# PHONOTACTIC DEVELOPMENT IN 2-4 YEARS OLD MALAYALAM SPEAKING CHILDREN

JIJINA.T

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**ALL INDIA INSTITUTE OF SPEECH AND HEARING**

**MANASAGANGOTHRI, MYSURU-570 006**

**May, 2019**

## CERTIFICATE

This is to certify that this Dissertation entitled "**Phonotactic Development in 2-4 Years old Malayalam Speaking Children**" is a bonafide work submitted in part fulfillment for degree of Master of Science (Speech-Language Pathology) of the student Registration Number: 17SLP013. This has been carried out under the guidance of a faculty of this institute and has not been submitted earlier to any other University for the award of any other Diploma or Degree.

Mysuru
May, 2019

**Dr. M. Pushpavathi**
**Director**
All India Institute of Speech and Hearing
Manasagangothri, Mysuru-570 006

## CERTIFICATE

This is to certify that this dissertation entitled "**Phonotactic Development in 2-4 Years old Malayalam Speaking Children**" has been prepared under my supervision and guidance. It is also been certified that this dissertation has not been submitted earlier to any other University for the award of any other Diploma or Degree.

Mysuru
May, 2019

**Dr. N. Sreedevi**
**Guide**
Professor & Head
Department of Clinical Services
AIISH, Mysuru-06

## DECLARATION

This is to certify that this dissertation entitled "**Phonotactic Development in 2-4 Years old Malayalam Speaking Children**" is the result of my own study under the guidance of Dr. N Sreedevi, Professor & Head, Department of Clinical Services, All Indian Institute of Speech and Hearing, Mysore, and has not been submitted earlier to any other University for the award of any other Diploma or Degree.

Mysuru,
May, 2019

Registration No.
17SLP013

**Dedicated to**

**My Amma, Achcha, Kuttan**

**&**

**My Family members**

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## INTRODUCTION

Communication is an essential component in defining humans as a social being. It is mainly a complex, two way and intentional process of conveying messages. It refers to any act in which information is given to or received from one person to another person concerning that person's needs, desires, perceptions, knowledge, or affective states. For this both speaker and listener require a common tool, therefore man invented a language for this purpose. According to Owens (2008) "Language is a learned code or system of rules". "It is a rule-governed by behavior, described by at least five parameters such as phonologic, morphologic, syntactic, semantic and pragmatic language learning and the uses are determined by the interaction of biological, cognitive, psychological and environmental factors" (American Speech Language Hearing Association, 1982).

Speech and language are analyzed in terms of various levels such as phonetics, phonology, morphology, lexis, syntax, and semantics by linguists. Phonology being one of the salient components of language refers to the description of systems and patterns of phonemes that occur in a language. Mackay (1987) defines Phonology as determining the language-specific distinctive phonemes and the rule-governed nature of these systems.

"All possible sequences or types of sounds and morphemes do not occur in any single language. These restrictions are called 'phonotactics' or 'distributional constraints' by the structuralists and morpheme structure (MS) rules (Halle, 1968) or morpheme structure conditions (Stanley, 1967) by the generative phonologists". Sounds and the structural organization of these sounds (in terms of shape and sequence of its elements)

by using respective phonotactic rules can lead to an evolution of a meaningful word (Velleman, 1998). Different languages have their own phonotactic structures, certain preferred word and syllable patterns distinguishing every language in the world and these patterns that are not allowed or even allowed. In generative phonology, two main functions are assigned to a morpheme structure: the 'possible' and 'impossible'. This explains why specific redundant patterns are seen in the lexicon of languages with regard to their segments and sequences of segments. Edwards and Shriberg (1983) defined phonotactics as the rules for how sounds can be combined to formulate syllables and words; and how these sounds can be distributed in a given language. Every language in the world has specific rules which define phonetic sequences in various word positions. Such rules which define the word and syllable patterns (shape and size) are called the *phonotactic constraints* of the language. Phonotactic rules increase the ease of production. The phonotactic rules reflect a variety of different factors in a language, including the following:

- The number of syllables that tend to occur in each word
- The numbers, types, and locations of consonants in clusters
- The presence or absence of final consonants
- The presence or absence of diphthongs or long vowels
- Harmony patterns in which consonants or vowels become more similar to each other.
- Phrase-level effects which change the pronunciations of sounds in phrases and sentences.

Young children usually produce their first words towards the end of their first-year life, a few months later their utterances consist of single words which are articulated separately. Further, in the latter half of the second year they begin to combine words to form simple multi-word utterances (Dore, 1985). However, the speech and language development in children is highly variable with respect to rate and the pattern of acquisition (Bernthal, Bankson, & Flipsen, 2013; Sotto, Redle, Bandaranayake, Neil-Strunjas & Creaghead, 2014) and the speech acquisition pattern can be studied in four phases (Bleile, 2004):

- Phase 1 (birth to 1 year) : Laying the foundations for speech
- Phase 2 (1 to 2 years) : Transitioning from words to speech
- Phase 3 (2 to 5 years) : The growth of the inventory
- Phase 4 (5 + years) : Mastery of speech and literacy

In a remarkable period of time, most children develop intelligible speech with structural growth. In fact, they even come to articulate well enough so that even people outside the immediate family can understand what they are saying. At that point, the child can already be recognized as a member of a specific language community by his or her speech patterns; that is, he or she will have acquired the incidental phonetically distinguishing features as well as the system of contrasting sounds of the specific language spoken in his or her environment. Hence the child acquires articulatory control and was able to produce different sounds and sound combinations.

Children learn more complex syllable and word shapes as they grow older. Different studies report that phonological development in the early years of a child is solely word or syllable based and that children's early phonological systems do not usually refer to the segmental level. Children of any age are able to generalize much better when sounds are targeted at syllable and/or word level rather than in isolation as reported by many speech-language clinicians (Velleman, 1998). Children with disordered phonology show developmentally inappropriate or unusual phonotactic constraints when compared with typically developing children and also these sound knowledge about the phonotactic constraints in a given language differs from other languages. Hence, it is essential to know how these patterns are developed in typically developing children in order to facilitate the diagnosis and rehabilitation strategies of communication disorders in different languages. In this context the present study is planned to explore the phonotactic development in native Malayalam speaking young children.

### 1.1 Need for the study

Authors around the world have carried out research on various Western languages pertaining to the area of phonotactics. Such a close examination of linguistic rules has to be carried out in India as it has diverse languages and dialects. Findings based on linguistic rules of one language cannot be generalized to other languages. This points us to examine each language in India for its diversity in terms of phonotactic rules. Among the Dravidian languages, Malayalam has a distinctive linguistic identity, where we can notice more nasalized consonants, chillaksharams (These are certain consonants which occur without vowel at the word-end, within combinations of words, or within

combinations of a base form and suffixes, and having a special graphic form, e.g.,/Il/-/kInər**Il**/, /In/-/mərət̪t̪**In**/ and /ir/-/pənIn**ir**/) and additional consonants (such as /r/, /ɭ /,/ʐ/ etc). Owing to these distinct features seen in Malayalam, the rules applicable for phonotactic structures may be varied.

Children learn to use rules of their language including phonotactic patterns as they grow. However many children with disordered phonologies exhibit difficulty in phonotactics, phonetic as well as phonemic limitations. A couple of studies are reported on the syllable patterns in native Malayalam speaking children in the infancy stage with tracking of the developmental trend. But there is a need to conduct research to follow a pattern of development in toddlers and preschoolers. This knowledge of phonotactic development helps in deeper understanding of child phonology and there by improves the diagnostic and therapeutic services offered in Speech-Language pathology. In the present days, parents seek for phonological services after the vocabulary spurt in children seen around 2 years of age. Hence there arises a need for studying the various phonotactic patterns in Malayalam in the early stages of development, which helps in developing a normative database with respect to phonology and specifically to phonotactics. Such a database would help Speech Language Pathologists in providing befitting phonological intervention which paves way to typical development of pre-academic skills in communication disordered population.

### 1.2 Aim of the study

The aim of the present study is to investigate the phonotactic development in typically developing 2-4-year-old Malayalam speaking children.

## 1.3 Objectives of the study

- To analyze and obtain various phonotactic measures, such as types and frequency of various syllable shapes, word shapes and consonant clusters (types, frequency and positions) of native Malayalam speaking children.
- To compare these phonotactic measures across gender
- To compare these phonotactic measures across age groups.

## 1.4 Clinical Implications

- The findings of the study will provide more insight into the phonotactic skills/phonotactic rules used by typically developing children. It can serve as a reference during the assessment of children with phonological deficits, especially childhood apraxia of speech and speech sound disorders.
- The study promotes the importance of developing language-based normative data.
- The normative data obtained can be used by Speech-Language Pathologists in improving the database for diagnostic and appropriate therapeutic goals for disordered phonology in children with communication disorders.

# Chapter II

## REVIEW OF LITERATURE

According to Edward and Shriberg (1983) (Cited in Hegde, 2000) phonology is "The study of the sound component of language". Phonology encompasses range and function of sounds in a specific language and that aids speech production and perception. The phonological structure has two components, 'a limited repertoire of sounds (phonemes) representing various classes (based on physiological and acoustic characteristics) and a set of phonotactic rules defining how these phonemes can be arranged into syllables' (Hodson & Paden, 1991). Having a sound knowledge of phonotactics of a particular language gives a good basis for understanding such phonological processes that occur during the developmental ages.

As stated by Tesar and Prince in 2003, phonotactic based analysis of these phonological processes helps to get the positives and negatives of the acquisition process, i.e., the analysis can reveal the pattern of syllable shapes, word types, phrase–level patterns that occur in the child's repertoire and the ones that are difficult to produce. The authors have also suggested a 'back and forth' analysis process in which the child maps various combinations based on the morphemic structures based on the phonotactics of the syllable. This mapping occurs due to repeated exposure to the plausible combinations in a particular language, thus suggesting that understanding phonotactics is a useful tool in updating the phonological processes occurring in a language. Apart from phonotactic based analysis, Stoel-Gammon and Dunn (1985) also described two levels of analyses

such as phonetic analysis and phonologic analysis, which aids understanding of the phonology of the given language.

Phonetic analysis of the sound system of a language encompasses three aspects:

- Analysis of articulatory dynamics or the way sounds are formed by the speech mechanism
- Analysis of acoustic or the physical component of speech sounds
- Analysis of psychological perspective or the way sounds are perceived by the listener.

