



Phonological representation skills in typically developing Preschoolers

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Abstract: Phonological representations are considered the source of speech sound information that forms the basis of spoken words. Phonological awareness tasks, as well as other expressive tasks, are used to infer phonological representations. However, receptive tasks are increasingly used to assess phonological representations in preschool children. Since the phonological structures vary in each language, there is an increasing need to examine the underlying representations in various languages. The present study evaluated articulation error identification for vowels and consonants in Malayalam speaking preschool children aged 3.6 to 5 years. An articulation error identification and correction test for vowels and consonants developed by the investigators was administered to all the participants. Thirty words with clusters within the vocabulary of children aged 3.6 to 5 years were used as target items for the test. The results revealed that age had a significant effect on the scores obtained in the tasks, with children in the older age group scoring higher than the younger age group. Better scores were obtained for consonants than for vowels, signifying a developmental trend in the ability to detect subtle articulatory modifications. From the results it is evident that preschool children have developed adequate phonological representations to distinguish errors in a single phoneme. The results also support the pivotal role of articulation error identification tasks for the assessment of underlying phonological representations in preschool children. Data of Phonological representations in Malayalam speaking preschool children is less. This study aimed at understanding the phonological representations in Malayalam speaking preschool children in the age range of 3.6-5.0 years.

Keywords: Phonological Representations, Preschool Children, Age Groups, Quality of Phonological Representation

1. Introduction

Phonological processing abilities play a crucial role in the development of oral and written language, with access to phonological representations of words being a key component in these processes (Anthony et al., 2010). Research from both typically and atypically developing children indicates that the quality of a child's phonological representations is essential for progress in literacy skills (Goswami et al., 2002). Phonological representation refers to the storage of phonological information about words in long-term memory and serves as the foundation for speech sound information that forms spoken words (Sutherland & Gillon, 2005). These representations include component phonemes, phoneme combinations, and their associated phonetic specifications. Early in development, linguistic representations are holistic, but as vocabulary grows, they become fine-tuned through lexical segmentation (Priya, 2017).

Deficits in phonological representations have been linked to language and literacy challenges in children with speech sound disorders (Anthony et al., 2010; Priya, 2017), Specific language impairment (SLI) (Priya, 2017), Childhood Apraxia of Speech (CAS) (McNeill & Dodd, 2009; Priya, 2017), and dyslexia (Bortolini & Leonard, 2000; Priya, 2017). Researchers have employed various tasks to study phonological representations in children, including picture naming (Roberts, 2005; Priya, 2017), imitation of words and non-words (Fowler & Swainson, 2004), gating paradigms (Dollaghan & Campbell, 1998), lexical decision tasks (Edwards & Lahey, 1996), and correcting mispronunciations (Fowler & Swainson, 2004; Priya, 2017). Gillon (2023) used phonological awareness tasks like rhyme production and segmentation to assess phonological representations in preschoolers, linking these skills to early literacy outcomes. Dodd et al. (2021) examined phonological representation formation in children with CAS,



highlighting differences using repetition and imitation tasks. Velleman *et al.* (2020) assessed phonological representations in children with speech sound disorders through picture naming and word repetition, emphasizing the role of phonological representations in articulation accuracy. Graham *et al.* (2022) used non-word repetition and phoneme segmentation tasks to explore the relationship between phonological deficits and literacy challenges in children with dyslexia. However, these tasks often require verbal responses, which can be challenging for very young children. Dynamic assessment techniques have emerged as promising alternatives. McHale *et al.* (2023) combined real-time phonological awareness training with neuroimaging to explore how phonological representations evolve in children with language delays, offering insights into the neural mechanisms underlying these deficits. Receptive tasks, such as determining whether a word is pronounced correctly or matching spoken words to pictures, have also proven effective (Sutherland & Gillon, 2005; Priya, 2017; Elbro & Peterson, 2004; Foy & Mann, 2001).

The Quality of Phonological Representation (QPR) task developed by Claessen *et al.* (2009) is a lexical decision task that does not require a verbal response. It effectively screens phonological representations by measuring judgment latency and accuracy for multisyllabic words in pre-primary children. Additionally, research using the mispronunciation sensitivity paradigm consistently shows that infants and toddlers are highly sensitive to phonological nuances. Recent studies by Von Holzen and Bergmann (2021) and Pomper *et al.* (2019) reveal developmental changes in sensitivity to mispronunciations from ages 2 to 4, including studies of toddlers with autism spectrum disorder. Mahr *et al.* (2023) found that children rely on lexical knowledge for familiar words but require detailed phonological representations for processing variable speech in real time.

