REVALIDATION OF MALAYALAM DIAGNOSTIC ARTICULATION TEST (4-5 YEARS)

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DEDICATED TO……

ALMIGHTY GOD

AMMA

&

ACHAN

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CHAPTER 1

INTRODUCTION

The power source for speech is the air provided by the respiration, and exhaled air is changed into sound by the process of phonation. The sound generated by vocal fold vibration is not the sound that is heard by the listener. More processes need to occur before a sound will be recognizable as speech sound belonging to a particular language. One such process is articulation. To shape specific sound, articulators such as the lips, velum, and tongue move and come close to or make contact with themselves and other immovable articulators, such as the teeth, alveolar ridge and palate. The movement of articulators to various locations and positions within the oral cavity that modifies the sound wave moving through the vocal tract and gives the sound specific characteristics that are recognized as distinctive speech sounds. Moving the articulators also changes the resonance characteristics of the vocal tract.

Humans express their ideas and feelings by producing speech, which need articulation. Articulation, in the simplest form can be defined as "a modification of the interrupted air stream into different sounds by the movement of articulators such as tongue, lips, jaw, teeth, soft palate, and others. It is a series of overlapping ballistic movements which places varying degrees of obstruction in the path of the outgoing air steam and simultaneously modifies the size, shape and coupling of the resonating cavities" (Nicolosi, Hanyman & Krescheck, 1978). Articulation is the

act of moving two articulators (of the lower margin and of the upper margin) toward each other for the obstruction of outgoing air. Articulation is making of speech sounds. It is also refers to the overt level of speech production. It is the motor component of the sounds that can be seen, heard, and produced.

Articulation is one of the five processes involved in speech production. The other processes are respiration, phonation, resonation and cerebration and all these five processes are interdependent. Any abnormalities in any five of these processes affect the other processes. There are many variables that affects articulation ie, organic factors, personal factors, sensory factors and structural variables. The factors affecting articulation are given in Table 1.

Factors	**Conditions**
Sensory	Speech sound discrimination, hearing, oral sensory perception, sensory deprivation
Structural	Oral structures (lip, teeth, tongue), ankyloglossia, hard palate, soft palate, facial patterns, tongue thrust
Organic	Hearing loss, neuromotor pathologies
Personal	Age, sex, intelligence, personality and adjustment, language development, socio-economic status, linguistic cultural & educational variation, siblings.

Table 1: *Factors affecting articulation*

Articulation is considered as normal when it does not deviate from the context of verbalization and it is abnormal when it deviates .Articulatory disorder is as the "faulty placement, timing, direction, speed or integration of articulation movements resulting in absent or incorrect speech sounds". Several authors define articulatory disorder based on different viewpoints. Wintiz (1969) described defective articulation as the "incorrect learning of phoneme system of languages" ie, person uses a system or a part of, that is deviant from the phonological system of language which has been learned. This is also referred to as phonemic errors. Misarticulation usually occurs during the early stages of speech development. Thus, when some articulatory errors occur at certain age levels, the child is not considered to have articulatory disorder. However, use of such articulatory and phonological patterns is characteristic of normal speech acquisition.

Roe and Milisen (1942) found that articulation continues to develop until the fourth grade. However, it is generally agreed that by the second grade or seven years of age most children have acquired normal articulation and basic phonological processes. Disordered articulation and phonology commonly reflect a hierarchy of sounds that is reasonably orderly and predictable. Later developing sounds are misarticulated more frequently than earlier developing sounds (Templin, 1957; Ingram, 1982). McDonald (1964) found that the following sounds were misarticulated most often: /s, z, r, l, ʃ, ʧ , θ, ɚ, k, g, f and v/. Weiss (1980) noted that /s, z, r, l/ and consonant clusters were most frequently misarticulated sounds.

Misarticulation follows an orderly sequence in regard to type and combination of phonemes. The most common are incorrect productions of (1) consonant clusters, followed by (2) single consonant, (3) diphthongs and (4) vowels. Nasal consonants are easier to produce than plosives; plosives are easier to produce than fricatives; and fricatives are easier to produce than consonant clusters. Regarding the sound position in a word, misarticulations are least common in initial position, followed by those in medial positions and most common in final position. Nasal continuants are easier to produce than fricatives; and fricatives are easier than consonants clusters. Pendergast et.al (1969) found that unvoiced consonants are misarticulated more frequently than voiced consonants. Therefore in order to differentiate abnormal articulation from normal articulation, development of a test is essential. The test of articulation is a basic test that is used by Speech language Pathologists to assess articulation. The articulation test is typically designed to:

1) To set up norms for the normal development of phonology.
2) To determine the phonetic proficiency.
3) To assist in screening purpose.
4) To monitor the progress in therapy.
5) To identify the articulatory errors in speech.
6) To scrutinize the speech of child and to determine the nature of deviancy.
7) To determine the factors that causes the articulatory problem or contributes its severity.
8) To plan speech therapy carefully.

A norm is performance measure of a normative group on a tested skill. Norm reference test are always standardized. When a child's performance falls outside the range of scores received by the individuals in the normative study, the child may be said have a non-normal speech or language behaviour. Hence monitoring the changes in child's articulatory and phonological abilities and performance across the time and age is important. The articulatory tests are developed in several languages and articulatory norms were also available in these languages. However, it is important to remember that such articulatory norms need to be revised over a period time to go with changed patterns of speech development.

Need for the study

Presently, children acquire speech sounds much earlier than before and therefore it is very important to re-establish the norms for the existing articulation tests. Maya (1990) developed the Malayalam Diagnostic Articulation Test (MAT) and standardized it on 240 children in the age range of 3-7 years. Divya (2010) using the same test (MAT) studied articulatory acquisition in 120 typically developing 2-3 years old Malayalam speaking children. She reported that out of the 82 test words in MAT, 15 words were found to be obsolete and were no more in the colloquial usage. So these words have to be revised to update the test. She also reported that by 2.9 years itself children begin to produce consonant clusters**.** In the existing MAT only 15 consonant clusters are tested. Therefore there is a need for revising the obsolete test words and also for testing more commonly occurring consonant clusters in order

to study the pattern of their acquisition. It has been more than 20 years since the norms have been established for Malayalam Diagnostic Articulation Test in the age range of 3-7 years. Hence there is an immediate need to revalidate the existing Malayalam Diagnostic Articulation Test.

Aim of the study

The aim of the study is to revalidate norms for Malayalam Diagnostic Articulation Test (Maya 1990) in the age range of 4-5 years.

The specific objectives of the study are

(1) To modify the existing Malayalam Diagnostic Articulation Test.

(2) To include more number of frequently occurring consonant clusters in the test.

(3) To administer the revised Malayalam Diagnostic Articulation Test to typically developing Malayalam speaking children in the age range developing Malayalam speaking children in the age range of 4-5 years to establish current norms 100% criteria will be considered for single phonemes and 90% for consonant clusters.

(4) To compare the articulatory skills across age and gender.

(5) To compare the difference in the articulatory acquisition of phonemes in initial and medial positions of the words.

(6) To compare the order of acquisition of initial and medial consonant clusters.

(7) To compare the data obtained with that of the earlier reported studies in both English and other Indian languages.

Brief description on Malayalam Language

Malayalam is one of the five major languages of the Dravidian language family, which also includes Tamil, Telugu, Kannada and Tulu. Malayalam is the principal language of around 40 million people of the state of Kerala and union territories of Lakshadweep and Mahe. It is closely related to Tamil and Sanskrit. Most of the traditional words in Malayalam have its roots in either Tamil or Sanskrit. Due to its lineage to Sanskrit and Tamil, the Malayalam orthography has the largest number of phonemes among the Indian languages. Malayalam language is primarly syllabic in nature. Each syllable is represented using a unique combination of consonants and vowel. The script consists of 52 characteristics including 16 vowels and 36 consonants. In addition to this basic set, the script also contains a large number of conjunct characters and special symbols.

Brief method of the study

The present study was conducted in 2 phases. **Phase 1** included the modification of Malayalam Diagnostic Articulation Test (Maya 1990). For this, 15 new words to replace the obsolete words, another fifteen words incorporating common clusters and 3 words incorporating aspirated stops were selected to include in the test material. So a new wordlist having the phonemes to be tested was given to three judges to check the familiarity of these words. For each phoneme to be tested, the words which were rated as very familiar by the judges were considered as the new test words. In the existing test (Maya, 1990) there were 82 test words including

fifteen consonant clusters and in the modified one there are 100 test words (10 vowels, 70 singleton consonants and 30 consonant clusters). All the 100 target words were picturized.

Phase 2 involved obtaining norms for the acquisition of articulatory skills in native Malayalam speaking children in the age range of 4 - 5 years. The subjects were sub divided into four groups with an inter age interval of three months (4 - 4.3, 4.4 - 4.6, 4.7 - 4.9 & 4.10 - 5 years). Each of the four groups comprised of a total of 30 subjects including 15 boys and 15 girls. So a total of 120 subjects were considered for the study. The subjects were prompted to name the target pictures that were presented through a laptop computer. Each target picture was designed to elicit the target sound as a single phoneme or cluster at each position. The response elicited was audio recorded using computer laptop. The data obtained from the 120 subjects were transcribed using broad and narrow IPA transcription. All the responses of each subject were analyzed sound-by-sound on a response sheet and a score was given and the total score for each subject was calculated. Later a mean score was obtained for each of the four age groups studied.

Implications of the study

The revised articulatory norms obtained will help us to identify and diagnose native Malayalam speaking children with articulation and phonological errors, and also to understand the acquisition of clusters in more detail. Norms obtained can be

used for planning intervention goals for communication disordered children and to document improvement in speech and language therapy.

Limitations of the study

- Sample size is limited
- Vowels were tested only in the initial position
- Diphthongs (2 in number) in Malayalam were not tested
- All the clusters occurring in Malayalam are not included in the test
- The present study considered only one age range (4-5 years)

CHAPTER II

REVIEW OF LITERATURE

The review of literature will be discussed under the following headings:

- Studies Pertaining to Acquisition of Vowels
- Studies Pertaining to Acquisition of Singleton Consonants
- Studies Pertaining to Acquisition of Consonant Clusters
- Articulation and phonological Tests

Phonology is the study of sound system of language. Phonology encompasses both the formation or articulation of sounds and the knowledge of sound system and patterns. There are two components of phonology- overt speech and covert speech. Overt speech is comprised of speech sounds which are produced, heard, and perceived. On the other hand, covert speech is the formulation of sound sequences based on the knowledge of the phonologic system of our language. Phonologic disorders affect both components and the effect occurs (1) at the articulatory or phonetic level which involves mastery of the motor ability, and (2) at the phonological level which involves the organizational aspects of sound system.

In the study of phonological development, two different strategies are most commonly used. In **longitudinal studies**, extensive data are collected at different points in a particular child's development. This strategy highlights the variability in

any one child's production at one point and over time, and across different children. Another strategy is the **cross-sectional research design**, in which a child is not followed over time; rather, different children at different age levels are tested at a single point of time on their ability to produce speech sounds, and a composite profile is extrapolated from the data.

After the production of first word the phonological development in children is marked by two ways. First, there is a rapid increase in the vocabulary and a relaxation of the selection constraints on adult words that the child attempts to produce. Second, the relationship between the sounds of the adult model and the child's pronunciation becomes more systematic. During the period of the first words, the words seem to be the basic unit of contrast. The child remembers and recognizes the phonetic shapes of whole words and articulates in terms of phonetic word-shapes. When the vocabulary begins to expand rapidly, around age 1.6-1.10 years, the child's production become more stable and systematic correspondence between the adult and child forms emerge. Due to the rapid vocabulary growth the child is forced to adopt a rule-governed approach to his phonological productions, resulting in a system based primarily on phonemes rather than whole words (Ingram, 1976). Once the rule-based system appears, phonological development proceeds rapidly by four years of age (Sander, 1972).

Speech sound development involves a time dependent mastery of the motor responses (Winitz, 1969). The consonants were usually tested in initial, medial and

final positions and were said to be mastered when a certain percentage (75% in most cases) of the subjects at a given age produced them correctly in all positions tested. Although there were some age differences across the studies (primarly due to methodological differences and data collection and analysis) the order of acquisition of sounds and sound classes was remarkably similar ie, stops, nasals, and glides are mastered first then liquids, and finally fricatives and affricates. Over the years, many investigators have tried to determine approximate ages of individual sound mastery in specific groups of children.

Acquisition of speech sounds takes many years to progress from the first cries at birth to being able to produce intelligible speech incorporating adult-like production of vowels, consonants, syllables structure, and prosody. There are four phases of speech acquisition

Phase 1: Laying the foundations for speech (birth to 1 year)

Phase 2: Transitioning from words to speech (1 to 2 years)

Phase 3: The growth of the inventory (2 to 5 years)

Phase 4: Mastery of speech and literacy (5+ years)

Studies Pertaining to Acquisition of Vowels

The acquisition of vowels has received less attention than that for consonants. The reason for this was easily and early acquired, rarely misarticulated, and little of theoretical importance. One reason for this is that vowel is influenced by the accent or dialect spoken by the children. For example, in German American English there are either 18 or 19 vowels and three or four diphthongs where as in English spoken by England, there are 12 vowels and eight diphthongs. There were only 10 vowels and three diphthongs in Scottish English (Smit, 2007).

There are two aspects of acquisition of vowels: Paradigmatic and Syntagmatic acquisition (James, van Doorn, & McLeod, 2001). The paradigmatic aspect to mastering vowel production refers to learning to produce vowel in isolation or in simple monosyllabic words. Children attempt the paradigmatic aspects of vowel production at very young age. During the first year, low, unrounded vowels are favored and height differences appear before front-back vowel differences.

The second aspect in the acquisition of vowels is called as syntagtmatic acquisition. This refers to the ability to produce sequences of vowels within syllables and words in conjunction with other phonological variables such as stress. Children acquire atleast some of the syntagtmatic aspects of vowels between three to five years of age. However, mastery of vowels in polysyllabic word and stressed syllables extends beyond three years of age (Robb & Gilbert, 2000; Stoel-Gammon

& Herrington, 1990). Allen and Hawkins (1980) found that children master vowels in unstressed syllables until they are four to five years old. Wellman etal (1931) reported that by two years of age, all the children produced the vowels /i/ and /ə/ correctly and the vowel /a/, /i/, /o/ and /ʌ/ were produced correctly by 75% of the subjects, whereas atleast half of the 3 year old children had difficulty in producing the vowels such as /I/ and /æ/.

Paschall (1983) studied the vowel development in 18 months old subjects and the results showed that the vowel /a/ had most accurate production (81%), and /æ/, /e/ and /ɛ/ had least accurate productions (50%, 46% and 35% respectively). The majority of errors were substitutions of articulatory adjacent vowels for target vowels. Substitutions of /I/ for /e/ and /ɛ/ were among the most frequent errors. Fudala and Reynolds (1986) studied the acquisition of vowels, which is based on a sample of 5,122 children in the age range of 1.6 - 13.11 years. The subjects were selected from four states in western United States. The authors used 90% criteria for sounds to be considered as acquired. The results indicated that:

- All vowels and diphthongs which include /ə/, /ʌ/, /ɛ/, /æ/, /ɔ/, /ʊ/, /a/, /i/, /u/, /ou/, /ai/, /ei/, and /au/ were produced by 97.7 to 100% by the age of 1.6 to 1.11 years of age.
- By the age of 5.6 years to 5.11 years mid central vowels like /ɚ/ and /ɝ/ and rhotic diphthongs /lr/, /or/, and /ar/ were not mastered by 90% of children. But the rhotic diphthongs /ɛr/ was acquired by 90% of children in the age range of 4.6 to 4.11 years.

