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Consonant Cluster Acquisition in Toddlers: An Explorative Study

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Abstract: The acquisition of consonant clusters is considered as one of the final stages of speech development in typically developing children. Nonetheless, the phonological development in children is now more advanced compared to the previously established norms. The current study aimed to determine how consonantal clusters, in particular non-geminate clusters, emerged throughout the early phases of phonological acquisition and to understand the positional variations in the cluster acquisition. The study involved 40 Malayalam speaking children aged between two to three years, divided into four groups with an age interval of 3 months. These children were administered 30 non-geminate consonant clusters from the Malayalam Articulation Test – Revised. Positional effect of the cluster acquisition was examined. In addition, the type of articulatory errors on consonant production were also determined. Findings from the present study revealed that children achieve the mastery of many consonant clusters by two to three years of age. Positional effect of cluster acquisition revealed medial clusters were acquired earlier than initial clusters. Cluster reduction was the dominant cluster error type, decreasing with age. Thus, compared with the previous established norms, the current findings demonstrate a much earlier acquisition of nongeminate clusters in Malayalam. The revised norms for cluster acquisition proposed from the findings of this study could benefit Speech-Language Pathologists to conduct age-appropriate assessment and treatment of speech sound disorders.

Keywords: Phonological Acquisition, Consonant Clusters, Malayalam, Toddlers

1. Introduction

The contribution of speech-language pathologists to their discipline depends on their understanding of normal speech and language development. Researchers believe that there is continuity between babbling and early speech (Storkel & Morrisette, 2002) and as the child develops, language progresses by producing actual words and concurrently expanding their vocabulary of new vowels and consonants present in their native language.

Shriberg and Kent (2014) reported that there are about 100 phonemes in the repertoire of languages across the world. Consonants are produced either as a singleton (alone) or as a combination forming clusters. In syllable structure, consonant clusters arise when two or more consonants occur at the same place (Smith, 1989). Combinations of these consonants can appear in words at the beginning (spoon), middle (kangaroo), or end (cold). The learning of consonants and consonant clusters is specified by a percentage criterion (50, 75, 90, or 100%) but in studies (Dodd *et al.,* 2003; McLeod & Arciuli, 2009) the term "mastery" is often assumed when at least 90% of the children in the sample produced the target consonant cluster correctly. Even though there are numerous studies on the normal development of children's speech, most of them seldom address cluster development. Also, the phonological acquisition in children is found to be more advanced when compared to norms established earlier. Hence, it is critical to fully understand the trends in cluster development for speech sound assessment.

1.1 Acquisition of Consonant Clusters

Meaningful consonant clusters are not reported to be acquired in children in the stages of gurgling, cooing, or babbling i.e. children under one year of age (Robb & Bleile, 1994; Stark *et al.,* 1993), additionally consonant

clusters are not discussed in the literature about children until the point at which they utter their first 50 words (Robb & Bleile, 1994).

Consonant clusters can be broadly classified into 2 types: non-geminate clusters and geminate clusters (Hiremath, 1980). Geminate clusters are described as doubled consonants or the same consonant cluster. They differ from their singleton counterpart based on length or duration (Ladefoged & Maddieson, 1996). In Indian languages, geminate clusters occur primarily in the medial position. Examples of geminate cluster in Malayalam include /mm/ in /amma/ (for mother), /ɳɳ/ in /ʋeɳɳa/ (for butter), /ɭɭ/ in /kaɭɭam/ (for lies), and so on. Non-geminate clusters are the combination of different singleton consonants. Examples in Malayalam include /ɳɖ/ in /t͡ʃaɳɖanam/ (for sandalwood), /ʈr/ in /paʈram/ (for newspaper), /kr/ in /t͡ʃakram/ (for wheel). In Kannada, Shishira (2013) reported that all the participants in the age range of 12-18 months have geminate clusters in their verbal repertoire, while the presence of non-geminate clusters was rare, and they are more seen above the age of 3 years. Rupela and Manjula (2006) also reported that geminate clusters are acquired earlier than non-geminate clusters in Kannada and geminate are the only clusters present during 12-18 months of age.

