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The Phonological Development in the Speech of Children of Collo at Skikda Speech Community

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Abstract
This study investigates phonological acquisition patterns among preschool children (ages 3–5 years, n=20) from the Collo dialect region in Skikda, Algeria, applying Optimality Theory (OT) as the primary analytical framework. Speech data were gathered through standardized picture-naming tasks using 26 black-and-white line drawings depicting culturally familiar concrete objects—such as animals (dog, cat), food items (orange, carrot), and household goods (chair, cup, shoes)—alongside repetition of 10 carefully selected target words that varied systematically in syllable structure (CV, CVC, CCVC, CVCC) and included challenging phoneme sequences and consonant clusters typical of Collo Arabic. All samples received narrow phonetic transcription, enabling detailed descriptive analysis that identified seven distinct phonological processes: assimilatory types (consonant harmony, initial consonant voicing, manner assimilation) and non-assimilatory types (consonant cluster reduction, weak syllable deletion, vowel epenthesis, fronting, backing).Findings revealed pronounced age-based differences: younger children (3–4 years) displayed elevated frequencies of assimilatory processes—for instance, consonant harmony occurring at 100%—driven by markedness constraints that prioritize phonological simplification in immature grammars. In contrast, older children (4–5 years) demonstrated substantially reduced rates across nearly all processes, consistent with OT's core mechanism of constraint reranking, whereby faithfulness constraints progressively outrank markedness ones to produce increasingly faithful adult-like outputs. Non-assimilatory phenomena, including cluster reduction guided by the Sonority Sequencing Principle, persisted across groups but similarly declined with maturation, highlighting unique Collo dialectal characteristics.Although constrained by a modest sample size and single-session protocol, these results provide essential baseline descriptive data on Collo phonological development. They illuminate systematic progress toward target phonology and affirm OT's robustness in modeling dialect-specific acquisition trajectories.

Keywords: Algerian Arabic; Collo Dialect; Developement; Optimality; Phonological Processes

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Introduction

First language acquisition represents a complex developmental process in which children gradually acquire the phonological system of their native language. While this process was historically explained through behaviorist learning mechanisms (Skinner, 1957), contemporary linguistic theory emphasizes innate linguistic capacities. Chomsky (1965) proposed the Language Acquisition Device (LAD) as a biologically determined mechanism enabling rapid language acquisition. The acquisition trajectory progresses through identifiable developmental stages (Steinberg, 1982), during which children employ systematic phonological modifications—termed phonological processes—to bridge the gap between the adult phonological target and their current developmental capacity. Phonological processes represent systematic sound modifications reflecting the child's emerging phonological competence. Common processes include consonant harmony (sounds assimilating across intervening elements), cluster reduction (simplifying consonant sequences), and syllable deletion (omitting weak syllables). These processes occur predictably and systematically rather than randomly, suggesting an underlying organizational principle governing phonological development.

Over the past three decades, Optimality Theory (OT)—developed by Prince and Smolensky (1993)—has emerged as the predominant theoretical approach for analyzing phonological phenomena, including acquisition. OT proposes that phonological systems result from the interaction between universal well-formedness constraints organized in a language-specific hierarchical ranking. Two primary constraint categories are posited. Markedness constraints penalize marked (complex, unusual) structures, favoring simpler, more economical phonological forms; examples include *COMPLEX (prohibiting consonant clusters) and *VOICELESS (disfavoring voiceless obstruents). Faithfulness constraints penalize deviation from underlying forms, requiring output fidelity to input specifications; examples include MAX-IO (prohibiting segment deletion) and IDENT-IO[FEATURE] (requiring preservation of distinctive features). Phonological acquisition within OT is characterized by constraint reranking: younger children exhibit constraint hierarchies where markedness dominates faithfulness, producing simplified outputs. As linguistic development progresses, constraint reordering gradually elevates faithfulness constraints above markedness constraints, yielding increasingly adult-like productions. This reranking mechanism elegantly explains both the systematic nature of child phonology and the developmental trajectory toward adult competence (Demuth, 1997; Kager, Pater, & Zonneveld, 2004).

1. Aims of the Study and Questions

This study aims to identify the phonological processes present in the speech of pre-school children in Skikda and examine whether phonological development in this region follows a homogeneous or heterogeneous pattern. Furthermore, it seeks to apply OT to analyze phonological variation and acquisition in children of Collo, offering insights into how constraint ranking influences speech development. By focusing on a dialectally diverse environment, this research contributes to a broader understanding of phonological acquisition and the role of dialectal variation in shaping early linguistic competence.Research questions guiding this investigation are the following:

- What phonological processes characterize the speech of normally developing 3–5-year-old Collo-speaking children?

-Does phonological development in Collo exhibit consistent or variable patterns across age groups?

-To what extent does Optimality Theory constraint reranking account for observed phonological development in this population?

2. Literature Review

Recent research has documented phonological development across multiple Arabic dialects. Alqattan (2015) conducted a cross-sectional study of 70 typically developing Kuwaiti Arabic-speaking children, identifying developmental error patterns and establishing that consonant acquisition order correlates with input frequency and phonological salience. AlAjroush (2020) examined 60 Saudi Najdi Arabic-speaking children (aged 1;10–4;02), reporting that children acquired consonants earlier through spontaneous speech than through picture naming, with significant effects of syllable position on phonological accuracy. Turki (2022) analyzed phonological development in 235 Saudi Hejazi Arabic-speaking children (aged 2;6–5;11), creating the first linguistically controlled assessment tool (SHAPA) for Arabic and demonstrating age-related mastery patterns for phonetic inventory and syllable structures. Within the Algerian Arabic research context, studies remain limited. Azieb (2017) investigated syllable-based phonological processes in Jijel Arabic-speaking children using OT principles, documenting cluster reduction, epenthesis, and syllable deletion. Benyoucef (2021) analyzed phonological processes in Mostaganem Arabic, identifying consonant and vowel assimilation patterns across the dialect. However, research specifically examining Skikda's dialects—particularly the Collo sub-dialect—remains absent from the published literature, despite Skikda's geographical location and linguistic history creating unique phonological patterns distinct from previously studied Algerian dialects and warranting systematic investigation.

