

Critical Periods in Language Development

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ABSTRACT: Children can learn many languages at once, and infants begin to talk early in life because of critical periods in language development. Language acquisition has been studied for many years. Experimenters and observers concluded children and infants can learn languages quicker and more naturally than adults (post-puberty). In this paper, we will go over how different components of language change with age and the main parts of developmental critical periods, including phonetic specialization contrasts, word formation, and sentence stringing/grammar. Learning how languages develop with age is crucial because we can understand why the brain has heightened times of language development and what functions the brain uses to retain and develop language. These discoveries can be useful in spreading the importance of bilingualism for infants, helping with language development for speech-disordered children, and improving the second language learning curriculum in the U.S. public school system.

KEYWORDS: critical periods, language development, phonetic specialization contrasts, word formation, and sentence stringing/grammar.

■ Introduction

Many researchers have theorized that if a human does not learn any verbal or nonverbal language from infancy to puberty, they may never learn any language. Although there is no way to experimentally test this theory on humans, as it would be inhumane, scientists have formed observations and proved critical periods in language development. A critical period is when a behavior is especially sure to develop, given environmental input.¹ Although most people connect age with the brain's cognitive abilities and intelligence, infants can learn languages more easily than adults who know how language structure and the world works.²

Although many studies and papers have been done on critical periods in language acquisition, we need one that connects the studies and summarizes them to benefit second language learning. This paper will cover language development from infancy to toddlerhood, ultimately concluding the importance of simultaneously introducing multiple languages to children. Studying how and why language develops quickly in infants can also help scientists further understand what system speech-disordered children lack that others possess.³ Some of these disorders include speech delay, stuttering, and motor speech development.⁴

This paper will review experiments using eye-tracking devices that conclude that infants have a broad ear for differentiating sounds/phonetics.⁵ We will also look at pioneer studies such as the genie psychology case study, which shows us what would happen if language does not develop during critical periods.⁶ These previous works allow us to conclude that there are critical windows in language development where phonological, word-forming, and sentence stringing occur.

Phonology: making sounds:

Phonemes are units of sound used in a language.⁷ Every language has a different set of phonemes; some may be similar, while others are non-existent between two languages. For example, phonemes in the English language would be /pa/ and /ba/. The phonemes are used to make up words and differentiate the meaning of the words. The phoneme /pa/ added to the root -at creates pat, a completely different word, meaning than bat, which would be the word created when /ba/ is added to the root. Babies begin to make sounds and babble at six months with no rhyme because they have developed motor skills to do so. They can hear and differentiate when the phonemes around them change.⁸

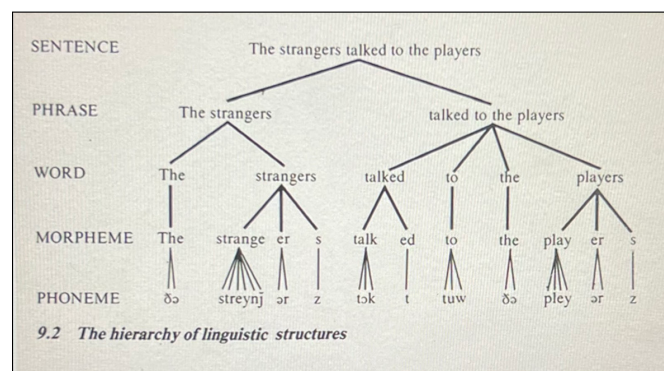


Figure 1: The figure above shows the development of language segments from phonemes all the way to a sentence.⁹

Many experiments have been done on the capacity infants have to differentiate phonemes. For example, *The Conditioned Head Turn Task* is done on infants of various age groups to test their ability to recognize phonemes not used in their native language.¹⁰ The experimenters go through several conditioning and criteria trials where they condition the infants

to turn their heads when the infants hear a different sound being made in the background. At first, a reinforcer is needed to initiate the head turn, but by the criteria stage, the infant should make anticipatory turns when the phonemes change. Once these two stages are complete, the experimenters move on to the testing trial, where phonemes are played randomly in the background. Different age groups varying from 6-8, 8-10, and 10-12 are tested on being able to turn their head when sounds, which should be undetectable to them because it's not in their native language phoneme range, change. The results showed that English-learning babies aged 6-9 months could differentiate the Hindi /da/ and /dtha/, phonemes not used in their language. However, the ability was lost with the older infants, and they could only differentiate the English phonemes /ba/ and /da/. This experiment shows how, past the phoneme differentiating critical window, infants narrow perceptually to only their native language's phoneme range.