Otomo and Stoel-Gammon (1992) conducted a longitudinal study of six children's acquisition of the unrounded American English vowels /i, e, æ, a/ between 22 and 30 months of age and found that /I/ and /ɛ/ were mastered early, then /e/ and /æ/; whereas /I/ and /ɛ/were least accurate. Children mastered the paradigmatic aspects of vowels by the age three (Selby, Robb & Gilbert, 2000; Vihman, 1992) or four years (Dodd et.al, 2003). However, several authors have stated that by the age of three years, all normal children have evolved a stabilized vowel system.

Studies Pertaining to Acquisition of Singleton Consonants

Wellman (1931) published norms in 204 children from two to six years of age. Sounds were assigned to age levels at which 75% of the children mastered them in all the three (initial, medial and final) positions in words. In this study Wellman did not report data on the /ʃ/ and /ð/ sounds. He also reported that all sounds except for the /θ/ and /hw/ were produced correctly by the age of 6 years. Three years later Poole (1934) reported norms on 65 children from 2.6 to 8.6 years and she reported that children were able to produce correctly by 100% in all three word positions. This procedure caused many sounds to be placed at a later developmental level. Five sounds /s/, /r/, /θ/, /z/, and /hw/, were placed 7.6 years level. Poole (1934) and Templin (1957) have given the patterns of acquisition of phonology in pre-school and primary school children. The results of their studies were similar. They concluded that

(1) In early years, diphthongs, vowels, consonant elements, double consonant blends and triple consonant blends are produced, in that order from most to least accurate.

(2) The consonants are produced in the following order, from most to least accurate, nasals, plosives, fricatives, combinations and semivowels.

(3) The voiceless consonant elements are produced more accurately than voiced ones.

(4) By eight years, all children produced all the sounds correctly.

Sander (1972) reviewed the data from the studies of Wellman (1931), Poole (1934) and Templin (1957) and suggested that the findings would be more useful if they were presented in two ways: (a) the age of customary production (defined as the age level at which "the combined tests averaged at various words positions exceeds 50% correct productions), (b) the stage of mastery (defined as the age level at which the combined tests averaged reaches 90% correct production). His reanalysis of Wellman's (1931) and Templin's (1957) data along these lines are presented in Table 2. From the reanalysis it is clear that, the time span between the ages of mastery is greater for fricatives and affricates than for other sound classes, ranging up to 5 years for the phoneme /s/.

Age	Consonants Customarily Produced	Consonants Mastered
Before 2	p, b, m, n, w, h	
2	t, d, k, g, ŋ	
3	f, s, r, l, j	p, m, n, w, h
4	v, z, ʃ, tʃ, dʒ	b, d, k, g, f, j
5	θ, ð	
6	ʒ	t, ŋ, r, l
7		θ, ʃ, tʃ, dʒ
8		v, ð, s, ʒ

Table 2: *Shows the age of customary production and mastery of consonantal phonemes (Sander, 1972)*

Prather, Hedrick, and Kern (1975) included two year old children in their study and tested consonants in the initial and final positions only. They assigned a sound to the age level at which 75% or more of the children produced it correctly in the two positions. The sample constitutes twenty-one children from seven age groups (24, 28, 32, 36, 40, and 48 months). They called their results the Sequenced Inventory of Communication Development (SICD). The elimination of medial position apparently resulted in earlier age levels for nearly all sounds. Arlt and Goodban (1976) tested 240 children in the age range of 3 - 6 years and they used the 75%, three-position criteria for placement. They found that one third of the sounds they tested (all but the /j/) were produced correctly by 75% of the children atleast one syllable earlier than would be expected , and from six months to 4 ½ years follows Templin's norms.

Goodman (1976) had studied the acquisition in English (3-6 years) and then compared to Templin, Wellmann and Poole's studies. It was found that 33% of the

sounds tested were produced one year earlier by 75% of the children. He concluded that the children of this generation are producing sounds correctly at an earlier age than a few years ago. This may be due to school and parents being more aware of speech problems of their children. Prather, Hedrick and Kern (1975) used the Sequenced Inventory of Communication Development - SICD and included 147 children in their study ranging from 24-48 months. Photo articulation test was administered. The consonants were tested only in the initial and final positions and vowels were tested in one context. They assigned mastery of the sound to the level at which 75% or more of the children produced it correctly in two positions. Their results indicated that children were producing more sounds correctly at earlier ages than suggested by the classical articulation research.

Stoel - Gammon (1985) investigated the phonetic inventories of 34 children (19 boys and 15 girls) in the age range of 15 to 24 months. She studied the range and type of consonant phones in the inventory by using spontaneous speech sample. The samples were collected every 3 months at ages 15, 18, 21 and 24 months. The following patterns were identified in the study.

- At 15 months of age, the inventories /b/, /d/, /m/, /n/, /h/ and /w/ were acquired in 50 % of the subjects in the initial position. In the final position, /t/ was present in the inventory of 50 % of the children.
- At 21 months of age the inventories /b/, /t/, /d/, /m/, /n/ and /h/ were acquired in 50 % of the subjects in initial position where as in the final position only /t/ and /n/ were acquired in 50% of the subjects.

- At 24 months of age /b/, /t/, /d/, /k/, /g/, /m/, /n/, /h/, /w/, /f/, and /s/ were in the inventories of 50% of the subjects in the final position and /p/, /t/, /k/, /n/, /r/ and /s/ were in the inventories of 50% of the subjects.

Fudala and Reynolds (1986) conducted a study on the acquisition of single phonemes and the results indicated that the age of fricatives /s/ and /z/ appears to be quite late compared to the earlier studies ie, from 6 to 6.5 years. As this group had older percentage of children who produced correctly got decreased to less than 90% (as low as 62% for the 7 to 7.11 years) then the percentage began to gradually increase again at 8 to 8.11 years, 98.4% of children produced it correctly. Similar results were obtained for final /-z/ and /-s/.

Dyson (1988) conducted a longitudinal study of phonetic inventories in 10 children who had a mean age of 2.0 and 2.9 years. Two speech samples which were taken approximately 5-6 months apart contains words that ranged from 53 to 250 and spontaneous speech/imitation/prompts questions were used to elicit samples. The analysis included were word final and word initial inventories of singleton consonant and consonant clusters. The results indicated the following:

- In word initial phonetic inventories, all stops were present in both age groups. The voiceless palatal fricative appears to be emerging. Affricates were used only by the younger age group. A full repertoire of nasals and glides and the liquid /l/ were seen at all ages.

- In word final inventories, the voiceless stops were always present but voiced stops appeared to be emerging. Word final affricates were common than word initial affricates. Nasals were well established.
- In cluster production, clusters were produced quite frequently. No subjects produced less than four different clusters. The initial cluster that was produced by five children was /fw/. Word final clusters were slightly less common than the word initial clusters.

Smit, Hand, Freilinger, Bernthal and Bird (1990) obtained some normative data on the acquisition of speech sounds in children residing in Iowa and Nebarska. The study included 1049 children in the age range of 3-9 years and they used an assessment instrument that tested all words initial and final singletons with the exception of /ʒ/, and word final /ð/. They also assessed production of intervocalic /r/, and /l/, syllabic /l/ and several word initial clusters and they had considered 90% level of acquisition for the mastery of sounds. The results indicated that

- Girls acquired sounds earlier than boys, although this effect reached statistical significance only by the age 6.0 and younger.
- The phoneme /m/, /n/, /h/, /p/, /f/, /w/ and /b/ were acquired by 3 years of age.
- The phonemes /l/, / ʧ/, /k/, /g/, /d/ and /t/ were acquired by 7 years of age.
- The phonemes /ŋ/ and /s/ were late acquired sounds by 7 to 9 years.

Bauman - Waengler (1994) reported that the sounds which were acquired early are nasals, stops, glides, liquids and fricatives and the sounds that develop later are

fricatives and affricates. Robb and Bleile (1994) studied the speech samples over a 12 month period of seven children, aged 8-14 months at the beginning of the study and 19-26 months at the end of the study. The findings reveled that

- The number of consonants in their inventories increased over time.
- The number of consonants used in the initial position was greater than in the final positions.
- Stops and nasals emerged earlier than fricatives.
- Bilabial, alveolar, glottal place of articulation predominated and were produced earlier than velars.

The age levels for the speech sound development according to researchers in English are presented in Table 3.

Speech sounds	Wellman, 1931 75%*	Poole, 1934 100%*	Templin'57 75%*	Mecham, '62	Sander, 1972 75%*	Prather' 75 75%*	Arlt '76	Irwin et al '83	Smit 1990, 75% *	Fudala & Reynolds, 2000, 90%* IP	FP
/m/	3	3 ½	3	3.5	< 2	2	3	1.5	3	2	2
/n/	3	4 ½	3	3.5	2	2	3	2	3	2	2.5
/h/	3	3 ½	3	3.5	< 2	2	3	2	3	2	-
/p/	4	3 ½	3	3.5	< 2	2	3	3	3	2	3
/f/	3	5 ½	3	4.5	3	2-4	3	3	3	3	3
/w/	3	3 ½	3	3.5	< 2	2-8	3	2	3	2.5	-
/b/	3	3 ½	4	3.5	< 2	2-8	3	1.5	3	2	3
/ŋ/	--	4 ½	3	3.5	2	2-8	3	3	7-9	-	4
/j/	4	4 ½	3 ½	4.5	3	2-4		3	4-5	5	-
/k/	4	4 ½	4	4.5	2	2-4	3	3	3.5	3	3
/g/	4	4 ½	4	4.5	2	2-4	3	3	3.5-4	3	3
/l/	4	6 ½	6	5.5	3	3-4	4	3	5-7	5	5.5
/d/	5	4 ½	4	4.5	2	2-4	3	4	3-3.5	3	3
/t/	5	4 ½	6	5.5	2	2-8	3	3	3.5-4	3	4
/s/	5	7 ½	4 ½	5.5	3	3	4	3	7-9	6	6
/r/	5	7 ½	4	5.5	3	3	5	3	8	6	-
/ʧ/	5	4 ½	4 ½	5.5	4	3-8	4	4	6-7	5	-
/v/	5	6 ½	6	5.5	4	4	3 ½	3.5	5.5	5	5
/z/	5	7 ½	7	7.5	4	4	4	3	7-9	6	6
/ʒ/	6	6 ½	7	7.5	6	4	4	3	-	-	-
/θ/		7 ½	6	5.5	5	4	5	4	6-8	5.5	-
/d/		7	4	4.5	4	4		4	-	-	-
/ʃ/		6 ½	4 ½	5.5	4	3-8	4 ½	3	5	5	1.5

Table 3: *Age levels for speech sound development according to different authors in English. * criteria for speech sound to be considered as acquired, - indicates the sound not acquired, Empty space indicates speech sounds not tested. IP: Initial Position, FP: Final position*

Articulatory Acquisition in Indian Languages

Extensive studies on articulatory acquisition have been carried out in the Indian context also. Some of them are: In **Tamil** – Thirumalai (1972), Usha (1986); **Kannada**- Kumudavalli (1973), Sreedevi (1976), Tasneem Banu (1977), Nataraja et al (1978), Prathima (2009), Deepa (2010); **Bengali** -Arun Banik (1988), **Telugu** - Padmaja (1988), Usha (2010); **Malayalam** -Maya (1990), Divya (2010). They concluded that the acquisition followed same pattern as in English but generally it was found that most of the sounds were acquired earlier in Indian studies compared to the western reports.

In Tamil, Thirumalai (1972) studied the acquisition of phonology in a 4.4 year old boy. The results indicated that among the consonants, the subject had acquired all the stop consonants like /k/, /ʧ/, /t/, and /p/. The subject had substituted alveolars for retroflex nasals and retroflex laterals. Kumudavalli (1973) studied the relationship between articulation and discrimination of Kannada speech sounds in terms of distinctive features on 105 school going children in the age range of four to eight years. A list of 17 minimal pairs was used as test stimuli. In the discrimination test, the children were asked to point out the picture pair among the four pairs illustrating the word pair. A picture articulation test was administered to elicit all the phonemes in Kannada. The results indicated that:

- The sounds which were discriminated correctly were also articulated correctly.
- The sounds that were misarticulated were also not discriminated.
- Many word pairs were articulated correctly were not discriminated.
- In both perception and production the alveolar and retroflex distinction was the last to be acquired.

Sreedevi (1976) studied the acquisition aspects of Kannada on four children (two boys and two girls) in the age range of 2 - 3.5 and 2 - 11.5 years. The utterances of the children were recorded once in five weeks for every child and thus the study offered four stages of recording during the period of investigation.

The tasks that were used to elicit responses were imitation and spontaneous speech. The results indicated that:

- The distinction between voiced and voiceless feature was acquired earlier than the distinction between aspirated and un aspirated.
- The distinction between short and long vowels is acquired more fully than sibilants, trills and laterals.
- Among the nasals, the bilabial and alveolar nasals were acquired earlier than other nasals.
- Among the sibilants, the alveolar and palatal sibilants were acquired earlier than the non identical clusters.

Tasneem Banu (1977) studied the articulatory acquisition in Kannada speaking children in the age range of 3-6.6 years. The subjects were selected randomly from Mysore city. The children were divided in to seven age groups of six month interval in each. The Kannada Articulation Test (Bettagiri, Babu & Rathna; 1972) was administered individually and it was scored on the basis of frequency of occurrence of phoneme. The results indicated that

- There was a significant difference in the articulation score for different age groups except between the groups V (5.1-5.6 years) and VI (5.7-6 years) and also between VI (6-6.6 years) and VII (6.7- 7 years).
- There was a gradual but definite change with increase in age. The fricative /h/ was not acquired even at 6.6 years of age.

- These children acquired most of the sounds earlier than English speaking children.
- There were no significant difference in scores between males and females.

Usha (1986) developed and studied the articulatory acquisition in 180 Tamil speaking children in the age range of three to six years. The children were divided into 6 groups with an interval of six months. The Tamil Articulation Test was administered and scores were obtained based on the frequency of occurrence of correct responses. Articulation development of particular sound was assumed to be complete if 90% of the children produced them correctly. The results indicated that

- There were significant difference between males and females in terms of articulatory skills. Females exhibited a superior articulatory skills compared to the male population in all age groups.
- All the vowels and most of the consonants except /ṣ/, /l/ and /r/ were acquired by three years of age.
- The fricatives /ṣ/ was not acquired even at six years of age.
- All the stops and nasals were acquired by three years
- Among the laterals /l/ was acquired by three years, /ḷ/ was acquired earlier but not consistently produced till 6 years of age, and /ḷ/ was not acquired even at the age of six years.
- The flap /r/ was acquired in the initial position by the age of five years, but not in the medial and final positions until age six.