Phonological processes reflect systematic modifications children employ to simplify adult targets, distinguished between assimilatory processes (where sounds become similar through mutual influence) and non-assimilatory processes (where sounds are simplified, deleted, or substituted independently of neighboring context). Consonant harmony—a ubiquitous assimilatory process whereby non-adjacent consonants become identical or more similar—represents long-distance assimilation occurring in both progressive (left-to-right) and regressive (right-to-left) directions (Levelt, 2011). Though rare in adult speech, consonant harmony appears in children across diverse linguistic systems, typically diminishing with age as constraint hierarchies rerank. Initial consonant voicing—substitution of voiceless obstruents with voiced counterparts—reflects preference for sonorous, articulation-economical forms, while manner assimilation involves sounds modifying to match neighbors' articulatory properties, facilitating phonological simplification. Non-assimilatory processes modify sounds through independent mechanisms. Consonant cluster reduction—systematic deletion of cluster members—occurs as children prioritize simpler CV (consonant-vowel) syllable structures over complex CCC sequences, with the Sonority Sequencing Principle (SSP) predicting which members are deleted (Parker, 2002). Weak or unstressed syllable deletion omits prosodically weak elements, while vowel epenthesis—insertion of vowels (typically schwa [ə])—represents alternative simplification mechanisms. Substitution processes like fronting (posterior sounds replaced with anterior articulations) and backing reflect place-of-articulation reorganization during development.

Within Optimality Theory, phonological acquisition is fundamentally a constraint reranking phenomenon (Barlow & Gierut, 1999; Boersma & Levelt, 2004). Early in development, markedness constraints dominate the hierarchy, producing simplified outputs; for instance, *COMPLEX outranks MAX-IO, resulting in cluster reduction, while *VOICELESS dominates IDENT-IO[-VOICE], yielding voicing harmony. As development progresses, gradual reranking elevates faithfulness constraints above markedness constraints, shifting toward adult-like outputs. This reranking model provides powerful explanatory capacity—predicting both why specific processes occur and why they decline with development—while accommodating cross-linguistic variation through language-specific constraint ordering with universal constraint inventories (Demuth, 1997; Kager, Pater, & Zonneveld, 2004).

Arabic phonological acquisition exhibits consistent patterns across studied varieties. Consonant acquisition order partially reflects input frequency: more frequently occurring consonants are acquired earlier than rare ones (Alqattan, 2015), with emphatic consonants showing protracted acquisition relative to non-emphatic counterparts. Syllable position affects acquisition, with word-initial consonants typically acquired before word-final positions (AlAjroush, 2020; Turki, 2022). Documented phonological processes include cluster reduction (Azieb & Mahadin, 2018), cluster assimilation (Benyoucef, 2021), and vowel-related processes influenced by diglossia. These findings support universality of constraint-reranking mechanisms while demonstrating language-specific manifestations reflecting Arabic's phonological structure. Despite expanding research, substantial gaps persist: most studies focus on Gulf dialects; North African varieties remain understudied; and no published research has systematically examined Skikda's dialect variations or the Collo sub-dialect. Additionally, few Algerian studies have rigorously employed OT with adequate statistical analysis and effect size reporting. The present preliminary study addresses this gap by providing foundational descriptive data on Collo phonological development while applying OT analysis, though with acknowledged limitations requiring future expanded investigation.

3. Methodology

The study has been conducted in Skikda, an Algerian coastal city with a rich linguistic history and dialectal diversity. Skikda's dialect exhibits variations across its districts, particularly in phonology. Collo, a distinct sub-dialect, presents unique phonological patterns that warrant investigation. The research focuses on children aged 3 to 5 years, a crucial period for phonological acquisition. Twenty pre-school children were randomly selected and divided into two age groups (3–4 years and 4–5 years). The study employed experimental methods, including picture-naming and object-based elicitation tasks. The experiment consisted of showing children familiar images from cartoons and TV programs, ensuring the stimuli contained phonemes intrinsic to the Skikdi dialect. Twenty-six black-and-white line drawings depicting concrete objects familiar to Algerian preschoolers were presented individually. Images included animals (dog, cat), food items (orange, carrot), household objects (chair, cup), and clothing (shoes). Images were selected to elicit phoneme targets representing major phonological contrast categories in Collo Arabic. Each image displayed target vocabulary in local colloquial Collo Arabic, with examples provided by a native Collo speaker researcher prior to data collection.The recordings were conducted in kindergartens, in a child-friendly setting with toys and drawings to maintain engagement.Ten target words were presented auditorily by the investigator (native Collo speaker), and children were asked to repeat them. Target words were selected to vary syllable structure (CV, CVC, CCVC, CVCC) and to include problematic phoneme sequences and consonant clusters. Nursemaids were instructed not to interfere, and researchers used contextual prompts if a child struggled to recall a word. A projector and recorder facilitated the elicitation process, ensuring accurate documentation of the children's speech productions. Speech samples were transcribed, and analyzed using OT to identify phonological processes. The analysis aimed to determine whether phonological acquisition in Collo follows a homogeneous or heterogeneous pattern.Due to the preliminary nature of this study and small sample size, formal inferential statistical testing was not conducted. Descriptive statistics (frequencies, percentages, proportions) are reported for each phonological process by age group. No statistical significance tests, confidence intervals, or effect sizes were calculated, as the sample size (n=20, n=10 per age group) is insufficient for reliable statistical inference.