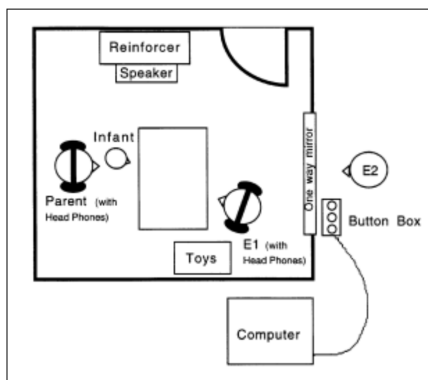


Figure 2: A schematic diagram of the *Conditioned Head Turn* procedure. The figure above shows the experiment visually. The components include reinforcer, experimenters, infant, and speaker.¹¹

The critical period of distinctively contrasting the basic phonemes is 4-9 months, but the ability is lost by 10-12 months.¹² This experiment shows how if an infant were exposed to multiple languages during this critical period, they would be able to perceptually narrow to two language sets of phonemes instead of one. This differs from when an adult is learning a second language because they have already passed this critical period and have narrowed it to one set of phonemes. It would be much more difficult for an adult to correctly pronounce every sound in a second language than for an infant within the phonetic specialization time period.¹³ Critical periods show how much acquiring language changes with age. As infants grow older, other language components begin to form, like word-forming, and infants become more tuned to their native language's phonemes. Now, instead of being able to hear different phonemes, they can pronounce and practice using the phonemes. This leads to word formation.

Word Formation: assigning names:

Most infants say their first word at 12 months; by two years of age, they know around 50 words.¹⁴ By three years of age, the average child knows over 1000 words.¹⁵ This critical period requires environmental input as an infant assigns words to objects and ideas during this time. Noam Chomsky pioneered the theory of LAD (Language Acquisition Device) and stated that humans are born with the innate ability to

language.¹⁶ The LAD is an example of a nativist view on cognitive ability, which states our understanding of the world is innate, and we have core systems.¹⁷ This is contrary to the empiricist view on cognitive ability, which states that information is perceived fully by observation, experience, and repetition. If the empiricist view were correct over the nativist view, then toddlers wouldn't be able to tell what property of an object was being referred to when the word was connected to an image. For example, when an adult said the word "cat," the child wouldn't know if the adult was referring to the animal, its furry exterior, its meow, etc. Similarly, when a word is said when referring to a picture, the infant wouldn't know the object or idea to which the word is connected. During the critical period of word formation, infants are exceptional at correctly identifying these connections based on their privileged hypothesis and acquisition device. The LAD concept is an instinctive mental capacity that allows an infant to acquire and produce language. This acquisition device is specific to the critical period. It is vital to how babies can grasp words so quickly and know what idea or object the word is referring to (privileged hypothesis).¹⁸ In contrast, when learning a language as an adult, the acquisition device does not exist. Adults learning a second language must depend on their memorization to learn words.

By nature, infants are much more observant, and when learning their first language, they are also learning the world around them. This is why the "native" language is truly a person's perception of the world. A native language is the first primary language a person learns. A person could have two native languages if the languages were learned simultaneously since infancy, for example, bilingual homes.¹⁹ When adults learn a second language, they've already grasped the world and are less observant because it is their second language. Infants' curious character leads to intense observation of the world around them. Another reason infants can acquire language during these critical periods is that brain plasticity is at a peak during infancy.²⁰ Brain plasticity is the ability of the brain to rewire itself according to new information. Without brain plasticity, the brain would be incapable of developing from infancy to adulthood.²¹ There is a relationship between plasticity and age, as our brains become more stable as we grow into adults.²² Adults are more settled in their views and lose the ability to rewire their brains when acquiring a second language.²³ This critical period shows how much language acquisition changes with age. When infants learn to say words, they are learning the world for the first time, so they are forced to learn the corresponding word to each object and idea.²⁴ However, the same does not apply to adults learning second languages. Adults learning second languages can survive and communicate with others regardless of acquiring a second language. They know the world around them and learn words by memorization rather than observation and building the world around them for the first time.²⁵ This word formation critical period proves infants and toddlers are going through a peak moment of language acquisition at their age. Acquiring a vocabulary the way infants do is an ability humans lose past the age of the critical period.

The drastic change from knowing, on average, 50 words at the age of 2 to over 1000 at the age of 3 can also be credited to the practice of speaking in sentences.²⁶ The ability to learn words grows rapidly when a child can communicate in conversations.