Phonological analysis of a sound system includes four aspects:

- Inventory of the phonemes of a particular language
- Description of patterns and the use of these phonemes
- Description of the phonemes as pronounced in various phonetic contexts or the allophonic variations
- Description of morpho-phonemic alterations in sound patterns

In terms of phonotactic patterns, child phonological system offers a different perspective in comparison to the adult phonological system. The syllable appears to be an important unit in early sound patterns (vocalizations) and the development of the syllabic organization of sounds act as a major framework for speech development. The word and syllable patterns (structure /shape) present in different languages vary with respect to certain phonotactic rules.

## 2.1 Syllable Shape/Syllable Structure

A syllable is clearly a fundamental unit of a syllable structure. If we are asked to break words down into component parts, then syllables seem to be more natural divisions than sounds. Many of the Native American languages will typically use syllable and not sound divisions if they are asked to analyze a word into its component parts. Syllable shape deviations are changed in the consonant/vowel (CV) makeup of syllables of standard adult word forms. The number and sequence of vowels and consonants in the surface form of the target word differ from that in the adult standard form. For example, if the word ice-cream (/aiskrIm/) is pronounced as /aikIm/, the CV makeup is changed from VVCCCVVC to VVCVVC, and structure of the syllable has been changed. These kinds of processes have been noted in the speech of typically developing children and are thus considered developmental phonological processes such as weak syllable deletion, cluster reduction, deletion of final consonants and glottal replacement (Weiner, 1979).

A syllable is divided into the 'onset and the rhyme'. The rhyme consists of the nucleus plus the coda or the final consonant of a syllable. Syllables are also categorized according to the presence or absence of a coda. Syllables that do not contain a coda are called unchecked or open syllables. Syllables that do have codas are called checked or closed syllables. The peak is the most prominent, acoustically most intense part of the syllable. A peak may stand alone as in the first syllable of the word 'a-lone', or it can be surrounded by other sounds as in 'stand'. Although vowels are more prevalent as syllable peaks, in many languages, consonants that serve as syllable peaks are called syllabic consonants. In American English, both onset and coda are not necessary for a syllable. The number of segments that can be constrained in onset or a coda is regulated by the

rules of that particular language. In American English, onsets can consist of one to three segments (e.g., */strIŋ/ string*), and codas can have from one to four consonants (e.g.,*/pro:mpts/ prompts*). Segments that occur as onsets of a syllable are termed syllable initiating segments, while those that are the coda of a syllable are labeled syllable terminating sounds.

### 2.1.1 Development of Syllabic Structures/ Syllabic Shapes

Jacobson (1968) in his earliest study proposed the hierarchy of syllable acquisition in infants starting from consonant-vowel (CV) or CV reduplication, followed by CVC and CVCV (differentiated). In comparison with open syllables (CV and V) closed syllables (CVC) is not reported to emerge until the child has acquired 8-11 different consonants at approximately 2.5 years (Grunwell, 1982). On the basis of data drawn from children speaking different western languages including English, Ingram (1978) reported some common tendencies in phonological acquisition in children between ages of 1.6 and 4.0 years, that is the capacity develops gradually with the acquisition of adult-like sounds of complex phonological structures. Majority of the children the world's languages begin phonological acquisition with CV syllable as the preferred basic unit (core syllable) of speech articulation. However, the preference of this pattern of syllables with consonant onset is not a universal phenomenon. For instance, in Portuguese language, Freitas (1996) reported that children in their early stages of word acquisition produced vowel-initial syllables. Shriberg (1993) stated the developmental sequence of syllable shapes and the number of syllables in English and is shown in table 2.1.

Table 2.1

*Age of acquisition of Syllable Shapes and number of Syllables in English speaking children (Shriberg, 1993).*

| **Age (in years)** | **Syllable shapes and number of syllables** |
|---|---|
| 2 | CV, VC, CVC, and 2-syllable words |
| 3 | Word initial and word final consonant clusters |
| 4 | Words with 3-syllable and more consonant clusters |
| 5 | Words with more than 3 syllables |
| 6 | All syllable structures as seen in adult language are acquired |

The CV syllable, occurring in virtually all of the world's languages, has long been recognized as a preferred basic unit of speech articulation (Bernthal & Bankson, 1998). This syllable form is one of the earliest syllables to be identified in infant vocalizations. A study by Kent and Bauer (1985), they accounted different syllable shapes of V, CV, CVC and VCVC during their early word production and found that their five 13 months old subjects with normal hearing produced 60% simple free-flowing sounds, the remaining were more complex syllable structures. The literature accounts for the consonant repertoire and syllable structure of hearing impaired 4-18 months toddlers produced fewer consonant repertoire and multisyllabic utterances than normal hearing subjects (Stoel-Gammon & Otomo, 1986). Branigan (1977) regarded the syllabic structure and phonemic inventory of one child and accounted that CV syllable as a training ground for consonant formation. Most consonants are produced first in the initial position of CV syllables and then, later, in postvocalic (e.g., VC) position.

Stoel-Gammon (1995; 1998) examined children's early vocabulary characteristics by studying words from the MacArthur Communicative Development Inventories (CDI), the analysis of syllable shape discovered the following patterns: such as of the 598 words in the data set, 356 (60%) are monosyllables and 218 (36%) are disyllables; 32 words (5%) are formed of three syllables, and only 7 (1%) have more than three syllables. The most common word shapes in terms of CV structure, in descending order of frequency, are CVC (30%), CVCV (9%), CCVC (8%), CVCC (7%), and CV (6%). In terms of clusters acquisition in English-speaking children of 24 months, 58% use two element clusters in the initial position, 48% in final position and 30% in medial position (Stoel-Gammon, 1985). In the Indian context as well, there has been attempts to study the development and frequency of occurrences of syllable structures /syllable shapes in adults as well as in typically developing children.

### 2.1.2 Development of Syllable Shapes/ Syllabic Structures in Indian languages

Phonotactic patterns in the spoken language of children in Indian languages are sparsely reported. A study was conducted by Nirmala, 1981 in Telugu (Telangana dialect), in the age range of 1.6-3.0 years over a period of six months. Controlled elicitation and free conversation were used to collect data from children. Results revealed that there were many substitutions among medial consonantal clusters produced by 2.6 to 3 year-olds. Geminate and homorganic clusters were acquired earlier than more complex clusters. Telugu words typically ended in open syllables. Two syllable words were more common than three or tetrasyllabic words. Syllable reduction was observed mainly with respect to three syllable words. This is in accord with the findings of Neeti Priya and Manjula (2007) in Telugu, wherein children from 3-6years were studied and CV was the

most predominant syllable form followed by CVC and then VC and V. Cluster analysis revealed medial geminate clusters were predominant compared to other types. Among word shapes, disyllabic was the most predominant followed by multi-syllabic in younger age, which reformed to more multisyllabic words as age increased.

In Kannada, Rupela and Manjula (2006) studied phonotactic development in 30 children between the age range of 0-5 years. Spontaneous speech samples and word imitations were used as stimuli. Results showed that CV syllables were the most commonly occurring syllable shapes compared to VC and CVC. CVC syllables which were reported to occur at 12 months and increasing in frequency by 54-60 months. The occurrence of medial geminates was the highest followed by medial non geminated clusters, initial clusters, and medial three-sound clusters. Monosyllables occurred rarely in children's speech and they were found to occur from 24 to 30 months. Amongst word shapes, disyllables occurred most frequently followed by trisyllables and multi-syllables. Anjana and Sreedevi (2008) established a quantitative and qualitative database on babbling in Kannada and the syllable shapes found were V, CV, CVC, VC and VCV and the mean occurrence of multi-syllabic words increased with age in months. Sreedevi and Jyothi (2012) in a longitudinal study of infants as early as 3 months to 12 months of age in Kannada found that open syllables occurred higher than closed syllables.VC syllables occurred between 6-11 months of age interval. During 8 to 12 months, open syllables like VCV, CVCV occurred predominantly matching with the structure of the ambient language. Shishira and Sreedevi (2013) studied 12-18 months old infants and reported that VCCV and CVCV syllable shapes increased in the 12-18 month age range. Literature accounts for phonetic repertoire and syllable structure in Kannada speaking toddlers

suggest that by18-24 months, they most commonly produced CVCV open syllable and also, disyllabic words and clusters. Among clusters, medial geminate clusters occurred predominantly than medial non-geminate clusters (Sushma & Sreedevi, 2013)

In Hindi speaking typically developing children in the age of 3 to 5 years, the syllable shapes found were CV, CVC, VC, V, CCV, CVCC, and VCC. Monosyllabic structures were found to be more frequent when compared to disyllabic structures and tri-syllabic words. Very few consonant clusters were produced (eg. CCV, VCC, and CCVC) by the age of 5 years, which implies that these were yet to mature / or were emerging structures in the developmental sequence (Shailaja, Manjula & Praveen, 2011). Akriti (2018) made a similar study on 40 Hindi speaking children in the age range of 3-4 years with a 3 month age interval. The results revealed that the major syllable structures were CV, VC, CVC, VCV, CVV, CVCC, CCVC, CVCV, CVCCVC, CVCVC, CVCCV, VCCV, CVVCV, CVCVCVC, CVCCVCV and CVCVCV, of which only CVV, CCVC, VCCV showed a significant difference across age intervals. Most frequently occurring word types were monosyllables and disyllables. Among consonant clusters, medial clusters occurred most frequently, within medial clusters non-geminate clusters were the majorly occurred combinations, followed by initial and final clusters.

Irfana and Sreedevi (2012) studied typically developing Malayalam speaking toddlers (12-15 and 15-18 months) and reported that their phonetic repertoire consisted of a variety of vowels, diphthongs, consonants, geminates and non-geminates. And the CV syllable shape was predominant in these toddlers. However, VCCV and CVCV syllable shapes occurred frequently in the older toddlers (15-18 months) group. The bisyllabic

word shapes were most frequent followed by monosyllabic in both age groups and multisyllabic word shapes were present only in the older age group.