Nataraja, Anil and Malini (1978) conducted a study on acquisition of articulatory skills in 36 Kannada speaking children in the age range of 3-7 years of age. The children were divided into four groups of one year age interval. The Kannada Diagnostic Articulation was administered to all the subjects. The findings revealed that

- There was a definite pattern of acquisition and all the children acquired the articulatory skills faster than compared to the Western studies. Girls performed better than boys.
- The vowels /a/, /a:/, /i/, /i:/, /u/, /u: /, /e/, /e:/, /o/ and /o:/ were acquired by both girls and boys by 3-4 years.
- By the age of 3-4 years, the consonants /k/, /g/, /t/, /ʧ/, /d/, /p/, /b/, /j/, /b/, /j/, /v/, /s/, and /h/ were acquired by both boys and girls in initial and medial positions. Boys articulated the sound /ʤ/ in initial positions and medial positions while the girls could articulate this only in initial positions. Girls acquired both the diphthongs, which was tested (/ai/ and /au/), whereas boys substituted the sounds /o/ for /au/. The acquisition of clusters just began in both groups by 4 years.
- By four to five years of age, boys acquired all the vowels and diphthongs including /au/. Girls acquired the consonant /ʃ/ in both initial and medial positions when the boys continued with the error.
- By five to six years of age, males acquired /r/ and / ʃ /. Girls were found to articulate triple consonant blends correctly by six years.

- Only 60% of the males of seven years had acquired the articulation of triple consonant blends.

Arun Banik (1988) developed screening test of articulation and discrimination in Bengali speaking children in the age range of 2-8. The 165 subjects were divided into groups with one year interval in each and the results indicated that

- The articulation score was directly proportional to age. There was a definite pattern in the acquisition of articulation. The children acquired most of the sounds earlier than English speaking children.
- There were significant differences between males and females in terms of articulatory skills. Females exhibited superior articulatory skills when compared to males in all the age groups.
- All the vowels were acquired by 2.3 years.
- Most of the consonants were acquired by three years except the fricative /zh/, flap /r/, trill /r/ .
- Most of the misarticulated sounds were omitted or substituted. The errors such as distortion or addition were not observed.
- The age of acquisition of sound and ability to discriminate correlated with each other. The earlier they were able to discriminate the sound, earlier they acquired the correct articulation.

Padmaja (1988) developed the Test of Articulation and discrimination in Telugu and studied the acquisition of sounds in 160 Telugu speaking children in the age range of 2.4-4.5 years. The subjects were divided into different age groups of six months interval and each group consisted of 40 children. The responses were elicited by using picture naming task or repetition. The result indicated that

- The articulation score increased as the age advanced. There was no significant difference between males and females in terms of articulatory skills in all the age groups.
- All the vowels and most of the consonants except /r/, /s/, /ʃ/, /t/, /d/ and aspirated stops were acquired by 2.5 years of age.
- All nasals were acquired by 2.6 years of age.
- Phonemes such as /s/, /r/, /l/, / l̤/, /ṣ / and aspirated consonants were acquired by 3.3 years of age and the phonemes /ṭ/, /ʃ/ and clusters which were acquired by the age 3.5.

Prathima (2009) studied the acquisition of Kannada speaking children to update the norms for the Kannada Articulation Test. Diagnostic Kannada Articulation Test was administered to 120 children in the age range of 3-4 years. The subjects were divided into two age groups (3-3.6 years and 3.6-4 years) with six months age interval. The criteria for acquisition considered were 75% and 90% of the children producing the phonemes of Kannada correctly. The total test items included were 62. The results indicated that

- There is no significant difference between the age groups as well as across gender.
- Among the boys all the vowels and diphthong /ai/ were acquired by the age 3-3.6 years, the diphthong /ou/ was acquired by the age 3.6-4 years and most of the consonants were acquired by 90% of children by the age of four years in both the positions. The phonemes /r/ and /h/ were exceptional. The phoneme /r/ was acquired by 90% of the children in the medial position and not in the initial position and /h/ was not acquired by age four also.
- Among the girls, all the vowels and diphthongs were acquired by 90% of the children by 3-3.6 years of age. Most of the consonants were acquired by 4 years except /r/ and /h/ in both the positions tested. The consonant cluster /ski/ was acquired by 90% and /ksta/ and /ble/ were acquired by 75% of the children by 3-3.5 years.

Deepa (2010) restandardized the Kannada Articulation Test. The test was administered in 240 typically developing children in the age range of 2 to 6 years. The subjects were divided into eight groups with an interval of six months (2 - 2.6, 2.6 - 3, 3 - 3.6, 3.6 - 4, 4 - 4.6, 4.6 - 5, 5 - 5.5, 5.6 - 6 years). The results indicated that

- There are significant differences between both age groups and gender. Girls obtained higher articulatory scores.
- All the vowels and diphthongs were mastered by 90% of the children by the age of two years.

- According to place of articulation, bilabials (/p/, /b/, /m/), labiodentals (/v/), dentals (/**t̪/,** /d̪/ and /n/) were acquired much earlier than the retroflex (/ɳ /, /r/, / ɭ /) retroflex (/ʈ/, /ɖ/), velars (/k/, /g/) and glottal (/h/) sounds.
- All the bilabials, labiodentals, velars were acquired by the age 2.6 to 3 years, palatal by the age 3.6 to 4 years, glottal /h/ was not acquired by the age of 6 years and palatal /ɖ/ was acquired much earlier than /**ʈ/.**
- All the stops were acquired by the age of 3-3.6 years. Dental /s/ was acquired by the age of 4-4.6 years and palatal /ʃ/ was acquired by 90% of children by the age of 3.6-4 years and retroflex / ɳ / was acquired by the age of 4 years by 90% of the girls and by the age of 4 .6 in boys

Divya (2010) studied articulatory acquisition in typically developing Malayalam speaking children in the age range of 2-3 years age. She administered Malayalam Articulation Test in 120 subjects and the results are as follows

- There was a sudden increase in the articulatory development of articulatory skills in the period of 2.6 to 2.9 years following which there was no significant change in the developmental scores till 3 years of age.
- All the vowels and some of the consonants were acquired by the 75% of the children by 2.3 years of age. The consonants not achieved were /g/, /ʤ/, /ŋ/, / /r/, /l/, /ɭ/, / ɳ/, / v/, /pʰ/, /s/, / ʂ/, /r/, /ʃ/, /R/, / ʧʰ/ , /d̪ʰ/, /l̪/, /ʈʰ/, /h/ and /kʰ/.
- There was no significant difference between boys and girls with respect to the correct production of consonant sounds.

- All the vowels /a/, /a:/, /i/, /i:/, /e/, /e:/, /o/ and /o:/ were acquired by 90% of the children by the age of 2.3 years itself.

Usha (2010) studied articulatory acquisition in typically developing Telugu speaking children in the age range of 2-3 years. The results were as follows

- There was no significant difference across gender in each age group.
- All the vowels except long vowel /u:/, and dipthongs /ai/ and /ou/ were acquired by 100% of the boys by 2-2.3 years whereas in girls except dipthongs /ai/ and /au/ rest of the vowels were acquired with 100% accuracy by this age.
- Considering the consonants, all the nasals and plosives except the aspirated stops, voiced (/b/, /g/), and dentals (/t̪/, /d̪/), the rest of the nasals and plosives reached 90% criteria by 2-2.3 years. Lateral /l/ was acquired with 90% accuracy and the fricative continuants /j/, /v/ reached only 75 % accuracy by this age. Aspirated stops /$p^{h/,}$ /b^{h}/, /d^{h}/, /k^{h}/ and /g^{h}/, fricatives /s/, /ʃ/and /h/, affricates /tʃ/, /dʒ/ and the retroflex sounds /ʈ/, /ɖ/, /ɽ/ were not acquired by 75 % of the children by 2-2.3 years.
- All the bilabials, dentals, labiodentals and velars, except the aspirated stops were acquired by 2-2.6 years and glottal /h/ by 2.6 -2.9 years with 90% accuracy. Palatals, retroflex and aspirated sounds met 75% criteria but not 90% by the age of 2.9- 3 years.

Tables 4 (a) and 4 (b) summarize the age levels for speech sound development in Indian languages according to different Indian studies.

Speech Sounds	**Tasneem Banu '77** **75%**	**Usha '86 (Tal)** **75%**	**Padmaja '88 (Tel)** **75%**	**Arun Banik '88 (Ben)** **90%**	**Prathima '09 (Kan)** **90%**	**Usha '10 (Tel)** **75%**	**90%**
/m/	3	3	2.6	2.5	3-3.6	2-2.3	2-2.3
/n/	3	3	2.6	2.5	3-3.6	2-2.3	2-2.3
/ŋ/				2.5			
/p/	3	3	2.6	2.5	3-3.6	2-2.3	2-2.3
/f/			2.9			2.6-2.9	-
/h/			2.6	3	-	2.3-2.6	2.6-2.9
/k/	3	3	2.6	2.7	3-3.6	2-2.3	2-2.3
/b/	3	3	2.6	2.5	3-3.6	2-2.3	2.3-2.6
/d/	3.6	3	2.6	3	3-3.6	2.3-2.6	2.6-2.9
/g/	3	3	2.6	3	3-3.6	2.3-2.6	2.6-2.9
/r/	4.6		3.9	4	-	2.6-2.9	-
/s/	3	3	3.3		3-3.6	2.6-2.9	2.9-3
/ʃ/	5.1	6	3.6	3	3.6-4	2.6-2.9	-
/tʃ/	3.7	3	2.6	3	3-3.6	2.3-2.6	2.6-2.9
/t/		3	2.6	3	3-3.6	2.3-2.6,	2.7-2.9
/v/	-	3	2.6		3-3.6	2-2.3	2.3-2.6
/l/	3	3	2.6	3	3-3.6	2-2.3	2.3-2.6
/j/	3	3	2.5	3	3-3.6	2-2.3	2.3-2.6

Table 4 (a): *Shows age levels for speech sound development in various Indian languages according to different researcher * Criteria for speech sound to be considered as acquired, - indicates the sound not acquired. Empty space indicates speech sounds not tested*

	Maya (1990) (Malayalam)	Divya (2010) (Malayalam)	
	75%	75%	90%
/m/	3-3.6	2.0-2.3	2.0-2.3
/n/	3-3.6	2.0-2.3	2.0-2.3
/ŋ/	3-3.6	2.0-2.3	
/p/	3-3.6	2.0-2.3	2.0-2.3
/f/	3-3.6	-	2.6-2.9
/h/	3-3.6	-	2.3-2.6
/k/	3-3.6	2.0-2.3	2.0-2.3
/b/	3-3.6	2.0-2.3	2.0-2.3
/d/	3-3.6	2.0-2.3	2.3-2.6
/g/	3-3.6	2.3-2.6	2.3-2.6
/r	3.7-4	2.6-2.9	2.6-2.9
/s/	3.6-4	-	2.6-2.9
/ʃ/	5-5.6	-	2.6-2.9
/tʃ/	3-3.6	2.0-2.3	2.3-2.6
/t/	3-3.6	2-.02.3	2.3-2.6
/v/	3-3.6	2.3-2.6	2.0-2.3
/l/	3-3.6	-	2.0-2.3
/j/	3-3.6	2.0-2.3	2.0-2.3

Table 4 (b): *Shows age levels for speech sound development in Malayalam according to different authors,* Criteria for speech sounds to be considered as acquired, - indicates the sound not acquire. Empty space indicates speech sounds not tested*

Studies Pertaining to the Acquisition of Consonant Clusters

A child learning to produce consonant clusters in any language is a challenging task. The acquisition of consonant clusters is a long lasting aspect of speech acquisition in normally developing children. A cluster is a group of same or similar elements occurring closely together. A consonant cluster is a group or sequence of consonants that appear together in a syllable without a vowel between them.

A study in 104 world languages, based on the work of Greenberg (1978) and Locke (1983) calculated that 39% had word-initial clusters only, 13% had final clusters only, and remaining 48% had clusters in both word-initial and word-final positions. In English, one third of monosyllables begin with a consonant cluster, and consonant clusters are predominant in word-final positions (Locke, 1983). This predominance in the word-final position is due to the addition of the phonemes /s, z, t, d/ to indicate grammatical morphemes. Although there are many studies on normal phonological acquisition of speech, the majority of the studies briefly mentioned only the development of consonant clusters and some do not discuss consonant cluster development at all. However, only few studies have specifically focused on normal consonant cluster development.

Children's first word and first utterances are assumed as not to contain consonant clusters. However no research specifically confirms this notation. Consonant clusters are not mentioned in the literature describing the gurgling, cooing, or babbling of children under one year of age (Robb & Bleile, 1994) and also not mentioned in the literature that describes children up to the age when they produce their first 50 words (Robb & Bleile, 1994; Stoel- Gammon, 1984). Studies have also reported that the ability to produce consonant clusters emerge when the children are around two years of age .The phase that Ingram (1991) refers to as the "word spurt". Watson and Scukanec (1997) reported that children as young as two years of age produce some consonant clusters correctly. Yet some other authors reported that children with in the age range of eight to nine years old are still

mastering consonant clusters (Smith, Hand, Freilinger, Bernthal & Bird, 1990). However, the protracted acquisition of consonant clusters, gradual developmental gains can be identified and described in greater detail than the singleton consonants (Smith et.al 1990).

There are several reasons that have been proposed for the emergence of consonant clusters in the second year of life. Firstly, Ingram (1976) suggested that the "word spurt" may be linked to a significant development in the children's phonological analysis of the receptive vocabulary in terms of phonotactics. Consonant clusters represent an important departure in phonotactics from the earlier word shapes of CV, VC, or CVCV. Secondly, the maturation of the children's early motor speech mechanism and continued anatomical development of the oromusculalature.

The consonant cluster inventories present in two to three year old children are frequently reported to contain word initial consonant clusters that are not permitted in the ambient language. Dyson (1983) studied the phonetic inventories of 10 two and three year old children and found that half of the subjects used only word initial consonant clusters [fw] and consonant clusters used less frequently included [bw, kw, tr, sp, st, sn, sl]. Watson and Scukanec (1997) reported that the type of clusters produced changed over time, from labial clusters [pw] and [bw] that were not present in the ambient language, to the permissible clusters [st], [sp], and [pl] by three years of age. Another study stated that the most common word-final clusters

produced by two year old subjects in their study contained nasals and are frequently found in English [-nd], [-nt], [-nt]. However, they had excluded morphophonemic clusters from their data set.

Watson and Scukanec (1997) reported that the production of consonant clusters [-nd], [-ts], [-nt], [-nz] by the age of 2.9 and [-nk] by the age of three years. Dyson (1988) reported that the only word final cluster used by over half of the two to three year old subjects was [-ts] and transitional clusters included were [-nk, -ps, -nt͡ʃ, -nts, -ns]. In languages other than English, the word final clusters are reported to be acquired before word initial clusters. Chervela (1981) reported that the first consonant cluster to be acquired by Telugu children was [-nt]. In literature several studies were reported on the emergence of different consonant clusters with respect to word shapes and number of different consonant clusters.

