

# Phoneme Modification in the Speech of Central Kurdish Children: A Phonological Study

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## Abstract

This study looks into the articulation and modification of native Central Kurdish (CK henceforth) by preschool children aged three, four, and five. It investigates the order of acquiring the consonants and examines the modifications of the consonants that are not fully acquired. The study also aims to find out variation among the different age groups in terms of consonant articulation — if and how the younger children articulate the consonants differently from the older ones. Children’s acquisition of L1 (what is L1? This is first mention, give the full form) consonants is researched in many languages. Consonant articulation and modification is language-specific; it is important to examine the phenomenon in different languages and varieties. However, the review of the literature suggests that this topic is not studied in CK. Therefore, 42 preschool children are examined in articulating the CK consonants in different word positions: initially, medially, and finally. Picture naming task is used as a data collection process. Results indicate that consonant accuracy significantly increases with age, with the most notable difference between three-year-olds and five-year-olds, while gender differences were not statistically significant. Loan consonants /h, ʕ/ and back consonants were modified most often, while fronting and coarticulation were the most prevalent modification processes observed.

**Keywords:**  
phonology  
Central Kurdish,  
preschoolers,  
consonant acquisition,  
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## About the Journal

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## 1. Introduction

First language acquisition requires the mastery of perception and production of phonological features of the target language, which involves the mastery of vowels, consonants, and suprasegmental features (tone, stress...). Among these, the mastery of consonants plays a particularly vital role due to its functional role in word formation (McLeod & Crowe, 2018). Many researchers have tackled the acquisition of L1 consonant phonemes across a variety of languages. In their way, they stumble upon some phoneme alterations in word articulation which is called phonemes phoneme modifications that occur during word articulation, especially at the early stages of speech development, from age zero to five years. Since the mastery of consonants is one of “the most widely used metrics of typical phonological acquisition and of phonological disorder” (Edwards & Beckman, 2008a, p. 937) studying the phoneme modifications has almost the same effect. In other words, once the phoneme modifications that occur in the typical speakers of one language are identified, the deviations lead to atypicality. Considering the importance of the mentioned subject, numerous studies have been conducted on similar subject matter in the literature. Many researchers have attempted to design articulation tests to pinpoint the phonological processes occurring in languages across the world such as Clinical Assessment of Articulation and Phonology (CAAP-2), Hodson Assessment of Phonological Patterns–3rd Edition (HAPP-3) by Barbra Hudson (2017), The Swedish Articulation and Nasality Test (SVANT), Schindler’s repetition test, and in Bahdini Kurdish there is a recent research designed by Ahmed called Bahdini Kurdish Articulation Test (BKAT) (2023). Since the articulation tests are language-specific, every language or variety requires a specific test and a unique investigation since they have a specific set of phonemes (Gharib, 2022). Given that, none of the previous research and tests were designed for the CK variety, forming a gap in the literature which this research attempts to fill. In addition, to the best of the researcher’s knowledge, the consonant modifications that occur in the speech of children have not been addressed in CK yet, creating another gap that needs to be filled.

To address these gaps, this study aims to evaluate consonant acquisition in Central Kurdish speakers between the ages of three and five. A primary objective is to identify the common phoneme modifications that occur in their speech, highlighting the full spectrum from the most to the least frequent processes observed in this age group. Furthermore, by designing and implementing the Central Kurdish Articulation Test (CKAT), this research seeks to establish a practical tool for the early recognition of both typical and atypical speech development. This paper addresses two primary questions: (1) What are the phoneme modifications used by Central Kurdish-speaking preschoolers? and (2) Which of these modifications occur with the highest and lowest frequency? To answer these questions, the paper will first detail the key phonological features of Central Kurdish. The subsequent section outlines the research methodology, followed by a presentation and analysis of the results, a discussion of their implications, and a final conclusion.

## 2. Literature Review

### 2.1 Central Kurdish Phonological Features

The Kurdish language, spoken mainly in Turkey, northern Iraq, western Iran, Syria, and Central Asia, is part of the Proto-Iranian language family (Hamid, 2019), with an estimated 30 to 40 million speakers and a sizable community in the diaspora (Ahmadi, et al., 2024) (Britannica, 2024). According to Haig, Öpengin (2014) and Fattah (2000) Kurdish language can be classified into five dialects: Northern Kurdish, Central Kurdish, Southern Kurdish, Gorani, and Zazaki. In this paper, the focus is only on the Central Kurdish (CK) dialect which is spoken in the Provinces of Sulaimani, Kirkuk and Erbil in Iraq and Kurdistan province in Iran.

The consonant of CK according to Hamid are 28 that include /p/, /b/, /t/, /d/, /k/, /g/, /q/, /ʕ/, /ʔ/, /m/, /n/, /ŋ/, /tʃ/, /dʒ/, /f/, /s/, /z/, /ʃ/, /ʒ/, /x/, /h/, /h/, /r/, /r/, /j/, /w/, /l/, /l/ (as shown in Table:1) excluding /v/ according to Hamid (2016) “the phoneme /v/ in northern Kurdish seems to be

cognate with the /w/ in CK” (p. 16) and that is what this paper agrees with too. The CK consonants have several diagnostic traits. One of the apparent features is the trill/flap opposition /r:r/. This can be demonstrated in minimal pairs like: /kar/(deaf) and /kar/(donkey), changing a phoneme to another in the same phonological environment changes the meaning of the word. Similarly, in CK the dental and velar /l:l/ are also two different phonemes. The evidence is minimal pairs, in words like /tʃil/(forty) and /tʃil/(branch), changing the phonemes form minimal pairs.

Table 1: CK consonants and their articulatory features by (Hamid, 2016)

	Bilabial	Labiodental	Alveodental	Alveolar	Postalveolar	Palatal	Velar	Uvular	Pharyngeal	Glottal
<b>Stops</b>	p b		t d				k g	q	ʕ	ʔ
<b>Nasals</b>	m		n				ŋ			
<b>Affricates</b>					tʃ dʒ					
<b>Fricatives</b>		f		s z	ʃ ʒ			χ	ħ	h
<b>Trill</b>				r						
<b>Flap</b>				ɾ						
<b>Central</b>						j	w			
<b>Lateral</b>			l	ɭ						

Additionally, borrowing phonemes from contact languages like Arabic, Iranian, and Turkic languages is visible in CK. One of the borrowed phonemes is the uvular stop /q/ which is shared with other Iranian and Turkic languages as well as with Arabic. Other borrowed phonemes are the glottal stop /ʔ/ and pharyngeal /ħ/ are borrowed from Arabic (Haig & Matras, 2002). However, the vowels are out of the scope of this research. Thus, they are not tackled.