On similar lines, Alphonsa and Sreedevi (2012) accounted for phonetic repertoire and syllable structure of Malayalam speaking toddlers of 18-24 months; children mainly produced CVV and CVCV open syllables followed by other syllable shapes and closed syllables were negligibly present. Also with regard to word shapes, disyllabic words were frequently produced. Among clusters, medial geminate clusters occurred predominantly than medial non-geminate clusters. Findings by different authors on the phonotactics of Malayalam are related to the phonological rule which governs syllable structures, syllable shapes and consonant clusters and the present study is an attempt to explore the development of phonotactics in Malayalam. Malayalam phonology is briefly reviewed in the following sections.

**2.2 Malayalam Phonology**

Malayalam belongs to the Dravidian language family, primarily spoken in the southwest of India. It is the official language of Kerala state and Lakshadweep union territory (Lewis, 2009). Within India alone there were over 35 million speakers of Malayalam in 1997, not including the other nearly 500,000 speakers outside India. Malayalam has 11 monophthongs, 2 diphthongs (i.e., /ai/ and /au/) and 39 consonant phonemes. Vowels which are characterized in terms of front, central and back pure vowels, as shown in table 2.2. The phoneme inventory of Malayalam consonants encompassing 7 places of articulation are labials, dentals, alveolars, retroflex, palatals, velars, glottal and 7 manners of articulation include nasals, stops(plain and aspirated),

fricatives, approximants (central and lateral) and rhotic (Source: Wikipedia) as shown in table 2.3.

Plosive sounds are found to be the most complicated in terms of manner of articulation, it demonstrates a five-way distinction in bilabials, dental,alveolo-palatals, retroflexes, and velars. A bilabial plosive, for example, is either voiced or voiceless. Within voiced bilabial plosives the distinction is between modal-voiced and breathy-voiced ones whereas for voiceless bilabial plosives a further distinction is made between aspirated and unaspirated ones. Additionally, an unaspirated voiceless bilabial plosive is either singleton (i.e. short) or geminate (i.e. long). The same five-way distinction is also found in dental, alveolo-palatal, retroflex, and velar plosives(Jiang, 2010).

According to Ladefoged and Maddieson (1996) a difference between apical, dental and interdental gestures with different manners of articulation occurs in Malayalam. This may be related to the fact that Malayalam has a contrast between dentals and alveolars for both stops and nasals. Acoustically, both dental and interdental stops are quite distinct from the contrasting alveolar stops in their burst as well as their formant transitions. The nasals have virtually no bursts, and are distinguished almost entirely by their formant transition. Those speakers of Malayalam who have interdental nasals might thus increase the difference by producing more distinct formant transitions as results of the interdental articulation. Dental stops are usually laminal rather than apical, with contact on both teeth and the front part of the alveolar ridge; whereas in Malayalam, the alveolar stops are often apical with contact usually on the centre of the alveolar ridge.

Table 2.2

***Phonemic Chart of Malayalam –Vowels***

| | **Front** | | **Central** | | **Back** | |
|---|---|---|---|---|---|---|
| **High** | i | ii | | | u | uu |
| **Mid** | e | ee | ʌ | | o | oo |
| **Low** | | | a | aa | | |

Table 2.3

***Phonemic chart of Malayalam-Consonants***

*International Phonetic Alphabet for Regional languages (Malayalam)*

| **Manner of Articulation** | | **Place of Articulation** | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | **Labial** | **Dental** | **Alveolar** | **Retroflex** | **Palatal** | **Velar** | **Glottal** |
| **Nasal** | | m മ ⟨m⟩ | n̪ ന ⟨n⟩ | n ന ⟨n̲⟩ | ɳ ണ ⟨ṇ⟩ | ɲ ഞ ⟨ñ⟩ | ŋ ങ⟨ṅ⟩ | |
| **Stops** | **Plain** | p പ⟨p⟩<br>bബ⟨b⟩ | t̪ ത(t)<br>d̪ ദ⟨d⟩ | t * ⟨t̲⟩ | ʈ ട⟨ṭ⟩<br>ɖഡ⟨ḍ⟩ | t͡ʃച⟨c⟩<br>d͡ʒജ⟨j⟩ | kക⟨k⟩<br>g ഗ⟨g⟩ | |
| | **Aspirated** | pʰഫ⟨ph⟩<br>bʰഭ⟨bh⟩ | t̪ʰഥ⟨th⟩<br>d̪ʰധ⟨dh⟩ | | ʈʰഠ⟨ṭh⟩<br>ɖʰഢ⟨ḍ⟩ | t͡ʃʰഛ⟨ch<br>d͡ʒʰഝ⟨jh⟩ | kʰഖ⟨kh⟩<br>gʰഘ⟨gh⟩ | |
| **Fricatives** | | fഫ* ⟨f⟩ | s സ ⟨s⟩ | | ʂ ഷ ⟨ṣ⟩ | ɕ ശ ⟨ś⟩ | | hഹ ⟨h⟩ |
| **Approxi-mants** | **Central** | ʋ വ ⟨v⟩ | | | ɻ ഴ ⟨l̲⟩ | j യ ⟨y⟩ | | |
| | **Lateral** | | | l ല ⟨l⟩ | ɭ ള ⟨l̤⟩ | | | |
| **Rhotic** | | | | ɾ ര ⟨r⟩ | r റ ⟨r̲⟩ | | | |

*(Source: Wikipedia)*

Malayalam phoneme inventory is quite credible and well balanced, except for three relatively unusual matters.

- As the sole member of alveolar plosives, /t□□/ is rather unusual because it is both aspirated and palatalized, with no other counterparts in the alveolar plosive category. Eg, /kəːttʌ/ (Wind), /pəːttʌ/ (flies)
- The palatalized tap/flap /r/ is exceptional, the tap/flap in Malayalam is palatalized so as to increase its perceptual difference from the trill /r/ considering the fact that they are two different phonemes but perceptually similar. Eg, /KarI/ (A black mark), /kəɾI/ (Curry)
- There is a voiceless alveolar fricative /s/, there is no voiced alveolar fricative /z/, a phoneme quite common in many languages.

However, lack of voicing contrasts in fricatives is actually not rare at all. Around two-thirds of the world's languages lack voicing contrasts in fricatives. The syllable structure in Malayalam can be schematized as CCCVVC. The onset can have up to three consonants whereas the coda only permits one consonant at the most, and the nucleus can either be a monophthong or a diphthong. Theoretically, the possible syllable type is minimally V and maximally CCCVVC in Malayalam, but there are many gaps (Maddieson et al., 2005).

To sum up, the review of literature indicates that there are numerous studies researched on this area in different Western and Indian languages. These findings suggest that phonotactic measures show many similarities as well differences to some extent across languages. Also it is evident that these phonotactic aspects show a developmental trend across age in children.

# Chapter III

# METHOD

## 3.1 Participants

A total of 40 participants in the age range of 2-4 years were enrolled for the present study. The participants were included with a 6 months age interval; ≥2.0 to ≤ 2.6 years; >2.6 to ≤ 3.0years; >3.0 to ≤ 3.6years; >3.6 to ≤ 4.0 years. They were conveniently selected from individual homes and pre-primary schools in Kasaragod district of Kerala.

### 3.1.1 Inclusion Criteria

- Native speakers of Malayalam, with minimal exposure to other languages and majorly using Malayalam to communicate at home.
- Typically developing children with normal speech and language skills ensured using a screening checklist (POCD, AIISH, 2008).
- All the participants belonged to Middle Socioeconomic Status as per the Kuppuswamy's Socioeconomic Status Scales, 2018.
- The participants were screened for both hearing and visual impairments, Oro-motor /structural anomalies and middle ear infections based on informal observation. Participants tested positive were excluded from the study.

### 3.1.2 Test Materials

To elicit natural speech sample the following materials were used as conversation generators, reinforcers, and theme-based controls:

- Common Story videos in Malayalam taken from YouTube (Rabbit and the Tortoise, Thirsty Crow, Fox, and the Grapes, The foolish crow).
- Toy Kit for 2-4 year-olds (Venkatesan, 2014)

### 3.1.3 Instrumentation

Dell Inspiron 15 laptop was used to display the story videos to the participants and the verbal interaction with each participant were recorded using a digital voice recorder (Olympus LS-100). 'Sony 310ap' headset was used for transcribing the recorded speech sample.

## 3.2 Procedure

### 3.2.1 Data Recording

Prior to the recording an informed written consent was obtained from the parents/ caregivers/ teachers of all the subjects (Appendix V). A spontaneous speech sample was recorded from each individual participant in a quiet room with minimal distraction. The speech sample was elicited by indulging in general conversation with the participants using toys, pictures and common story books appropriate to their chronological age. A minimum of 30 minutes speech sample was recorded from each participant using a digital voice recorder (Olympus LS-100).

### 3.2.3 Data Analysis

For the purpose of phonotactic analysis, a minimum of 100 utterances of each participant was transcribed using broad IPA transcription (International Phonetic

Alphabet, 2015). The transcribed samples were analyzed for the following phonotactic measures;

- Type and frequency of syllable shapes
- Type and frequency of word shapes (Mono-, Di-, Poly-)
- The position of clusters (initial, medial)
- Type and frequency of clusters (CC, CCC, geminates, non-geminate).

The percentage of occurrence of various syllable shapes, word shapes and clusters were calculated using the formula by Velleman (1998):

- Percentage of CV/VC/CVC/V/C syllables =

$$\frac{\text{Number of CV/VC/CVC/V/C syllables}}{\text{Total number of syllables}} \times 100$$

- Percentage of mono/bi/polysyllabic words =

$$\frac{\text{Number of mono-/di-/polysyllabic words}}{\text{Total number of words}} \times 100$$

- Percentage of initial/medial/final consonant clusters =

$$\frac{\text{Number of Initial/medial/final consonant clusters}}{\text{Total number of words}} \times 100$$

- Percentage of type of clusters (CC/ CCC/ geminates/ non-geminate) =

$$\frac{\text{Number of CC/ CCC/ geminates/ non-geminate cluster}}{\text{Total number of words}} \times 100$$

### 3.2.3.1 Criteria for Syllable Shape identification/Classification

The total number of syllables produced was noted for every participant followed by classification of various syllable shapes such as C, V, CV, VC, and CVC excluding the consonant clusters. Velleman (1998) recommended to consider the pattern of CCVC, CVCC as 'CVC', pattern of VCC as 'VC', and pattern of CCV as 'CV'. On similar lines, the present study also identified the following syllable shapes for each participant's transcribed sample as shown in table 3.1.