The ability to produce consonant clusters can be linked to the ongoing anatomical development of the oro musculature and the maturation of the child's motor speaking mechanics (McLeod, 2001a). Earliest attempts at the production of consonant clusters usually result in the production of forms that are inconsistent with the ambient language (McLeod *et al.,* 2001b). Cluster reduction (deletion of one or more consonants), cluster simplification (when two elements of the clusters are produced, but one or both of the elements are produced in a non-adult manner), epenthesis (insertion of a vowel -e.g. /pallet/ for plate), coalescence (reduced cluster contains a new consonant composed of features from original consonants-e.g. /fim/ for swim), and metathesis (reversal of adjacent segments) are some examples of phonological processes that can be used to explain the development of clusters. Greenlee 1974; Elbert and McReynolds, 1979) stated four stages of cluster acquisition. In Stage 1, there is deletion of the entire cluster (for e.g., producing blue as [u]). In stage 2, reduction of the cluster to one member is observed (for e.g., blue as [bu]). Further, in stage 3, there is use of cluster with substitution of one or both members of the cluster (e.g., blue produced as [bju]). Finally, in stage 4, both segments are used appropriately. (e.g., blue produced as [blu]).

A study on the acquisition of English consonant clusters by McLeod et al. (2001b) concluded that consonant clusters containing plosives (e.g., /pl/, /kw/) are acquired earlier than clusters containing fricatives (e.g., /st/). Watson and Scukanec (1997) reported the production of consonant clusters [-nd], [-ts], [-nt], [-nz] by the age of 2.9 and [-nk] by the age of three years. A similar kind of observation was reported by Kirk and Demuth (2005) in their study on asymmetries in the acquisition of word initial and word final consonant clusters in 12 two-year-old English-speaking children. The results showed that word final stop + /s/ clusters and nasal + /z/ clusters were produced more accurately than word initial /s/ + stop clusters. In contrast, Demuth and Mccullough (2009) confirmed the earlier acquisition of initial clusters when compared to the word final clusters in a study done on French-speaking children's acquisition of clusters in the age range of 2 to 3 years.

In the Indian context, clusters were studied more extensively as part of development of articulation tests. In Telugu, Neethipriya (2007) studied the acquisition of clusters in typically developing children in the age range of 3-6 years. She concluded that nasal plus stops (Eg: /nt/, /nk/, /mt/) were predominant in the word medial position followed by fricatives plus plosives (/st/) combinations. Similarly, Usharani and Sreedevi (2010) concluded that all four clusters (2 clusters /kʃ/, /ʃr/ in medial position and 2 clusters /bl/, /sk/ in initial position) were acquired by 60% of the Telugu speaking children by the age of 3 years. In Kannada, Divyashree (2018) explored the development of clusters in 3- to 6-year-old children and the findings revealed that children begin to master clusters between the ages of 3.6 to 4 years. Several processes in the children's non-adult renditions of the target cluster included cluster reduction, simplification, metathesis, epenthesis, and coalescence errors.

Similar studies in Malayalam reveal acquisition of many clusters in young children. Divya (2010) conducted a study using eight consonant clusters from the Malayalam Articulation Test and she found that, by around 3 years of age clusters such as /-nt-/, /-nʈ-/, /-ndʒ-/, /-nd-/, /-nk-/, and /-ʈʃ-/ met 90% criteria i.e. 90% of the participants produced them correctly. Neenu (2011) found that approximately six initial clusters (/gl-/, /kl-/, /pl-/, /gr-/, /kl-/, /kj-/) was achieved by more than 80% of the children by the age of 4 years and four medial clusters (/-nt-/, /-nʈ-/, /-ndʒ-/, /-nd-/) achieved 90% mastery by the age of 3 to 3.3 years by both boys and girls. Vrinda (2011) conducted

a similar study in the age group of 5 to 6 years and she observed that around 12 initial clusters (/pr-/, /sk-/, /gl-/, /kl-/, /pl-/, /sl-/, /bl-/, /sth-/, /tR-/, /br-/, /sth-/ and /kj-/) and 11 medial clusters (/-nt-/, /-nʈ-/, /-ndʒ-/, /-nd-/, /-nk-/, /-ʈy-/, /-nɖr-/, /-sk-/, /-lj-/, /-sʈ-/ and /-sʈr-/) reached 90% criteria by 5 to 5.3 years of age. On comparing these studies, earlier acquisition of clusters containing nasal sounds and loan English words are evident. Alphonsa (2012) examined early phonetic repertoire and syllable structure in Malayalam speaking toddlers and findings show that only medial geminates and medial non-geminates were seen in the 18–24-month children's phonetic repertoire. Among the medial geminates, nasal geminates /mm/ found the maximum frequency of occurrence followed by stop geminates /pp, /tt/ and /kk/.

The acquisition of consonant singletons has been the main focus of majority of studies on phonological development and less is known about the emergence and mastery of consonant clusters particularly in the Indian scenario. Malayalam is one of the main languages of the Dravidian family. Updated knowledge on cluster acquisition is important for Speech-Language Pathologists (SLPs) to provide more effective and timely interventions for children with speech sound disorders. Therefore, the current study aimed to understand acquisition of non-geminate clusters in typically developing Malayalam speaking children in the age range of 2 to 3 years and to determine the positional variations in the acquisition of non-geminate consonant clusters. The phonological acquisition in children is found to be more advanced and studies done on Malayalam Articulation Test were more than a decade back. Hence this study is warranted.