Word Shape

The word final consonant clusters were reported to appear earlier than word initial consonant clusters in two year old children (Watson & Scukanec 1997). Paul and Jenning (1992) noticed that subjects between 1.6 and 2.10 years of age, CVCC syllable shape occurred more frequently than CCVC. The occurrence of consonant clusters were present in two year old children's repertoires, the most common syllabic shapes produced do not contain consonant clusters and are in the form of CV, CVC, CVCV and CCVC (Watson & Scukanec, 1997).

Non- Adult Production Of Consonant Clusters

Though children as young as two years of age can produce consonant clusters, their attempts result in the non-adult productions either a reduction in the number of elements of the consonant clusters, production of different phonemes with the retention of correct syllable shape, or changes in both syllable shape and constituent phones. There are a number of approaches for the consideration of non adult production of consonant clusters. These include: mismatches, phonological processes, describing the deleted member, acoustic analysis, and homonymy (McLeod et.al (2001).

a) Mismatches: Smit (1993) tabulated the age range and frequency of the errors made on word -initial consonant clusters and results provided a percentage of specific errors for each age and each word-initial consonant clusters. She reported that two to three year old children produce /bl-/ in block correctly at 30% of time, as [b] at 15-50% of time, and as [l] less than 3% of time.

The typical errors which produced by the children were:

(a) Reduction of obstruent in obstruent + approximant clusters.

(b) Reduction of second element in /s/ clusters.

b) Phonological Processes: A number of phonological processes can be applied to consonant cluster production. The most common include

(i) Cluster reduction

(ii) Cluster simplification

(iii) Epenthesis

(iv) Coalescence

(v) Metathesis

(i) Cluster reduction: Cluster reduction is defined as the deletion of one or more consonant from a target cluster so that only a single consonant occurs at syllable margins . Sheriberg and Kwiatkowski (1980) described cluster reduction as "the most common and longest lasting stage" in the development of cluster production. Cluster reduction has frequently been described in the speech of normally developing children (Watson & Suckanec, 1997). As children become older, the occurrence of cluster reduction diminishes

(ii) Cluster simplification: Cluster simplification occurs when two elements of clusters are produced, but one or both elements are produced in non-adult manner. The effect of cluster simplification of singleton phonemes (gliding, stopping, and fronting) is often described as cluster simplification in the context of consonant clusters. The most commonly reported of consonant simplification results in gliding of approximants ie, /w, r, l, j/ .Example of gliding, the word /grin/ is pronounced as [gwin]. Watson & Suckanec (1997) reported that clusters simplification shows a pattern of increase followed by decline in 12 subjects, aged two to three years. The comparison between the percentage of occurrences of cluster reduction and cluster simplification according to them is shown in Table 5. When compared to cluster

reduction, cluster simplification has been reported in children during the latter stages of development.

Age in years	2.0	2.3	2.6	2.9	3.0
% cluster reduction	45.5	47.6	33.6	24.7	16.9
% cluster simplification	16.6	25.5	45.8	33.3	30.8

Table 5 *: Shows comparison between the percentage of occurrences of cluster reduction and cluster simplification (Watson and Suckanec 1997)*

(iii) Epenthesis: It is the insertion of a vowel (frequently schwa) between the consonants within the clusters, and such effects can cause a change in the syllable shape (Sheriberg & Kwiatkowski, 1980). Example for epenthesis, /pleit/ becomes [pəleit]. Epenthesis is usually seen in the speech of 2 to 3 year olds as well as in older children (Dyson & Paden 1983; Higgs, 1968). Ingram et.al (1976) reported that epenthesis occurred frequently in children in Grade 2 and to a lesser extent in Grades 3 and 4. Epenthesis may also occur when foreign words are borrowed that contain consonant clusters not permissible in the native language

(iv) Coalescence: It occurs when the reduced cluster contains a new consonant composed of features from the original consonants. For example, /swim/ becomes /fɪm/ because the [+ fricative] feature of /s/ co-occur with the [+labial] feature of /w/, resulting in a labial fricative, [f]. Coalescence is reported to occur in the speech of 2 to 3 year old children (Dyson & Paden, 1983).

v) Metathesis : It is the reversal of adjacent segments of an element within the word (Shriberg & Kwiatkowski, 1980). Example for metathesis, /ask/ is produced as [aks]. Metathesis occurs in the speech of young children and it is reported that the incidence of metathesis is negligible.

c) Acoustic Analysis of Consonant Cluster Development

Acoustic analysis also plays an important role consonant cluster development. Acoustic analysis conducted by using spectrograph has been used to describe subtle and sometimes auditorily undetectable features of speech production. Catts and Kamhi, (1984) performed a longitudinal study in six children aged 1.9-2.10 years, over a period of five to 17 months, until correct clusters were achieved. The investigators have identified two types of processes, cluster reduction and cluster simplification. They also found that the children consistently produced short-lag stops as substitute for clusters. The literature shows a shorter VOT for stops in /s/ + stop context and shorter duration for /s/ as the first element in two-element clusters and a longer VOT for voiceless stops in stop + /r, l/ clusters when the child's speech is compared with adult speech (Weisner & Gillbert, 1982,)

d) Homonymy

A homonymy occurs when the phonological contrasts are neutralized and the resulting production of a particular word is not audibly different from another word.

For example, if the child attempts to produce *snail*, instead produces [neɪl], this word is a homonymy with *nail.* Homonyms are common in normal language acquisition in children (Stoel-Gammon,1984). Homonymy would occur in normally developing children's speech as a result of cluster reduction. McLeod, van Doorn, and Reed (1998) described the nature and occurrences of homonymy in normally developing 2 - 3 year old children's production of consonant clusters. Templin (1957) and Smit et.al (1990) studied word-initial consonant clusters. Age of acquisition of consonant clusters is in Table 6.

Clusters	**Smit et.al (1990)**		**Templin (1957)**	**Higgs (1968)**
	Female	**Males**		
/tw, kw/	3.6	3.6	4.0	
/sp, st, sk/	4.6	5.0- 6.0	4.0	4.6
/sm,sn/	5.6	5.0-7.0	4.0	
/sw/	4.6	6.0	7.0	
/sl/	6.0	6.0	7.0	
/pl, bl, kl, gl, fl/	4.0 -4.6	4.0-5.6	4.0-5.0	
/pr, br, tr, dr, kr, gr, fr/	4.6- 6.0	5.0-6.0	4.0-4.6	
/θr/	7.0	7.0	7.0	
/skw/	4.6	7.0	6.0	
/spl	6.0	7.0	7.0	
/spr, str, skr/	8.0	8.0	5.0-7.0	

Table 6: A*ge of acquisition of consonant clusters*

Smit et.al (1990) reported that 75% of normally developing children produce a consonant cluster consisting of a stop + /w/ (eg, queen) by age 3.6, clusters containing /l/ (eg, play) excluding /sl-/ by age 4.5 to 5.6, clusters containing /s/ (eg, sweep, stop) and /θr/ (through) by age seven. Several studies have also been

conducted, by considering the age of acquisition of specific consonants. Arlt and Goodban (1976) assessed six consonant clusters, but did not report age of acquisition findings in their study. They reported that /gr/ and /br/ were produced six months later by their subject's than by Templin's (1957). Higgs (1968) studied the age acquisition of consonant clusters such as /sp/, /st/ and /sk/. She concluded that there was a steady increase in the percentage of consonant clusters correct from ages 2.6 to 5 years. At the age of 2.6, the percentage of consonant clusters correct for /sp/, /st/, and /sk/ were 38, 38 and 37 respectively. At the age of five, the percentage of consonant clusters for /sp/, /st/, and /sk/ was 84 %. These results obtained in Higgs (1968) were lower than those obtained by Templin (1957), indicating that Templin's (1957) subjects developed the consonant clusters earlier than the study by Higgs.

Some consonant clusters are easier to master than others. Children typically master stop + liquid elements (eg, /pl/ before they master fricatives + liquid clusters (eg, /sl/) (Wellman et.al., 1931, Smit et.al.1973, Templin, 1975, Ingram, 1976 & Smit et.al.1990). Powell and Elbert (1984) noted that 75% of Templin's (1957) four year old subjects were able to produce all stop + liquids clusters (expect /gr/), but they could not produce any fricative + liquid clusters. Their findings were supported by Powell (1993), who studied four and five year old children to determine the factors that accounted for variances in the production of consonant clusters.

(i) Factor – I is the most prominent factor, the presence of liquid segment in clusters which accounted for around 42.8% of the variances.

(ii) Factor II – word final with alveolar fricative

(iii) Factor III – word final /s/ clusters

(iv) Factor IV – word –initial /j/ clusters

(v) Factor V – three element clusters

(vi) Factor VI – word final /l/ clusters

He also reported that the position in which consonant cluster occurred (ie, word- initial versus word final) was not a factor of difficulty of the clusters for the four to five year old children, but may be a factor for younger children. The three-element clusters were more difficult to produce than two-element clusters.

Developmental Stages of Cluster Acquisition

Greenlee (1974) proposed a three stage route to the development of consonant clusters. In Greenlee's earliest stage of cluster development, the entire cluster is deleted. For example, desk- [dɛ], although this is fairly rare. In second stage of cluster development, this involves reduction to a single consonant. For example, snake [neIk], which is very common and often persists for several months. In Greenlee's third stage of cluster acquisition, the number of elements in the cluster is preserved but with substitution of one or more of the consonants in the cluster for example, frog [fwag]. Finally, children achieve full accuracy in producing clusters.

Greenlee's stages were summarized and expanded by Elbert and McReyonold (1979) to include all two elements clusters.

1. Both segments are omitted (eg. blue produced as [u]).

2. One segment of the cluster is used while the other is omitted (eg. blue is produced as [bu].
3. Both segments are marked in some way (eg. blue is produced as [bwu]).
4. Both segments are used appropriately (eg. blue is produced as [blu])

McLeod et.al (2001) had generated a list of general trends found in 70 years of literature on the normal acquisition of consonant clusters. This list assists in assessment, analysis, and selection of appropriate intervention targets for children with phonological impairments. The following were the observation found in normal acquisition of consonant clusters:

1. Two year old children can produce consonant clusters, but these may not be of the same form as in the ambient language.
2. The word final clusters generally appear in the inventories earlier than word initial consonant clusters. The children's production of word final clusters is the emergence of grammatical morphemes (eg. plurals and past tenses) and the creation of morphological consonant clusters.
3. Two element consonant clusters are generally mastered earlier than three-element clusters.
4. The consonant clusters containing stops (eg. /pl/, /kw/) are acquired generally before cluster which contains fricatives (/st/, /θr/).
5. Young children typically delete one element in a consonant cluster (cluster reduction), and this deletion may be explained by principles of markedness and sonority.

6. Homonymy occurs in young children attempt to produce consonant clusters. Homonymy usually occurs as a result of cluster reduction as well as cluster creation.
7. There are a number of other non-adult realizations of consonant clusters and the most common is the cluster simplification. The other non-adult realizations include epenthesis and coalescence and metathesis is rare.
8. The acquisition of consonant clusters is a gradual process and there is a typical developmental sequence. For word initial clusters, children may initially delete a member of a consonant cluster (one element realization), then preserve the members while producing one in a non-adult manner (two element realization), and finally they will produce the consonant clusters correctly (correct realizations). The other developmental sequences are possible for word final clusters.
9. There is an interrelationship between the cluster reduction, cluster simplification and correct productions of consonant clusters. Initially, most children reduce consonant clusters. Overtime, the occurrences of cluster reduction diminishes, where as the occurrences of cluster simplification increases. Simultaneously, the occurrence of correct productions increases, until production is mastered.
10. Being a typical developmental sequence, the acquisition of consonant clusters is marked by reversals and revisions with considerable individual variation.

Acquisition of Consonant Clusters in Indian languages

There are few studies on the acquisition of consonant clusters in Indian languages. Chervela (1981) studied acquisition of consonant clusters in Telugu children and found that reduction, substitution and assimilation played major roles in cluster acquisition. The co-occurrence restrictions and hierarchical application of the three phonological processes were noted.

Padmaja (1988) developed the test of articulation and discrimination in 2.6 - 4.6 years Telugu speaking children and reported the occurrence of few common clusters. She also reported that all these clusters were acquired by 3.6 years. Maya (1990) studied the acquisition of consonant clusters in 3 - 7 year old children and results indicated that

- The medial clusters /-nt-/, /-nṯ-/, /-nt/, /-nd-/, /-nk-/ were acquired by 3 – 3.6 years , /-ṯy/ by 3.7 – 4 years and /- nḏra/
- The other consonant clusters /- nḏr-/, /pr-/, /-kr-/, /- ṯra-/ were acquired by 4.7 to 5 years.
- /- sṯa-/ was acquired by 5 - 5.6 years whereas /-ska-/ by 6 - 6.6 years.
- /- sṯra-/ and /- kṣ-/ were acquired by 6 - 6.6 and 6.7 - 7 years respectively.

Jayashree (1999) studied phonological process in normal Kannada speaking children in the age range of four-five years old. She found that even by 5 years of age, there were processes that persist in child's phonology. The persisted processes

were cluster reduction, fronting, stopping and the processes which completely disappeared were metathesis, epenthesis, prevocalic voicing and palatalization. Vani Rupela (2006) studied the phonotactic development in 0-5 years Kannada speaking children and found that

- Medial geminated clusters were first to be acquired and were present in the age range of 12- 18 months
- Medial non geminated clusters appeared at 18- 24 months; more frequent at the age of 30- 36 months and became predominant at the age of 30- 36 months.
- Initial clusters were stabilized by 24 – 30 months
- Three sounds clusters in the medial position were found to stabilized from 42 – 48 months onwards

Neethi Priya (2007) studied the phonotactics in 60 Telugu speaking children in the age range of 3-6 years and found that medial clusters occurred predominantly with 60- 70 % of frequency and within medial clusters, geminated clusters occurred more frequently. Prathima (2009) studied articulatory acquisition skills in 3 - 4 year old Kannada speaking and reported that clusters /ske/ and /kra/ were acquired by 90% of children by four years of age. Deepa (2010) tested the clusters /st/, /sku/, /ske/, /dra/, /rtʃı/, /kra/, /kʃa/, /ble/ and /skru/ in its naturally occurring positions. The clusters /st/ and /dra/, was tested in initial and medial positions and /st/ and /dra/ in initial and medial positions. She reported that clusters /st/, /sku/ were acquired by both boys and girls by 4 - 4.6 years and 3.6 - 4 years respectively. The cluster /dra/ in medial position was acquired earlier than in initial position and the cluster /rtʃı/ was acquired by 90% of the children by the age of 6 years. In girls, the clusters /ske/,

/kra/, /kʃa/, /ble/ had 90 % of acquisition by the age 3.6 - 4 years whereas boys acquired the same clusters by the age of 4-4.6 years.

Divya (2010) studied of the acquisition of consonant clusters in 2 - 3 years and reported that

- None of the clusters reached 75% criteria by three years of age.
- Only a single boy in the age range of 2.9 to 3 years produced /ʈra/, /sʈa/, and /ska/ in medial positions.
- At 2.9 years children begin to produce clusters but they have substitution errors. The clusters with substitution errors seen in this study were /ʃʈa/, for /sʈa / and /ʃka/ for /ska/. The palatal fricatives were used for dental fricatives.