Table 3.1

*Grouping of Syllable shapes*

| **Target Syllable shapes** | **Syllable shapes produced by children** | **Examples( In IPA)** |
|---|---|---|
| **V** | V,<br>VV | V- / **ə**d$^{h}$/ (That) ,<br>VV- / **ə:**mə / (Tortoise) |
| **C** | C | C- /**m**/ (Yes) |
| **CV** | CV | CV - / **kə**-**rI** / (Curry) |
| | CVV<br>CVVV | CVV- / **ʧɛ:**ttən / (Elder brother),<br>CVVV-/**mIə:**vU/ ( Cat's cry) |
| | CCV,<br>CCVV,<br>CCCV | CCV-/ə**mmə**/(Mother),<br>CCVV-/U**kkə:**lIl/ (School)<br>CCCV- /əI**skri:**mʌ/(Ice-cream) |
| **VC** | VC,<br>VVC | VC-/**Up**mə:v/ (Upma),<br>VVC-/**əis**ki:m/ (Ice-cream) |
| **CVC** | CVC | CVC-/mə**rəm**/ (Tree) |
| | CVVC | CVVC-/ **nə:n**/ (I) |
| | CCVC<br>CCVVC | CCVC-/ə**chchən**/ (Father),<br>CCVVC- /ə**mmɛ:m**/ ( with Mother) |

***[(* Since vowel length is phonemic in Malayalam, the syllable structure of long vowels has been indicated by VV as per Malayalam Phonetic Reader (Kumari, 1972)]***

***Note: Syllable shape examples are indicated in bold and underlined portion of the transcribed words***

### 3.2.3.2 Criteria for frequency of occurrence of phonotactic measures

To consider a phonotactic measure as most frequently occurring, a 60% criteria was adopted, i.e., 6 or more participants out of 10 had to produce the specific phonotactic measure. Similarly a 40% - 60% criteria was adopted for less frequently occurring phonotactic measure, i.e., 4 or more and lesser than 6 participants out of 10 produced the specific phonotactic measure; and a <40% criteria for rarely occurring phonotactic measure, i.e., lesser than 4 participants out of 10 produced the specific phonotactic measure. The same is indicated in table 3.2.

Table 3.2:

*Criteria for frequency of occurrence of phonotactic measures*

| **Percentage of occurrence** | **Category** |
|---|---|
| ≥ 60% | Most frequently Occurring |
| ≥ 40 < 60% | Less frequently Occurring |
| < 40% | Rarely Occurring |

## 3.3 Reliability

### 3.3.1 Inter and Intra Judge Reliability

Three (Post graduate) speech language pathologists including the investigator served as judges for determining inter and intra (included only the primary investigator) judge reliability. The judges listened to the sample individually in a quiet room set-up using headphones.

In order to obtain the overall reliability of transcribed samples, 10% of transcribed utterances of two participants in each age interval were selected. The reliability coefficient (Cronbach's alpha) was calculated using SPSS and was found to be 0.901. Given that the Cronbach's alpha measure was found to be above 0.9, it is inferred that the analysis is adequately reliable.

### 3.4 Statistical Analysis

From the transcribed samples, the frequency of occurrence of syllable shapes, word types and consonant clusters were calculated in each age group. Following this the percentage of occurrence of these parameters were also calculated by using the formula by Velleman (1998). The obtained data in terms of percentage of each phonotactic measure analyzed was fed to SPSS (Statistical Package for Social Sciences) version 21.0 for statistical analysis.

#### 3.4.1 Descriptive Statistics

The data was subjected to Shapiro-Wilk test for examining normality. The data showed non normal distribution with high standard deviation and thus non-parametric tests were applied. Mean and median scores were computed for descriptions and comparisons. A non-parametric Mann-Whitney U-test was performed to see the gender effect with respect to age. The test result revealed no gender effect. Therefore the data of boys and girls is combined in each age group for further analysis. A flow chart of the statistical analysis carried out in the study is shown in figure 3.1.

A non-parametric Kruskal-Wallis H-test was performed to examine the overall age effect (or to compare the age groups) for all phonotactic measures (i.e., Syllable shapes, word types and clusters in different positions). Mann-Whitney-U test was employed for pair wise comparison of phonotactic measures across age intervals.

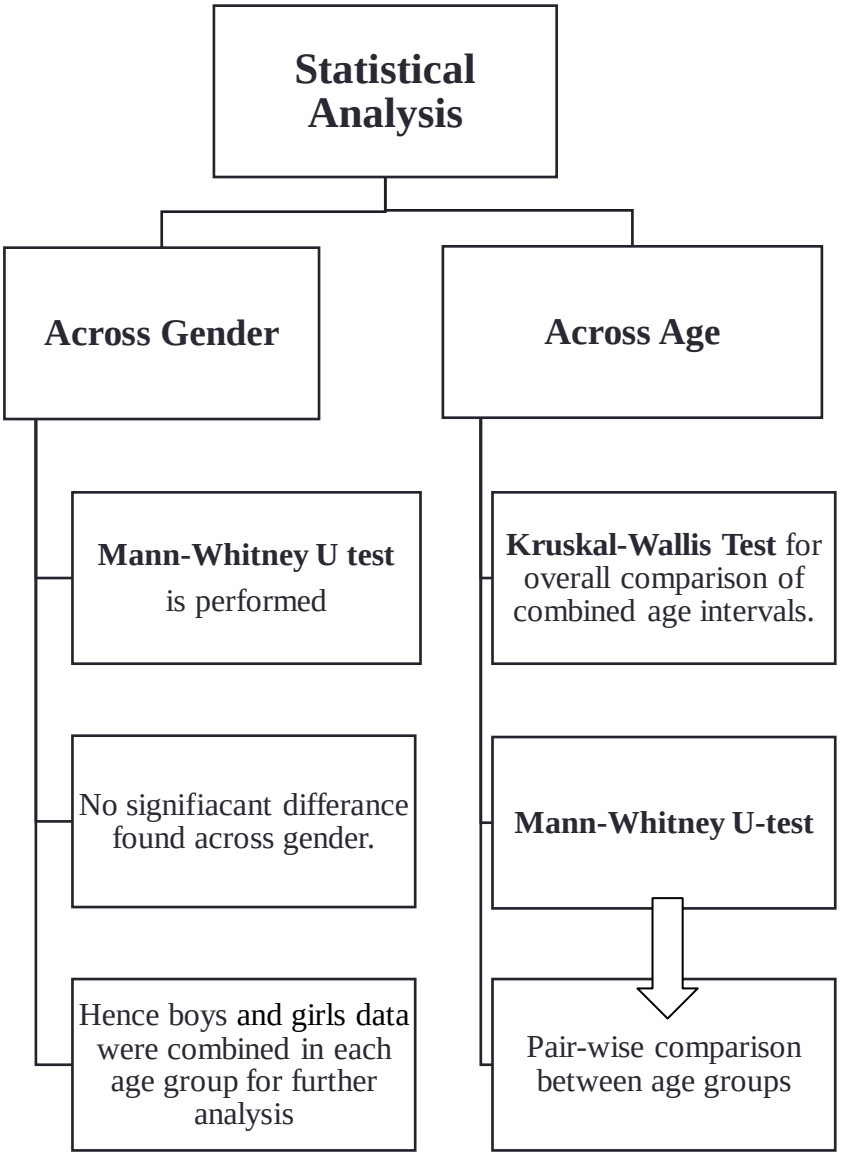


*Figure 3.1.*Flow chart of the Statistical analysis

# Chapter IV

## RESULTS

The aim of the present study was to investigate the phonotactic development in 2-4 years old typically developing Malayalam speaking children with the following objectives;

- To analyze and obtain various phonotactic measures, such as types and frequency of various syllable shapes, word shapes and consonant clusters (types, frequency and positions) of native Malayalam speaking children.
- To compare these phonotactic measures across gender
- To compare these phonotactic measures across age groups.

The recorded data of 100 utterances from each of the 40 participants (5 boys and 5 girls in each age interval) was phonetically transcribed using International Phonetic Alphabet (2015). The various types of phonotactic measures were extracted and analyzed from the yielded 4000 transcribed spontaneous speech samples. The phonotactic measures that were considered for the present study are represented in Figure 4.1.

The results are discussed under the three following phonotactic measures:

4.1 Syllable shapes

4.2 Word Types

4.3 Consonant Clusters

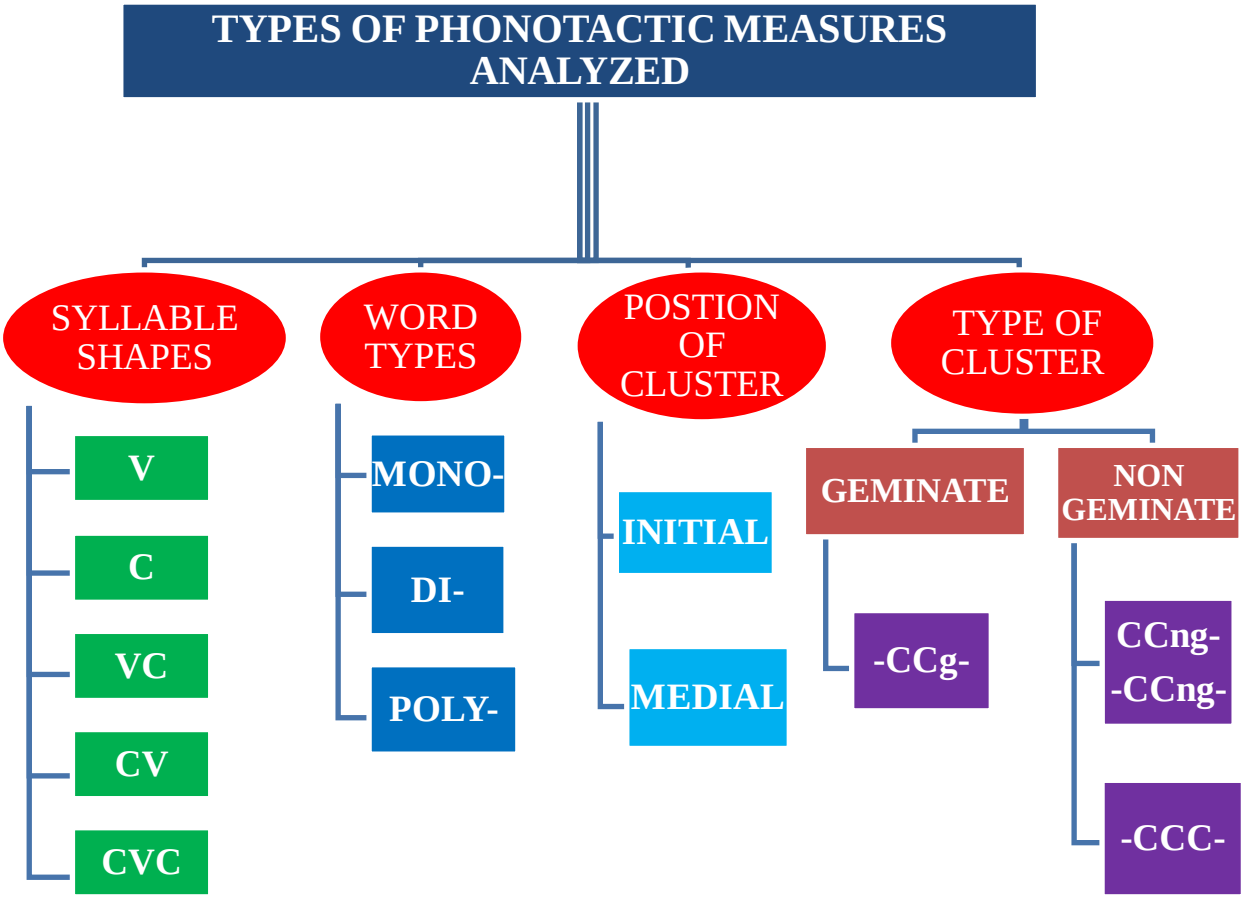


*Figure 4.1.*The table represents the types of phonotactic measures analyzed in Malayalam speaking children in the age range of 2-4 years.

*NOTES: V- Vowel, C-Consonant, CV-Consonant-Vowel, VC-Vowel-Consonant, CVC-Consonant-Vowel-Consonant, CC-Consonant-Consonant, CCC-Consonant-Consonant-Consonant*

### 4.1 Syllable Shapes

The main syllable shapes found in the samples were V, C, VC, CV and CVC excluding the clusters. The Malayalam word structures were phonetically divisible with these syllable shapes as used by Velleman (1998). The result showed a specific curve of growth for these syllabic shapes during the 2-4 years of age. Total corpuses of 10,330 syllable shapes were obtained from the analyzed 4000 word samples. Table 4.1 shows the mean and standard deviation of various syllable shapes.

Table 4.1

*Mean and standard deviation of mean percentage occurrence of different syllable shapes*

| **Age (years)** | | **2-2.6 yrs** | **2.6-3 yrs** | **3-3.6 yrs** | **3.6-4 yrs** |
|---|---|---|---|---|---|
| **V** | Mean | 18.8 | 16.6 | 13.5 | 10.3 |
| | SD | 3.37 | 2.12 | 1.28 | 2.07 |
| | Median | 18.2 | 16.1 | 13.5 | 10.1 |
| **C** | Mean | 0.809 | 0.313 | 0.527 | 0.179 |
| | SD | 0.568 | 0.399 | 0.407 | 0.250 |
| | Median | 0.84 | 0.19 | 0.40 | 0.00 |
| **VC** | Mean | 0.127 | 0.240 | 0.193 | 0.257 |
| | SD | 0.281 | 0.204 | 0.265 | 0.203 |
| | Median | 0.00 | 0.185 | 0.00 | 0.180 |
| **CV** | Mean | 74.0 | 74.7 | 77.5 | 81.1 |
| | SD | 2.67 | 3.65 | 1.57 | 2.07 |
| | Median | 74.3 | 74.5 | 78.0 | 81.4 |
| **CVC** | Mean | 5.85 | 8.53 | 9.88 | 11.4 |
| | SD | 2.27 | 2.05 | 2.16 | 2.02 |
| | Median | 5.74 | 8.59 | 9.15 | 10.88 |

- V syllable shape occurred most frequently in younger age group (2-2.6 years) and declined as the other syllable shapes increased in occurrence.
- CV and CVC syllable shapes showed a developmental trend across age groups; CV syllable shape (approximately 75% of the total corpus) most frequently occurred in the age groups of 3-3.6 and 3.6-4 years since more multisyllabic words started to emerge during this age range. The frequency of occurrence of

CVC syllable shape also increased in number as more nasalized consonants, chillaksharams (as explained in need of the study) which occurred without a vowel at the word-final position.

- The frequency of occurrence of C and VC syllable shapes did not show any consistent pattern of increment, C syllable shape were seen mainly in younger age group (2-2.6 years) with percentage of occurrence less than 2%.
- The overall standard deviation was higher in younger age groups, which indicates that children's word spurts varied among them. The findings indicated that there were developmental changes between 2-4 years of age for V, CV and CVC syllable shapes. However, C and VC patterns were exceptions.
- Figure 4.2. shows developmental patterns for different syllable shapes. The predominance of CV syllable shape is consistent across age groups. CVC syllable shape showed slight increase in percentage till 4 years of age. This result suggests that children have acquired these 5 syllable shapes by 2 to 2.6 years of age itself and were maintained till 4 years of age.

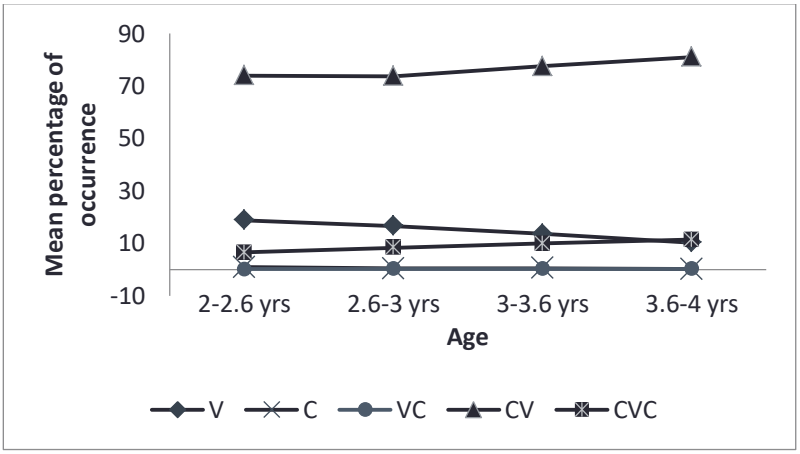


*Figure 4.2* Mean percentage occurrence of syllable shapes in children between 2-4 years of age.

Kruskal Wallis test was performed to find the overall significant difference of syllable shapes across age groups. The statistical results revealed that syllable shapes of V, CV and CVC showed significant difference across age groups ($p<0.05$). Mann-Whitney U-test was run to verify pair-wise comparison across age groups; the test results are as indicated in table 4.2:

Table 4.2

*Pair-wise comparison of V, CV and CVC syllable shapes across age groups.*

| | **Group I (2-2.6yrs)** | **Group II (2.6-3yrs)** | **Group III (3-3.6yrs)** | **Group IV (3.6-4yrs)** |
|---|---|---|---|---|
| **Group I** | | ✗ | ✓ | ✓ |
| **Group II** | | | ✓ | ✓ |
| **Group III** | | | | ✓ |
| **Group IV** | | | | |

*Note: ✓ depicts there is significant difference between the two groups compared and ✗ depicts no significant difference between the two groups compared*

Qualitative analysis of data revealed that overall CVC syllable shapes showed developmental increase since most of the words ended with nasal /m/, Chillaksharam /-**In**/, /-**Il**/,/-**Ir**/. Few examples are listed below:

| Words ending with nasal sound | Words ending with Chillaksharam |
|---|---|
| -/mərə**m**/ (Tree) | - /vi:tt**il** ( In house) |
| -/kəllə**m**/ (lie) | - /mi:**n**/( Fish) |

Apart from these Malayalam words ending with CVC type, there were few common loan English words used by these children, which also ended in CVC syllable shapes like

'pen', 'car', and 'school'. The English adopted words occurred in about 2% of the entire sample on an average. Mainly the V syllable type occurred alone and in word initial position. Among them those were words with short and long vowels and diphthongs. Few examples are listed below:

| Short vowel | Long vowel | Diphthongs |
|---|---|---|
| -/**ə**mmə/(Mother) | - /**ə:**nə/ (Elephant) | - /**əi**su/ (Ice) |
| -/**ə**thʌ/(That) | - /**o:**dI/ (Ran) | - /**ai**lʌ/( in that) |

## 4.2 Word Types

The major word types monosyllabic, disyllabic and multisyllabic were analyzed from the transcribed speech samples. Table 4.3 shows the mean and standard deviation of mean percentage occurrence of different word types in the age range of 2-4 years.

Table 4.3

*Mean and Standard deviation of mean percentage occurrence of word types*

| | **Age (years)** | **2-2.6 yrs** | **2.6-3 yrs** | **3-3.6 yrs** | **3.6-4 yrs** |
|---|---|---|---|---|---|
| **Mono-** | Mean | 11.5 | 7.0 | 5.20 | 3.40 |
| | SD | 3.50 | 2.16 | 1.81 | 1.06 |
| | Median | 11.7 | 6.0 | 5.0 | 3.50 |
| **Di-** | Mean | 48.2 | 53.0 | 51.3 | 39.1 |
| | SD | 3.70 | 3.49 | 3.02 | 2.18 |
| | Median | 48.5 | 53.0 | 51.0 | 39.5 |
| **Poly-** | Mean | 22.8 | 25.1 | 27.8 | 31.8 |
| | SD | 2.74 | 2.47 | 2.13 | 1.88 |
| | Median | 22.0 | 25.0 | 28.5 | 31.5 |

- The data showed that as age develops, the monosyllabic words occurred rarely and these were V, C, VC, CV, CVV, CVVV and CVVC.
- Disyllabic words gradually increased from 2-2.6 to 2.6-3 years of age with frequency of occurrence around 50%, following which there was a gradual decrease to 40% from 3-3.6 years to 3.6- 4 years age.
- Polysyllabic words showed developmental increment across age. It increased from 20% at 2-2.6 years to 30% at 3.6-4 years of age. The developmental pattern of most frequently occurring disyllabic and polysyllabic word types are shown in table 4.5 and table 4.6 respectively.
- Figure 4.3 shows the mean percentage occurrence of different word types (i.e., mono, di and polysyllabic). The occurrence of disyllabic (till 3.6 years) and poly syllabic words showed a relatively stable increment across age groups.