2. Method

2.1 Participants

Forty typically developing Malayalam speaking children in the age range of 2 to 3 years were recruited randomly from different localities of Wayanad and Thrissur districts of Kerala. These children were divided into four groups of three months age intervals (Groups I-≥ 2 ≤ 2.3, II- ≥ 2.4 ≤ 2.6, III- ≥2.7 ≤ 2.9 and IV-≥ 2.10 ≤ 3 years). A 3-month age interval was chosen to document the exponential changes in phonological development that occur during this linguistic phase.

Enrolment of the participants to the present study were subsequent to obtaining an informed consent from either of their parents. This study did not involve the use of any invasive procedures. Before beginning with the study procedures, the researchers established a rapport with the children. The data collection procedures did not cause any harm or discomfort to the children and were carried out in a playful manner. If any participant was fatigued, data collection was suspended and resumed after a short rest of 15 to 20 minutes or other brief engaging activities. All the participants were reportedly healthy with no history of speech and language disorders. This information was cross-checked based on an informal parental interview and a formal administration of the assessment checklist for speech - language skills (Swapna *et al.,* 2010), WHO Ten Questions (Malhi & Singhi.,2002) and ling six sound test. Based on the modified Kuppuswamy Socioeconomic Scale (Sood & Bindra, 2022), all the participants belonged to upper middle socioeconomic class. All the participants were exposed to only Malayalam. However, it may be noted that Malayalam has several loan words from English which are of frequent use in day-to-day conversations (Abraham, 2019). Some examples of such words include, papa, car, watch, curtain and so on.

2.2 Procedure

Malayalam Articulation Test – Revised (MAT-R, Neenu *et.al.,* 2011) comprising of 30 consonant clusters (in 15 initial and 15 medial positions) was used as the test material in the present study. These 30 test stimuli were depicted as colour pictures on individual flashcards to elicit the different consonant clusters in the order within the test material.

Prior to the administration of the task, participants were instructed to name the item present in the picture flashcard. If the participants failed to identify the pictures and give a verbal response, appropriate semantic cues were given to them. Repetition task was adopted only when the participants failed to respond even with cue. Responses were audio recorded using an audio recording app (name: Recorder app) on a POCO phone (model x3) placed approximately 10cms away from the subject's mouth. The recorded data was transcribed using broad versions of International Phonetic Alphabet (2020).

2.3 Data Analysis

Different stages of cluster development identified by Greenlee (1974) were used to determine the score for consonant clusters. A score of `1`was given to each correct production of clusters, whereas a score of `0' was assigned to an incorrect production. Additionally, each incorrect productions were categorized broadly as cluster simplification, cluster reduction, cluster deletion, metathesis, epenthesis, and coalescence errors. The total score of clusters (out of 30) was determined for each participant. The scores for consonant clusters were also separately examined for word-initial and word-medial clusters. These scores were subjected to further statistical analysis.

Percentage data (50%, 75%, and 90% criteria) was used to identify the acquisition of consonant clusters. Further the percentage of the different error types on the production of consonant clusters were also determined.

2.4 Statistical Analysis

In order to examine inter rater reliability, three Speech Language Pathologists (SLPs) served as judges to analyse 20% of the recorded sample (8 participants). To ensure the consistency in data analysis, these three SLPs were familiarised with possible errors in the production of clusters using three training samples. These training samples were not part of the samples utilized in this study. Intra rater reliability was also checked among the three SLPs. 10% (4 participants) of the samples was selected for the same. Statistical analysis was performed using SPSS 26. The reliability of the responses was determined using Cronbach's alpha. Shapiro-Wilk test and box plots were used to determine the distribution of the responses across groups of participants and across word positions. Descriptive analysis was run for each group of participants. This was followed by between group comparisons using Kruskal Wallis test and subsequent pairwise comparisons. Within group comparisons (to identify differences in word position of cluster) involved Wilcoxon sign rank test.