4. Results and Discussion

The phonological acquisition of Skikdi children displays different patterns shaped by dialectal variation and linguistic constraints. Analysis identified both assimilatory and non-assimilatory phonological processes in children's speech samples. Results are presented descriptively, organized by process type, with explicit attention to developmental patterns and theoretical interpretation through Optimality

Theory. Assimilatory processes showed generally higher occurrence in the younger age group (ages 3–4 years) with reduced frequency in older children (ages 4–5 years), consistent with developmental expectations. Non-assimilatory processes displayed more variable patterns, with some processes (cluster reduction, weak syllable deletion) showing similar age-related reduction, while others (vowel epenthesis, backing) showed less pronounced age differences.

4.1. Assimilatory Processes

Assimilatory processes are fundamental to phonological acquisition, enabling children to simplify speech production by making adjacent sounds more similar. These processes, including consonant harmony, initial consonant voicing, and manner assimilation, occur as children develop their linguistic competence. Consonant harmony modifies earlier sounds to match later ones, initial consonant voicing replaces voiceless consonants with voiced ones, and manner assimilation alters articulatory properties for smoother speech. Governed by markedness and faithfulness constraints within Optimality Theory, these processes are more prevalent in younger children and diminish with age. Understanding these patterns provides insights into language development and phonological learning mechanisms.

4.1.1.Consonant Harmony

According to the collected data in Collo district, consonant harmony (CH) is a staple phonological process attested in the speech of children in the last two years before the supposed end of their critical period. According to Clara. C. Levelt (2011, p. 1692), consonant harmony is a phonological process by which the properties of a particular consonant influence those of another sound even though they are not immediately adjacent. Thus, it is known as an assimilation-at-distance process. Levelt Also has contended that consonant harmony is a rare phonological process that it is barely found in the speech of adults and only very few groups of children who speak some specified language that are known in term of number can resort to this simplificatory phonological error. CH is deemed to be ambivalent in terms of property. The alterations that inflict the sounds so that they become harmonic can occur either forwardly or backwardly with a total ignorance of the vowels that come in between. To put in different words, if a sound influences regressively a preceding sound and harmonizes with it, then, it is called progressive or right to-left consonant harmony. On the other hand, if a sound modifies a sound that follows and harmonizes it, then, it is called regressive or left-to-right consonant harmony. In Collo district, children have manifested the process of consonant harmony with both of its directions. Below are some of the attested examples:

Table 01: Examples on Consonant Harmony

Adult form	Child form	Gloss	Stimulus
[zʊːʒ]	[zʊːz]	two	 Pp. (n.d.). 99,300+ Drawing Of A Two Fingers Peace Sign Illustrations, Royalty-Free Vector Graphics & Clip Art - iStockhttps://www.istockphoto.com/illustrations/drawing-of-a-two-fingers-peace-sign
[friʒidɛr]	[sisid r]	fridge	 Drawings, E. (2021). Fridge. Easy Drawings [More Than 1001 Tutorials]. https://easydrawings.net/appliance/draw-fridge/
[ʒɛzɛr]	[zɛzɛr]	carrot	 Abdul, R. (2022). Download the carrot drawing illustration in cute cartoon style on isolated background 16332945 royalty-free V. . .. Vecteezyhttps://www.vecteezy.com/vector-art/16332945-carrot-drawing-illustration-in-cute-cartoon-style-on-isolated-background

The examples provided illustrate left-to-right consonant harmony, where a sound influences a preceding sound to become similar or identical to it. A pertinent question that arises is why this influence is not exerted in the opposite direction, with the roles of the influencing and influenced sounds reversed. The answer lies in the fact that languages worldwide share certain universal properties, regardless of their language family or origin. These universal properties are influenced by a single variable: age. In other words, children are more likely to develop mental representations of some sounds at specific ages (within the critical period of first language acquisition) at the expense of others. According to Brian A. Goldstein and Leah Fabiano-Smith (2009), such sounds are referred to as marked sounds, which make speech production more accessible. For instance, the sound [z] in the word [friʒidɛr] may be significantly altered by a three-and-a-half-year-old child, who might substitute [s] for [z] because [s] is acquired before [z].The occurrence of consonant harmony in children's speech varies in frequency. It is observed in the speech of both age groups but is notably less frequent among children aged 4 to 5 years old. The table below displays the percentage and frequency of consonant harmony occurrences in the speech of both age groups.

Table 2: Frequencies and Percentages of CH Occurrence

Age group	Frequency	Percentage
3-4	10	100%
5	6	60%

This phonological process can be explained through the principle of relative ranking of constraints. In this context, it is essential that markedness constraints are promoted while faithfulness constraints are demoted. Thus, the surface representations of the aforementioned words are governed by a high-ranked markedness constraint, AGREE/C, which requires segments to exhibit total identity. In terms of Optimality Theory (OT), total segmental identity means that segments must be 100% compatible in their specifications. The marked constraint AGREE/C overrides another marked constraint, NOGAP, which emphasizes label locality. Label locality refers to the proximity of elements in a structure that prevents the insertion of new segments (sounds). NOGAP dominates a faithfulness constraint, IDENT-IO[F], which prohibits any changes to the value of a segment (such as place, voice, or manner). The [F] stands for "a distinctive feature." This hierarchy can be represented by the following model: AGREE/C ≫ NOGAP ≫ IDENT-IO[F]. The tableau below further illustrates this model:

Table 03: The Optimal Output for [friʒidɛr]

friʒidɛr	AGREE/C	NOGAP	IDENT-IO[F]
a.friʒidɛr	*		
b.☞srisidɛr		*	*

The table illustrates a clash of candidates, where candidate (b) emerges as the winning candidate due to its adherence to high-ranked markedness constraints without incurring any fatal violations. Candidate (a) fails because it violates a primary high-ranked markedness constraint. The presence of consonant harmony in this constraint confrontation suggests that the process of phonological acquisition is ongoing. This indicates that children's grammar is still developing and has not yet achieved the level of accuracy found in adult grammar, as evidenced by the lower ranking of faithfulness constraints (FC).

