax acquisition [7]. Closely related to the MCPH is the Joseph Conrad Effect, indicating that after the critical period, it becomes exceptionally challenging, if not impossible, for language learners to achieve native-like proficiency across all language modules.

Results from tasks like the Grammatical Judgment Test (GIT) suggest that learners who begin their linguistic journey post-adolescence might approach native proficiency in areas like vocabulary and grammar. However, their mastery in modules like phonology may remain wanting, thereby eliminating the possibility of adult learners achieving comprehensive native-like proficiency across all modules.

Ingleton demonstrated that childhood acquisition of a second language is more promising. Scovel argued that children tend to achieve higher proficiency in phonological acquisition, while adults often struggle to eliminate a foreign accent. Patkowski conducted a grouped study on English as a second language acquisition, finding that groups with a younger starting age scored better in English proficiency tests. Many scholars also concluded through various experiments that “Only children who

start learning a second language at an early age can achieve native-like proficiency in L2” [8]. Thus, from the perspective of outcomes, the premise that "younger is better" holds. Studies suggest that to achieve proficiency akin to a native speaker, learners should commence their language journey before the age of 10-12. Those who begin later witness a drastic decline in their learning pace around 17-18[9]. Research has pointed out that the dominance of the second language in a learner's linguistic system is a significant indicator of the outcome of second language acquisition.

However, some scholars have questioned this theory. They found that there are some individual language learners whose onset of second language learning is after this critical period but eventually attained a proficiency comparable to native speakers. Some scholars find that Native-like proficiency in L2 can be achieved by early second language learners and a minority of late starters [5,10-13]. So, some of them believe that the critical period doesn't exist.

2.2. Rational Criticism of the CPH

Since 2000, there has been rising opposition in the research field of second language acquisition concerning the Critical Period Hypothesis (CPH). The main lines of argument are as follows:

(a) Identifying successful adult second language learners as counterexamples: The existence of the Critical Period Hypothesis is challenged by individual cases of language learners who began learning after the supposed critical period but still achieved linguistic proficiency comparable to native speakers (termed "native-like late starters").

(b) Seeking evidence of a gradual decline in language ability: The term "critical period" emphasizes the "critical" aspect as a distinct cutoff point. Once past this critical period, language learning proficiency is presumed to exhibit a linear decline. Thus, evidence of a continuous decline in linguistic ability becomes one of the arguments against the Critical Period Hypothesis [14,15].

(c) Exploring the modular development of linguistic ability: The concept of "domains of native-likeness" has entered the research discourse. Many researchers have found that second language learners can achieve native speaker levels in specific linguistic modules but might struggle in others, such as phonetics [16-18]. This has led to the introducing of the concept of "domains of native-likeness."

(d) Investigating the influence of non-biological factors: While earlier research on the age-related constraints with the CPH at its core predominantly approached the topic from a biological perspective, post-2000 studies have also examined non-biological factors [19]. There's advocacy for a comprehensive consideration of external factors like socio-economic status, parental support levels, learning inclination, teacher competence and motivation, teaching methods, etc., to explain the age-related constraints in second language acquisition.

2.3. Research on CPH in Phonological

Scovel argued that children tend to achieve higher proficiency in phonological acquisition, while adults often struggle to eliminate a foreign accent. Birdsong drew the following conclusions through a comprehensive analysis of second language learners' ultimate achievement in lexical syntax and phonetics: (a) Observing all participants as a collective sample, the effect of age is undoubtedly evident. (b) For learners who came to the U.S. and started exposure to a second language after adolescence, the later they began, the lower their potential ultimate proficiency. (c) Results from most studies concentrating on those who arrived in the U.S. early are inconclusive.

Researchers have varying opinions on the applicability and explanatory power of the Critical Period Hypothesis (CPH). However, its existence in the acquisition of phonetics and intonation is rarely contested. This study explores whether there exists a critical period for Chinese native speakers in the phonetic acquisition of English. This could further confirm the significance of the critical period

in phonetics acquisition and provide instructional insights. According to the Multiple Critical Period Hypothesis, the period from birth to 4 to 7 years old is crucial for children to segment sounds, grasp phonetics, and learn vocabulary combinations. Beyond this period, acquiring authentic phonetics and intonation becomes challenging.

Although existing research on this topic is extensive, most studies on the critical period in phonetics tend to focus on bilingual speakers within the Indo-European language family. There's limited research on Chinese native speakers learning English, especially concerning consonants. Only a study has explored the consonants /s/ and /θ/ and connected them with the critical period [20]. To some extent, this phenomenon reflects the inadequacy of this research in this field.