## 2.2 Previous Studies on Consonant Acquisition

A significant finding in L1 acquisition is the gradual increase in correct articulation. Meaning, there is a positive correlation between age and correct articulation. This finding is supported on a universal scale by McLeod and Crowe's (2018) cross-linguistic review of 27 languages, which found that the mean accuracy for 5-year-olds reaches 93.8%. Similarly, research on Bahdini Kurdish (BK) children reported accuracy rates of 77% at age 3, rising to 88% at age 4, and 94% by age 5. This trend is associated with the developmental factors, including the development of oral-motor and neurological systems, alongside increased exposure to language (MacLeod, et al., 2010; Ahmed, 2023). While this trend is universal, there are several language-specific traits, such as the specific rate of acquisition, the age of mastery for individual phonemes, and the overall inventory of sounds acquired by a given age.

The sequence of phoneme mastery is significantly language-specific. Research, providing a cross-linguistic context, by McLeod and Crowe (2018) highlights a predictable sequence of consonant acquisition based on the complexity of articulation. Their findings indicate that early-acquired consonants (mastered by 3;11) include stops (/b, d, t, k, g/), nasals (/m, n, ŋ/), glides (/w, j/), and the glottal fricative (/h/). Later-acquired sounds include fricatives and affricates (/s, z, ʃ, ʒ, tʃ, dʒ, v, ð/), liquids (/l, ɭ/), and the interdental fricative /θ/, which is often the last sound mastered, sometimes after age 6.

However, this pattern is adopted differently in each language. For instance, Ahmed's study on Bahdini Kurdish (2023) showed that a different set of phonemes, including /p, t, tʃ, ħ, x, ʕ, f, m, n, h, w, d, l/, were mastered before age 3; a notably larger and different inventory than the early-acquired consonants in English or Arabic (McLeod & Crowe, 2018) and Québécois (MacLeod,

et al., 2010).

### 3. Methodology and Data Collection

#### 3.1 Research Design

A test called CKAT (Central Kurdish Articulation Test) is designed to achieve the objectives of the research. It is essential to evaluate the articulation of the phonemes in natural word production to assess children's phoneme modifications. CKAT is structured to examine the phoneme articulation of Central Kurdish in the initial, middle, and final positions of words through a Picture-Naming Test.

The test consists of 75 tokens (68 words) with seven types repeated twice and their corresponding pictures. The explored phonemes are solely the consonants. All of the consonants in CK have been included in this research which are 28 consonants. However, some consonants have a defective distribution, such as /ʔ/ and /ŋ/, which means they do not occur in all possible phonetic environments. While, for others, to the best of the researchers' knowledge as a native speaker of CK, a suitable representation (picture) or concept (word) could not be found in the target language. Therefore, not all the consonants are explored in all positions. The focus on consonants in this study goes back to several factors. Most importantly, the consonants are more reliably transcribed (Pollock & Berni, 2001). Also, vowels are acquired before the consonants and in a very young age, consonants take a longer time to develop (Dodd, et al., 2003) (Smit, et al., 1990). Finally, while dependent on dialects, vowel may vary hugely (Pollock & Berni, 2001).

In choosing each word and its corresponding picture, the cognitive level of the selected age group is highly considered. The concepts are chosen based on the commonality of their usage in the daily life of the target language users. Additionally, 90.6% (68 out of 75) of the pictures represent one phoneme in a certain position, while 9.2% (7 out of 75) are used to represent two phonemes to make it less time-consuming and more engaging for the participants. Moreover, the selected age group is yet to learn reading, thus, picture naming is seen as the best option in the current case, similar to other studies in the same field (MacLeod, et al., 2010), (Prather & Hedrick, 1975), (Arlt & Goodban, 1976), (Dodd, et al., 2003). On these accounts, CKAT is cautiously constructed, aiming to explore phoneme modifications of native CK speakers corresponding with the designed test.

#### 3.2 Participants

The participants of CKAT are 53 Central Kurdish-speaking preschoolers between the ages of 3 to 5 years who are residents of an area where CK is spoken. The selected age is considered to be the most appropriate, as by the age of 2 most children have a very limited vocabulary bank, and their words are mostly vague to be understood by adults (Vihman, 1996). Whereas, by the age of 5, most of the phoneme modifications seem to disappear (Vihman & Miller, 1988). Therefore, the target population covering 3-5 aligns best with the objective of the research. In this test, the preschoolers with any speech abnormalities are excluded. Since the objective of this study is to establish a baseline for typical articulation patterns, preschoolers with any known speech abnormalities were excluded. To achieve this, the caregivers are consulted and asked to exclude kids with any speech disorder. Moreover, the researchers evaluated the participants through normal conversations before the test. Also, any preschooler with a dominant effect of foreign languages is excluded. It is also worth mentioning that the research adheres to ethical guidelines by preserving the identity of the participants. The participants remain anonymous and are identified by numbers; only the recording of their articulation is used for the purpose of this research.

The participants are selected and compared based on their age and gender. In the first stage, the sample participants are distributed as shown in Table 2.

Table 2: Participants of CKAT

Age	Male	Female	Total
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<b>3</b>	8	7	15	53
<b>4</b>	12	6	18	
<b>5</b>	5	15	20	
<b>Total</b>	24	27		

However, a group is carefully chosen to be eliminated using a purposive sampling method with regard to the mistakes they made, the hints they were given, the effect of foreign languages like English, and maintaining gender balance to the greatest extent possible. Participants with major mistakes and a lack of knowledge of the chosen concepts are excluded. Also, to maintain gender balance, some participants are eliminated. (Table 3: the explored participants of CKAT) shows the participants whose data are included and explored in the CKAT.