4.1.2. Intial Consonant Voicing

One of the assimilatory processes observed in the speech of Collo children is known as initial consonant voicing. This process refers to the sonorization of a sound at the beginning of a word. Sonorization involves substituting a voiceless sound with a more sonorous one that causes the vocal cords to vibrate. In some languages, including English, when this pattern of speech sound error occurs, the new sound that replaces the original one shares at least one property with the latter. For example, in [pæt] and [bæt], the [p] and [b] sounds are analyzed as a pair in phonetics and phonology. Both sounds are produced at the same place of articulation (the front of the mouth) with both lips sealed and rounded, blocking the airstream before releasing it. The main difference is that [b] is voiced, while [p] is voiceless. This 'sonorization' results from the non-existence of /p/ as a phoneme in Arabic, and ,thus, the child realizes it like the the Arabic phoneme /b/

Children in Collo exhibit this phonological process infrequently in both age categories. This rarity is due to their advanced stages of phonological acquisition relative to the critical period. They no longer need to produce voiced sounds, which are simpler to articulate than voiceless sounds, as the latter require more involvement of speech organs. Instances of this phonological process in the children's speech are limited to two cases. Here are the examples:

Table 04: Examples on Initial Voicing

Adult form	Child form	Gloss	Stimulus
[pɪ:tzʌ]	[bɪ:tzʌ]	pizza	 Caroline. (2023a, May 27). Pizza Drawing - How To Draw A Pizza Step By Step. I Heart Crafty Things. https://iheartcraftythings.com/pizza-drawing.html
[pʊrtˤʌbl]	[bʊrtˤʌbl]	mobile phone	 Easylinedrawing. (2021c, September 6). How to Draw a Mobile Phone Step by Step - EasyLineDrawing. EasyLineDrawing. https://www.easylinedrawing.com/how-to-draw-a-mobile-phone-step-by-step/

The table below shows the percentages and frequencies of initial consonant voicing occurrences in the speech of both age groups:

Table 4: Frequencies and Percentages of Initial Consonant Voicing Occurrence

Age group	Frequency	Percentage
3-4	3	30%
5	0	0%

The core idea in Optimality Theory (OT) is that, in the early stages of language acquisition, markedness constraints generally outweigh faithfulness constraints. In other words, markedness constraints take precedence over faithfulness constraints, adhering to the principle that simpler forms precede more complex ones. This is also true in the Collo district. Children in this area have substituted the [p] sound with the [b] sound. To account for these results, it is important to consider the markedness constraint *VOICELESS and the faithfulness constraint IDENT-IO(-VOICE). The *VOICELESS constraint prohibits the presence of voiceless obstruents, such as [p, k, t], while being indifferent to the presence of their voiced counterparts, [b, d, g]. Conversely, the faithfulness constraint IDENT-IO(-VOICE) aims to preserve the voiceless features of segments in the output. Based on the analyzed data, the hierarchical ranking of constraints can be represented as follows: *VOICELESS ≫ IDENT-IO(-VOICE). The table below further illustrates this model:

Table 5: The Optimal Output for [pʊrtˤʌbl]

pʊrtˤʌbl	*VOICLESS	IDENT-IO (-VOICE)
a.pʊrtˤʌbl	*	
b.☞ bʊrtˤʌbl		*

The immediate inference from the table is that candidate (b) is preferred for surface representation over candidate (a), as it does not incur any fatal violations of the higher-ranked markedness constraint, which dominates the lower-ranked faithfulness constraint in the hierarchy. Candidate (a) fails because, although it adheres to the demands of the faithfulness constraint, it does so at the expense of violating the more critical markedness constraint. Children in the younger age category are still undergoing phonological development, and their grammatical systems are not yet as advanced as those of adults. As they progress and approach the end of the critical period, there will be a reordering of the hierarchical ranking of constraints, leading to a more sophisticated system similar to that of competent speakers.

4.1.3. Manner Assimilation

Manner assimilation is another phonological process observed in the speech of Collo children. This process involves the modification of a sound by adopting the articulatory properties of another sound. Typically, manner assimilation occurs in larger units of spoken language. When words co-occur in rapid speech, sounds can merge, creating a new sound. For instance, in the English greeting [gʊd mɔːniŋ], the alveolar sound [d] is considered a final consonant (FC), and [m] is an initial consonant (IC). In rapid speech, where there is no clear pause between words, the final consonant [d] is influenced by the initial consonant [m], acquiring all its properties (voicing, bilabiality, and nasality) and becoming identical to it: [gʊmˈɔːnɪŋ]. Manner assimilation can occur not only between words but also within a single word.

According to Abeer Hadi Salih (2007), children use manner assimilation to achieve homogeneity between assimilated sounds, which simplifies and speeds up speech production. Roach (1991) notes that manner assimilation is not ephemeral. When it occurs in a child's speech, it persists for a significant period before being replaced. The assimilated sound remains for a long time, as it compensates for sounds that may be beyond the child's level of acquisition and could hinder phonological development. For example, the alveolar fricatives [s] and [z] can become the palato-alveolar fricatives [ʃ] and [ʒ] when they occur in interactive contexts. The study's findings reveal a significant presence of manner assimilation in the speech of Collo children across both age groups. Here are some of the attested examples:

Table 06: Examples on Manner Assimiliation

Adult form	Child form	Gloss	Stimulus
[flʌʃ]	[flʌs]	smoothie	 presse-algerie. (2017b). vitaminedz.com. https://www.vitaminedz.com/ar/%D8%A7%D9%84%D8%AC%D8%B2%D8%A7%D8%A6%D8%B1/%D9%86%D8%AC%D9%84-%D9%85%D8%A7%D9%84%D9%83-%D9%81%D9%84%D8%A7%D8%B4-%D9%88%D9%85%D8%B3%D9%8A-%D8%B1-%D9%82%D9%86%D8%A7%D8%A9-%D8%AE%D8%A7%D8%B5%D8%A9-6036552-Articles-0-0-1.html
[ʃəms]	[səms]	sun	 Sun Drawing png images | PNGWing. (n.d.). https://www.pngwing.com/en/search?q=sun+Drawing
[Səbɑːtˤ]	[ʃəbɑːtˤ]	shoes	 Caroline. (2023, May 27). Shoe Drawing - How To Draw A Shoe Step By Step. I Heart Crafty Things. https://iheartcraftythings.com/shoe-drawing.html