Usha (2010) tested four consonant clusters**,** 2 clusters (/kʃa/, /ʃra/) were tested in medial position and two clusters (/bl/, /sk/) in initial position. None of the clusters were acquired with 75% accuracy even by 3 years of age both in boys and girls. All the clusters crossed approximately 50% criteria.

The age of acquisition of consonant clusters in some of the Indian languages is given in Table 7.

Maya (1990) (Malayalam) 75%* (3- 7 years)		**Divya (2010) (Malayalam) 90%* (2- 3 years)**		**Prathima (2009) (Kannada) 75%* (3- 4 years)**		**Deepa (2010) (Kannada) 90%* (3-6 years)**		**Usha (2010) (Telugu) 75%* (2- 3 years)**	
Cluster tested	**Age**	**Cluster tested**	**Age**	**Cluster tested**	**Age**	**Cluster tested**	**Age**	**Cluster tested**	**Age**
pr-	5.0	pr-	>3	st-	3.6	st-	4.6	kʃ	>3
sk-	6.0	sk-	>3	sk-	3.6	sk-	4.0	bl-	>3
-nt-	3.6	-nt-	3	dr-	>4	dr-	5.6	ʃr-	>3
-nʈ	3.6	-nʈ	3	rtʃ-	4.0	rtʃ-	>6	sk-	>3
-ndʒ-	3.6	-ndʒ-	3	kr-	4.0	kr-	4.0		
-nd-	3.6	-nd-	3	-kṣ-	>4	-kṣ-	>6		
-nk-	3.6	-nk-	3	bl-	>4	bl-	5		
-ʈj-	4.0	-ʈj-	3	skr-	>4	skr-	4.6		
-nɖr-	5.0	-nɖr-	>3						
-sk-	6.0	-sk-	>3						
-kṣ-	7.0	-kṣ-	>3						
-kr-	5.0	-kr-	>3						
-ʈra-	5.0	-ʈra-	>3						
-stʈ-	6.0	-stʈ-	>3						
-stʈr-	6.5	-stʈr-	>3						

Table 7: *Age of acquisition of consonant clusters in some of the Indian languages*
** Criteria considered for the cluster to be acquired.*

Articulation/Phonological tests

Misarticulation is the disturbance of speech sound production, which is probably the most common type of speech disorders. An articulation test is an evaluation which yields information about the nature, number and characteristics of articulatory errors that are present in a person's speech. It is a technique that is used to measure the general phonemic capacity of an individual. The speech language pathologist should be in a position to differentiate between a normal and abnormal

population and this can be achieved through the administration of an appropriate articulation tests.

Articulation test is typically designed to:

1. Determine whether a person's speech sound production is sufficiently different from normal development to warrant intervention.
2. Determine treatment directions, including target behaviours and strategies used in the management of the client.
3. Make prognostic statements relative to phonological changes with or without intervention/therapy.
4. Monitor changes in phonological performance across time.

Types of articulation tests

1. **Screening tests:** The purpose of a screening test is to identify individuals who merit futher evaluation or a complete phonological assessment, including analysis and interpretation. Because of time expenditure, clinicians will do a screening test to determine if a comprehensive assessment is needed or not. The purpose of screening is to identify those who have an articulatory/phonologic disorder and not used for making diagnosis. A full assessment is the usually recommended for those individuals who do not pass the screening.

I. Diagnostic Tests

The diagnostic test of articulation provides detailed information about a child's ability to produce a wide range of speech sounds in a variety of possible

phonetic context (Templin and Darley, 1960). In this type of articulation test the phoneme to be tested is tested in many contexts in which it occurs in running speech, in order to analyze the correctness or incorrectness of the phonemes.

II. Deep Tests

In this type of articulation tests, the sounds are tested in various phonetic contexts to determine the context that facilitates correct production. The Deep Test of Articulation, developed by McDonald (1964) is used to gain clinical information by examining a sound in a variety of phonetic contexts. It assesses consonants and their effects on each other, by testing each phoneme in approximately 60 different contexts. In this manner this test will help to identify contexts in which misarticulated phonemes may be correctly articulated. It also has a sentence form and a screening form. The test includes a combination of twenty five consonants and ten vowels on small, coloured pictures.

III. Predictive Screening Tests

It helps the speech language pathologist to predict whether or not the client is having a particular speech defect, will outgrow his problem with age. It also helps in detecting whether speech therapy is required or not. Several articulation tests were developed in English and some of them are listed in Tables 8 (a) and 8 (b).

Sl No	Author	Year	Name of the test	Langu-age	Test Description/ skills assessed	Score provided	Age Range/ No of Subjects
1	Templin & Darley	1967	Templin-Darley Test of Articulation -2nd Ed.	English	Evaluates articulation errors. Includes the IOWA Pressure articulation subtest, as well as diagnostic tests for /r/, /l/, and /s/ clusters.	Age-based standard scores.	3-8 years (500)
2	Anthony, Ingram & Mclsaac	1971	Edinburgh Articulation Test	English	Evaluation of speech sound use in all positions of words and consonant blends	Age-based standard scores.	3-6 years (187)
3	Fisher & Logemann	1971	Fisher-Logemann test of articulatory competence	English	Provides a distinctive feature analysis of the client's phonological system. All the English phonemes are examined according to syllabic function - prevocalic, intervocalic, and postvocalic - with frequent reliability checks.	Analysis recognizes and accounts for regional and ethnic differences.	3-80 years
4	Khan & Lewis	1976	Khan-Lewis Phonological Analysis - 2nd Ed. (KLPA-2)	English	Evaluates phonological processes used in young children's specch.	Provides percentile rankings, and age equivalent scores.	2 - 21 years (1890)
5	Weiss	1980	Weiss comprehensive articulation test	English	Incorporate several methods for quantifying articulatory abilities and reveals the presence of articulation disorders, the type of articulation patterns	Norm-referenced test for persons of all ages. Scores obtained include articulation scores, age-equivalent scores, intelligibility scores, and stimulability scores.	3-8 years (4000)
6	Goldman & Fristoe.	1986	The Goldman - Fristoe Test of Articulation - 2nd Ed. (G-FTA-2)	English	Evaluation of speech sound use in all position of words and consonant blends; stimulability testing	Age-based standard scores with separate gender norms.	2-21 years (2350)
7	Hodson	1986	Assessment of phonological processes — Revised (APP-R).	English	Evaluates phonological processes used by children	Provides number and percentage of occurrence scores.	3-12 years (980)

Table 8 (a): *Articulation and phonological tests developed in English*

8	Bankson and Bernthal	1990	Bankson-Bernthal Test of Phonology (BBTOP)	English	Assesses phoneme use in words, Standardized scores are provided for Word Inventory (words correctly articulated), Consonant Inventory (consonants correctly articulated), and Phonological Processes Inventory (phonological processes used).	Standard scores, and percentile rank scores are available	3–9 years (1000)
9	Kresheck & Tattersall	1993	Structured PAT featuring Dudsberry: Articulation and Phonolgical assessment	English	An assessment of sound use in words. Provides a systematic assessment of children's speech skills.	Standard scores, confidence intervals, percentile ranks, percentile bands and test-age equivalents available	3-9 years (2270)
10	Lippke, Dickey, Selmar & Soder	1997	Photo Articulation Test - 3rd Ed. (PAT)	English	An assessment of articulation errors	Standard scores, percentile rankings, and age equivalents are reported.	3-8.11 years (800)
11	Smit & Hand	1997	Smit-Hand Articulation and Phonology Evaluation (SHAPE)	English	Assesses the production of initial and final consonant singletons and initial two - and three-element consonant clusters	Includes norms and age of acquisition	3 - 9 years (2000)
12	Fudala & Reynolds	2001	Arizona Articulation Proficiency Scale - 3rd Ed. (AAPS-3).	English	Evaluates articulatory proficiency. Provides description of intelligibility and severity of misarticulations	Provides developmental age equivalents; percentile rankings and standard scores (based on means and SD)	1.5 - 18 years. (5500)
13	Second & Donohue	2002	Clinical Assessment of Articulation and Phonology (CAAP)	English	Quick inventory the articulation abilities in young children. A measure of overall articulation competence can be derived. To estimate the occurrence of 10 common phonological process patterns in children's speech.	Age-based Standard scores.	2.6-8.11 years. (1707)
14	Hodson	2003	The Hodson Computerized analysis of Phonological Patterns (HCAPP)	English	This program compares the client's phoneme by phoneme productions to the adult standard productions.	The computer analysis yields the % of each of the 11 major phonological deviations described by Hodson (2004)	Pre-school and high school children

Table 8 (b): *Articulation and phonological tests developed in English*

Several studies are done in the Indian context also on the development of articulation tests. Some of these are listed in Table 9

Sl No	Author	Year	Name of the test	Language	Age Range/ No of Subjects
1	Babu, Ratna and Bettagiri	1972	Kannada Articulation Test (KAT)	Kannada	3-6.6 years (180)
2	Usha	1986	Tamil articulation test (TAT)	Tamil	3-6 years (180)
3	Kacker, Basavaraj, Thapar, Menon, & Vasudeva	1989	Test of articulation in Hindi (HAT)	Hindi	3-6 years (180)
4	Arun Banik	1988	Articulation test in Bengali (screening and discrimination test)	Bengali	2- 8 ears (165)
5	Padmaja	1988	Articulation test in Telugu	Telugu	3 - 6 years (160)
6	Maya	1990	Articulation test battery in Malayalam	Malayalam	3 - 7 years (240)
7	Deepa	2010	Restandardization of Kannada Articulation Test	Kannada	2-6 years (240)
8	Merin John	2010	Computer based Assessment of Phonological Processes in Malayalam (CAPP-M)	Malayalam	3-3.6 years (30)

Table 9: *Articulation and phonological tests developed in Indian languages*

From the review of literature it is evident that there are several tests developed by various authors for the assessment of articulation and phonological disorders. Some of these tests have been developed almost two decades ago. As per some of the recent norms on articulatory acquisition, children master speech sounds much earlier now. Hence it is important to revalidate these tests for the purpose of assessment and intervention of articulation and phonological disorders more appropriately.

CHAPTER III

METHOD

The aim of the present study was to revalidate the norms for Malayalam Diagnostic Articulation Test (Maya, 1990) in native Malayalam speaking children in the age range of 4.0 -5.0 years. The study was conducted in 2 phases. Phase 1 included the modification of Malayalam Diagnostic Articulation Test (Maya 1990). Phase 2 involved obtaining norms for the acquisition of articulatory skills in native Malayalam speaking children in the age range of 4 - 5 years.

Phase 1: Modification of Malayalam Diagnostic Articulation test

The existing Malayalam Diagnostic Articulation Test (Maya, 1990) has 82 stimuli including 10 vowels, 32 singleton consonants and 15 consonant clusters. Recently Divya (2010) in her study on establishment of norms for children in the age range of 2-3 years using the same test, reported that 15 test words were obsolete among the 82 target words. The obsolete words were the following: (/uri/, /gaða/, /gaʤam/, /ɲaːɲɲuːl /, /taːppə/, /t̪uːɳ/, /ðiːpam/, /maððaḷam/, /panka/, /ʃankə/, /pʰalam/, /ʧʰaːja/, /kaṯʰakaḷi/, /vastram/ and /kʰagam/). These 15 words were replaced by new words in the present study. Also in addition to the existing 15 clusters in the test, another fifteen words with common clusters and 3 words with aspirated stops were incorporated in the present test material.

The modification of Malayalam Diagnostic Articulation Test was carried out in two stages:

i) Target words selection

ii) Picture selection for the target words

i) Target words selection

To replace the 15 obsolete words, five new words with the test phoneme in the same position as in the obsolete words were selected for every obsolete word. So a new word list comprising a list of 75 words (15 x 5) were made. For eg. the word /di:pam/ was found to be outdated. Hence 5 new common picturable words (/d̪ipa:vali/, / d̪e:vi/, /d̪o:ʃa/, /d̪ili:p/ & /d̪e:ham/) were selected for the target phoneme /d̪/ in the initial position. These words were presented to three judges who were native Malayalam speaking kindergarten teachers. The judges had to rate the familiarity of words on a three point rating scale; very familiar, familiar and unfamiliar. The words which were rated as very familiar out of the five words by two out of three judges were considered as the new test words. In the above example, the word /d̪o:ʃa/ was rated as very familiar by the judges and hence this word was selected as the target stimuli for the consonant /d̪/ in initial position**.** Three obsolete words (/ʧʰa:ja/, /vastram/ and /kʰagam/) were not replaced because familiar picturable words incorporating the target phonemes in the specified position were uncommon. Judges also rated the existing words as familiar compared to the new words presented.

Similar procedure was followed for including 3 additional aspirated phonemes (/k^h/, /b^h/, /d^h/) as test stimuli in the modified version. In the existing test only four aspirated phonemes are tested. So a total of 7 aspirated phonemes are tested in the present study.

For cluster stimuli selection, a total of 30 clusters incorporating both initial and medial clusters were selected and the judges were instructed to select the most commonly occurring words with clusters from the list, since picturable words incorporating clusters are limited in children's phonemic repertoire. Thirteen words with clusters in the initial and two words with clusters in the medial positions which were rated as commonly used in Malayalam were selected.

Including these 15 newly selected clusters, and the earlier existing 15 clusters, the modified test tests 30 clusters. These 30 clusters comprised of 15 each in the initial and medial positions. So the modified Malayalam Diagnostic Articulation Test tests 10 vowels in the initial position, 35 consonants in different positions and 30 clusters in initial and medial positions. This amounts to total of 100 test stimuli, whereas the earlier version of Malayalam Diagnostic Articulation Test consisted of 82 test stimuli only.

ii) Selection of pictures for the target words

For each of the 100 target stimuli, five different pictures were selected from the internet. The five target pictures of each target word were numbered and were arranged on a single slide using power point mode. Totally there were 97 such slides as three target stimuli were repeated. Three judges (2 preschool teachers and 1 clinical psychologist) who are associated with young children on a regular basis were asked to rate the selected pictures for familiarity, clarity and ambiguity. The picture which was rated as familiar, clear and unambiguous among the 5 pictures for each target word by at least two out of three judges was selected as the test stimuli picture.

Phase 2: Obtaining norms

Subjects: Malayalam speaking typically developing children in the age range of 4 - 5 years were selected randomly from different localities of Thiruvananthapuram city in Kerala as subjects. The subjects were sub divided into four groups with an inter age interval of three months (4 - 4.3, 4.4 - 4.6, 4.7 - 4.9, 4.10 - 5.0 years). Each of the four groups comprised a total of 30 subjects including 15 boys and 15 girls. So a total of 120 subjects were involved in the study. The subjects were selected based on the following criteria.

1. Native speakers of Malayalam reared in an ambient environment of Malayalam and belong to middle socio economic status.

2. The subjects were free from any speech, language, hearing or any other motor difficulties. They were selected based on parents/teachers report.