Table 3: the explored participants of CKAT

<b>Age</b>	<b>Male</b>	<b>Female</b>	<b>Total</b>	
<b>3</b>	7	7	14	42
<b>4</b>	9	5	14	
<b>5</b>	4	10	14	
<b>Total</b>	20	22		

### 3.3 Validity and Reliability

To ensure the validity and reliability, as mentioned above, the test was assessed by 5 respected jury members who are experts in linguistics and applied linguistics. Their feedback is used to enhance the quality of the designed test. Each jury member received a form consisting of the list of the targeted words and their corresponding pictures, followed by the below questions:

- 1- Are the concepts appropriate for the selected age (3-5 years old)?
- 2- Are the chosen pictures appropriate for the selected age (3-5 years old)?
- 3- Do you think the test aligns with the study's purpose?
- 4- Any other suggestions/recommendations?

The questions, except for the 4<sup>th</sup> one, are answered by either 'yes' or 'no', in case the answer is 'no' the juries are asked to explain the reason and to provide their suggestions. The responses and feedback that the researchers received are compared and used to improve the quality of the test.

### 3.4 Pilot test

A pilot study is a small version of the actual test. It is to test the methods, tools, materials, and practicality of the test by doing it on a small sample (Mackey & Gass, 2022). The researchers similarly examined the test by conducting it on 5 (3 female and 2 male) participants from the selected age groups and the same targeted environment (setting), however, they were not included in the finalized test. Consequently, based on the feedback and assessing the perception of the participants, the researchers adjusted a number of the words and/or pictures that were included in the test. For example, a concept like "piggy bank /daɣila/" is seen to be unfamiliar by the participants of the pilot test. Thus, it has been replaced by "garden /baɣtfa/". Another thing that should be mentioned is that the pilot test has also displayed the need to teach the words in a different setting prior to the real test day to achieve better results in the picture recognition. Thus, the pilot test was conducted to measure any unexpected inconvenience in the practicality of the test in the field.

### 3.5 Ethical Considerations

To obtain ethical considerations, the researcher has asked for the permission of the management staff of both institutions prior to the test, they both expressed their agreement on the test being conducted, and they also informed the parents of the participants being tested. However, to avoid panic and confusion, the participants were only informed that they would be shown some pictures and they should articulate the words correctly to get the small reward (the candy) they had been promised beforehand. Also, the name and identity of the participants are anonymised by the researchers, only their voices have been used for the later transcription and analysis.

### 3.6 Data Collection Methods

To achieve the objectives of the research, the CKAT use the abbreviation. was designed to ensure that a single, standardized set of pictures and concepts was appropriate for the cognitive level of the entire 3-to-5-year-old age group. Then, based on the feedback the researchers received from five respected jury members, the test underwent the first editing phase. Later on, the institutions were chosen, which include a private pre-school and two private daycares in the city of Chamchamal in the Sulaymaniyah province. After getting permission from their staff and parents, the researcher started the fieldwork.

After the first edition, a pilot test was conducted on 5 participants of the selected age group, different from the ones who underwent the final test, which led to the second editing phase before the actual test was conducted. Also, to achieve better results concerning the concepts used in the test, one day prior to the test, the researcher, acting as a teacher, showed the participants each one of the selected pictures through a data show and told them the names of the pictures as a rehearsal to further validate the responses on the test day. Lastly, the test was conducted at the mentioned settings.

The pictures were shown to the participants through a screen controlled by the researcher. Asking 'What is this?' the participants answered the question by mentioning the name of the concept in the pictures. Each participant's response was audio-recorded using native recording application for later transcription. At the time of any confusion, the field researcher interfered by giving hints. If the participant remained unfamiliar with the target word even after the hint was provided, the field researcher articulated the word and asked the participant to repeat it multiple times, ensuring the accurate recording of the produced word. Moreover, to encourage active participation, the researcher offered the participants a small reward (a candy) as an incentive for their cooperation. All of the participants received the candy regardless of their level of engagement. Consequently, the time spent on the test ranges between 5 to 10 minutes for each participant; thus, the test proves to be very practical and handy.

### 3.7 Data Analysis

To analyze the data, first of all, the recorded voice of the participants is carefully checked, and the deviations from the correctly uttered words are pinpointed. Then the modified words are transcribed by one of the researchers, and the other researcher, being a competent phonologist, has checked the transcription according to the International Phonetic Alphabet (IPA) and CK phoneme inventory system. After that, the phoneme modifications were identified and classified based on the age and the frequency of the same modifications.

For statistical analysis, to evaluate the significance of the existing difference among age groups and genders, the SPSS. 26 software is used. Test types such as one-way ANOVA, chi-square test, are used. One way ANOVA test is used to compare the difference in phonological accuracy among age groups and genders. Moreover, to examine the association between categorical variables like age and incorrectly uttered words, the Chi-Square Test is used. Post-Hoc Analyses, such as Tukey's HSD Test and Bonferroni Correction, are utilized. The former is used for pairwise comparisons between age groups when ANOVA revealed significant effects. The latter is used to adjust for multiple comparisons and control Type I error rates. In addition, Microsoft Excel is utilized in making the tables and Figures presented in this paper.

Later on, the phoneme modification types are classified, counted, and rated from most frequent to the least frequent based on their occurrence across age groups. Alongside, using Figures for more clarity and visualizing experience, the thematic analysis and examples for each modification type are presented.

## 4. Results and Discussion

### 4.1 Correct articulation percentage

In analyzing the average of correct and incorrect consonant articulation, the following table demonstrates the percentage of correct articulation of the phonemes in the word's final, medial, and initial positions. Then, an average rate of all positions is calculated to find the percentages

below.