The table below displays the percentages and frequencies of initial consonant voicing occurrences :

Table 7: Frequencies and Percentages of Manner Assimilation Occurrence

Age group	Frequency	Percentage
3- 4	4	40%
5	1	10%

In the examples shown above, it is evident that a new sound is created that closely resembles the properties of the original sounds. Children in Collo, across both age groups, exhibit manner assimilation involving two common sounds: [s] and [ʃ]. Notably, there is a tendency for the sound [ʃ] to be replaced by [s], especially in the age group of 3 to 4 years old. The preference for [s] over [ʃ] is due to the former being produced slightly toward the front of the mouth. The tip of the tongue comes close to the alveolar ridge with a gentle contact, allowing the airstream to pass through a narrow opening, creating a hissing sound. In contrast, [ʃ] is produced slightly farther back. The middle of the tongue positions between the alveolar ridge and the soft palate, with the sides of the tongue touching the upper back teeth, and the airstream flows through the tongue without vibrating the vocal cords.

This phonological process observed in Collo children can be explained by considering the markedness constraint *ʃ and the faithfulness constraint IDENT-[MANNER]. The markedness constraint *ʃ prohibits the appearance of the sound [ʃ], while the faithfulness constraint IDENT-[MANNER] aims to preserve the manner features of sounds in the output. Consequently, the markedness constraint *ʃ dominates the faithfulness constraint IDENT-[MANNER], as represented in the following model: *ʃ ≫ IDENT-[MANNER]. The table below provides further details on this model:

Table 8: The Optimal Output for [Səb'ɑːtˤ]

Səbɑːtˤ	*ʃ	IDENT-[MANNER]
a.Səbɑːtˤ	*	
b.☞ʃəbɑːtˤ		*

Similarly, the interpretation of this table revolves around the idea that, in the process of phonological development, markedness constraints consistently dominate the hierarchy. This dominance begins to shift as development nears its conclusion. Accordingly, children in this locality reflect this constraint hierarchy in their speech patterns. Candidate (b) is preferred as the surface representation because it does not incur a fatal violation of the markedness constraint *ʃ, making it optimal. In contrast, Candidate (a) fails to avoid this fatal violation and remains in the underlying representations.

4.2. Non-assimilatory processes

Phonological processes play a crucial role in speech development, with some involving changes that do not depend on assimilation. These are known as non-assimilatory processes, which modify speech sounds independently of their surrounding phonetic context. Unlike assimilation, where a sound becomes more like a neighboring sound, non-assimilatory processes include alterations such as consonant cluster reduction, syllable deletion, vowel epenthesis, fronting, and backing. These processes reflect the developmental patterns of speech acquisition and are often observed in young children as they refine their phonological systems. The following sections explore each of these processes in detail, illustrating their occurrence with examples and relevant theoretical frameworks.

4.2.1.Consonant cluster reduction

According to Abd Ali Nayif Hasan (2019), a consonant cluster refers to a sequence of consonants with no intervening vowels or pauses. In other words, it is a group of consonants that are pronounced together without being vocalized. When an element of a consonant cluster is omitted, the phonological process known as "consonant cluster reduction" occurs. Consonant clusters are not merely unvocalized sequences; they also represent morphosyntactic complexities in speech production and perception (Marianne Pouplier, 2022).

Children do not typically produce consonant clusters during the early stages of phonological development. The ability to produce consonant clusters generally begins around age 2. Prior to this age, children often cannot produce consonant clusters due to the phonemic complexities that exceed their articulatory control. By age 2, children whose first languages include frequent consonant clusters, such as Italian, start to produce two- and sometimes three-consonant clusters. However, in earlier attempts, these children may struggle to produce the target phonemic sequences, leading to forms that do not align with the target language. The progression from initial attempts at producing consonant clusters to mastery involves significant mental development. Early attempts are not bound by adult forms; they are independent in their representation. Children use only the sounds they have acquired from their ambient language's phonemic inventory. As development advances and their phonemic inventory approaches completeness, children recognize the inadequacies of their representations and begin to imitate adult forms. This imitation often results in systematic errors, such as the truncation of one element of the cluster, a process known as "consonant cluster reduction" (Sharyne McLeod et al., 2001). Data collected in Collo show that children in both age groups exhibit this phonological process. The examples are illustrated in the table below:

Table 9: Examples on Consonant cluster reduction

Adult form	Child form	Gloss	Stimulus
[lbən]	[bən]	fermented milk	 Courses Net. (2023, April 12). Lben Soummam au bifidus actif - 1L - Courses Net. https://www.coursesnet.dz/product/lben-soummam-au-bifidus-actif-1l/
[rməl]	[məl]	sand	 How to Draw a Beach Scene - Step by Step Easy Drawing Guides - Drawing Howtos. (2022, September 10). Drawing Howtos. https://drawinghowtos.com/beach-4801/