Assessing phonological representations is crucial due to its significant influence on the development of oral language and emergent literacy skills. However, there is limited evidence on phonological representations in preschool children, a critical period for phonological awareness and literacy development. Malayalam, spoken in Kerala, India, has about 52 phonemes, including vowels, consonants, and diphthongs. Since phonological structures vary across languages, it is essential to examine underlying representations in different linguistic contexts. This study aims to analyze and compare age-related differences in the ability to identify articulation errors for consonants and vowels among typically developing Malayalam-speaking children aged 3.6 to 5.0 years.

2. Method

2.1 Participants

Sixty typically developing children in the age range of 3.6 to 5.0 years were included in the study, all served with the written consent of their parents. All the participants were native speakers of Malayalam, raised in an ambient environment of Malayalam and are residents of Kerala. They were divided into three subgroups with an inter-age interval of 6 months ($>3;6 - \leq 4;0$ years, $>4;0 - \leq 4;6$ years and $4;6 - \leq 5;0$ years) with 20 participants in each group (10 males and 10 females). Oral peripheral mechanism was checked to ensure there is no structural or functional abnormality of the oral mechanism. They were assessed for age-appropriate language skills using the Malayalam Language test (Rukmini, 1994). Informal interview was carried out with the parent/teacher to obtain information about the developmental aspects of the child. Individuals with a background of delayed development, sensory issues, and behavioral or neurological problems were not included in the study. The exclusion criteria were applied through the administration of the WHO Ten Questions Disability Screening Checklist (Singhi, Kumar, Malhi & Kumar, 2007). An informed written consent was obtained from the caregivers of all participants. The research methodology adhered to the ethical guidelines established by the ethical committee for bio-behavioral research at All India Institute of Speech and Hearing, Mysuru.

2.2 Test stimuli

An articulation error identification and correction test for vowels and consonants developed by the investigators was administered to all the participants. Thirty words with clusters within the vocabulary of children aged 3 to 5 years were used as target items for the test. These words were developed by the authors considering the vocabulary of children speaking Malayalam language in the age range of 3-5 years and also by referring the Malayalam diagnostic articulation test (Neenu, Vipina, Vrinda, Sreedevi, 2011) as well as textbooks from the kindergarten and nursery classes. The corpus of Malayalam words developed for children within the age group of



three to five years were considered while developing the stimuli. Also the frequency of occurrence of phonemes in Malayalam language were considered while selecting the target words. The list consists of both native Malayalam words as well as common words borrowed from English which are considered as nativized words. A pilot study was carried out with 80 words with clusters developed for the study and was administered to 10 children in the age range of $>3;0 - \leq 3;6$ years to test for the familiarity of the items used in the test. Based on the responses of the pilot study, 50 words with clusters were shortlisted. These words were then given to 3 Speech language pathologists of Kerala with minimum of five years of working experience to rate for familiarity on a 3-point rating scale as 1) most familiar, 2) familiar, and 3) not familiar. These 3 speech language pathologists were used throughout the study for rating the stimulus. After rating, 30 words were shortlisted and used as target items. These 30 words developed as two separate word lists were used to assess articulation error identification abilities for vowels and consonants.

2.3 Preparation for test stimuli for Articulation error identification test for vowels

In order to prepare the word list, one vowel of each of the target words prepared in step one was modified to create another set of nonwords with vowel modifications. The syllable shape was maintained, and 30 nonwords were formed. A total of 60 items were included in the final list, of which 30 were true words (a correct form of target words) and 30 were nonwords (formed by substituting vowels in true words).

2.3.1 Preparation for test stimuli for Articulation error identification for consonants

To prepare this, one consonant in each of the true words prepared in step one was changed to produce a different set of nonwords. A difference of a minimum of one to a maximum of three distinctive features were present between the true word and the corresponding nonword. The features of the place, manner and voicing or a combination of these were used to form nonwords.