Table 4: Correct articulation percentage

Manner of Articulation	Phonemes	Age 3	Age 4	Age 5
Plosives/ Stops	/p/	98%	98%	100%
	/b/	95%	100%	100%
	/t/	100%	100%	98%
	/d/	100%	100%	100%
	/k/	91%	91%	96%
	/g/	93%	93%	100%
	/q/	86%	93%	100%
	/ʕ/	61%	68%	100%
	/ʔ/	100%	100%	100%
Nasals	/m/	98%	100%	100%
	/n/	98%	100%	100%
	/ŋ/	75%	86%	100%
Affricates	/tʃ/	69%	84%	95%
	/dʒ/	69%	84%	98%
Fricatives	/f/	93%	100%	98%
	/s/	55%	86%	88%
	/z/	88%	93%	88%
	/ʃ/	95%	93%	98%
	/ʒ/	74%	74%	88%
	/χ/	79%	88%	98%
	/ħ/	50%	79%	91%
	/h/	100%	100%	100%
Flap	/r/	72%	79%	93%
Trill	/r/	74%	89%	93%
Approximants	/j/	90%	86%	100%
	/w/	98%	100%	100%
	/l/	74%	81%	100%
	/ʎ/	68%	86%	100%
<b>Average</b>		83%	90%	97%

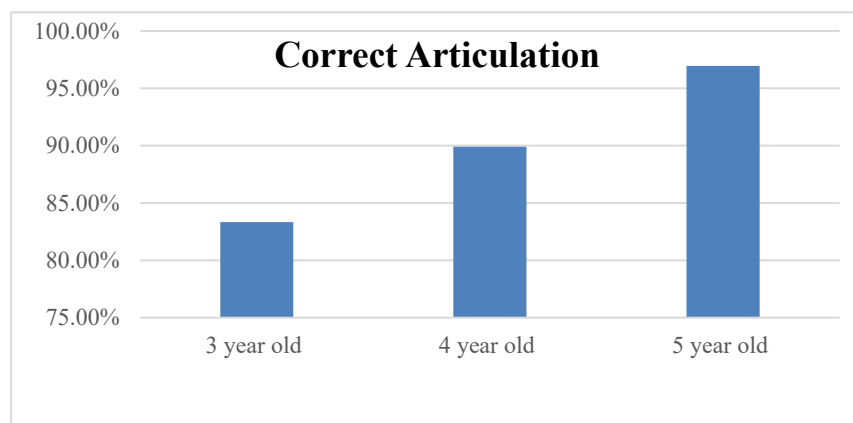


Figure 1: Correct Articulation Average

As displayed in table 4 the age 3 participants have difficulty acquiring phonemes /ʃ/, /ŋ/, /tʃ/, /dʒ/, /s/, /z/, /h/, /r/, /l/, /t/; especially /h/ and /s/ which have the lowest percentage on the table. However, the mentioned age(age 3) group has acquired phonemes /q/, /z/, /x/ and actually mastered phonemes /p/, /b/, /t/, /d/, /ʔ/, /m/, /n/, /ʃ/, /h/, /w/. It is also found that by the age 4 all the phonemes except phonemes /ʃ/, /z/ are acquired but not all of them are fully mastered like /ŋ/, /tʃ/, /dʒ/, /s/, /z/, /x/, /h/, /r/, /r/, /j/, /l/, /t/. On the flip side, by the age of 5, almost all the phonemes are acquired, except for a few phonemes which have not been mastered yet, such as /s/, /z/, /z/.

The results also show that the average percentage of 3-year-old participants has the lowest accuracy level of 83.33%. The second age group (4 years) is in 2<sup>nd</sup> position with 89.90% correctly pronounced consonants. At the first position, the 5-year-old comes to view with the correct articulation percentage of 97%.

#### 4.2 Gender Difference in Articulation Accuracy

Turning to the effect of gender on the correct articulation, first, the evaluation of gender distribution is needed. As shown in Table 3, the number of female participants is 22, and the number of male participants is 20.

Table 5: gender distribution

Test	Value	Df	p-value	Notes
Pearson Chi-Square	3.63	2	.163	
Likelihood Ratio	3.72	2	.156	
Linear-by-Linear Association	1.26	1	.262	
N (Valid Cases)	42	—	—	0 cells (0%) < 5 expected

As presented in table 5, a Pearson chi-square test examined gender balance across age groups (3-, 4-, and 5-year-olds). No significant association was found between age and gender distribution,  $\chi^2(2, N = 42) = 3.63$ ,  $*p* = .163$ . Since the p-value (.163) is greater than .05, you fail to reject the null hypothesis. The null hypothesis states that there is no association between the distribution of gender and age group. Therefore, these results support the claim of having a fair distribution of gender across the selected age groups.

Examining the role of gender in making a difference in the level of consonant accuracy, as can be seen in table 6. A one-way ANOVA was conducted to examine the effect of gender (male vs. female) on correct consonant articulation scores.

Table 6: the role of gender in consonant accuracy

Source	Sum of Squares	df	Mean Square	F	p-value	$\eta^2$
Between Groups	56.615	1	56.615	0.515	.477	.013
Within Groups	4397.273	40	109.932			
Total	4453.887	41				

As the results demonstrate, no statistically significant difference is found between genders,  $F(1, 40) = 0.52$ ,  $*p* = .477$ , with a negligible effect size ( $\eta^2 = 0.01$ ). The results propose that pronunciation accuracy does not vary significantly based on gender in the studied sample. Although the ratio of the genders is fairly distributed in this research, the results on SPSS and

ANOVA show that the gender-based difference is not significant to be studied.

### 4.3 The effect of age on average articulation accuracy

The age difference is a subject of deeper examination, which the table below (Table 7) aims to analyze.

Table 7: The effect of age on articulation accuracy

Source	Sum of Squares	df	Mean Square	F	p-value	$\eta^2$
Between Groups	1251.409	2	625.705	7.620	.002	.281
Within Groups	3202.478	39	82.115			
Total	4453.887	41				

The One-Way ANOVA revealed a statistically significant effect of age on the average pronunciation accuracy for initial ( $p = .003$ ), medial ( $p < .001$ ), final ( $p = .049$ ) sounds, and overall pronunciation accuracy as presented above ( $p = .002$ ).