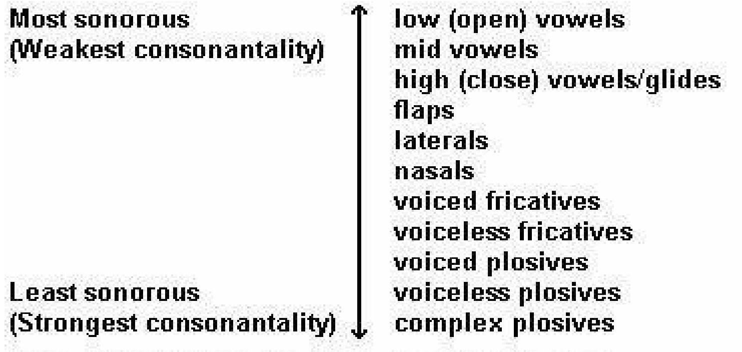
The type of consonant cluster reduction observed in Collo children is known as partial consonant cluster reduction. In this process, the sequence of consonants forming the onset of a syllable typically has the canonical form (CCV). Children often truncate one element of the cluster, leaving behind a single consonant. This omission results in what is known in phonology as singletons (single consonants), which are acquired before clusters. Optimality Theory (OT) accounts for this phonological process by proposing the markedness constraint *COMPLEX, which opposes the presence of consonant clusters in the output, and the faithfulness constraint MAX-IO-(C), which requires every element in the input to have a corresponding element in the output. Consequently, the markedness constraint dominates the faithfulness constraint: *COMPLEX ≫ MAX-IO-(C).The table below displays the percentages and frequencies of initial consonant reduction cluster occurrences :

Table 10: Frequencies and Percentages of Consonant Cluster Reduction

Age group	Frequency	Percentage
3- 4	4	40%
5	1	10%

The deletion of elements from a consonant cluster is not random but follows specific restrictions. For example, one might question why the [l] sound is omitted from the cluster instead of the [k] sound in [klimʌtɪzer], or why the [b] sound is omitted instead of the [l] sound in [lbən]. The answer lies in the Sonority Sequencing Principle (SSP), which describes the distribution of sonority within a syllable. By definition, a syllable is a sequence of neighboring segments that includes a single peak of acoustic energy (the nucleus). This peak of acoustic energy decreases towards the margins of the syllable (the onset and the coda). The SSP provides two main principles: (1) a syllable must contain a single peak of sonority represented by a vowel (the nucleus), and (2) the margins of the syllable exhibit a gradual decrease in sonority towards the nucleus (Stephen G. Parker, 2002). In the context of Collo children, the effect of the SSP is evident. Preferences for sound omission are driven by the need to preserve the distribution of sonority. According to Hooker's chart in the same field of study, voiced plosives are less sonorous than liquids. Therefore, the sound [b] is preserved while the sound [l] is omitted.

Figure 1.Hooker's chart of sonority



The following table cuts short the previous explanation in regard to the hierarchy ranking of constraints.

Table 11:The Optimal Output for [klimʌtɪzer]

klimʌtɪzer	*COMPLEX	MAX-IO-(C)
a.klimʌtɪzer	*	
b.☞ kimʌtɪzer		*

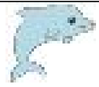
The ranking of the markedness constraint *COMPLEX is higher in the hierarchy than that of the faithfulness constraint MAX-IO-(C). Consequently, candidate (a), which incurs a fatal violation of the markedness constraint, is deemed less optimal. The form favored to appear in the output is candidate (b), which is considered the optimal candidate.

4.2.2.Weak and Unstressed Syllable Deletion

Weak and unstressed syllable deletion is another phonological process observed in the speech of Collo children. By definition, it involves the truncation of unstressed syllables within a word. Stress is a crucial prosodic feature in all languages; no word is devoid of a syllable pronounced with notable air pressure. The stressing of a syllable is not random but depends on three key factors: the nucleus of the syllable must be pronounced with higher frequency, its duration must be longer, and its intensity must be greater than that of neighboring unstressed syllables (Rohani Sri Margareth, 2020). Consequently, the distribution of stress within words is clarified. The most prominent syllable in a word carries the primary stress, denoted by (2) and marked with an acute accent, while the weakest syllables are represented by (0).

In phonological acquisition, stress plays a significant role. According to the theory of Multisyllabic Word Production (MWP), children's phonological development is closely linked to the syllabic structure and stress patterns of their acquired language. Mastery of syllable prominence, according to MWP, typically occurs by age 4, but with polysyllabic words, this process may result in the omission of the most prominent syllable if it is not in the initial position (Glenda Mason, 2015). In Collo, this process is evident and more frequent in the age category of 3;4 to 4 years old. The table below displays the examples that have been observed:

Table 12: Examples on Weak and unstressed syllable deletion

Adult form	Child form	Gloss	Stimulus
[dəlfɪːn]	[fɪːn]	dolphin	 Alena. (2021). How to Draw a Dolphin. How to Draw for Kids. https://howtodrawforkids.com/how-to-draw-a-dolphin/
[səb'ɑːtˤ]	[b'ɑːtˤ]	shoes	 Caroline. (2023, May 27). Shoe Drawing - How To Draw A Shoe Step By Step. I Heart Crafty Things. https://iheartcraftythings.com/shoe-drawing.html

The table below displays the percentages and frequencies of Weak and unstressed syllable deletion occurrences:

Table 13: Frequencies and Percentages of Weak and Unstressed Syllable Deletion

Age group	Frequency	Percentage
4	10	100%
5	5	50%

OT accounts for this phonological process by proposing the markedness constraint *PROMINENT-(FOOT, LEFT), which deters the appearance of initial unstressed syllables in surface representations. The term *PROMINENT refers to the strength of the syllable, while "FOOT, LEFT" denotes the left-dominant foot of the word. In this context, a foot is a rhythmic unit of a word consisting of one or two syllables, one of which is stronger than the other. Hence, the primary distinction between feet and syllables is that feet are more complex units. This markedness constraint *PROMINENT-(FOOT, LEFT) outranks another faithfulness constraint, PARSE-SEG. PARSE-SEG requires that underlying segments be parsed into the syllable structure, ensuring that each segment has a place within the word's structure. This constraint is on par with another faithfulness constraint, MAX-IO-[SYLLABLE], which prohibits the deletion of syllables and demands that every syllable present in the underlying representation appears in the surface representation.