Table 1. Descriptive Statistics for Cluster scores

Age Group	Score	Mean	Standard Deviation	Median	Interquartile Range	95% Confidence Interval for Mean	
						Lower Bound	Upper Bound
2.0-2.3	Combined	7.7	1.70	8	2.25	6.48	8.92
	Initial Total	0.8	1.23	0.5	1	-0.08	1.68
	Medial Total	6.9	1.29	7	2.25	5.98	7.82
2.3-2.6	Combined	12.1	2.28	12	3.5	10.47	13.73
	Initial Total	3.9	1.97	3.5	4	2.49	5.31
	Medial Total	8.2	1.03	8.5	1.25	7.46	8.94
2.6-2.9	Combined	15.4	3.03	14.5	4.75	13.24	17.56
	Initial Total	6.6	2.50	5.5	3	4.81	8.39
	Medial Total	8.8	0.92	9	1.25	8.14	9.46
2.9-3.0	Combined	17.7	2.71	17.5	4.25	15.76	19.64
	Initial Total	8	2.83	8	4.5	5.98	10.02
	Medial Total	9.7	1.06	9.5	2	8.94	10.46

3. Results

The study included 40 children the age range of 2 to 3 years divided into 4 groups (n=10 each). A total of 30 non geminate consonant clusters (in 15 initial and 15 medial positions) were considered. Inter and Intra rater reliability was computed using Cronbach's Alpha. The test reported good inter-rater reliability (α = .94) across the 3

raters. Intra rater reliability scores were noted to be good within each of the three raters (α = .93, .96, 1.0 respectively).

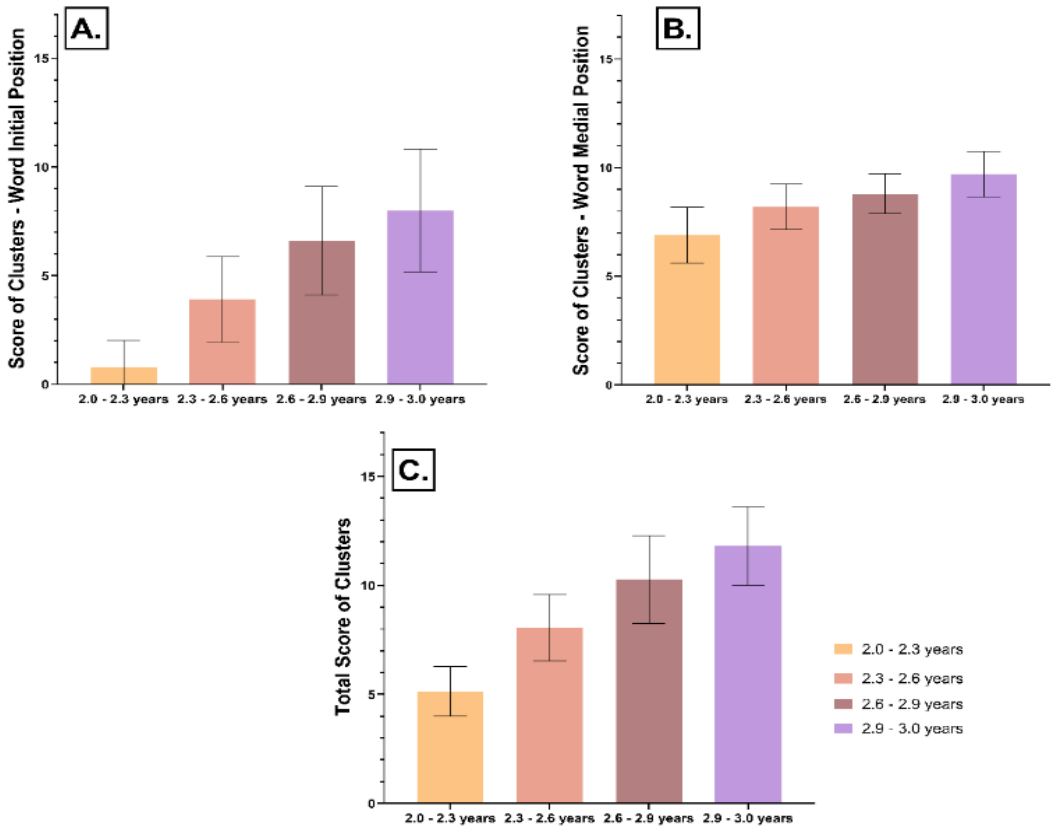
Findings from Shapiro- Wilk test indicated that the data did not follow normal distribution ($p < 0.05$) across groups of participants and across word positions. Visual examination of box plots also revealed non normal distribution of data. Hence nonparametric tests were utilized for further statistical analysis. Descriptive statistics (mean, standard deviation, median, interquartile range, and 95% confidence interval) were derived (Table 1) for various parameters used in the current study, *viz.*, combined scores, and initial and medial cluster totals within each age group. It can be observed that the mean scores of different parameters increased from lower to older age group.