Table 8: Post Hoc Pairwise Comparisons of Pronunciation Accuracy Across Age Groups (3–5 Years)

Test	Age (I)	Age (J)	Mean Difference (I-J)	Std. Error	p-value	95% Confidence Interval
Tukey HSD	3	4	-13.37	3.43	.001	(-21.71, -5.02)
	3	5	-6.94	3.43	.119	(-15.28, 1.41)
	4	5	6.43	3.43	.159	(-1.92, 14.77)
Bonferroni	3	4	-13.37	3.43	.001	(-21.94, -4.80)
	3	5	-6.94	3.43	.149	(-15.51, 1.63)
	4	5	6.43	3.43	.204	(-2.14, 15.00)

Both Tukey's HSD and Bonferroni post-hoc tests consistently show that there is a statistically significant difference in overall average pronunciation between the 3-year-old group and the 5-year-old group. Specifically, the 5-year-olds have a significantly higher average pronunciation score than the 3-year-olds.

There are no statistically significant differences in overall average pronunciation between the 3-year-old group and the 4-year-old group, or between the 4-year-old group and the 5-year-old group.

### 4.4 Consonant Modifications

After getting the above results, the phoneme modifications conducted by the selected age group are deeply explored. Figure 2 clearly shows that the first age group is more prone to making phoneme modifications twice as often as the second age group, and the second age group makes modifications twice as often as the third age group.

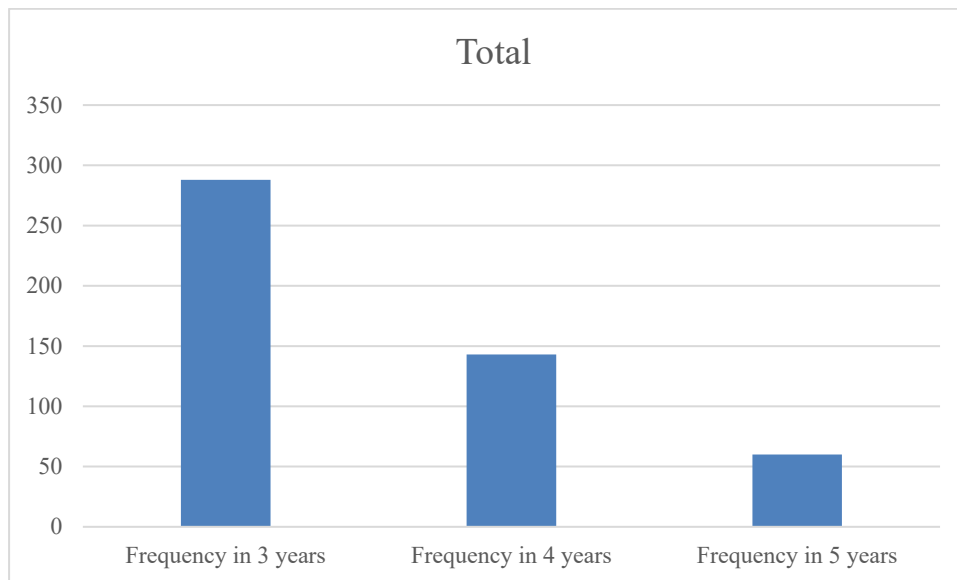


Figure 2: total average of consonant modification across ages

The number of consonant modifications that occurred in the speech of the participants; the above Figure shows the frequency of the modifications in each age. As presented in the Figure, the 3-year-olds show the highest level of modification among all age groups, with 288 times. Followed by 4-year-olds with 143 times. 5-year-olds, however, rank third with a total of 60 times.

When it comes to the frequency and the types of phoneme modifications, Figure 3 shows the frequency of the types of modifications in all three age groups on average. The data revealed numerous types of consonant modifications, which are systematic processes children use to simplify adult speech as they learn to talk. These processes include common patterns such as fronting, where a sound made in the back of the mouth (like /k/ as in /kabab/) is replaced with one made in the front (like /t/as in /tabab/); stopping, where a long 'fricative' sound (like /s/ as in /sew/) is replaced with a short 'stop' sound (like /t/ as in /tew/); and cluster reduction, where a sequence of consonants (like /prt/ as in /prtaqa/) is simplified (to /pt/ as in /ptaqa/). Figure 3 below illustrates the frequency of these and other modification types found in the study.

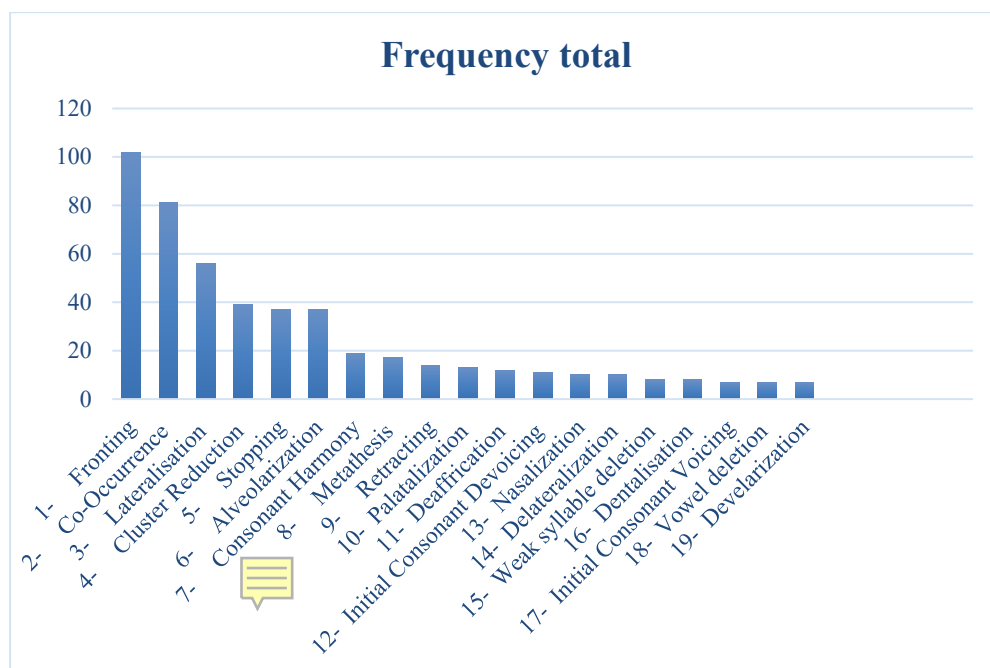


Figure 3: frequency of phoneme modifications in total

The Figure demonstrates the frequency of each phoneme modification in all the age groups, on average ranking from the most occurring phoneme modification to the least. At the top of the list