The following model and table summarize the constraints: *PROMINENT ≫ PARSE-SEG, MAX-IO-[SYLLABLE].

Table 14: The Optimal Output for [sərdʊːk]

sərdʊːk	*PROMINENT-(FOOT,LEFT)	PARSE-SEG	MAX-IO-[SYLLABLE]
a.sərdʊːk	*		
b.☞dʊːk		*	*

The ranking of *PROMINENT-(FOOT, LEFT) over PARSE-SEG and MAX-IO-[SYLLABLE] allows candidate (b) to be the optimal choice. Candidate (a) is excluded because it incurs a fatal violation of the higher-ranked constraint while satisfying the lower-ranked ones.

4.2.3. Vowel Epenthesis

Vowel epenthesis is another phonological process observed in the speech of Collo children. It refers to the insertion of a vowel to break up a consonant cluster (Graham Williamson, 2016). Children use this process to make speech production faster and simpler. Occasionally, they encounter unvocalized consonant clusters that are complex to produce. To facilitate smoother transitions between consonants, children may add a vowel, typically the schwa [ə], to simplify the cluster. Below are the examples:

Table 15: Examples on Vowel Epenthesis

Adult form	Child form	Gloss	Stimulus
[kursi]	[kurəsi]	chair	 Sladjana. (2022, April 29). Chair Drawing — How To Draw A Chair Step By Step. I Heart Crafty Thingshttps://iheartcraftythings.com/chair-drawing.html
[bʌslə]	[bʌsələ]	onion	 2,849,366 Onion Images, Stock Photos, 3D objects, & Vectors | Shutterstock

The table below displays the percentages and frequencies of vowel epenthesis occurrences:

Table 16: Frequencies and Percentages of vowel epenthesis

Age group	Frequency	Percentage
4	4	40%
5	1	10%

In these examples, all the words are originally bisyllabic. Children insert the schwa sound to break up consonant clusters encountered in the second syllable. This process alters the canonical form of the words by adding the schwa [ə], resulting in a new syllable structure: from CVCV to CVCVCV. For children, the canonical form CV is simpler and more manageable than CC in some contexts.

Table17: The Optimal Output for [nəmlə]

nəmlə	*COMPLEX	MAX-IO-[C	DEP-IO
a.nəmlə	*		
b.☞nəmələ		*	*

OT accounts for this phonological process by proposing the markedness constraint *COMPLEX and the faithfulness constraints DEP-IO and MAX-IO-[C]. The markedness constraint *COMPLEX prohibits consonant clusters from appearing in surface structures, while DEP-IO prohibits epenthesis, and MAX-IO-[C] prohibits the deletion of segments. Consequently, the markedness constraint *COMPLEX is dominant in the hierarchy, as consonant clusters are not represented in the surface structure. The absence of segment deletion in the output places the faithfulness constraint MAX-IO-[C] in a higher rank than DEP-IO. The following model and tableau illustrate this explanation: *COMPLEX ≫ MAX-IO-[C] ≫ DEP-IO.

4.2.4. Fronting

Fronting is a phonological process where a sound produced posterior to the alveolar ridge is replaced with a sound made at or in front of the alveolar ridge (Graham Williamson, 2016). This sound error is observed in the speech of children in this locality, though it is rarely found in the older age category. The examples are shown below:

Table 18: Examples on Fronting

Adult form	Child form	Gloss	Stimulus
[kəlb]	[θəlb]	dog	 How to Draw a Dog Step by Step - EasyLineDrawing
[drʊ:ʒ]	[drʊ:z]	stairs	 Farida. (2022b). How to Draw Stairs. How to Draw for Kidshttps://howtodrawforkids.com/how-to-draw-stairs/
[keʊkeʊ]	[θeʊθeʊ]	peanuts	 https://images.app.goo.gl/TLe51wfLbB3hsCDn9

The table below displays the percentages and frequencies of fronting occurrences:

Table 19: Frequencies and Percentages of fronting

Age group	Frequency	Percentage
4	5	50%
5	0	0%

In the examples above, two types of fronting are observed. In the word [kəlb], the velar voiceless stop [k], produced with the back of the tongue blocking the airstream by contacting the soft palate, is replaced by the voiceless dental fricative [θ], where the articulator makes a narrow constriction against the point of articulation, causing frication noise. This represents initial velar fronting. In the word [drʊ:ʒ], the voiced palato-alveolar fricative [ʒ], produced at the back of the alveolar ridge, is replaced by the voiced velar fricative [z], which is produced at the alveolar ridge. This is an example of final post-alveolar fronting.An optimality analysis of this phonological process suggests the markedness constraint *VELAR, which prohibits the appearance of velar sounds in the output, and the faithfulness constraint IDENT-IO-[PLACE], which prevents the alteration of the place of articulation from the underlying form to the surface form. Thus, the markedness constraint *VELAR dominates the faithfulness constraint IDENT-IO-[PLACE], as represented in the following model and table: *VELAR ≫ IDENT-IO-[PLACE].

Table 20: The Optimal Output for [keʊkeʊ]

keʊkeʊ	*VELAR	IDENT-IO-[PLACE]
a. keʊkeʊ	*	
b.☞θeʊθeʊ		*

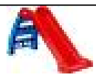
An analysis of the table leads to the following interpretations: Candidate (a), which satisfies the faithfulness constraint IDENT-IO-[PLACE] but incurs a fatal violation of the markedness constraint *VELAR, is eliminated from consideration. It is not supported to appear in the child's output. Candidate (b), which violates the faithfulness constraint IDENT-IO-[PLACE] but adheres to the markedness constraint *VELAR, is favored and thus is the optimal representation in the surface structure.

4.2.5. Backing

Backing is a phonological process characterized by the replacement of a non-velar or non-glottal sound (including labial, labio-dental, dental, alveolar, post-alveolar, and palatal sounds) with a velar or glottal sound. This process can be categorized into two types: syllable-initial backing and syllable-final backing (Graham Williamson, SLTinfo, 2016).