3.1 Comparison across Age Groups

Kruskal-Wallis test was carried out to determine the differences across the age groups with respect to the combined score of clusters, and the totals of initial and medial clusters. For combined score, there was a statistically significant difference ($\chi^2(3) = 28.721$, $p< 0.001$) between the four groups. Hence, pairwise comparisons with Bonferroni corrections were carried out, which revealed that Groups I and III (/Z/ = 3.835, $p<0.001$), Groups I and IV (/Z/ = 5.037, $p<0.001$), and Groups II and IV (/Z/ = 2.912, $p<0.022$) differed significantly in the combined cluster score.

Similarly, the total score of word-initial clusters also demonstrated a statistically significant difference between the age groups ($\chi^2(3) = 26.324$, $p< 0.001$). Subsequent pairwise comparisons with Bonferroni corrections revealed a trend similar to the combined cluster score. There was a statistically significant difference between Groups I and III (/Z/ = 3.961, p <0.001), Groups I and IV (/Z/ = 4.740, p <0.001) on the total score of word-initial clusters.

Likewise, a statistically significant difference was also found between the age groups on the total score of word-medial clusters total also ($\chi^2(3) = 19.303$, $p<0.001$). Pairwise comparisons with Bonferroni corrections indicated that Groups I and III (/Z/ = 2.888, $p = 0.023$), and Groups I and IV (/Z/ = 4.253, $p<0.001$) were significantly different. The mean combined scores, initial and medical cluster total scores are represented in Figure 1.



Graphs representing the mean score of clusters for the different age groups involved in this study for A. Word Initial Position, B. Word Medial Position and C. Total score including both word initial and word medial clusters.

Figure 1. Mean Combined Sores, Initial and Medial Cluster Scores for Different Age Groups.

3.2 Comparison across Positions within Age Groups

The mean scores indicated that the medial clusters are acquired earlier than the initial position clusters. With increase in age, there may be changes with respect to positional variation. Hence, Wilcoxon Signed rank test was administered to determine the differences within the age group across cluster positions. There were significant differences across cluster position within each age group except Group IV (Table 2). Thus, there is an effect of position on the development of clusters.

Table 2. Results of Wilcoxon Signed Rank Test for Comparison Across Cluster Positions

Age group		/Z/	*p*-value
Group I	>2.0 ≤2.3	2.823	0.005
Group II	>2.3 ≤2.6	2.68	0.007
Group III	>2.6 ≤2.9	2.304	0.021
Group IV	>2.9 ≤ 3.0	1.56	0.119

No significant difference within the Group IV (p> 0.005), reveal that with increasing age, clusters are acquired irrespective of positional variations. Figure 2 represents the mean percentage of initial and medial clusters for all the age groups. Across all the age groups, the medial clusters exhibited higher scores compared to the initial clusters.

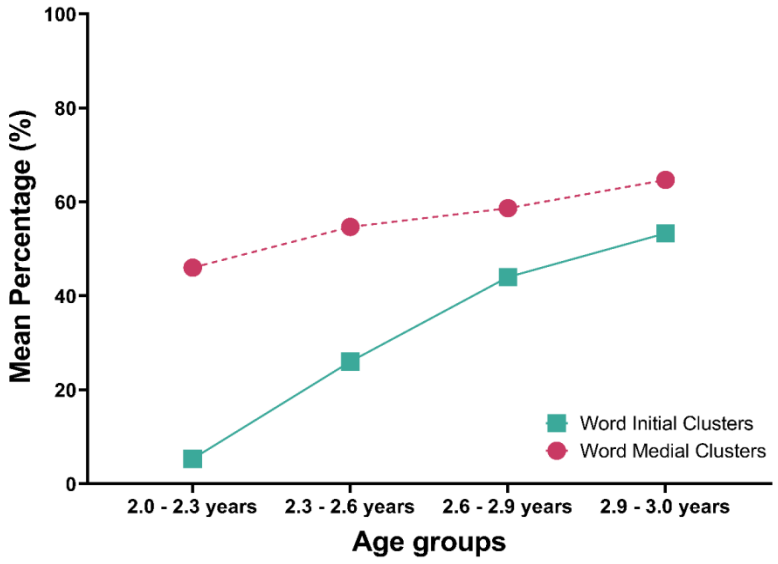


Figure 2. Comparison of Mean Percentage of Clusters across Initial and Medial Positions

3.3 Acquisition of Consonant Clusters

Percentage of children acquiring each consonant cluster was analysed in each age group (Figure 3). The learning of consonants and consonant clusters is specified by a percentage criterion (50, 75, 90, or 100%). The concept of 'mastery' is frequently associated with the correct production of target consonant clusters by at least 90% of the children in the sample.