Grammar: sentence stringing:

There is an overlap of the word formation and sentence stringing critical periods for some time. At around age 3, toddlers begin to form sentences with three words and upward.²⁴ Sentences begin to include subjects, verbs, direct objects, and adjectives. These complete sentences allow the toddlers to communicate with others in conversation form.²⁷ The conversations lead to learning more words simply through speaking because an adult uses new and filler words. Filler words are words that are said in between verbs, adjectives, and general speaking.²⁸ Some examples include like the, you know, and um. Words like these don't have an object for children to connect them to. No child is specifically taught these words; they are just picked through social interactions and speaking in complete sentences.²⁹

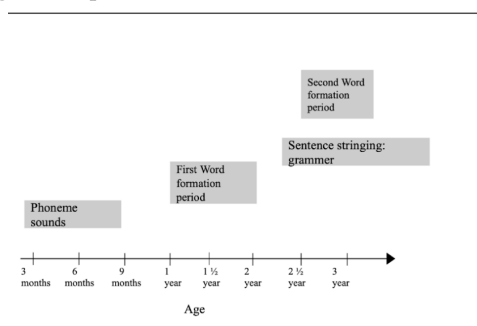


Figure 3: The figure above shows the critical periods existing throughout the age. The second word formation period and grammar co-exist. This graph summarizes the development of language throughout the age.

Additionally, toddlers begin to categorize the sentences in the correct grammatical way, introducing past tense and pronouns. Sentences begin to include more words and prepositional phrases. Sentences go from “Sally runs” to “Sally runs to the park.”³⁰ The latter sentence has a noun, verb, filler words, and a direct object. Children learn to chronically organize sentences without even knowing what the components are.³¹ Pronouns are, again, not taught to toddlers, but they pick it up without noticing. Sentences go from “Sally runs” to “She runs”. Through these additions to vocabulary and speaking, children become fluent in their native language(s).

This process is also specific to the language the child is learning. Languages have different grammar rules and structures. For example, in English, a child would say “beautiful house,” while in Spanish, a child could say “casa bonita,” which translates to “house beautiful” in English, an incorrect phrase according to English grammar rules. A person trying to learn Spanish as an adult would struggle greatly to use the grammar naturally in a way that makes sense to them. On the contrary, infants learning Spanish and English at once could swiftly use the grammar specific to the language they are speaking. The children could unconsciously keep the

grammar of the two languages separate, showing how critical grammar development is in this period.²⁵

Tenses like past, present, and future are added to toddlers’ language during this critical window. Toddlers can pick up past and future tense rules without being taught.²⁹ For instance, they can unconsciously pick up the root -ed for past tense words. Children will then apply this to every verb they come across: -ed to stop, yielding stopped. Likewise, with irregular verbs, the root -ed is added to run, yields runned, but this verb is not the valid past tense. The fact that toddlers incorrectly apply the rule to verbs shows they can spontaneously identify verbs and that they happened in the past.²⁹ A famous experiment shows this process of learning grammar rules unconsciously in another way. The *Wug* Test is set up to show a picture of an imaginary animal with the nonsense name Wug to a toddler.³⁰ It continues to add another Wug to the equation. The experimenter communicates, “Now there are two. You have two.” The experiment allows the toddler to give verbal feedback where a toddler communicates back “wugs.” This shows that toddlers have picked up on plural tense and can apply rules to words they’ve never been introduced to, like the Wug.³¹

All these rules don’t have to be taught because there is a critical period where children pick them up without trying. One instance shows what would happen if children were not in an environment where these critical periods could be developed. The Genie Case Study follows a girl who was abused throughout her childhood and never had the chance to develop language due to a lack of social interactions.³² She was rescued, and linguists were very interested in how her language would develop now that she was past the ages of critical periods for most language learning. Genie went on to learn many vocabulary words and even began to speak in short, incomplete sentences. She would say, “I want apple,” instead of using the correct grammar.³³ Genie couldn’t fully develop language skills. Even with the help of some of the most renowned experts in the field. Her case shows, to some extent, how crucial these critical periods for language functions are.

This grammar/sentence-stringing critical period proves toddlers are much better at picking up all grammar aspects of language without knowing what they are. The fact that toddlers can learn two languages’ sets of adjectives, verbs, tenses, nouns, and more simultaneously and keep them separate proves the existence of a critical period.^{25, 31} Past the critical period, an adult would take much more time and effort to use tenses for each verb correctly. This critical period proves, again, that infants and children are the best language learners.

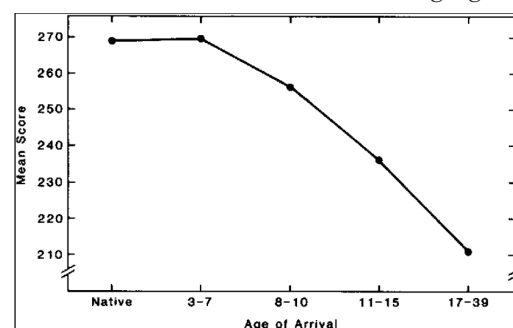


Figure 4: The graph above visually demonstrates grammar tests taken by several adults. The independent factor was when they had arrived in the country where the language being tested was spoken. Native speakers of the country and language ranked the highest, with the scores decreasing as the age of arrival increased. This shows the two factors have an indirect relationship. The later a person begins to learn a language reflects how accurate their grammar is.³⁴