“fronting” can be seen with more than 100 times. Followed by “co-occurrence (81), lateralization (47), cluster reduction (39), stopping (37), Alveolarization (37), consonant harmony (19), metathesis (17), retracting (14), palatalization (13), deaffrication (12), initial consonant devoicing (11), nasalization (10), delateralization (10), retroflexion (9), weak syllable deletion (8), dentalisation (8), initial consonant voicing (7), vowel deletion (7), and develarization (7). In addition to the more common processes shown on the Figure, a number of other modifications occurred with very low frequency. While these occurrences are noted here for the sake of completeness, a detailed statistical analysis of them is beyond the scope of the current study, as their low frequency makes it difficult to draw significant conclusions. However, their presence is noteworthy, and they represent potential avenues for future research into specific or less common modification patterns. These rare modifications include: initial consonant deletion (3 occurrences), liquid substitution (3), pharyngealization (2), epenthesis (2), fricativization (2), final consonant devoicing (1), and affrication (1).

Moreover, when we take a closer look at the ages and their frequency of the phoneme modifications, Figure 4 is needed.

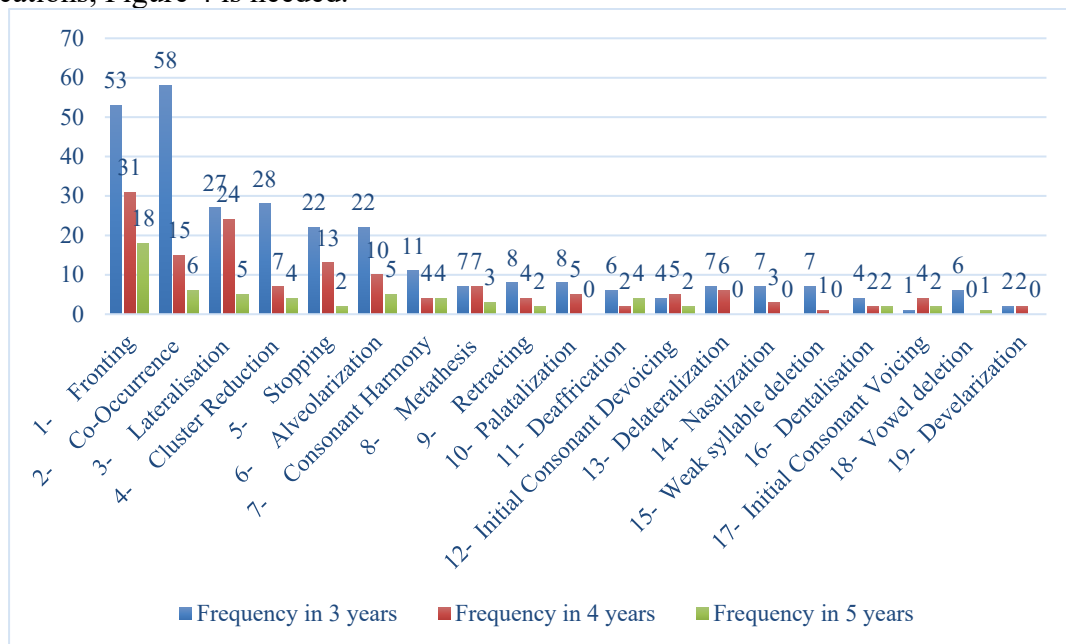


Figure 4: frequency of the phoneme modification across the ages 3,4,5

Figure 4 demonstrates the frequency of each phoneme modification in each one of the targeted age groups separately. As can be seen, age 3 is often at the top of the Figure, followed by age 4, then age 5. Except for cases like ‘deaffrication’, ‘initial consonant devoicing’, ‘initial consonant voicing’, ‘develarization’, in which this sequence is altered.

#### 4.5 Correct articulation

The data suggests that across the ages, the correct articulation percentage increases. Multiple variables can underlie this outcome. The maturation of the oral and motor system of the participants might be a significant variable. Another significant factor might be the development of the neurological system. Also, the increased exposure at an older age may add to the escalation of the accuracy percentage. These factors explain why the current data shows these statistics.

A related but distinct issue is the percentage of correct articulation in this research. Similar to other research done on Bahdini Kurdish (Ahmed, 2023) and Québécois (MacLeod, et al., 2010), in which the correct articulation is gradually increasing. Since the same age or gradual ages have been studied in both research and the current research.

The data shows that the accuracy percentage in this research is presumably higher than other research, like the research on Bahdini Kurdish by Ahmed (2023) in which age 3 has an accuracy percentage of 77%, age 4 has 88%, and age 5 has 94%. Also, in research done on the consonants of a variety of languages like Arabic, German, English, Hungarian, Malay, Portuguese, Swahili, Setswana, Turkish, Xhosa collected in an article, show that age five’s accuracy percentage is

93.8% (McLeod & Crowe, 2018). This result might be due to different methods of conducting the test, such as the practice that has been done before the real test day. In addition to methodological differences, it is crucial to consider that this variation could be due to the inherent nature of language acquisition itself. Cross-linguistically, speakers acquire the specific phonological features of their L1 at different stages, meaning the timeline for mastering certain consonants can naturally vary from one language to another (Blevins, 2004).

However, the sequence of the mastered phonemes is different. Based on this data, the stops like /p/, /b/, /t/, /d/, /k/, /g/, /q/, /ʔ/, nasals /m/, /n/, fricatives /f/, /z/, /ʃ/, /ç/, /h/, and approximants /j/, /w/ are acquired by the age 3. The phonemes /ʕ/, /ŋ/, /ʝ/, /dʒ/, /s/, /z/, /ħ/, /r/, /r/, /l/, /ʔ/ are not acquired by age 3. Also, the phonemes of /ʕ/, /z/ are not fully developed by the age 4. At age 5, although current data show the acquisition of almost all phonemes by this age, similar to the results of 27 language acquisition studies (McLeod & Crowe, 2018), the mastery of phonemes such as /s/, /z/, and /z/ is not yet achieved.