The shortlisted stimuli (60 target words each in consonant and vowel tests, respectively) were audio-recorded in a sound-treated room. The target words were audio recorded by a typical adult female with good voice characteristics using a unidirectional microphone placed at a distance of 6 inches from the mouth and was recorded using Computerized Speech Lab (Kay Elemetrics Corporation, New Jersey) software. The adult female uttered each target stimulus in a random order and a neutral tone with an inter-stimulus interval of one second. The recording was digitized at 44,100 Hz sampling.

These were played to the same 5 speech language pathologists. They were asked to listen to the three tokens of each stimulus and select the best recording regarding naturalness and clarity. Naturalness was rated on a 3-point scale where 1= not natural, 2= just natural and 3= most natural. The one token rated as the most natural among the three tokens was selected to make the final list of items. The stimulus was shuffled across each trial using Macros in PowerPoint. A constant loudness level for each stimulus was ensured by normalization, and randomization was done to minimize the bias in responses. A total of six randomized lists were prepared, three each for vowels and consonants. Clarity was checked by asking the listeners to write down the words or nonwords heard, and the written responses were analyzed. The match obtained between the spoken targets and the written responses of the listeners was 100%.

The picture stimuli to be used as target words were selected. These were shown as a PowerPoint presentation on a computer screen to 5 Speech language pathologists to rate the ambiguity of pictures on a three-point scale as 1= not ambiguous, 2=ambiguous, and 3=most ambiguous. The pictures rated as not ambiguous were used for the test. The pictures which were as ambiguous were modified until they were rated as not ambiguous and were used for the study.

2.4 Interjudge reliability

To assess interjudge reliability, a Speech Language Pathologist with at least three years of clinical experience was enlisted. This professional transcribed and analyzed samples from 10% of participants within each age group. The total scores for each child were recorded. Subsequently, a reliability analysis was conducted for the



evaluations of the two investigators. The findings indicated an interjudge reliability (Cronbach's alpha = 0.9) for both word and syllable shapes.

2.5 Administration of the test

A picture identification task was done initially on the subjects to make sure the stimulus (true words) were in the receptive vocabulary of children. The investigator asked the children to identify an appropriate picture from three pictures (stimulus and two semantical distractors) for each stimulus named. Repeated trials were given until the participants identified the target word correctly.

Articulation error identification and correction tests for vowels and consonants included the presentation of pictures along with audio-recorded stimuli. The audio-recorded stimuli was presented via headphone from an HP laptop along with the stimulus in power point presentation. The corresponding picture and distractors were displayed on the laptop screen. The participant had to judge whether the stimuli he/she heard matched with the picture depicted. Two practice trials were given to ensure that the participant understands the instructions of the test and the way to respond. The actual administration of the test followed this. Each trial used a randomized stimuli list separately for consonants and vowels. Three trials were given for vowels and consonants using six randomized stimuli lists. Correct responses scored 1, and incorrect responses scored 0. The total score for each trial was calculated for each participant. The test was carried out individually in a quiet environment in the home setting. The test was carried out in 1-2 days, depending on the participant's cooperation.

3. Results

A comparison of children's performance in three age groups were made for the two tasks: articulation error identification of consonants and articulation error identification of vowels. The investigator first carried out the picture identification task to ensure that participants were familiar with the stimuli used in the articulation error identification tasks. The scores obtained by the participants are given in Table 1. The highest possible score was 30. The results indicated that the stimuli used in the articulation error identification tasks were within the receptive vocabulary of the participants.

3.1 Effect of age on Articulation error identification task for vowels and consonants

The mean, median, and standard deviation scores obtained by participants within and across the age groups for vowels and consonants were calculated and shown in Tables 1 and 2. Kolmogorov-Smirnov test of normality revealed that the data were distributed normally ($p > 0.05$) for the articulation error identification task for vowels in most of the age groups. Non-normal distribution was observed for a few scores. Hence, parametric and non-parametric analyses were used to analyze data on the Articulation error identification task for vowels and consonants.