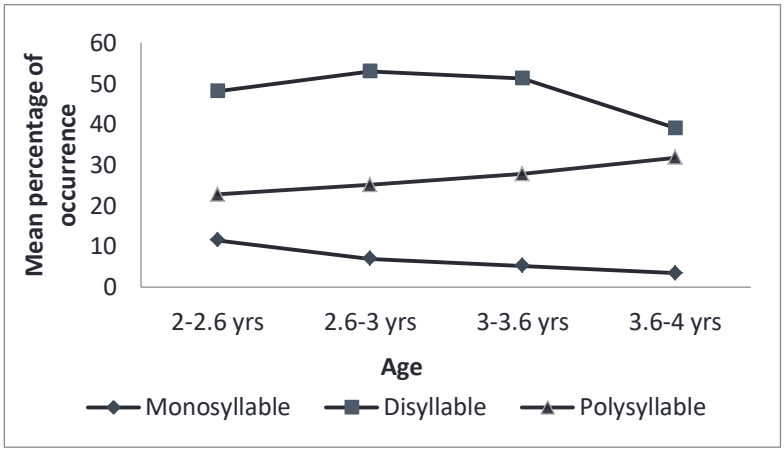


*Figure 4.3* Mean percentage occurrence of word types in children.

Kruskal Wallis test was performed to explore the significant difference of word types across age groups and the results revealed that word types of mono, di and polysyllabic showed significant difference across age groups ($p<0.05$). Mann-Whitney U-

test was run to verify pair-wise comparison across age groups. The test results are as indicated in the table 4.4:

Table 4.4

*Pair-wise comparison of mono, di and poly syllables across age groups.*

| | **GroupI (2-2.6 yrs)** | **Group II (2.6-3 yrs)** | **Group III (3-3.6 yrs)** | **Group IV (3.6-4 yrs)** |
|---|---|---|---|---|
| **Group I** | | ✓ | ✓ | ✓ |
| **Group II** | | | ✓ | ✓ |
| **Group III** | | | | ✓ |
| **Group IV** | | | | |

*Note: ✓ depicts there is significant difference between the two groups compared for mono-,di- and poly- word types..*

Table 4.5

*Mean and standard deviation of mean percentage occurrence of frequently occurred di syllabic word types across age groups*

| **Age** | **2-2.6 yrs** | | **2.6-3 yrs** | | **3-3.6 yrs** | | **3.6-4 yrs** | |
|---|---|---|---|---|---|---|---|---|
| **Word types** | Mean | SD | Mean | SD | Mean | SD | Mean | SD |
| **VCV** | 2.80 | 1.81 | 3.50 | 2.50 | 3.80 | 2.14 | 2.20 | 1.03 |
| **VVCV** | 2.50 | 1.17 | 1.80 | 1.13 | 1.70 | 1.41 | 1.20 | 1.31 |
| **VCCV*** | 13.5 | 2.06 | 10.5 | 2.27 | 9.00 | 2.16 | 9.55 | 2.10 |
| **VCCVC*** | 2.40 | 0.96 | 3.40 | 0.77 | 3.70 | 0.61 | 4.80 | 0.63 |
| **CVCV** | 1.90 | 0.87 | 2.50 | 0.84 | 2.80 | 1.22 | 3.90 | 0.73 |
| **CVVCCV*** | 3.80 | 1.47 | 4.30 | 1.15 | 4.80 | 1.09 | 4.65 | 1.56 |
| **CVVCV*** | 6.70 | 1.49 | 6.20 | 1.47 | 7.30 | 1.15 | 7.25 | 1.18 |
| **CVCCVC*** | 2.30 | 0.82 | 3.20 | 1.54 | 4.80 | 1.27 | 4.80 | 0.63 |
| **CVVCVC*** | 1.20 | 1.05 | 4.00 | 1.88 | 3.80 | 1.54 | 4.90 | 1.40 |

*Note: * indicates word structures showing significant difference across age in Kruskal Wallis test ($p<0.05$).*

Table 4.6

*Mean and standard deviation of mean percentage occurrence of polysyllabic word types across age groups*

| **Age** | **2-2.6 yrs** | | **2.6-3 yrs** | | **3-3.6 yrs** | | **3.6-4 yrs** | |
|---|---|---|---|---|---|---|---|---|
| **Word types** | Mean | SD | Mean | SD | Mean | SD | Mean | SD |
| **VCCVCCV*** | 1.80 | 1.03 | 3.90 | 0.99 | 5.60 | 1.04 | 6.30 | 1.00 |
| **VCVCV*** | 2.00 | 1.15 | 3.30 | 1.40 | 5.90 | 1.10 | 6.00 | 1.01 |
| **VCCVCV*** | 0.60 | 0.69 | 2.40 | 1.17 | 3.70 | 1.15 | 3.90 | 0.63 |
| **CVCVCV*** | 0.80 | 0.78 | 1.60 | 1.07 | 4.30 | 1.25 | 5.80 | 1.12 |
| **CVCVCCV*** | 2.10 | 0.87 | 3.00 | 1.15 | 5.00 | 1.04 | 5.90 | 0.92 |
| **CVCVCVCV*** | 0.40 | 0.69 | 0.90 | 0.73 | 2.00 | 1.05 | 4.10 | 0.99 |
| **CVVCVCCV** | 0.90 | 0.67 | 1.50 | 1.08 | 3.60 | 1.07 | 3.60 | 0.84 |

*Note: * indicates word structures showing significant difference across age in Kruskal Wallis test (p<0.05).*

With reference to types of word structures present in children's vocabulary, higher individual variations were evident. The major syllable types produced by the younger age group were mainly open V (eg., /**a**/), CVV (eg.,/**t̪ə:**/), CVVV (/**mIə:U**/), VCV(eg.,/ə**t̪**ʌ /, VVCV(eg.,/**ə:nə**/) and VCCV (eg.,/**Illə**/) and older children produced more number and variety of syllable structures ranging from open to closed syllables. The disyllables showed relatively linear increase from youngest to oldest age groups, which are VCCV (e.g.,/**əmmə**/, VCCVC (e.g.,/**onnUm**/), CVCV(e.g.,/**vədI**/), CVVCV (e.g., /**ku:rə**/), CVVCCV (e.g., /**pə:ttə**/, CVVCVC (e.g.,/**pə:dUm**/) and CVCCVC (eg.,/**t̪əllUm**/) structures. In contrast to the monosyllables, polysyllabic structures (CVCVCV, VCVCV, VCCVCCV, CVCVCCV, CVCVCVCV and CVVCVCCV) also showed linear increase with age. Monosyllables (V, CV, CVV, and CVVV) and few

disyllables (VCV and VVCV) showed linear decrease with age. Among the syllable shapes produced by children, such as VVCV (e.g.,/**aI**lu/-In that, CVV (e.g.,/k**əI**/-hand), CVVV (e.g.,/m**Iə:**U/-Cat's cry), CVCVV (e.g.,/vəl**Iə**/-Big) are seen to be directed as a diphthong combination at the initial, medial and ending word positions. The diphthongs found to be produced are opening (e.g.,/pUt̪**Iə**/-(New), /oŋ**Iə**/-(Slept ?)), closing (/k**əU**ɕələm/-kausalam (Clever)) and height harmonic diphthongs(e.g.,/k**uI**kkUm/-kudikkum (Will drink)). Among these, opening and height harmonic diphthong were largely produced by youngest age group of 2-2.6 years. Closing diphthongs were relatively produced more by older age group. The vowel combination varied as short (e.g., /k**əI**/-hand) and long (e.g., /m**Ia:**u/-cat's cry) vowels. The short combination was perceived (phonetically identified) as diphthong (e.g.,[k**əI**]- Hand) and the long become a triphthong (e.g.,[m**Iə:**vU]-Cat's cry) which are observed to be scantily occurring in each age group.

### 4.3 Consonant Clusters

Consonant clusters found in children's speech were initial 2 consonant clusters **(CC-),** medial 2 consonant clusters **(-CC-),** and medial three consonant clusters (-**CCC**). Medial clusters included both geminated (-**CCg**-) and non-geminated **(-CCng-)** types. Table 4.7 depicts the mean and standard deviation of percentage occurrence of various types of consonant clusters and figure 4.4 depicts the developmental trend of consonant clusters across the different age groups.

- A total of 15 and 35 various combinations of geminate and non-geminate clusters were observed respectively across the 40 participants.

- Among the cluster types, medial two consonant clusters occurred maximally with 74-89% of cluster corpus.
- Within medial two consonant clusters, geminate clusters occurred more frequently with a percentage of 60-69% and this was maintained across all age groups.

Table 4.7

*Mean and standard deviation of mean percentage occurrence of clusters*

| Clusters | Age (Years) | 2-2.6yrs | 2.6-3 yrs | 3-3.6 yrs | 3.6-4 yrs |
|---|---|---|---|---|---|
| **CC-** | Mean | 0.00 | 0.40 | 0.70 | 1.90 |
| | SD | 0.00 | 0.516 | 0.82 | 0.99 |
| | Median | 0.00 | 0.00 | 0.50 | 2.0 |
| **-CC-** | Mean | 74.90 | 78.80 | 83.0 | 89.90 |
| | SD | 3.72 | 3.83 | 3.22 | 3.34 |
| | Median | 75.0 | 79.0 | 83.0 | 90.0 |
| **-CCg-** | Mean | 61.80 | 63.70 | 64.50 | 69.50 |
| | SD | 4.51 | 3.26 | 3.22 | 3.13 |
| | Median | 62.50 | 64.0 | 65.0 | 70.0 |
| **-CCng-** | Mean | 13.10 | 15.10 | 18.50 | 20.40 |
| | SD | 2.18 | 2.13 | 1.84 | 1.71 |
| | Median | 13.0 | 15.0 | 18.50 | 20.0 |
| **-CCC-** | Mean | 0.50 | 0.90 | 1.40 | 1.80 |
| | SD | 0.52 | 0.73 | 0.69 | 0.91 |
| | Median | 0.50 | 1.0 | 1.50 | 1.70 |

- Among medial geminate clusters nasal geminates **[mm], [nn]** and lateral geminates **[ll]** had the maximum frequency of occurrence followed by stop geminates **[pp], [tt], [kk], [dd]** and affricate geminate **[ʧʧ].**
- Medial non-geminated clusters ranged from a frequency of 13 - 20% from the youngest to the oldest age groups considered in the study. Within non-geminated clusters, **nasal + homorganic stops (eg: /mb/,/nd/,/nt/ etc**) were most frequently produced by all age groups followed by **glide + velar (-jk-), glide + nasal(-jn-) and nasal +velar (-nk-)**.