Contrary to the previous research on cluster acquisition in children, within 3 years of age, around 20 out of the total 30 clusters are acquired by more than 50 % of the children. Ten out of the total 15 initial clusters showed acquisition > 50% from Group II (2.4 -2.6 years) onwards. Medial clusters (n=8) were observed to be mastered (> 90%) compared to the initial clusters. Three element clusters and /r/, /l/ clusters continue to be difficult (< 50%) for the 2- to 3-year-olds. However, the developmental pattern of clusters can be appreciated; a greater number of

clusters are acquired with increase in age. The percentage of the different error types on the production of consonant clusters were also different for the different age groups. Cluster reductions were prominent for all the age groups for word-initial clusters (Figure 4). There was a representation of other error types like epenthesis and coalescence in all the groups for word-medial clusters (Figure 5). However, the error types reduced with increasing age.

Position	Sl.No	Cluster	Word	Meaning	2.0 to 2.3 years	2.4 to 2.6 years	2.7 to 2.9 years	2.10 to 3 years
Initial Clusters	1	/kj-/	/kja:mara/	Camera				
	2	/sk-/	/sku:ʈar/	Scooter				
	3	/gl̪-/	/gl̪a:ssə-/	Glass				
	4	/ʈr-/	/ʈreln/	Train				
	5	/pl̪-/	/pl̪e:tə-/	Plate				
	6	/sl̪-/	/sl̪e:tə-/	Slate				
	7	/bl̪-/	/bl̪æɖə-/	Blade				
	8	/stʰ-/	/stʰalam/	Place				
	9	/sp-/	/spu:ɳ/	Spoon				
	10	/br-/	/braʂə-/	Brush				
	11	/pr-/	/pra:və/	Pigeon				
	12	/kl̪-/	/kl̪o:k/	Clock				
	13	/gr-/	/gra:mam/	Village				
	14	/ʃv-/	/ʃva:sam	Breathe				
	15	/kr-/	/kriʃɳan/	Krishna				
Medial Clusters	16	/-nt-/	/pa:ntə-/	Pant				
	17	/-nʈ-/	/panʈə-/	Ball				
	18	/-ndʒ-/	/sandʒi/	Cover				
	19	/-nɖ-/	/ʈi:vanɖi/	Train				
	20	/-nk-/	/kanka:ru/	Kangaroo				
	21	/-lj-/	/kalja:ɳam/	Marriage				
	22	/-ʈj-/	/inʈja/	India				
	23	/-dj-/	/sadja/	Feast				
	24	/-nɖr-/	/ʧandran/	Moon				
	25	/- sk-/	/biskattə-/	Biscuit				
	26	/-stʈ-/	/pustʈakam/	Book				
	27	/-str-/	/vastram/	Dress				
	28	/-ʈr-/	/pa:ʈram/	Vessel				
	29	/-kr-/	/ʧakram/	Wheel				
	30	/-kʃ-/	/nakʃatram/	Star				

Note:

≥90% of the children have acquired the cluster,

≥ 75% of the children have acquired the cluster,

≥ 50% of the children have acquired the cluster,

< 50% of the children have acquired the cluster.

Figure 3. 50%, 75% and 90% Acquisition of Initial and Medial Clusters Across Different Age Groups

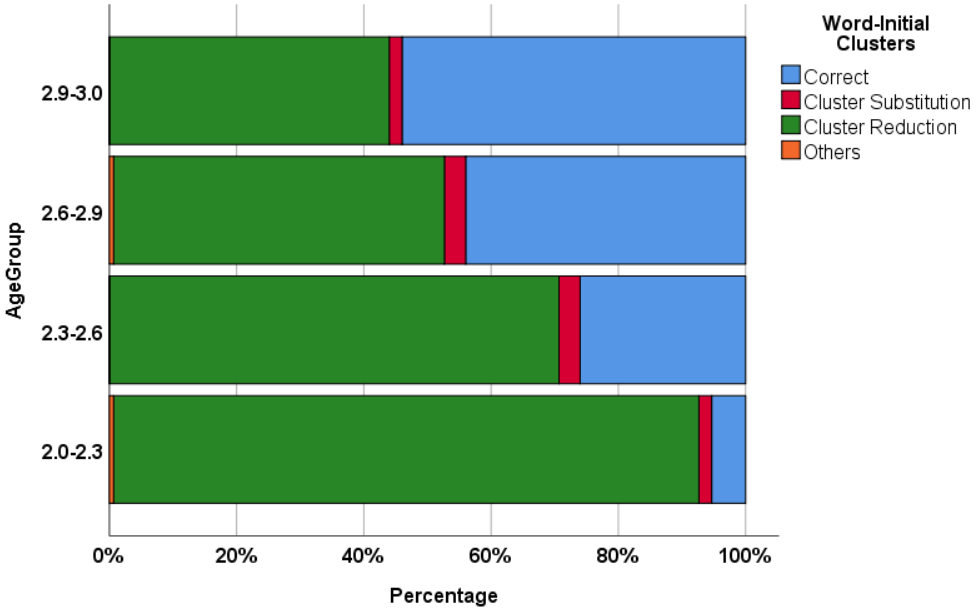


Figure 4. Percentage of Cluster Error Types across Different Age Groups for Word-Initial Clusters