Test Material: The modified diagnostic test of articulation in Malayalam which included the revised 15 target words, 15 words with consonant clusters and the 3 words with aspirated stops along with the existing stimuli were used as the test material. Thus the present Articulation Test consisted of 100 target words for testing 10 vowels, 35 singleton consonants and 30 consonant clusters. The vowel sounds were tested only in the initial position. Considering the consonants, 17 were tested in the initial and medial positions, two sounds in medial and final positions, three sounds in all the positions, eight in medial and five in initial positions only. The consonant clusters were tested in initial and medial positions (15 each). Each test picture is designed to elicit the target sound as a single phoneme or cluster at each position. Table 10 shows the positions tested for the target phonemes.

Positions / Sounds	**I**	**M**	**I M**	**M F**	**I,M ,F**
Vowels	10	-	-	-	-
Consonants	5	8	17	2	3
Cluster initial	15	-	-	-	-
Cluster medial	-	15	-	-	-

Table 10: *Number of word positions tested for the target phoneme (I–Initial, M–Medial, IM– Initial, Medial; MF – Medial, Final; I,M,F – Initial, Medial, Final)*

Procedure: Each child was tested individually in a noise free environment, seated comfortably next to the examiner. The examiner presented the stimulus one at a time on a laptop (Compaq CQ 40) computer screen. Before administrating the test, children were instructed as follows:

"I will show you some pictures; you have to name it one after the other. If you are not able to name it, you can repeat after me." The responses elicited were audio recorded on to a laptop computer with an external microphone (BeetelBoom, 100) placed approximately 10 cms away from the subject's mouth.

Data Scoring: The data obtained from all the 120 subjects were transcribed using broad and narrow IPA transcription. All the responses of each subject were analyzed sound-by-sound on a response sheet. The scoring was as follows:

Correct responses (CR) for Vowels and Singleton Consonants	: Score of 1.0
Substitution errors (S)	: " 0.50
Distortion errors (D)	: " 0.75
Omission errors (O)	: " 0
Other types of articulatory deviations (Ao)	: " 0

For consonant clusters, scoring was based on Greenlee's (1974) stages of cluster development which are as follows:

Entire cluster deletion	: Score of 0
Coalescence, Cluster simplification, Metathesis and Epenthesis	: ” 0.50
Number of elements in the cluster is preserved but with substitution of one or more of the consonants in the cluster	: ” 0.75
Correct production of the cluster	: ” 1.0

A score of 0.5 was given to errors such as coalescence, cluster simplification, metathesis and epenthesis because they involved the reduction of consonant cluster to a single consonant or simplification into a form were a part of the cluster is preserved, for example; /tʃandran/ as /tʃandaran/. A score of 0.75 was given when the number of elements in the cluster is preserved but with substitution of one or more of the consonants in the cluster, for example /st^{h}alam/ as /skalam/. Finally the total score for each subject was calculated. Recent study by Divya (2010) in Malayalam reported that 90% of the singleton consonants were acquired by children by 3 years of age. Hence a criterion of 100% correct response was considered in the present study for singleton consonants. In the same study it was reported that the clusters emerge by 2.9 years of age. Hence a 90% criteria was considered for the consonant cluster acquisition in the present study. A sample of the scoring sheet used is given in Appendix 1.

Inter-judge Reliability: To examine inter-judge reliability, 10% of the total samples were selected randomly from the four age groups and it was transcribed and

analyzed by two experienced Speech Language Pathologists who were native speakers of Malayalam. The transcribed samples of the two judges were compared and the mean percentage of phoneme agreement was calculated.

Test retest reliability: Reliability of the responses was measured by test- retest method. 5% of the total number of children was retested within a period of 3-7 days from the time of their initial testing. The transcribed samples of the two testing were analyzed and compared and the mean percentage of phoneme agreement was calculated.

Data analysis: Vowels and singleton consonants which were produced correctly by 100% of the subjects in each age group for all the positions tested were identified separately using manual mode. Similarly consonant clusters which are produced correctly by 90% of the subjects in each age group in the initial and medial positions were calculated separately.

The data obtained was tabulated and subjected to suitable statistical analysis using the statistical package SPSS (Ver-17) to obtain the mean, standard deviation and significant difference across each age group separately for boys and girls in the initial, medial and final positions.

CHAPTER IV

RESULTS AND DISCUSSION

The aim of the present study was to revalidate the norms for Malayalam diagnostic articulation test in the age range of 4 - 5 years. Modified Malayalam Diagnostic Articulation Test was administered to 120 typically developing Malayalam speaking children in the age range of 4 - 5 years. Subjects were divided into four groups with an inter age interval of 3 months (4.0 - 4.3 years, 4.4 - 4.6 years, 4.7 - 4.9 years, 4.10 - 5 years). All the responses of each subject were recorded and analyzed and scores were allotted to the responses. The total score for each subject were calculated.

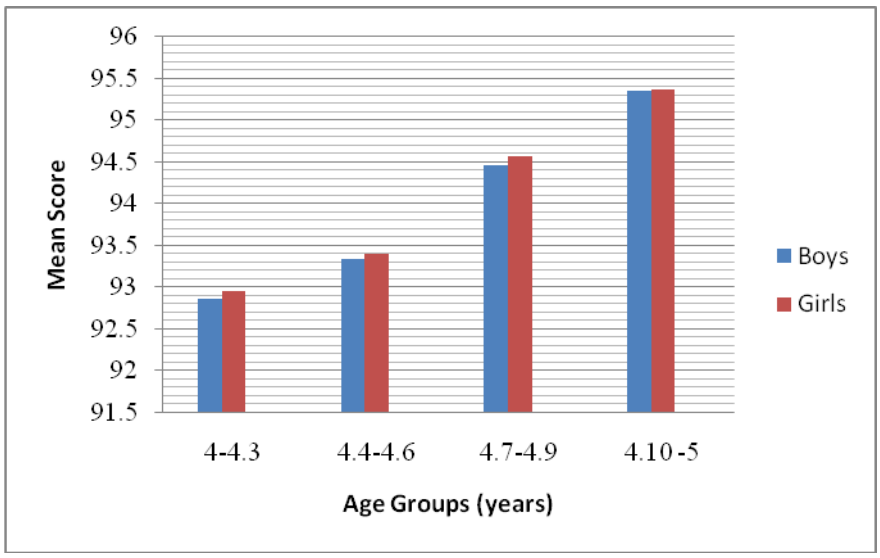
The data was subjected to appropriate statistical analysis using SPSS (17-ver). Descriptive statistics was used to find the mean and standard deviation of the total scores for different age groups in children in the age range of 4 - 5 years (Table 11). The maximum score expected in the Modified Malayalam Diagnostic Articulation Test is 100 which included scores for vowels, singleton consonants and consonant clusters. On observation it is seen that the overall mean articulatory scores linearly increased from the youngest group to the oldest group studied in both boys and girls. However the standard deviation did not show a linear change across age, but the overall variability reduced as age increased. This indicates that children

achieved better articulatory skills with increase in age. The mean Articulation scores expected for typically developing Malayalam speaking children in the age range of 4 -5 years old using the Modified Malayalam Diagnostic Articulation Test is shown Appendix II.

Gender	Age	Mean (Std. Deviation)	N
Boys	**Group I**	92.85 (0.65)	15
	Group II (4.0 - 4.3 years)	93.33 (0.46)	15
	Group III (4.4 – 4.6 years)	94.46 (0.47)	15
	Group III (4.7 -4.9)years	95.35 (0.47)	15
	Group IV (4.7 -4.9)years	95.35 (0.60)	15
	Mean Total Scores	94.00 (1.12)	60
Girls	**Group I (4.0 - 4.3 years)**	92.95 (0.65)	15
	Group II (4.4 – 4.6 years)	93.46 (0.48)	15
	Group III(4.7 -4.9)years	94.66 (0.40)	15
	Group IV (4.10 – 5.0 years)	95.35 (0.60)	15
	Mean Total Scores	94.11 (1.10)	60
Combined Score	**Group I (4.0 - 4.3 years)**	92.90 (0.64)	30
	Group II (4.4 – 4.6 years)	93.40 (0.47)	30
	Group III (4.7 -4.9)years	94.56 (0.44)	30
	Group IV (4.7 -4.9)years	95.36 (0.58)	30

Table 11: *Overall mean and standard deviation of total score in different age groups in boys and girls*

Graph 1 shows the overall comparison of the scores across age and gender. It is interesting to find that in the three younger age groups, girls had higher articulatory scores. However in the oldest group (4.10-5.0 years) considered, both boys and girls performed uniformly.



Graph 1: *Overall mean articulatory scores for different age groups (4 - 5 years) in boys and girls*

Two-way ANOVA was carried out to find the significant difference in overall articulatory scores between the age groups as well as gender. Overall results indicated that there was significant difference [F (3) =124.411 ($p<0.05$)] across age groups. The results also indicated that articulation scores were directly proportional to age ie, the scores increased as the age advanced. When the scores were compared across gender, the results revealed no significant difference between boys and girls.

The results are futher discussed under the following three main headings

1. Vowel acquisition
2. Consonant acquisition
3. Consonant clusters acquisition

1. Vowel Acquisition

In the present study, Modified Malayalam Diagnostic Articulation Test tests 10 vowels (/a/, /a:/, /i/, /i:/, /u/, /u:/, /e/, /e:/, /o/ and /o:/) in initial position. The results indicated that all the vowels had reached 100% criteria by 4 - 4.3 years of age. This is an expected finding because Divya (2010) found that all the vowels /a/, /a:/, /i/, /i:/,/u/, /u:/, /e/, /e:/, /o/ and /o:/ were acquired by 90% of the children in the age of 3 itself (Malayalam). Another presently ongoing study by Neenu (2011) in 3 - 4 years old children also reported that vowels attained 100% criteria by 3- 3.3 years itself. This is in support with several western and earlier and recent Indian studies.

2. Consonant Acquisition

The Modified Malayalam Diagnostic Articulation Test consists of 35 consonants in which 17 are in the initial and medial positions, two in medial and final positions, three sounds are tested in all the positions and eight in medial and five consonants in initial positions only. So based on the position of occurrence of these sounds, the acquisition pattern for each phoneme was noted for both boys and girls separately.

The acquisition of singleton consonants are discussed under the following headings

a) Age and gender
b) Order and Word position vs. Speech sound acquisition
c) Acquisition based on place, voicing and manner features

d) Position of speech sounds

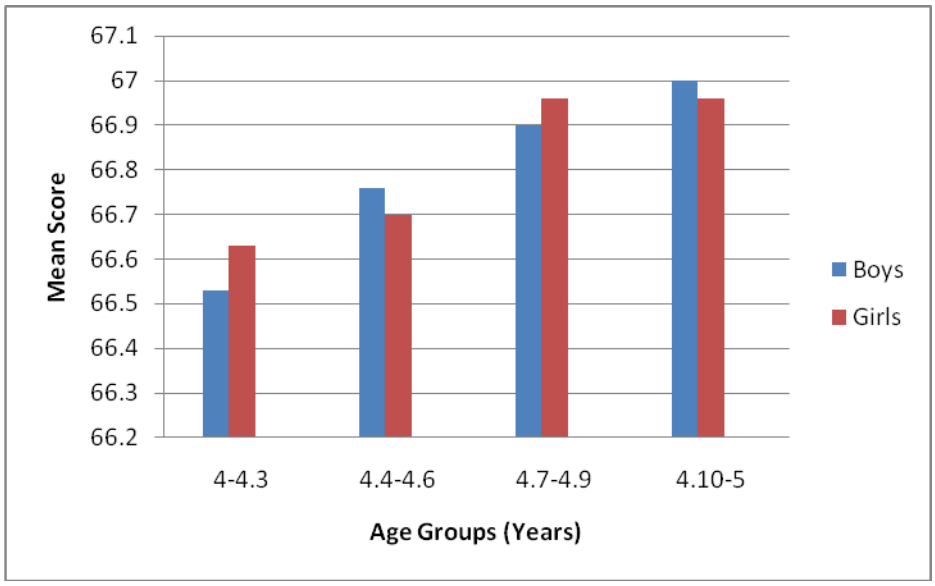
a) Age and Gender

Using descriptive statistics, mean and standard deviation of the articulatory scores for singleton consonants (including vowels) were calculated for all the four age groups. The maximum score expected for singleton consonants including vowels is 70. The mean and standard deviation of singleton consonants are shown in Table 12. On observation, it is seen that as age increases, the mean articulatory scores also increase. The overall variability of the scores reduced from the youngest to the oldest group in both males and females. This is because children achieved increased articulatory precision with increase in age.

Gender	Age	Mean (Std. Deviation)	N
Boys	**Group I (4.0 - 4.3years)**	66.53 (0.35)	15
	Group II (4.4 - 4.6 years)	66.76 (0.25)	15
	Group III (4.7 - 4.9 years)	66.90 (0.20)	15
	Group IV (4.10 - 5 .0 years)	67.00 (0.00)	15
	Mean Total Scores	66.80 (0.29)	60
Girls	**Group I (4.0 - 4.3years)**	66.63 (0.22)	15
	Group II (4.4 - 4.6years)	66.70 (0.25)	15
	Group III (4.7 -4.9 years)	66.96 (0.12)	15
	Group IV(4.10 - 5 .0 years)	66.96 (0.12)	15
	Mean Total Scores	66.81 (0. 24)	60
Combined Scores	**Group I (4.0 - 4.3years)**	66.58 (0.29)	30
	Group II (4.4 -4.6 years)	66.73 (0.25)	30
	Group III(4.7 -4.9 years)	66.93 (0.17)	30
	Group IV(4.10 – 5 .0 years)	66.98 (0.09)	30

Table 12*: Mean and SD of articulation scores for singleton consonants (including vowels) in different age groups*

Graph 2 shows the mean articulatory scores for singleton consonants (including vowels) in different age groups for boys and girls. From the graph it is inferred that in Group I and III girls performed better whereas in the other two groups boys were superior.



Graph 2: *Mean articulatory scores for singleton consonants (including vowels) in different age groups (4 - 5 years) for boys and girls*

Two-way ANOVA was carried out to find the significant differences in articulatory scores for vowels and consonants between different age groups (Group I: 4 - 4.3 years, Group II: 4.4 - 4.6, Group III: 4.7 - 4.9 and Group IV: 4.9 - 5 years) at [$F(3) = 124.411$, ($p < 0.05$)] .The obtained results are as follows

Group I (4.0- 4.3 years): When Group I was compared with the other three age groups, there was significant difference in mean articulatory scores.

Group II (4.4-4.6 years): On comparing Group II with Group III and Group IV a significant difference in mean articulatory scores was noted.

Group III (4.7-4.9 years) & Group IV (4.10-5 years): When Group III was compared with Group IV there was no significant difference between Group III and Group IV.