While there is debate over whether the CPH applies to various language modules (like phonetics, syntax, grammar, vocabulary, etc.), the age effect on phonetic acquisition is hard to dispute. Empirical studies consistently show that phonetic acquisition is indeed constrained by the critical period. Beyond this period, achieving a proficiency level comparable to native speakers becomes difficult, especially in phonetics. However, this research still has some limitations. Long systematically outlined the limitations and shortcomings of empirical studies on the age effect in second language acquisition. These include conflating acquisition rate with ultimate proficiency [4]; unreasonable participant selection and disputes between L1 and L2[5]; short migration periods rendering participants' language proficiency as invalid data [21,22]; inappropriate measures of acquisition start time and migration start time [10]; improperly instructing evaluators [23,24]; and limited coverage of participants in daily language ability and language behavior measurements [5,10,25,26]. Many researchers have mistakenly categorized advanced language learners as having reached a Native-Like Proficiency (NLP).

Therefore, this paper focuses on ultimate proficiency, based on prior research, avoiding excessive variables. These include migration time and L1 and L2 opposition. The study incorporates AI evaluation to mitigate the subjectivity of human evaluators and solely investigates consonant pronunciation's attainment of NLP. It also excludes data where consonant pronunciation is accurate but word pronunciation isn't. Studies on age-related issues in language environments provide crucial insights into determining the starting age, pace, and methods of instruction. It is hoped that this research can guide the start age for English instruction in China, encompassing content and curriculum design.

3. Hypothesis

- (a)The critical period does affect the production of phonological consonants.
- (b)The critical period does not affect the output of phonological consonants.

4. Logic

Since we plan to explore the critical period's impact on consonant production, we will set up speech samples according to the differences between Chinese and English consonants. The reading task will be involved in the present study. Then, both the native English speakers without regional accents and the AI assessment software rate the participants' reading performance. The higher the score, the better the participants perform in terms of the speech production of consonants.

If the critical period affects consonant speech production, the scores of the three participants' groups will show a significant difference. Participants who study English before the critical period should have higher scores than those who look after the critical period. If there is no effect, the score will be reversed or more average.

5. Methods

5.1. Participants

Three groups of subjects participated in this study. All participants have no problems with their brains, hearing, vision, or corrected vision.

Group 1 consisted of 10 native speakers of British English (4 males and 6 females; average age 27), who spoke English with a neutral, non-regional accent.

Group 2 consisted of 11 Chinese native speakers (7 males and 4 females; average age 42). They were chosen for this study based on the assessment by university-level EFL professionals who consider them highly accomplished learners, exhibiting proficiency in British English listening, writing, and reading. Every participant in this group is deemed a late English learner who primarily learned the language through formal instruction, especially in the beginning stages.

Group 3 consisted of 20 Chinese native speakers (9 males and 11 females; average age 30). They embarked on their English learning journey between the ages of 6-12, following the guidelines from the book "Second Language Acquisition and the Critical Period Hypothesis."

To avoid the impact of dialects, participants in Groups 2 and 3 were all born and raised in Beijing, where the citizens are regarded as speaking the most standard Mandarin.

5.2. Materials

50 words will be selected as stimuli. The 50 words should be selected from the following criteria: 1. They are all chosen from a vocabulary database (based on the IELTS test) that all the participants have mastered. 2. Based on the existing research on the differences between Chinese and English consonants in terms of pronunciation. All the words contain English consonants that differ from Chinese ones in pronunciation from different cases, including the absent consonants in Chinese, the different consonants order from English to Chinese in words, and consonant clusters in English. Due to the vast number of words containing consonant clusters and those with consonants not at the beginning, and the difficulty in categorizing them, we have only selected a few as representatives and did not categorize the 50 words we chose.

Table 1: Words for the test.

measure	train	world	dream	drink	this	try	vain	drive	casual
vision	dry	than	love	change	very	thin	girl	vacation	other
sponsor	screen	two	with	super	trash	dress	garage	straw	brother
those	visit	wealth	transfer	decision	vulnerable	trade	they	drop	think
thick	trust	usual	mother	trouble	conclusion	vase	seizure	vote	draw

5.3. Procedures

The speech samples will be recorded by the researcher. The participants will be required to sit in a quiet room and promise to do this experiment without any distractions and interruptions before finishing. Before reading the words into the microphone, the subjects will be allowed to briefly look over the words printed on a sheet placed before them on table 1 where they sit. They will not be allowed to practice. When the experiment started, speech samples were elicited from all subjects by having them read the following 50 words two times. If any discomfort occurs during the experiment, participants have the right to terminate the experiment.