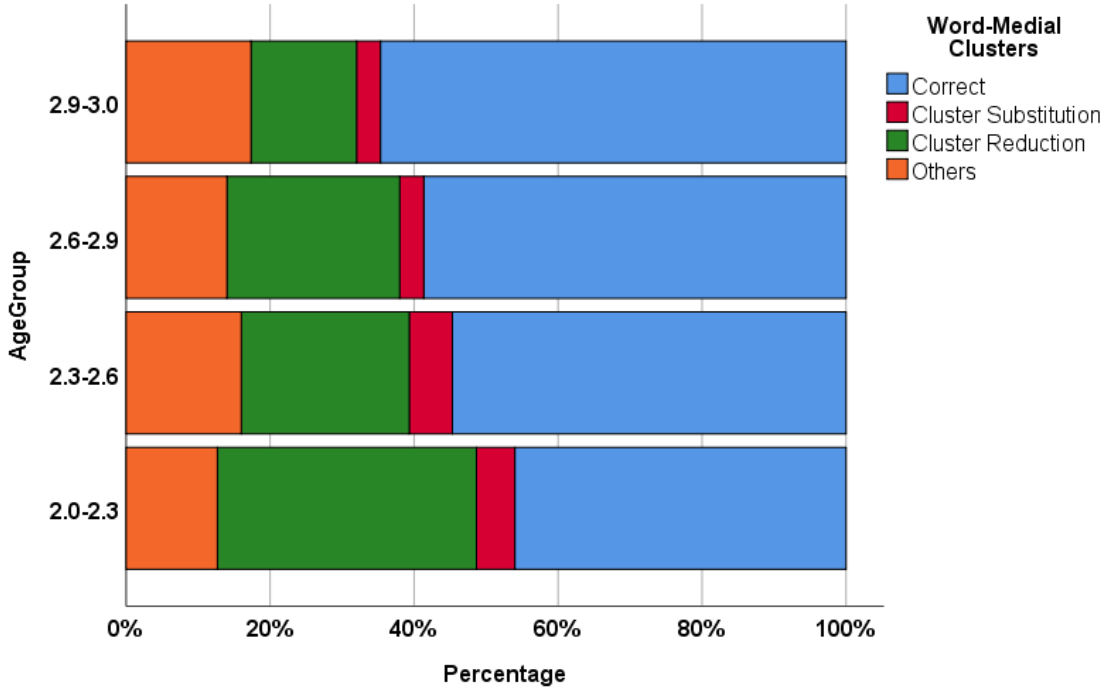


Figure 5. Percentage of Cluster Error Types across Different Age Groups for Word-Medial Clusters

4. Discussion

The aim of the present study was to understand how consonantal clusters, particularly non-geminate clusters, emerged during the early stages of phonological acquisition and to establish the ages at which the participants produced the clusters correctly. The present results show advancement in the acquisition of non-geminate clusters when compared to the earlier norms for Malayalam speaking children (Alphonsa, 2012; Neenu, 2011; Vipina, 2011).

Findings from the present research validates the anticipated pattern noted by McLeod et al. (2001a) that children as young as two years of age can produce consonant clusters, and that the ability to do so increases with age. Similar findings were reported from studies conducted in various languages, Hebrew (Bloch, 2011), Dutch (Jongstra, 2003), French (MacLeod *et al.,* 2011) and English (McLeod *et al.,* 2001a). Nevertheless, Schaefer & Fox-Boyer (2016) reported that only a limited number of clusters met the age of acquisition criteria (75%) in German speaking two-year-old children. The present study contributes to the existing literature by demonstrating an earlier acquisition of consonant clusters even by two years of age. By 3 years of age, 20 out of the total 30 clusters are mastered by over 50% of the children in the present study.