Table 1. Mean, median, and standard deviation scores obtained by participants in three trials of articulation error identification test for vowels and consonants

Agerange years	Vowels			Consonants		
	Trial 1	Trial2	Trial3	Trial 1	Trial2	Trial3
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
(>3;6-≤4;0)	47.4 (1.8)	48.3(1.6)	49.1(1.7)	50.6(1.4)	50.6(1.5)	50.8(1.4)
(>4;0-≤4;6)	51.7(2.4)	51.4(2.3)	52.5(2.5)	54.1(1.2)	54.6(1.1)	55.2(1.4)
(>4;6-≤5;0)	55.5(2.2)	55.7(1.9)	56.7(2.0)	56.4(1.9)	56.9(1.7)	57.4(1.8)

To validate these results through statistical means, SPSS was used to conduct a thorough data analysis. Reliability analysis was carried out separately for the three trials of vowels and consonants within each of the three



age groups. This analysis demonstrated strong reliability across all three age groups for both vowels and consonants (Cronbach’s alpha = 0.94, 0.92, 0.91 for vowels; 0.91, 0.92, 0.93 for consonants). Hence, the scores obtained from the three trials for both vowels and consonants were combined. Subsequently, the cumulative scores were subjected to additional analysis. Table 2 provides the mean values and standard deviations for the total scores associated with vowels and consonants.

Table 2. Mean and standard deviation of the total scores obtained by participants in the articulation error identification test for vowels and consonants

Age range in years	Vowels	Consonants
	Mean (SD)	Mean (SD)
(>3;6-≤4;0)	144.8 (5.1)	152.0 (4.3)
(>4;0-≤4;6)	155.6 (7.2)	163.9 (3.7)
(>4;6 -≤5;0)	167.9 (6.1)	170.7 (5.4)

The mean and standard deviations of the scores obtained by the participants across the three trials of the articulation error identification tasks for vowels and consonants show that the scores increased as the age increased. To confirm the findings statistically, the Independent-Samples Kruskal-Wallis H Test was conducted to test if there were any significant differences between Articulation error identification task scores for vowels across different age groups. Dunn’s pairwise tests were carried out for all age groups to determine the considerable age groups. Important values were adjusted using Bonferroni correction for multiple tests. The results showed a significant difference in the distribution of scores among different age groups, p-value = <0.001 (which is less than the significance level of 0.05). The results show that the age group >4;6 -≤5;0 has the highest score of all other age groups.

The Wilcoxon Signed Ranks Test compared all age groups' mean ranks between consonant and vowel scores. The results provided evidence of a significant difference in articulation error identification scores distribution between Vowels and Consonants in all Age groups, p-value = <0.001 (which is less than the significance level of 0.05). The average scores for articulation judgment tasks, focusing on both vowels and consonants, across the three age groups are illustrated in Figure 1.

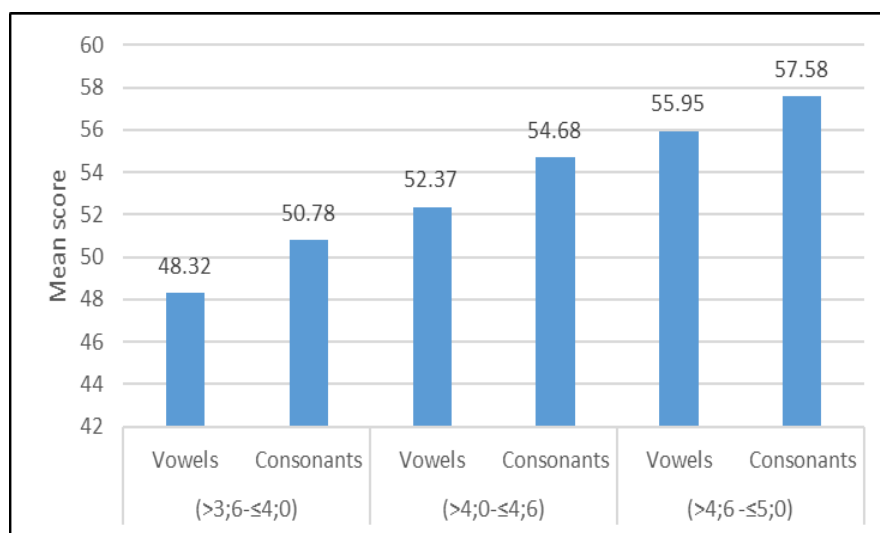


Figure 1. Comparison of mean scores obtained by participants in the articulation error identification tasks for vowels and consonants

The results show that the scores of articulation error identification for consonants were higher than that of articulation error identification for vowels across all age groups. The distribution of scores for both vowels and consonants across all three age groups showed a normal distribution (p > 0.05). Analyzing the impact of age and stimulus types on these scores through repeated measures ANOVA indicated significant effects based on age [F(2,57)= 15.432, p < 0.001, and stimulus type F(1, 57) = 28.947, p < 0.001]. The interaction between age and



stimulus type was not significant [$F(2, 57) = 1.842, p > 0.05$]. Post hoc analysis utilizing Bonferroni-adjusted multiple comparisons highlighted significant differences ($p < 0.05$) among the three age groups.