5.4. Data analysis

After the experiment, thirteen British English native speakers (6 males and 7 females, average age 44) assessed the speech samples. Their selection will be based on specific criteria: Residency in Great Britain; an educational level analogous to the Chinese participants in the study; a background as an EFL instructor or phoneticians; and, crucially, the ability to articulate standard British English devoid of any regional accent.

To ensure the objectivity of the experimental results, in addition to these 13 judges, an AI with the capability to evaluate speech accuracy will analyze the voice samples based on the same criteria, serving as a reference for the experimental results.

Each judge scores based on the speech samples they hear. All the words presented to the judges also included their phonetic transcriptions. We mark the consonants in each word. If the judge believes that the consonant in the word is pronounced at a native speaker level, then it is counted as one point. If the entire word is mispronounced, the word becomes invalid data. The total number of invalid data will be counted, and then the same number of words will be extracted from the thesaurus for detection again. The judges are tasked with scoring all 2,050 samples (i.e., 50 x 41). Each word will be followed by a 1-second pause, allowing the judges to deliberate. Moreover, a 30-second pause will be observed after each speech sample. Additionally, before the assessment, 10 preliminary samples from 10 distinct speakers who were not participants in the experiment will be presented for practice.

Before the rating task, the judges received written and oral tape-recorded instructions. They were also told they would hear speech samples provided by an unspecified proportion of native speakers of British English and non-native speakers of that language.

The artificial intelligence software will score the voice samples based on the following criteria: when the pronunciation of consonants matches 90% with their pronunciation in its database, it is counted as one point. It will rate all 2050 (i.e., 50×41) samples for accuracy as well.

The measurement is the average score. We eliminate the correct score in consonant pronunciation but wrong in word pronunciation and any accidental mispronunciations instead of their inability to produce the sound. For the study, we will utilize the subjects' second attempt at reading words unless irregularities such as tongue slips or hesitations are present. In those instances, the first attempt will be preferred over the second. To evaluate the similarities and discrepancies between the AI and judge-assigned ratings, the Euclidian distances of the rating patterns from the 13 evaluators were computed through the SPSSX-proximities process. Each pattern contains 2050 ratings, corresponding to each combination of subject and sample. Using SPSSX-alscal, the AI and judges are represented multidimensionally based on these Euclidian distances. A two-dimensional layout is sufficient, as indicated by a stress value of 0.089. In this representation, dots signify judges, while triangles indicate the AI. Distances between these markers mirror the rating variances between the AI and the judges. Employing the Mann-Whitney test on the distances from the strict pattern produces a z-value ranging from 0 to 1, showing more similarities between judges and AI. In this case, we will discard one rating data set and calculate the group average. If it is more than 1, then it shows fewer similarities judges between judges and AI. We will introduce Excel for data analysis. We remove the highest and lowest values, respectively, and then calculate the average of the judges' and AI scores for each participant. Finally, the average scores of each group are calculated and compared.

6. Results and Discussion

The impact of the critical period in L2 speech acquisition can be seen in participants' performance in consonant production. Therefore, the possible results are as follows:

(a) If the average group score of Chinese native speakers who started learning English before the critical period is significantly higher than the average group score of Chinese native speakers who started learning English after the critical period, it demonstrates that the critical period does affect consonant speech production.

(b) If the difference in mean value between the two groups is small or even the average score of the group of Chinese native speakers who start learning English before the critical period is lower than the average score of the other group, it indicates that the most phonetic consonant production during the critical period has no significant effect.

7. Conclusion

Starting from the field of the influence of the critical period of adults' second language acquisition, we designed a scientific and rigorous study to explore whether the critical period will affect the production of phonetic consonants. Based on the common phenomena in adult L2 acquisition and previous theories, we analyzed a large amount of existing literature and made reasonable hypotheses. To conduct the experiment and data analysis, we also introduce multiple methods and data patterns, which makes our results more reliable.

7.1. Implications

(a) It may explain why adults commonly show poorer performance in L2 acquisition, especially in speech production.

(b) The research on the difference in consonant speech production makes the research on the critical period of speech more detailed.

(c) The study results could offer an enlightening point for pedagogy, especially in settings wherein the English language is disseminated to non-native speakers.

7.2. Limitations

(a) Only native Chinese speakers learning English were selected as participants in the experiment, so there is more reference significance for Chinese-English bilingual learners.

(b) The speech samples don't include all consonant types, especially the relatively rare and complex types.

7.3. Future Enquiries

Given the scope of this subject, there's room for further inquiry and refinement. Future studies could benefit from examining the role of frequency and radical consistency. It would also be intriguing to broaden the participant pool beyond Beijing, gauging whether regional linguistic nuances play a part in phonological expression.

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