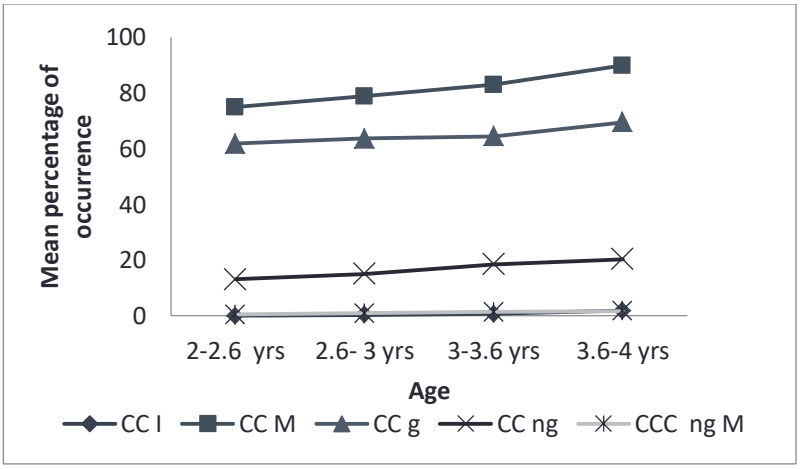


*Figure 4.4* Mean percentage occurrence of various clusters

- The initial clusters occurred with a frequency of less than 2%. However, the final clusters observed in the samples were borrowed English words in all age groups since in Malayalam there is no word with final consonant cluster (Geetha Kumary, 2002).
- Three consonant clusters occurred medially with combinations of **/-nkk-/,/-jkk-/, /-dʧʧ/,** /-**nd̪ʱd̪ʱ**-/, /-**rʈʈ**-/ more rather than /-**nd̪ʱr**-/,/-**ntr**-/,/-**skr**-/ combinations and some examples are given below. However frequency of these clusters was also less than 2% and fell under rare category in all the age groups from 2-4 years.

e.g., /-nkk-/- [ɛnkkʌ] (For me)

/-jkk-/- [mə:jkkʌ] (Clear it)

/-nd̪ʱd̪ʱ/- [pənd̪ʱd̪ʱʌ] (Once upon a time)

/-nd̪ʱr-/- [pənd̪ʱrənd̪ʱd̪ʱʌ] (Twelve)

/skr/- [əIskri:m] (Ice-cream)

Kruskal Wallis test was performed to find whether there is significant difference in occurrence of consonant clusters across age groups. The results revealed that the

clusters of initial non-geminate and medial (geminate and non-geminate) 2 consonant clusters, showed significant difference across age groups ($p<0.05$). Mann-Whitney U-test was employed for Pair-wise comparison, the test results are as indicated in the subsequent table 4.8 (Initial clusters) and table 4.9 (Medial geminate and non-geminate clusters);

Table 4.8

*Pair-wise comparison of initial non-geminate 2 consonant clusters across age groups*

| | **Group I 2-2.6 yrs** | **Group II 2.6-3 yrs** | **Group III 3-3.6 yrs** | **Group IV 3.6-4 yrs** |
|---|---|---|---|---|
| **Group I** | | ✗ | ✓ | ✓ |
| **Group II** | | | ✗ | ✓ |
| **Group III** | | | | ✗ |
| **Group IV** | | | | |

✓ *depicts there is significant difference between the two groups compared and* ✗ *depicts no significant difference between the two groups compared*

Table 4.9

*Pair-wise comparison of medial (geminate and non-geminate) 2 consonant clusters across age groups*

| | **Group I 2-2.6 yrs** | **Group II 2.6-3 yrs** | **Group III 3-3.6 yrs** | **Group IV 3.6-4 yrs** |
|---|---|---|---|---|
| **Group I** | | ✓ | ✓ | ✓ |
| **Group II** | | | ✗ - CCg-<br>✓ -CCng- | ✓ |
| **Group III** | | | | ✓ |
| **Group IV** | | | | |

✓ *depicts there is significant difference between the two groups compared and* ✗ *depicts no significant difference between the two groups compared*

The findings of the present study are summarized in table 4.10

Table 4.10

*Summary of findings*

| | **Findings (Observations)** |
|---|---|
| | **Syllable Shapes** |
| **CV syllable** | Most common syllable shape seen compared to CVC, V, C and VC from 2 - 4 years and it increased with age. |
| **CVCsyllable** | Second most common syllable shape seen with increase in age. |
| **V syllable** | Predominant in youngest age group (2 - 2.6 years) and frequency of occurrence decreased as age increased. |
| **C and VC** | Found rarely with percentage of occurrence less than 2% |
| | **Word Types** |
| **Mono-** | Found rarely and produced more frequently by youngest age group (2 - 2.6 years) |
| **Di-** | Found to be the most common word shape (≃50% occurrence) in all four groups, followed by polysyllables. |
| **Poly-** | Polysyllabic words showed developmental increment with age. It increased from 20% at youngest age (2-2.6 years) to 30% at the oldest age group (3.6-4 years). |
| | **Consonant Clusters (CCs and CCCs )** |
| **Initial 2 CCs** | Found rarely, with percentage of occurrence less than 2% |
| **Medial 2CCs and 3CCs** | Medial 2CCs occurred most frequently (≃80%) in all groups.Within Medial 2CCs, medial geminate clusters were the early developing and the most frequently (60-69%) occurring type followed by medial non-geminate clusters (13 - 20%) and medial 3CCs (≃2%) |

# Chapter V

## DISCUSSION

The results of the present study suggests that there is a developmental trend noticed for phonotactic measures such as syllable shapes, word types and consonant clusters in Malayalam speaking children between 2-4 years of age. Among syllable shapes, CV and CVC showed high percentage of occurrence over V, C and VC and is in agreement with Neeti Priya and Manjula (2007) in Telugu and Shailaja, Manjula and Praveen (2011) in Hindi. This result also seems to suggest that Malayalam speaking children are following universal order of syllabic acquisition where CV syllable shape is reported to be acquired earlier by children of all languages (Jacobson, 1968; Bernthal & Bankson, 1993). The high percentage of occurrence of CV was also found in other studies. Kent and Bauer (1985) Pollock and Schwartz (1988) reported that first syllable structures to emerge are CV. Then child reduplicates the utterances and produces more of CVCV combinations, followed by CVC.

In Malayalam, along with CV, high occurrence of the syllable shape CVC could be due to the increased frequency of occurrence of nasal(m) and chillaksharam (/-In), (-Il) and (-ir) at word endings. This is one of the distinctive identity of Malayalam. Therefore even though most of the words in Malayalam are open ended, due to this reason there is occurrence of closed syllable word types (there are also few borrowed words from English). Younger age groups produced V syllable shapes (vowels) more than other older

age groups; also they were able to differentially use long and short vowels by the age of 2 years itself. According to research, languages wherein the vowel length contrast is robustly durational (e.g., Malayalam), with little quality difference, children distinguish long and short vowels by duration very early in age by 1.6 years for Japanese learners (Ota, 1999) or by age 2.0 for Swedish (Stoel-Gammon & Buder, 1998). In contrast to the present finding, the syllable shapes produced by Kannada children in the age range of 0-5 years (Rupela & Manjula, 2006) showed a developmental pattern as age increases, such as CV followed by VC and CVC. But in Malayalam, VC syllable shape did not show any developmental pattern as age increased. It was produced less frequently and fell under the category of rarely occurring, this is in accord with the findings of Shailaja et al. (2011) in Hindi.

Most of the participants exhibited wide variability (majorly the younger groups) in the frequency of occurrence of syllable shapes and word types, as children tend to produce trial and error word combinations during this learning stage. In general, a young child's speech patterns are less stable than an adult's and evidence shows that the stability continues to improve until the child reaches puberty due to neuro maturational factors (Kent, 1976).

With regard to word types and syllable structures, younger group tend to produce more number of open syllable like CV, CVV, CVVV, CVCV, VCV, VVCV, VCCV, CVVCV, CVVCCV and few closed syllables CVC, CVVC, VCVC. Whereas older children apart from these, produced more complex syllabic structures (both open and closed) like VCVCV, CVCVCV, VCCVCCV,CVCVCVCV, CVVCVCCV, VCCVC, CVVCVC, CVCCVC, CVCVCCVC. These results are in accord with the findings of

Alphonsa (2012) in Malayalam. Amongst word types, disyllables occurred most frequently followed by polysyllables and monosyllables when age increases, which is supported by the observation of many studies in the Indian context (Rupela & Manjula, 2006; Neethi Priya & Manjula, 2007). Monosyllabic words gradually declined in frequency of occurrence and are in consensus with Rupela and Manjula (2006). High occurrence of mono syllables are seen in 2-2.6 years of age; this could be because Malayalam has a proportion of meaningful monosyllables like /va/,/ta/,/po/,/ba/ and /ɲəːn/ etc which often occur in daily communication and helps children to convey meaning easily. In contrast to the present finding, the word types produced by Hindi speaking children in the age range of 3-5 years (Shailaja, Manjula & Praveen, 2011; Akriti & Sreedevi, 2018) showed that monosyllabic words produced more frequently, followed by disyllabic and tri-syllabic word types.

Even though Malayalam has two diphthongs in general (i.e**., /əI/ and /əU**/), the sample showed various other diphthongs such as **/Iə/,/Uə/,/ɛo/,/Iɛ/ and /UI/**. This can be due to children's tendency to produce words which are simpler; the direction of such simplification is CV to VV (e.g., /vəlI**jə**/ - CVCV**CV** to /vəl**Iə**/- CVC**VV**). Among diphthongs, opening and height harmonic diphthongs were more produced by youngest age group of 2-2.6 years. Closing diphthongs were relatively produced more by older age group and these were produced majorly by combining rudimentary vowels with high vowels (e.g.,/k**UI**kkUm/-(hand),/ k**əU**ɛələm/-kausalam (Clever)) which is in consonance with Reeny and Sreedevi (2014;2017) in Malyalam learning infants and Sreedevi and Jyothi (2013) in Kannada learning infants. The studies of Watson (2007) in Liverpool English, Leimgruber (2009) in Singapore English and Kumari (1972) and Punnoose

(2010) in Malayalam are supporting the fact that production of closing diphthongs are universally present in adult spoken languages.