A closer look at these later-acquired consonants reveals they share properties known to be challenging for young children. The list includes sounds that require complex articulation, such as the affricates /ʝ/ and /dʒ/, and the liquids and rhotics /l/, /ʔ/, /r/, and /r/, and fricatives /s/, /z/, and /z/, which are notoriously late-acquired across many languages (McLeod, 2007) (Grunwell, 1987). It also contains the pharyngeal consonants /ħ/ and /ʕ/, which are non-native loan sounds in CK borrowed from Arabic, making them less frequent and phonologically distinct from the native inventory (Khattab & Al-Tamimi, 2013). The difficulty with these specific groups of sounds aligns with cross-linguistic trends where articulatory complexity and non-native status often predict a later age of acquisition.

Other studies (Ahmed, 2023) (McLeod & Crowe, 2018) have different results. In Bahdini Kurdish phonemes such as /p, t, ʃ, ħ, x, ʕ, f, m, n, h, w, d, l / are mastered before the age of 3 (Ahmed, 2023) while in Arabic and English children acquire fewer consonants (e.g., Arabic: /b, f, j, h, m, n, l, w, t/; English: /m, n, b, f, w, h/) by this age (McLeod & Crowe, 2018). phonemes / dʒ, and q, k, z / are mastered before the age of 4 in Bahdini Kurdish (BK), / s, ʃ, z and r/ are mastered before the age of 5, while sounds such as /b, ɣ, v, g and j/ are not fully mastered even by the age of five, by this age, children show confidence but still use phonological processes (e.g., fronting). A study conducted on 27 different languages suggest that 12 consonants were acquired at a mean age of between 3y 0mo and 3y 11mo namely, /b, m, d, n, h, t, k, g,w,ŋ, f, j/; seven consonants were acquired at a mean age of between 4y 0mo and 4y 11mo, namely, /l, dʒ, ʃ,s,v,ʃ, z/; three consonants were acquired at a mean age of between 5y 0mo and 5y 11mo, namely, /ʔ, z, ð/; and one consonant was acquired at a mean age of between 6y 0mo and 6y 11mo (72–83 months), namely, /θ/ (McLeod & Crowe, 2018).

The mentioned phenomena might be due to the different phonological systems of languages as well as the research methodology. In addition, it also supports Chomsky's argument about exposure to language. Chomsky brings about the idea of having a set of universal principles that are innate, combined with language-specific input; both are combined in acquiring languages (Chomsky, 2015). Moreover, the frequency of the phonemes plays part in early acquisition. In other words, frequent phonemes are acquired earlier (Edwards, et al., 2004)

## 4.6 Phoneme modifications

### 4.6.1 Most Frequent Modifications

The phonemes, particularly the ones that have not been mastered by the children yet, undergo a variety of modifications by different age groups. The most common trends among the target age groups are fronting and co-occurrence. A closer analysis reveals that among age 3 year-old, the most common modification is “co-occurrence” which is the occurrence of more than one phoneme modification in one word such as modifying /darga/ (door) to /dada/ (cluster reduction + fronting) with the frequency time of 58, among 4 years is ‘fronting’ such as in altering /miʃk/(mouse) to /miʃt/, occurred 31 times, and among 5 years is ‘fronting’ and ‘lateralisation’ for instance, changing /spi/(white) to /θpi/ and changing /wirʃ/(bear) to /wɪʃ/ with the frequency of 18 each.

Fronting may occur due to the ease of articulating the front sounds and replacing the back sounds. Since the front consonants are acquired earlier than the back consonants, it is reasonable for the participants to replace them with the later-acquired ones. Moreover, the back consonants require more complex movements of articulators like the tongue. The participants might reduce the complexity of the phonemes to lessen the articulatory effort (Grunwell, 1987).

Co-occurrence, however, may occur to neutralize the cognitive load on production by applying multiple simplification techniques. Not only that, but also the low frequency words may undergo several modifications more frequently (Edwards, et al., 2004). Words such as /hʊʃtr/ (camel), due to the rarity of its referent in the target ecosystem as well as the phonological complexity of the word, is modified to /χʊʃtil/ (fronting + lateralization). Building upon that, articulatory motor systems that are complex, meaning they require more than one sound class, such as fricatives (/χ/)+ affricates (/tʃ/) (/baχtʃa/ (garden) → /baʃa/) might activate several phoneme modifications at a time (Kent, 1992).

In line with the findings, the affricates /tʃ/ and /dʒ/ were among the most frequently modified consonants by the participants. This can be attributed to their articulatory complexity, a finding that is well-supported in developmental phonology. An affricate is a complex sound that requires the speaker to perform two distinct articulatory gestures in a rapid sequence: a complete blockage of the airstream (a stop), followed immediately by a controlled, turbulent release (a fricative). This dual nature demands precise motor coordination that is often still developing in young children. Consequently, a common simplification process is 'deaffrication,' where the initial stop is omitted and only the fricative portion is produced (e.g., pronouncing /tʃ/ as /ʃ/). This inherent complexity is a primary reason for their later acquisition and frequent modification across many languages (McLeod & Crowe, 2018).

#### 4.6.2 Modification Types

The results present the occurrence of 19 phoneme modification types in CK. Most of which are similar to universal languages such as English (Haelsing & Madison, 1986), Turkish (Topbaş, 1997), German (Fox & Dodd, 1999), Persian (Zarifian, et al., 2017), and Bahdini Kurdish (Ahmed, 2023) for instance fronting, cooccurrence, lateralization, cluster reduction, stopping, alveolarization, consonant harmony, metathesis, retracting, palatalization, deaffrication, initial consonant devoicing, nasalization, weak syllable deletion, dentalisation, vowel deletion. Except for modifications like: delateralization, initial consonant voicing, develarization, which seem to be CK specific.

Similar to the study in BK (2023), the current study has lateralization in the third position. This similarity might be attributed to the closeness of the varieties of Bahdini Kurdish and CK. However, the mentioned study has cluster reduction as its most common phonological process. It might be due to the complexity of the target words, meaning that more consonant-clustered words are included in their study. Words of the current study, however, are mainly simple words.

## 5. Conclusion

This research examined the consonant acquisition of pre-school Central Kurdish (CK) speakers and the consonant modifications that occur in their speech. The results demonstrate a clear developmental trend, with consonant accuracy increasing significantly with age. The five-year-old participants showed the highest level of accuracy, followed by the four-year-olds and then the three-year-olds.