Further investigation was conducted to explore how age impacted scores in identifying articulation errors in vowels and consonants individually. The outcomes of a one-way MANOVA revealed a main effect of age for both vowels [$F(2, 57) = 16.421, p < 0.001$] and consonants [$F(2, 57) = 22.584, p < 0.001$]. Post hoc analysis, employing Bonferroni's adjusted multiple comparisons, highlighted that children aged between 3.6 and 4.0 years exhibited a significant variance from the other two age groups. Interestingly, no substantial distinction was observed between the age groups of 4.0 to 4.5 years and 4.6 to 5 years. Additionally, the findings indicated notable differences between vowels and consonants across all age groups.

4. Discussion

In this study, an attempt was made to compare the articulation error identification skills of vowels and consonants in typically developing Malayalam-speaking preschool children aged 3.6 to 5 years. The findings revealed a clear developmental trend: as age increased, so did the children's scores in identifying articulation errors. This supports the notion that phonological representations undergo gradual refinement during early childhood. These results align with Priya's (2017) findings in Kannada-speaking children, aged 3.6 to 5.0 years, which demonstrated a similar trend of improvement in phonetic category representation with age.

A key observation in this study was the significant difference in performance based on the type of stimuli—consonants versus vowels. Across all age groups, children were more adept at identifying mispronunciations of consonants than vowels. This aligns with previous findings by Priya and Manjula (2016), who observed similar discrepancies in a study involving Kannada-speaking children. Nazzi (2005) also highlighted this difference, noting that 20-month-old infants exhibited greater phonetic specificity in detecting consonant mispronunciations compared to vowels when learning new words. These findings suggest that consonants play a more prominent role in phonological development, likely due to their distinct acoustic and articulatory properties.

One explanation for the superior performance with consonants lies in their segmental features, which are often more distinctive and easier to differentiate than those of vowels. Consonant substitutions typically involve changes in place of articulation, manner of articulation, voicing, or a combination of these factors, making them more noticeable to young children. In contrast, vowel substitutions often involve more subtle variations in the place of articulation, which may be harder for children to discern. This difference underscores the complexity of vowel perception and the developmental challenges it presents.

Additionally, the study emphasized the importance of understanding phonological development in the context of the child's language environment. Malayalam and Kannada, though distinct languages, share some phonological similarities, which might explain the parallels observed in developmental patterns. However, future research should explore whether these findings hold true across other Indian languages with varying phonological systems to gain a broader understanding of phonological development in multilingual settings.

In conclusion, this study highlights the developmental progression in articulation error identification among Malayalam-speaking preschoolers and underscores the distinct roles of consonants and vowels in phonological development. Expanding future research to include gender differences, more diverse language groups, and additional dimensions of consonant and vowel substitutions could provide deeper insights into the complexities of phonological representation development. Understanding these patterns is crucial for speech-language pathologists to design effective interventions that enhance both oral and written communication skills in young children.

5. Conclusions

To determine the development of phonological representations in Malayalam-speaking, typically developing preschool children, articulation error identification tasks for vowels and consonants were created and administered. The results revealed that both consonants and vowels followed a developmental pattern in articulation error identification skills. Consonant error identification scores consistently outperformed vowel identification scores across all ages. This suggests that consonants, being more distinctive and easier to differentiate, are more accessible to preschoolers compared to vowels, which exhibit less distinct phonetic properties. These findings



indicate that preschool children have developed adequate phonological representations to distinguish errors in a single phoneme. The articulation judgment tasks proved valuable in assessing phonological representations in preschool children. Further research focusing on dimensions such as gender differences and various consonant substitution patterns may enhance the understanding of phonological development and provide crucial insights for speech-language pathologists into the competencies necessary for oral and written communication.

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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.

Author Contribution Statement

Both the authors equally contributed and read approved the final version of this work.

Has this article been screened for Similarity?

Yes

Conflict of interest

The Authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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