The present findings with regard to consonant clusters showed that medial two consonant clusters occurred more frequently than initial clusters. Among medial clusters, medial geminate occurred more followed by medial non-geminate and initial non-geminate clusters. This is because of the ambient language influence where medial clusters occur in much larger proportion and this observation is also supported by Dravidian language studies (Neethi Priya & Manjula, 2007 in Telugu; Rupela & Manjula, 2006 in Kannada; Alphonsa & Sreedevi, 2012 in Malayalam). In contrast to the present finding, in terms of clusters acquisition, English-speaking children of 24 months used 58% two element clusters in word initial position, 48% in final position and 30% in medial position (Stoel-Gammon, 1987) and this is due to language influence from the ambient environment. And in Hindi also, studies have reported that among medial clusters, non-geminate clusters have higher occurrence compared to geminate clusters (Koul, 2008; Akriti & Sreedevi, 2018).

# Chapter VI

## SUMMARY AND CONCLUSIONS

The present study aimed at investigating the phonotactic development in typically developing 2-4 years old Malayalam speaking children. The main objectives of the study were to obtain the phonotactic measures, such as the type and frequency of various syllable shapes, word shapes and consonant clusters (types, frequency and positions) of typically developing Malayalam speaking children and to compare the findings across gender and age groups.

A total of 40 participants in the age range of 2-4 years were enrolled for the present study. The participants were included with a 6 months of age interval; ≥2.0 to ≤ 2.6 years; > 2.6 to ≤ 3.0 years ; >3.0 to ≤ 3.6years; >3.6 to ≤ 4.0 years comprising of 10 participants (5 boys and 5 girls) in each age group. The participants were selected from individual homes and pre-primary schools in Kasaragod district of Kerala through convenience sampling method. A general history of child's development, details of speech and language, hearing, vision, oromotor, articulatory and cognitive skills were obtained through interview of parents and caretakers using a screening checklist developed at department of Prevention of Communication Disorders (2008) at AIISH. Kuppuswamy's Socioeconomic Status Scales (2018), was used to ensure that all the participants were from middle socio-economic background and were exposed predominantly to Malayalam. A 30 minutes spontaneous speech samples were obtained from all the participants in a natural setting using a digital voice recorder. This speech samples was elicited using story videos, toy kit and general conversation. A minimum of 100 word

sample from each participant was selected and were transcribed using International Phonetic Alphabet (2015) by the investigator. The obtained 4000 utterances of 40 participants were syllabified for further analysis. The types and frequency of occurrence of various phonotactic measures were extracted from the transcribed sample. For the calculation of percentage of occurrence of various syllable shapes, word types and clusters in different positions, the formulae by Velleman (1998) were used. Prior to the data analysis 10% of the transcribed samples was subjected to inter and inter judge reliability.

The findings revealed that the major syllable shapes found in Malayalam were V, C, VC, CV and CVC. Among the 5 syllable shapes CV (≃75% of the corpus) and CVC (≃10%) showed developmental trend across age groups. Younger age group (2-2.6 years) produced V/VV syllable shapes (short and long vowels) more frequently than other older age groups, and showed a decrement in frequency with increasing age due to CV and CVC predominance. C and VC syllable shapes were rare category with less than 2% occurrence.

Among word types, disyllables were predominant followed by polysyllabic words. As age increased, polysyllabic words increased in frequency and disyllabic words reduced in frequency. Monosyllabic words occurred rarely with increase in age. Cluster analysis revealed that medial two consonant clusters occurred most frequently (≃80% of the cluster data) compared to other types. Within medial two consonant clusters, geminate clusters occurred predominantly (≃65%) than non-geminate clusters (13-20%). This frequency was relatively maintained across all age groups. Initial two consonant

clusters and medial three consonant clusters fell under rare category with less than 2% occurrence among clusters.

The present study revealed the developmental changes with respect to phonotactic measures (various syllable shapes, word types and clusters in different positions) in typically developing 2-4 years old Malayalam speaking children. The developmental patterns established would help Speech Language Pathologists in accurate assessment of disordered phonology in children with communication disorders. These norms on Malayalam phonotactics will also serve as guidelines for setting up speech and language therapy goals for such children.

Limitations of the present study

- Participants limited to Kasaragod dialect of Malayalam only
- Sample size limited to 40 ( 10 in each age group)

Future Directions

- The study can be replicated including children from different geographical pockets of Kerala
- The study could be expanded in terms of age from 0 to 6 years.
- Study of acquisition of consonants in terms of word positions

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## APPENDIX I

1) Inventory of various vowel sequences ( diphthongs) observed in the participants

| **Diphthongs** | **Examples** | **Meaning (In English)** |
|---|---|---|
| əI | [k**əI**], [p**əI**kkəlu], [b**əI**kkU] | Hand, Cows, Bike |
| əU | [k**əU**ɕələm] | Clever |
| Iə | [pU**Iə**], [vəl**Iə**], [piːd**Iə**] | New, Big, Shop |
| Uə | [oːd**Ua**],[ʧəːd**Ua**] | Running, Jumping |
| ɛo | [eːd**ɛo**] | Somewhere |
| Iɛ | [sad**Iɛ**:ʧʧI], [kəːtt**Iɛ**] | One name, Show |
| UI | [k**UI**kkUnnU] | Drinking |

## APPENDIX II

1) Exemplars of various Word structures (in terms of mono, di and poly syllables) observed in the repertoire of the participants

### FREQUENTLY SEEN MONOSYLLABIC STRUCTRUES

| **Word Structures** | **Examples** | **Meaning(In English)** |
|---|---|---|
| **V** | [ə] | Yes |
| **C** | [m] | Yes |
| **CV** | [t̪ə] | Give |
| **VC** | [ɛs] | Yes |
| **CVVC** | [ɲə:n] | I |
| **CVC** | [pɛn] | Pen |
| **CVV** | [kəI] | Hand |
| **CVVV** | [mIə:U] | Cat's cry |

## APPENDIX III

### FREQUENTLY SEEN DISYLLABIC STRUCTURES

| Word Structures | Examples | Meaning (In English) |
|---|---|---|
| **VCV** | [əṯʌ] | That |
| **VVCV** | [ə:mə] | Tortoise |
| **VCCV** | [ɛntɛ] | Mine |
| **VCCVV** | [Illə:] | No |
| **VCCCVC** | [əlppəm] | Some |
| **VCCVC** | [əppəm] | Food |
| **VVCVC** | [ə:dUm] | Swing |
| **VCVC** | [əṯUm] | That also |
| **VCCVVC,VVCCVVC** | [əmmɛ:m], [ɛ:ʧʧi:m] | With mom, with Sister |
| **VCVV** | [ɛni:] | Stand up |
| **CVCV** | [vələ] | Net |
| **CVCVV** | [vəlIə] | Big |
| **CVCCV,CVCCVV** | [mUllə], [potti:] | Jasmine, Brocken |
| **CVCVC,CVCCVC** | [ṯodUm],[kUkkUm] | Will touch, Will drink |
| **CVCCVVC,CVVCCVC** | [vəndi:m],[pə:ttUm] | Vehicles, songs |
| **CVVCVC,CVVCCVVC** | [vɛ:nəm],[sə:mbə:r] | Want, Sambar curry |
| **CCVVCVC** | [pre:ṯəm] | Ghost |
| **CVVCCV,CVVCCVV** | [ʧe:ʧʧI], [kə:ttIɛ] | Elder sister, Show |
| **CVVCV,CVVVCV** | [nə:jI], [mIə:vU] | Dog, Cat's cry |

## APPENDIX IV

## FREQUENTLY SEEN POLYSYLLABIC STRUCTURES

| Word Structures | Examples | Meaning (In English) |
|---|---|---|
| **VCVCCV** | [oŋʌnnU] | Sleeping |
| **VVCVCCV** | [o:dəndə] | Don't run |
| **VCCVVCV** | [Uppə:jI] | Dress |
| **VCCVVCCV** | [əmme:ntɛ] | Mother's |
| **VCCVCCV** | [əmməmmə] | Grand mother |
| **VVCCVVCV** | [e:ttəntɛ] | Elder brother's |
| **VCVVCCV** | [Ile:ntɛ] | Leaves |
| **VCCVCV** | [Innələ] | Yesterday |
| **VCVCV** | [Iŋənɛ] | Like this |
| **VVCCVCCV** | [e:ttəntɛ] | Elder brother's |
| **VCCVCVC** | [əmməjUm] | With mother |
| **CVCVCV** | [pU̪t̪Ijə] | New |
| **CVCCVVCV** | [mUttə:jI | Chocolate |
| **CVVCCVCV** | [ku:ttIlʌ] | In nest |
| **CVVCVCV** | [kə:rIlʌ] | In car |
| **CVVCVCCV** | [po:jIttʌ] | Went |
| **CVCCVCCV** | [t̪ottIllə] | Didn't touch |
| **CVCCVCV** | [vəʃʧInU] | Kept |
| **CVCVCCV** | [nədənnU] | Walked |
| **CVVCVCCVC** | [pu:vəlləm] | All flowers |
| **CVVCVCVC** | [və:ŋənəm] | Will buy |
| **CVCVCCVCCV** | [kədIkkUnnU] | Biting |

## APPENDIX V

### Informed consent taken from parents/caretaker

### Informed Consent

I have been informed about the aims, objectives and the procedure of the study. The Possible risks-benefits of my participation as human subject in the study are clearly understood by me. I understand that I have a right to refuse participation as subject or withdraw my consent at any time without adversely affecting my/my ward's treatment at AIISH. I am also aware that by subjecting to this investigation, I will have to give more time for assessments by the investigating team and that these assessments may not result in any benefits to me. I have the freedom to write to Chairman, AEC, in case of any violation of these provisions without the danger of my being denied any rights to secure the clinical services at this institute.

I, ----------, the undersigned, give my consent to be participant of this investigation/study/program.

**Signature of Parent/ Guardian** **Signature of Investigator**

**(Name and Address)** **Name and Designation**

**Date:**