A key finding was the lack of any statistically significant difference in articulation accuracy between genders. The analysis also revealed that certain consonants are more prone to modification. Specifically, loan (non-native) consonants like /h/ and /ʕ/ and back consonants were modified more frequently than native and front consonants. Furthermore, the study cataloged the phonological processes used by the children, identifying a sequence from most to least common: fronting, co-occurrence, lateralization, cluster reduction, stopping, alveolarization, and others.

The findings of this study can be used to assess the consonant modification of children with speech or neurocognitive disorders. By establishing a baseline for typical development in CK-

speaking children, these results provide a valuable tool for early identification and intervention. While providing a foundational understanding, this research is limited by its participant number and its focus on single-word articulation. Future research should build on these findings by exploring consonant acquisition in connected speech and by investigating other age groups or different varieties of the Kurdish language. Additionally, the rare but noteworthy modification patterns identified in this study, such as pharyngealization and epenthesis, present an excellent opportunity for more targeted future research.

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## دهستكارى كردنى فونيمه كان له قسه كردنى مندالانى كوردى نيوهنديدا: توهڙينه وهيهكى فونولوژى

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### پوخته

ئهم توڙينه وهيه لىكولينه وه له چونه تي دهبرين و دهستكارى كردنى مندالانى باخچه ساوايانى تهمن 3 بۆ 5 سال دهكات. توڙينه وه كه ورددهبته وه له ريزبه ندى فيربونى نه بزوينه كان و مندالان چۆن ئه و نه بزوينه دهگورن كه به ته واوه تي فيرنبوون و شاره زايان تيباندا به دهست نه هيتاوه. ئامانجى توڙينه وه كه ديارى كردنى جياوازي له دهبرينى دهنگه نه بزوينه كانه له نيوان ته منه جياوازه كاندا، به تايبه تي لىكولينه وه له وهى ئايا مندالانى بچووكتر نه بزوينه كان جياواز له مندالانى گه ورته دهبرين يان نا. به له بهر جاوگرتنى هه بونى توڙينه وه به ده ديكه له سه ر بيغربوونى مندالان بۆ نه بزوينه كانى زمانى يه كه م له زۆربه ي زمانه كاندا. فيربوون و دهستكارى كردنى دهنگه نه بزوينه كان له زمانىكه وه بۆ زمانىكى ديكه جياوازه. بۆيه لىكولينه وه له م ديارده به له زمان و شيوه زاره جۆراو جۆره كاندا زۆر گرنگه. هه رچه نده به گوڙه ي زانبارى توڙه ران، ئهم بابته له زمانى كوردى ناوه نندا به دوا داچوونى بۆ نه كراوه. هه ر بۆيه 42 مندالى باخچه ساوايان له م توڙينه وه به ده هه لده سه نكي ندرين له سه ر چو نيه تي دهبرينى دهنگه نه بزوينه كانى شيوه زارى كوردى نيوه نندا له سه رته تا، ناوه راس ت و كو تاي وشه دا. ئه ركيكى ناولپنانى و نه به كارد يت وه ك شيوازيك بۆ كو كرده وه ي داتا. ئه نجامه كان نيشانى ده دن كه له گه ل ته منه نى تاكه كان، وردى ده برينيان له ده برينى نه بزوينه كان به شيوه به كى به رچاو با شتر ده بيت و هيج جياوازي به كى به رچاو له نيوان ره گه زه كاندا به دى نا كريت. نه بزوينه كانى كه قه رزكراون وه ك /h, ʔ/ و دهنگه نه بزوينه كانى پشت وه زۆر ترين جار گوراون، له كاتيكدا fronting و coarticulation باوترين پروسه ي گورا نكارى بوون كه تيبينى كراون.

وشه سه ره كيبه كان: فونولوژى، كوردى ناوه نندا، مندالى پيش قوتابخانه، فيربوونى دهنگه نه بزوينه كان، دهستكارى كردنى دهنگه نه بزوينه كان

### تعديل الصوتيات في حديث الأطفال الكرديين المركزيين: دراسة صوتية

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### الملخص

تدرس هذه الدراسة نطق وتعديل اللغة الكردية المركزية الأصلية (CK) فيما بعد) لدى الأطفال في سن ما قبل المدرسة الذين تتراوح أعمارهم بين ثلاث وأربع وخمس سنوات. تبحث الدراسة في ترتيب اكتساب الأصوات الساكنة وتفحص التعديلات على الأصوات الساكنة التي لم يتم اكتسابها بشكل كامل. تهدف الدراسة أيضًا إلى معرفة الاختلاف بين الفئات العمرية المختلفة من حيث نطق الأصوات الساكنة - ما إذا كان الأطفال الأصغر سنًا ينطقون الأصوات الساكنة بشكل مختلف عن الأطفال الأكبر سنًا. تم البحث في اكتساب الأطفال للحروف الساكنة في اللغة الأم (L1) في العديد من اللغات. نطق الحروف الساكنة وتعديلها يختلف حسب اللغة؛ من المهم دراسة هذه الظاهرة في لغات وأنواع مختلفة. ومع ذلك، فإن المؤلفين ليس لديهم علم بأن هذا الموضوع قد تم دراسته في CK. لذلك، تم فحص 42 طفلًا في سن الحضانه في نطق الأصوات الساكنة في CK في مواضع الكلمات المختلفة: في البداية، وفي الوسط، وفي النهاية الكلمة. تم استخدام مهمة تسمية الصور كعملية لجمع البيانات. تشير النتائج إلى أن دقة الحروف الساكنة تزيد بشكل كبير مع تقدم العمر، دون وجود اختلافات واضحة بين الجنسين. تم تعديل حروف العلة المستعارة /h, ʔ/ والحروف الساكنة الخلفية في معظم الأحيان، بينما كانت عملية fronting و coarticulation هما الأكثر شيوعًا التي تم ملاحظتها.

الكلمات المفتاحية: علم الأصوات، اللغة الكردية المركزية، أطفال ما قبل المدرسة، اكتساب الحروف الساكنة، تعديل الحروف الساكنة