The finding revealed that from Group III (4.7 - 4.9 years) to Group IV (4.10 - 5 years) articulatory scores did not change significantly in both boys and girls. On comparison of the mean articulatory scores across gender in each age group no significant difference in scores was noted.

b) Order and Word position vs. Speech sound acquisition

Group I (4 – 4.3 years): 100 % of the children studied mastered most of the consonants by 4 - 4.3 years of age. The exceptions were the aspirated phonemes (/ɸʰ/, /t̪ʰ/, /ʈʰ/, /kʰ/, /dʰ/, /bʰ/, /gʰ/) and also palatal nasal /ɲ/, dental plosives /d̪/ and glottal /h/ in the medial position. Among the unaspirated phonemes, both /d̪/ and /ɲ/ achieved by 66% and 73% in both boys and girls, whereas glottal /h/ was acquired only by 10% of the children. Most of the children substituted /g/ or /b/ for /h/ (eg: /simgam/ or /simbam/ for /simham/), /n/ for /-ɲ-/ (/u:nnal/ for /u:ɲɲa:l/) and /d̪/ was either substituted as /l/ or omitted (eg: / ʤalalo:ʃam/ or /ʤalo:ʃam/ for / ʤalad̪o:ʃam/. With respect to the aspirated sounds, most of the children produced these sounds as unaspirated ones (eg: /ʃa:ja/ for /ɸʰa:ja/). Among the aspirated phonemes, /ɸʰ/ attained higher scores and /ʈʰ/, /bʰ/ and /gʰ/ had the least scores. Hence out of 35 singleton consonants, 25 consonants met the 100% criteria in both boys and girls in Group I. Table 13 shows the percentage of articulatory acquisition of single phonemes in boys and girls.

Group II (4.4 - 4.6 years): Compared to Group 1, the unaspirated phonemes /d̪/ and /ɲ/ increased their mean scores to 73% and 80%. Glottal /h/ was the least achieved

sound produced by 33% and 26% in boys and girls. Compared to the previous age group the aspirated phonemes clearly showed an improvement in scores. Among these aspirated phonemes /ʧʰ/, /ʈʰ/ and /k^h/ attained a maximum score of 66%. So out of 35 singleton consonants tested, 25 consonants met the100% criteria. Though this group also mastered only 25 consonants as in Group I, there was definite increase in acquisition scores for those phonemes which did not meet the 100% criteria. Table 14 shows the percentage of acquisition of single phonemes (vowels and singleton consonants).

Group III (4.7-4.9 years): Among the unaspirated phonemes, /ɖ/ and /ɲ/ reached the correct production of above 60 – 80%. Whereas /h/ remained as the difficult phoneme still, however, there was an improvement in mean scores (40%) in this age group. The voiced aspirated phoneme /d^h/ reached correct production of 60% here. The pattern of aspirated phonemes (/ʧʰ/**,** /ʈʰ/ and /ʈ̪ʰ/) continued to be the same however; there was an improvement in their mean scores. The aspirated phonemes /k^h/ and /g^h / attained a correct production score of 75%. Hence, out of 35 singleton consonants, 25 consonants are mastered. Table 15 shows the percentage of acquisition of single phonemes as per 100% criteria for both boys and girls.

Group IV (4.9-5 years): The unaspirated phonemes /ɖ/ and /ɲ/ reached correct production of 70 – 86%, whereas /h/ remained at a score of 40% only. The aspirated phonemes /ʧʰ/, /ʈʰ/, /ʈ̪ʰ/ and /g^h/ attained a correct production of 60%. Whereas /k^h/ achieved correct production of 80% by girls and a score of 73% in boys. The voiced aspirated phonemes /b^h/ and /d^h/ reached a mean articulatory score of 60- 66 % in both boys and girls. The pattern of these aspirated phonemes remained the same as

compared to the previous group. However, these showed an improvement in scores, even though none of the aspirated sounds reached 100% criteria. Even in this age group only 25 consonants met 100% criteria. Table 16 shows the percentage of acquisition of single phoneme in boys and girls in 4.10 -5 years.

From the order of acquisition, it was observed that three unaspirated sounds (/d̪/, /ɲ/ and /h/) and none of the aspirated were produced correctly by100% criteria. But there was definite increase in scores with increase in age for these phonemes. The present findings revealed that unaspirated sounds were achieved earlier compared to aspirated sounds.

Speech sounds	Initial position Obtained %		Medial position Obtained %		Final position Obtained %	
	Boys	**Girls**	**Boys**	**Girls**	**Boys**	**Girls**
k	100	100	100	100		
g	100	100				
ŋ	100	100	100	100		
ʧ	100	100	100	100		
ʤ	100	100	100	100		
ɲ	100	100	66.66	73.33		
t	100	100				
ḍ	100	100	100	100		
ṇ	100	100	100	100	100	100
ṭ	100	100	100	100		
ḍ̲	100	100	86.66	86.66		
n	100	100	66.66	73.33		
p	100	100	100	100		
b	100	100	100	100		
m	100	100	100	100	100	100
j	100	100	100	100		
l	100	100	100	100	100	100
ḷ			100	100	100	100
v	100	100	100	100		
h			10	10		
-t̲	100	100				
s	100	100	100	100		
pʰ	100	100	100	100		
r	100	100	100	100		
ʃ	100	100	100	100		
l̲			100	100		
R	100	100	100	100	100	100
ṣ	100	100	100	100		
ʧʰ	53.33	60				
ṭʰ			40	46		
ṭʰ			46	53.33		
kʰ	53	60	46	53.33		
dʰ			53.33	53.33		
bʰ	40	46				
gʰ			40	46		

Table 13: *Percentage of articulatory acquisition in boys and girls (4 - 4.3 years) Empty space indicates sound not tested*

Speech sounds	Initial position		Medial position		Final position	
	Obtained %		Obtained %		Obtained %	
	Boys	Girls	Boys	Girls	Boys	Girls
k	100	100	100	100		
g	100	100				
ŋ	100	100	100	100		
ʧ	100	100	100	100		
ʤ	100	100	100	100		
ɲ	100	100	66.66	73.33		
t	100	100				
ḍ	100	100	100	100		
ṇ	100	100	100	100	100	100
ṭ	100	100	100	100		
ḍ	100	100	80	73.33		
n	100	100				
p	100	100	100	100		
b	100	100	100	100		
m	100	100	100	100	100	100
j	100	100	100	100		
l	100	100	100	100	100	100
ḷ			100	100	100	100
v	100	100	100	100		
h			26.66	20		
-t	100	100				
s	100	100	100	100		
pʰ	100	100	100	100		
r	100	100	100	100		
ʃ	100	100	100	100		
l			100	100		
R	100	100	100	100	100	100
ṣ	100	100	100	100		
ʧʰ	60	60				
ṭʰ			53	46.66		
ṭʰ			66.66	60		
kʰ	66.66	60	66.66	73.33		
dʰ			66.66	60		
bʰ	53.33	46.66				
gʰ			53.33	46.66		

Table 14: *Percentage of articulatory acquisition in boys and girls (4 .3- 4.6 years) Empty space indicates sound not tested*

Speech sounds	Initial position		Medial position		Final position	
	Obtained %		Obtained %		Obtained %	
	Boys	Girls	Boys	Girls	Boys	Girls
k	100	100	100	100		
g	100	100				
ŋ	100	100	100	100		
ʧ	100	100	100	100		
ʤ	100	100	100	100		
ɲ	100	100	73.33	73.33		
t	100	100				
ḍ	100	100	100	100		
ṇ	100	100	100	100	100	100
ṯ	100	100	100	100		
ḏ	100	100	86.66	86.66		
n	100	100				
p	100	100	100	100		
b	100	100	100	100		
m	100	100	100	100	100	100
j	100	100	100	100		
l	100	100	100	100	100	100
ḷ			100	100	100	100
v	100	100	100	100		
h			33.33	33.33		
-t̲	100	100				
s	100	100	100	100		
pʰ	100	100	100	100		
r	100	100	100	100		
ʃ	100	100	100	100		
l̲			100	100		
R	100	100	100	100	100	100
ṣ	100	100	100	100		
ʧʰ	60	60				
ṯʰ			60	60		
ṭʰ			60	60		
kʰ	66.66	73.33	66.66	60		
dʰ			66.6	60		
bʰ	53	60				
gʰ			53.33	60		

Table 15: *Percentage of articulatory acquisition in boys and girls (4.7 - 4.9 years)*
Empty space indicates sound not tested

Speech sounds	Initial position		Medial position		Final position	
	Obtained %		Obtained %		Obtained %	
	Boys	Girls	Boys	Girls	Boys	Girls
k	100	100	100	100		
g	100	100				
ŋ	100	100	100	100		
ʧ	100	100	100	100		
ʤ	100	100	100	100		
ɲ	100	100	93.33	80		
t	100	100				
ḍ	100	100	100	100		
ṇ	100	100	100	100	100	100
ṯ	100	100	100	100		
ḏ	100	100	80	80		
n	100	100				
p	100	100	100	100		
b	100	100	100	100		
m	100	100	100	100	100	100
j	100	100	100	100		
l	100	100	100	100	100	100
ḷ			100	100	100	100
v	100	100	100	100		
h			40	40		
-t	100	100				
s	100	100	100	100		
pʰ	100	100	100	100		
r	100	100	100	100		
ʃ	100	100	100	100		
l			100	100		
R	100	100	100	100	100	100
ṣ	100	100	100	100		
ʧʰ	60	60				
ṯʰ			60	66.6		
ṭʰ			60	60		
kʰ	80	73.33	80	73.33		
dʰ			66.6	60		
bʰ	66.6	60				
gʰ			60	60		

Table 16: *Percentage of articulatory acquisition in boys and girls (4.10 - 5 years)*
Empty space indicates sound not tested

When the results of the present study was compared with Western (Templin'57; Poole'34; Fudala and Reynolds'86) and the earlier and recent Indian

studies (Tasneem Banu'77, Prathima, '09 and Deepa, '10 in Kannada, Padmaja'88 and Usha, '10, Usha '86; Maya'90 and Divya,'10), it was observed that the order of acquisition of the consonants were the same.

According to Fudala and Reynolds (2000), the age of acquisition of /s/, /z/, /ŋ/, /j/, /l/, /s/, /r/, /tʃ/, /v/, /θ/ and /ʃ/ appears to be quite late. These sounds were acquired by 90% of the children by age six and a few sounds such as /h/, /r/, /tʃ/, /θ/, /d/ in final position were not acquired by this age. In the present study, it was observed that all the consonant phonemes were acquired by 100% of the children in the first group (4 - 4.3 years) itself except nasal palatal (/ɲ/), glottal (/h/) and dental (d̪) and the aspirated sounds were the late acquired phonemes.

On comparison of the present study with other Indian studies there are some similarities as well as differences observed on the age of acquisition. Deepa (2010) reported in Kannada that /h/ was not acquired by 90% of the children by the age of 6. But Maya (1990) reported that /h/ was acquired by 75% of the children by 3 - 3.6 years while in the present study 40 - 53% acquired /h/ by the age of 4.10 - 5 years. Currently in an ongoing study by Neenu (2011) also found that glottal /h/ was produced by only 10% of children in 3 -4 years of age. This finding is also similar to the reports of Tasneem Banu (1977) and Prathima (2009) in Kannada.

In the present study, the children mastered majority of the phonemes in all the positions tested. The exception for this was nasal palatal (/ɲ/), glottal

(/h/) and dental (/d̪/) in the medial positions and the aspirated phonemes. Among the seven aspirated phonemes tested, /k^h/ was the only one which was tested in both initial and medial positions. It was observed that /k^h/ was produced correctly by 70 - 80 % of the children in the initial position and 60 - 70 % in the medial position by 4.10 – 5 years of age. This finding is in contradiction to the results of Divya (2010) where she reported that /k^h/, was first acquired in the medial position of words. The present results also showed that /ɲ/ and /d̪/ were first acquired in initial position by 100% in both boys and girls where as in medial positions it was achieved 80% and 90% respectively by 4.10 - 5 years.

Generally it was noted that when comparing the age of acquisition of different consonants in Indian languages with the Western studies the acquisition was relatively earlier in Indian studies. However this observation needs to be interpreted with much caution as most of the reported studies in the western context that are available are carried out from early thirties to the late nineties or so.

c) Acquisition based on place, voicing and manner features

(i) Acquisition based on place of articulation: Based on the place of articulation, unaspirated phonemes of Malayalam can be classified as bilabials (/p/, /b/ and /m/), labiodentals (/v/), dentals (/t̪/, /d̪/ and /n/), alveolars (/ṭ/,/s/, /l/, /r/ and /R/), retroflex (/ḍ/,/ṇ/,/ḷ/ and /ṣ/), palatals (/ʧ/, /ʤ/ ,/j/,/ʃ/, /l̪/, and /ɲ/), velars (/k/, /g/

and /ŋ/) and glottal (/h/) sounds. The stimuli words of the test phonemes are presented in Appendix 1.

In the present study, bilabials, dentals, labiodentals, alveolars, retroflex, palatals and velars except the palatal (glottal (/h/), and dental (/d̪/ /) and aspirated sounds were acquired by 4 - 4.3 years at 100% criteria. Among the palatal sounds (/ʧ/, /ʤ/,/j/,/ʃ/, /l̠/, and /ɲ/), all the phonemes except /ɲ/ acquired 100% criteria. /ɲ/ attained 80% of correct production by 4.10 – 5 years. Among velars (/k/, /g/ and /ŋ /,) /ɲ/ was the sound that acquired late in medial position. Glottal /h/ acquired only by 40 - 53% in 4.10 – 5 years. This finding agreed with Deepa (2010) in Kannada and Divya (2010) in Malayalam who reported that /h/ was a late achieved sound. But this finding contradicts with that of Maya (1990). It is possible that in the present study, samples from southern part of Kerala (Thiruvananthapuram) were considered where the colloquial usage of /h/ is relatively less because of Tamil influence.

(ii) Voicing feature: In the present study, both voiceless and the voiced phonemes acquired 100% criteria by 4 - 4.3 years. The exception were the voiceless phoneme /h/ and voiced phoneme /ɲ/ and /d̪/ . Here it was not possible to infer the difference in the acquisition of voiceless and voiced phonemes as the age group considered is higher and both are mastered by this age. However the early acquisition of voiceless phonemes is reported by several Indian and Western researcher. Divya (2010) reported that voiceless sounds were first achieved

compared to its voiced cognates. Dyson (1988) stated that in word final inventories voiceless stops were always present but voiced stops appeared to be emerging. Prather (1975) reported early acquisition of voiceless stop /p/ (2 years) compared to voiced stop /b/ (2-8 years). Smith et.al (1990) also supports the earlier acquisition of voiceless /k/ compared to voiced /g/. Presently two ongoing studies by Neenu (2011) and Vrinda (2011) in Malayalam by the age range of 3 - 4 and 5 - 6 years also reported that voiceless sounds were ahead compared to voiced phonemes. Tables 13 -16 show percentage of articulatory acquisition in boys and girls during 4-5 years.