■ Discussion

There are critical windows for language development where phonemes are identified, words are formed, and grammar rules are learned.^{1,4} The research for this paper was conducted on Google Scholar primarily. Keywords such as critical periods, language acquisition, phoneme specialization, and word formation were used in the search to understand the previous studies of critical periods fully. These keywords allowed information to be gathered on the three critical periods mentioned in this paper and discover experiments/studies done on critical periods. Although many scientists have studied critical periods, the experiments could expand in some areas. Acquiring verbal language is one of the defining characteristics of the human species.¹⁷ Although there are critical periods, almost any other factor of one's environment could uniquely affect one's language acquisition. While researching scientific studies and journals for this paper, it was noted to include papers and information on other factors of children's language learning, like brain plasticity and LADs, to fully explore the other reasons that may overlap and affect critical periods in language learning.^{17, 21} Although there are critical periods in language development and ages assigned to those periods, every child is different. Many infants don't say their first word until three years of age and grow up to fluently speak their native language.¹⁶ Some children begin to practice grammar rules and form complex sentences earlier than three years of age. Critical periods do not always have an acute period to which they can all be defined and spotted.³ In this paper, we did not discuss all the hypotheses that cloud critical periods. Some scientists claim that higher differentiation of phonemes in infancy can lead to better second language acquisition when those infants are adults.³⁵ Referring back to the Genie Case, although it gives experts an idea of what would happen if language did not develop past critical periods, the case cannot be used as concrete proof. Genie was a one-of-a-kind instance for a good reason. She cannot be compared to anything else for reference; we don't know all the independent cases. There is no way to tell if Genie was born with a speech and language disorder, leading to her inability to speak, or if her abuse left a permanent mark on her mental state, hindering her from reaching language milestones.³³ In this paper, we also didn't fully cover LAD for adults due to a lack of studies on language acquisition devices in adults. We only covered three critical periods, although more exist throughout the age. Critical periods are agreed among most linguists to exist, but other factors such as brain plasticity, LAD, the high concentration of observation among babies and toddlers, the lack of any prior spoken communication, and more could also lead to children being better language learners than adults. Language learning certainly doesn't stop at the age of 3. Many possibilities are yet to be proven regard-

ing studying and concluding human language development. There are gaps in the study and future directions to where the study of language development and critical periods could go.

■ Conclusion

The studies covered in this paper show the importance of language development at a very young age. They can all come to one agreement: teach infants multiple languages at the same time, as young as a few months. Language learning begins the second a newborn is born, and even in the womb, babies are the best language learners.³⁶ They can learn many languages simultaneously, aching the pronunciation, word connections, and grammar while still keeping the languages separate from each other.³⁷ Other factors, such as peaked brain plasticity during infancy and the curious nature of infants, also point to the fact that they are exceptional language learners.²¹ Knowing multiple languages is an extremely valuable skill, and babies are far too naturally gifted at learning languages not to give them input into multiple languages.

As said in the review paper earlier, studies on critical periods and how language develops can be applied to second language learning. In the United States, most public schools introduce second languages to kids at a high school level. Most high schools require several years of language learning to graduate. However, many high schoolers find it challenging to acquire language during the years of their life when their ages range from 14 to 18.³⁸ It is now known that the essential critical period of language learning for most aspects of language is pre-puberty, so language should be required earlier in the US public school system like other countries. For example, in Germany, while still learning German, usually at home, children are introduced to English learning or another second language at a primary school level: ages 4 to 6. English is learned throughout the remainder of their school and adult life. Germans are much more advanced at English by a high school age than a US student who only got introduced to German; for example, at the age of 14, 60% of Germans can speak a second language due to school learning, while only 10% of Americans can speak a second language from school.³⁸ The US public school system could reshape its curriculum based on the critical period's studies, and bilingualism could be much more common when earlier language learning is expanded. Critical periods can also be a foundation for studies of speech disorders. Using the knowledge of critical periods, scientists would be able to identify what time period and age in which speech-disordered and delayed children lack acquisition. These are all hypothetical claims on how our world as we know it could change when critical period knowledge is applied.

From this paper, it can be concluded that there are critical windows in language development where phonological, word-forming, and sentence stringing occur. The critical periods are the ages of a child when they are especially prone to developing specific parts of language. Those periods build on each other with age. Our ability to acquire language changes with age.³ It begins with young infants being able to differentiate the languages and phonemes used, to when that critical window ends and older infants use their motor skills to pronoun-

unce phonemes. Babbling leads to the word formation period, where babies can use their observation skills, curiosity, and acquisition device, in addition to the critical period, to soak in words. A second word formation period co-occurs with the sentence formation period. The two periods benefit each other, learning more words, leading to better grammar and speaking better sentences, leading to learning more words. These critical windows for language development are vital to regulating a human because language is part of who we are and critical to our well-being.

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