The data collected from this district indicate that children exhibit this sound pattern less frequently across both age categories. Below are some examples of backing observed:

Table 21: Examples on Backing

Adult form	Child form	Gloss	Stimulus
[zəlˈɛːqə]	[ʒəlˈɛːqə]	slide	 Staff_Illustrator. (n.d.-a). How to Draw a Slide. DrawingNow DrawingNow. https://www.drawingnow.com/tutorials/117981/how-to-draw-a-slide/
[ʕʊˈkɛz]	[ʕʊˈkɛʒ]	a medical crutch	 https://images.app.goo.gl/c7cM3gYWJHBL6pYe7
[ʕæzɪːz]	[ʕæʒɪːʒ]	a boy's name	

The table below displays the percentages and frequencies of backing occurrences

Table 22 : Frequencies and Percentages of Backing

Age group	Frequency	Percentage
3- 4	7	70%
-5	3	30%

Based on the examples, it is observed that the most susceptible sound to this phonological process is the voiced alveolar fricative [z], which is substituted by the voiced palato-alveolar sound [ʒ] produced further back towards the alveolar ridge. In terms of OT, this pattern of speech error involves a hierarchical ranking of constraints where the markedness constraint *POST-ALVEOLAR, which prohibits the presence of post-alveolar segments in the output, outranks the faithfulness constraint IDENT-IO-[PLACE], which requires the retention of the same place of articulation for the segments from input to output. The following model and table further illustrate this explanation: *POST-ALVEOLAR ≫ IDENT-IO-[PLACE].

Table23: The Optimal Output for [zəlˈɛːqə]

zəlˈɛːqə	*POST-ALVEOLAR	IDENT-IO-[PLACE]
a. zəlˈɛːqə	*!	
b.☞ʒəlˈɛːqə		*

Conclusion and Recommendations

This preliminary exploratory study describes phonological processes occurring in the speech of 20 Collo-speaking children aged 3;0–4;11 years. Findings reveal both assimilatory (consonant harmony, initial consonant voicing, manner assimilation) and non-assimilatory (consonant cluster reduction, weak syllable deletion, vowel epenthesis, fronting, backing) phonological processes, with generally higher frequencies in younger children. Application of Optimality Theory constraint reranking provides coherent theoretical explanation for observed developmental patterns: markedness constraints dominate in younger children's grammars, producing frequent simplification processes, while gradual constraint reordering elevates faithfulness constraints in older children, reducing process frequencies. Addressing the first research question regarding what phonological processes characterize Collo children's speech, preliminary analysis documents seven identifiable process categories, though confidence in this enumeration is limited by small sample size and would require validation through expanded research. Regarding the second research question concerning homogeneity of phonological development, observed patterns appear directionally consistent with developmental predictions and with findings from other Arabic dialects, suggesting some universal elements; however, the small, non-stratified sample prohibits definitive statements about whether Collo development is homogeneous or heterogeneous. In response to the third research question about whether OT constraint reranking accounts for observed development, OT provides a coherent theoretical framework accommodating observed patterns, with developmental trajectory (from markedness-to-faithfulness dominance) aligning with OT predictions; however, without formal constraint inventory validation or alternative theoretical comparison, the degree of explanatory power remains partially indeterminate.

The study addresses a research gap by providing the first systematic description of Collo phonological development. Preliminary descriptive data may inform future studies and potentially contribute to differentiation between typical development and phonological disorder in this understudied population. This research carries substantial methodological limitations that require acknowledgment and future refinement. Sample size of n=20 is insufficient for reliable statistical inference, and future studies should recruit minimum n=60–100 per age group (or n=100–150 for cross-sectional studies across age bands) to enable statistical hypothesis testing with adequate power. Percentages based on counts fewer than 10 create misleading precision; future work should report raw frequencies alongside percentages and apply minimum threshold criteria (e.g., minimum 20 token opportunities) before calculating percentages. Single recording session per child may not capture stable phonological patterns; future studies should conduct minimum 2–3 recording sessions per child across different contexts (structured and natural), aggregating data across sessions. Stimuli development lacks formal frequency analysis or validity studies; future work should conduct preliminary frequency analysis of Collo child-directed speech, pilot test stimuli with target population, document image familiarity and word recognition, and conduct validity studies confirming appropriateness for age groups. Transcription reliability assessment covered only 20% of data, below the recommended minimum 30%; future studies should implement independent transcription of minimum 30% of data, calculate inter-rater agreement statistics (intraclass correlation coefficient [ICC] targeting ICC ≥ 0.90), and maintain detailed reliability documentation. The present study employed no inferential statistics; future work should implement descriptive statistics with confidence intervals, conduct appropriate inferential tests (ANOVA for age-group comparisons, chi-square for frequency comparisons), calculate effect sizes (Cohen's d, eta-squared), and report p-values and 95% confidence intervals. This research lacks comparison data; future investigation should include dialectal comparison groups (e.g., Algerian Arabic speakers from other regions) and comparative analysis with published Arabic developmental data. Despite these limitations, findings provide foundational descriptive data on Collo phonological development and highlight the need for rigorous methodological refinement in future investigations. Future research should pursue expanded longitudinal tracking of children across broader age ranges, theoretical comparisons of alternative frameworks for explaining Collo data, systematic dialect comparison studies examining whether patterns reflect universal principles or dialect-specific variation, and development of standardized phonological assessment tools grounded in normative Collo data. Additionally, speech-language pathologists should recognize that phonological processes documented in this study may represent typical development rather than disorder indicators; applying non-dialect-specific phonological norms may inappropriately categorize typically developing Collo speakers as disordered. Pending rigorous validation through larger-scale research, preliminary findings suggest that current phonological assessment practices require refinement to accurately differentiate typical development from phonological disorder in Collo-speaking populations.

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