The overall pattern of the data in the current study indicates that, at all ages, medial clusters are acquired earlier than initial clusters. Similar pattern has been observed by several authors in different Indian languages such as Malayalam (Neenu, 2011; Vipina, 2011); Telugu (Neethipriya, 2007; Sneha, 2012); and Kannada (Deepa, 2010; Divyashree, 2018; Rupela & Manjula, 2006). Such disparities in cluster acquisition are attributed by researchers to the location and frequency of clusters in ambient language (Krik & Demuth, 2003; Reynolds, 2011). Also, frequency of occurrence of clusters is more in the medial position in Indian languages (Hiremath, 1980; Rupela & Manjula, 2006). And English loan words form a significant part of the word list of most articulation tests. However, there are negligible studies on consonant cluster acquisition among Malayalam speaking children in less than three years of age. Findings from this study align with the findings of Alphonsa (2012), who reported the presence of medial geminates and non-geminates as early as 18–24-months of age.

Earlier research on cluster acquisition in English speaking two-year-olds have revealed, 58% of the children were able to produce at least two distinct initial clusters. While 48% could produce final clusters, only 30% were able to produce two or more words with adjacent consonants or medial clusters (Stoel-Gammon, 1987). Furthermore, wide range of consonant clusters appeared both at the beginning and end of words in children aged between 2;0

and 3;3 years (Dyson, 1988). In English, word-final clusters are simpler to articulate than word-initial consonant clusters, possibly because some sequences of consonant clusters are easier to produce than others because of their phonetic context (Kirk & Demuth, 2005). This asymmetry appears to stem from factors related to articulation, rather than structural, morphological, or frequency-based factors articulatory factors (Kirk & Demuth, 2005). Similar trends were reported by McLeod et al., (2001a). Two-year-old children began to produce few consonant clusters having /w/ in word-initial clusters and nasals in word-final consonant clusters.

In the present study, cluster reduction was observed for most of the consonant clusters followed by cluster substitution and epenthesis. The findings are in consonance with earlier studies on cluster acquisition of children greater than three years of age in different Indian languages: Telugu (Sneha, 2012), Malayalam (Neenu, 2011; Vipina, 2011, Vrinda 2011), Hindi (Santhosh, 2001), Tamil (Barathi, 2001), Kannada (Divyashree, 2018). Saleh et al., 2023 observed a decline in the frequency of cluster reduction, from 74% in children aged 2 years and 6 months to 46% in children aged 3 years to 3 years and 6 months, and finally to 10% in children aged 3 years and 6 months to 4 years. This agrees with the findings of both Hodson and Paden (1983), and Smit (1993) who reported that cluster reduction was infrequently seen in the speech attempts of their typically developing 4-year-old participants, indicating it is one of the final phonological patterns to disappear.

The acquisition of consonant clusters can be linked to the ongoing anatomical development of the oro musculature and the maturation of the child's motor speaking mechanics (McLeod 2001a). When children first attempt to produce consonant clusters, their efforts are marked by systematic substitution patterns, also known as phonological processes (Grunwell, 1987). The most frequently observed of these processes are "cluster reduction" and "cluster simplification". Cluster errors mostly involved reductions in younger children and at higher age range, other error types that were frequently noticed were epenthesis and coalescence. This is in agreement with Greenlee (1974) stages of cluster acquisition and report of McLeod (2001a) which states that the occurrence of cluster reduction diminishes overtime, whereas the occurrence of cluster simplification increases.

5. Conclusions

The acquisition of speech sounds by children has accelerated over the years. Phonological developmental studies in children are ample but not specifically on cluster acquisition. The present research adds to the literature indicating earlier acquisition of consonant clusters by three years of age itself contrary to the earlier notion of late acquisition of clusters. A developmental trend was noted with number of clusters mastered increasing as age advanced. Further, medial clusters are acquired earlier than the initial position clusters. Cluster reduction was the prominent error type, decreasing with age, suggesting the pattern of developmental change towards target production. The evidence-based practice of Speech-Language Pathologists (SLPs) depends on thorough and up to date information relevant to their ambient language. Current findings augment SLPs' knowledge on cluster acquisition to provide more effective and timely interventions especially for young children with speech sound disorders. Based on the findings of this study, SLPs can examine the presence of consonant clusters in children greater than two years of age and can include these clusters for intervention. Upcoming studies can examine the development of consonant clusters in a longitudinal fashion using large sample sizes. In addition, studies can also determine the impact of bilingualism or multilingualism on cluster acquisition. Moreover, future studies can also examine the effects of regional dialects on cluster acquisition.

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Study Conception and Design: NS and AM, Data collection: AR and HM, Data Analysis: AR, HM and AM, Interpretation of the findings: NS and AM, Drafting the manuscript: AR, HM and AM, Revision of the manuscript: NS.

Data availability

Data analysed in this study are not publicly available. However, these could be obtained from the corresponding author on a reasonable request.

Ethics Statement

This study was carried out and reported adhering to ethical standards. A written informed consent was obtained from the parents or caregivers of all the participants before initiating the study procedures.

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