(ii) Manner of articulation: When considering the manner of acquisition it was observed that nasals, unaspirated stops, semivowels (/j/ & /v/) were acquired first compared to laterals, fricatives, affricates, flaps and trills. In plosives, the results indicated that, all the unaspirated plosives were acquired by 100% of the children in the age of 4- 4.3 years except aspirated plosives /kʰ/, /ʈʰ/, /bʰ/, /dʰ /, /ɖʰ / and /gʰ/. Among the aspirated plosives /kʰ/ was achieved first (73 - 80%), followed by /bʰ/, /dʰ/, /ʈʰ/, /ɖʰ/ and /gʰ/ (60 - 66%). Considering the three affricates, / ʤ/, /ʧ/ and /ʧʰ/, the aspirated /ʧʰ/, was not achieved by 100% of the children by 4.10 – 5 years whereas other two unaspirated affricates attained 100% by 4 - 4.3 years itself. Chart 1 shows the manner wise acquisition of phonemes in Malayalam in 4 – 5 years

Sounds	Age groups			
	4 – 4.3 years	4.4 – 4.6 years	4.7 – 3.9 years	4.10 – 5 years
Plosives				
/k/	→			
/g/	→			
/ʈ/	→			
/ɖ/	- - -	- - -	- - -	- - - →
/p/	→			
/b/	→			
/t/	→			
/θʰ/	- - -	- - -	- - -	- - - →
/kʰ/	- - -	- - -	- - -	- - - →
/ʈʰ/	- - -	- - -	- - -	- - - →
/f/	→			
/ɖ/	→			
/ɖʰ/	- - -	- - -	- - -	- - - →
/bʰ/	- - -	- - -	- - -	- - - →
/g/	- - -	- - -	- - -	- - - →
	→			
Fricatives				
/s/	→			
/ʃ/	→			
/ʂ/	→			
/h/	- - -	- - -	- - -	- - - →
Affricates				
/ʧ/	→			
/ʧʰ/	- - -	- - -	- - -	- - - →
/ʤ/	→			
/ɳ/	- - -	- - -	- - -	- - - →
Nasals				
/m/	→			
/n/	→			
/ŋ/	→			
/ɳ/	→			
Glides				
/j/	→			
/v/	→			
Trills				
/l/	→			
/ɭ/	→			
/ɻ/	→			
Flaps				
/ɾ/	→			
Trill				
/R/	→			
Semivowels				
/ʋ/	→			
/ɻ/	→			

Chart 1: *Shows the age of phoneme acquisition by 100% of the children in 4 – 5 years*

→ *Indicates sounds acquired by 100% of the children.*

- - - → *Indicates sounds not acquired by 100% of the children*

3) Acquisition of Consonant clusters

In the modified Malayalam Diagnostic Articulation Test, a total of 30 consonant clusters are tested, in which 15 were tested in the initial position and 15 in the medial position. The word initial clusters included /pr-/, /sk-/, /gl-/, /kl-/, /pl-/, /tR-/, /sl-/, /sp-/, /kr-/, /br-/, /bl-/, /gr-/, /st^{h-}/, /ʃv-/, /kj-/ and the word medial clusters included /-nt-/, /-nʈ-/, /-ndʒ-/, /-nd-/, /-nk-/, /-ʈj-/, /-nɖr-/, /-sk-/, /-kṣ-/, /-lj-/ /-kr-/, /-ʈr-/, /-sʈ-/, /-dj/ and /-sʈr-/. Maximum expected score for cluster production is 15 each in initial and medial positions, which gives a total score of 30. The present study considered 90% criteria for consonant clusters because Divya (2010) reported that the consonant clusters emerged by the age 2.9 years in Malayalam. Hence in the present study, as it considered an older age group of 4 - 5 years, a higher mastery criterion was considered for consonant clusters.

Descriptive statistics was used to find the mean and standard deviation of the articulatory scores for clusters in all the age groups (Group I, Group II, Group III and Group IV). The overall mean and standard deviation of cluster scores for all the four age groups is given in Table 17. The mean scores obtained by boys and girls in Group I were 26.31 and for Group IV they were 28.31 and 28.35 respectively. The overall mean articulatory scores for clusters linearly increased from the youngest group to the oldest group in both boys and girls as shown in Graph 3. The results also showed that there was a significant difference across age groups. However the variability did not show a linear change across age. There was no significant

difference between genders but it was noticed that, girls have marginally higher articulatory scores compared to boys in Group II and IV.

Group I (4.0- 4.3 years): When Group I was compared with other three groups, there was a significant difference with all the other groups.

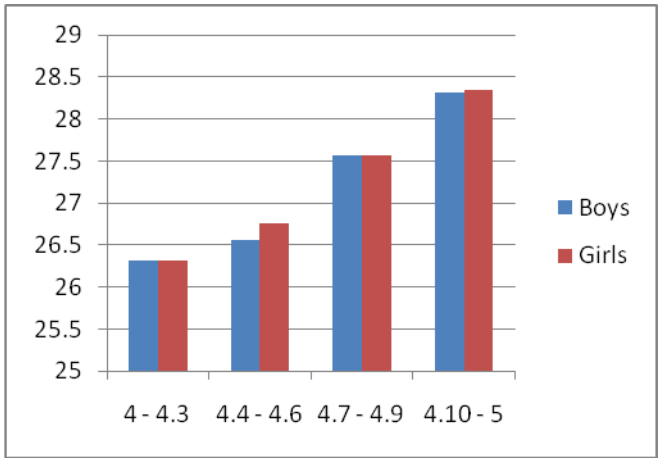
Group II (4.4-4.6 years): When Group II was compared with the other three groups, there was a significant difference with all of them.

Group III (4.7-4.9 years): When Group III was compared with the other three groups there was a significant difference with all the three groups.

Group IV (4.10-5 years): When Group IV was compared with the other three groups there was a significant difference with other three groups.

Gender	Age	Mean (Std. Deviation)	N
Boys	**Group I (4.0 -4.3 years)**	26.31 (0.57)	15
	Group II (4.4 -4.6 years)	26.56 (0.43)	15
	Group III (4.7- 4.9 years)	27.56 (0.47)	15
	Group IV (4.10 – 5 years)	28. 31 (0.52)	15
	Mean Total Score	27.20 (0.97)	60
Girls	**Group I (4.0 -4.3 years)**	26.31 (0.55)	15
	Group II (4.4 -4.6 years)	26.42 (0.43)	15
	Group III (4.7- 4.9 years)	27.56 (0.52)	15
	Group IV (4.10 – 5 years)	28.35 (0.54)	15
	Mean Total Score	27.30 (0.94)	60
Combined Scores	**Group I (4.0 -4.3 years)**	26.31 (0.55)	30
	Group II (4.4 – 4.6 years)	26.66 (0.44)	30
	Group III (4.7- 4.9 years)	27.63 (0.42)	30
	Group IV (4.10 -5 years)	28.33 (0.56)	30

Table 17: *Overall mean and standard deviation of consonant clusters in different age groups (4- 5 years) for boys and girls*

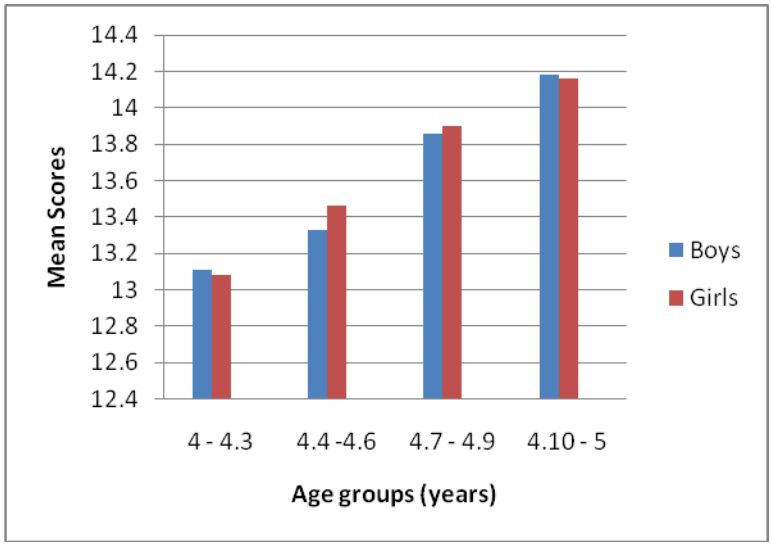


Graph 3: Overall m*ean articulatory scores of consonant clusters for different age) groups (4 – 5years in boys and girls*

Two-way MANOVA was carried out to find the significant differences in overall cluster scores across different age groups (Group I: 4-4.3 years, Group II: 4.4-4.6, Group III: 4.7-4.9 and Group IV: 4.9-5 years) for both initial and medial clusters. The results indicated that there was a significant difference across age groups for initial clusters [F (3) = 70.439 ($p<0.05$)] as well as for medial clusters [F (3) = 63.040 ($p<0.05$)]. The results also indicated that articulation scores were directly proportional to age i.e. the scores increased as the age advanced but no significant gender difference was observed. Table 18 shows the mean articulation scores and SD of initial clusters in different age groups for males and females. Table 19 shows the mean articulation scores and SD of medial clusters in different age groups for males and females. Graphs 4 and 5 indicate the visual comparison of mean scores for initial and medial clusters.

Gender	Age	Mean (Std. Deviation)	N
Boys	**Group I (4.0 – 4.3 years)**	13.11 (0.33)	15
	Group II (4.4 – 4.6 years)	13.33 (0.30)	15
	Group III (4.7 – 4.9 years)	13.86 (0.28)	15
	Group IV (4.10 – 5 years)	14.18 (0.41)	15
	Total mean score	13.62 (0.53)	60
Girls	**Group I (4.0 – 4.3 years)**	13.08 (0.34)	15
	Group II (4.4 – 4.6 years)	13.46 (0.28)	15
	Group III (4.7 – 4.9 years)	13.90 (0.31)	15
	Group IV (4.10 – 5.0 years)	14.16 (0.30)	15
	Total mean score	13.67 (0. 53)	60

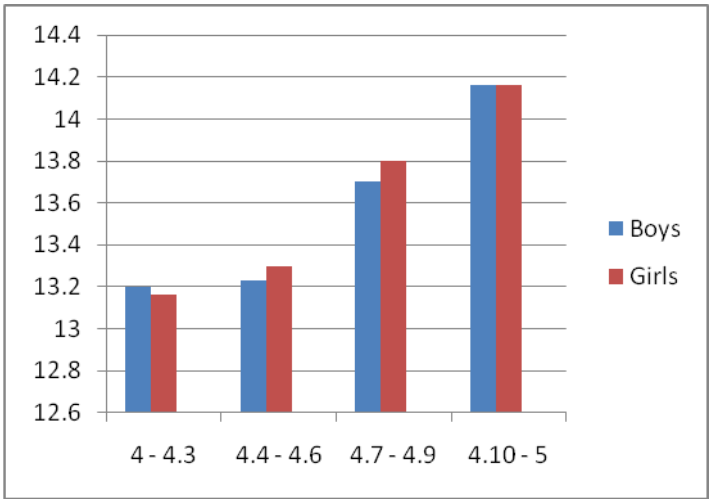
Table 18*: Mean articulatory scores and Standard deviation of initial clusters in different age groups for boys and girls (4-5 years)*



Graph 4: *Mean articulatory scores for initial clusters in different age groups(4-5 years) for boys and girls*

Gender	Age	Mean (Std. Deviation)	N
Boys	**Group I (4.0 – 4.3 years)**	13.20 (0.33)	15
	Group II (4.4 – 4.6 years)	13.23 (0.41)	15
	Group III (4.7 - 4.9 years)	13.70 (0.36)	15
	Group IV (4.10 - 5 years)	13.57 (0.51)	60
	Mean Total Scores	13.60 (0.49)	60
Girls	**Group I (4.0 - 4.3 years)**	13.16 (0.24)	15
	Group II (4.4 - 4.6 years)	13.30 (0.27)	15
	Group III (4.7 - 4.9 years)	13.80 (0.31)	15
	Group IV (4.10 - 5 years)	14.16 (0.30)	15
	Mean Total Scores	14.16 (0.30)	15

Table 19*: Mean articulation scores and Standard deviation of medial clusters in different age groups(4-5 years) for boys and girls*



Graph 5: *Mean articulatory scores for medial clusters in different age groups for boys and girls*

Initial Clusters

As observed in the comparison of overall cluster scores, there was a significant difference observed for initial cluster scores also across each of the age groups.

Medial Clusters

Group I (4.0- 4.3 years): When Group I was compared with other three groups, no significant difference was observed between Group I and Group II. But there was significant difference with Group III & Group IV.

Group II (4.4-4.6 years): When Group II was compared with other groups, there was significant difference with Group III and Group IV.

Group III (4.7-4.9 years): When Group III was compared with the other groups, there was a significant difference seen across the groups.

Group IV (4.10-5 years): When Group IV was compared with other three groups; there was a significant difference with other groups (Group I, Group II & Group III).

The acquisition pattern for each cluster was analyzed for both males and females in each group. Tables 20 and 21 show the age of initial and medial cluster acquisition for 90% criteria in both boys and girls (4 - 5 years). The obtained results are explained below:

Group I (4 – 4.3 years): In Group I, none of the initial clusters achieved 90% criteria in both boys and girls. Among medial clusters, seven consonant clusters **(**/-nt-/, /-nʈ-/**,** /-ndʒ-/**,** /-nd-/, /-nk-/, /-ʈy-/**,** /-lj-/) met 90% criteria (for both boys and girls). So it can be inferred that medial clusters were mastered earlier than initial clusters. The initial clusters /kr-/ in / kriʃn̪an/ (13.33), /sp-/ in /spu:n̪/ (46.66) and /ʃv-/ in /ʃva:sam/ (40%). Among the medial clusters /-dj-/ had highest score (80%) and /kṣ/ obtained the least score (33- 40%). Hence, none of the 15 initial clusters reached the 90% criteria. But seven out of 15 medial clusters reached the 90% criteria. The percentage of cluster acquisition in boys and girls in different age groups for initial and medial positions are given in Tables 18 and 19. In Group I, boys had higher score in initial and medial clusters than girls. The main cluster errors that were observed in this group of children were cluster reduction (e.g /pa:və/ for /pra:və/) followed by cluster simplification like epenthesis (/tʃandiran/ for /tʃandran/) and coalescence (/fu:n̪/ for /spu:n̪/).

Group II (4.4 - 4.6 years): Compared to the previous age group only one initial consonant cluster /-kj-/ mastered 90% criteria. Among the medial clusters, no new

clusters attained 90% criteria. However, improvement in scores was noticed compared to the previous age group. Six among the initial clusters crossed 80% by this age. They were /sk-/, /gl-/, /kl-/, /pl-/, /gr-/ and /bl-/. However, marked improvements in scores were not observed for the medial clusters. On observation from Tables 18 and 19, it is evident that girls performed superiorly than boys for some of the initial and medial clusters. These initial clusters were /gl-/, /tR-/, /sp-/, /kr-/, /br-/, /bl-/ and /ʃv-/ and medial clusters were /-kṣ-/ and /- st̪a-/. Hence on overall observation, out of 15 initial clusters only one reached 90% criteria and for medial clusters it was the same as that of the previous group. The errors observed in this age group were similar to those in the previous age range which includes cluster reduction, epenthesis and coalescence among which reduction was the most common error.

Group III (4.7 - 4.9 years): When compared to the previous age group, the clusters /sk-/, /gl-/ and /kj-/ met 90% criteria among initial clusters and among the medial clusters only /-dj-/ met the 90% criteria. /-sk-/ and /-kṣ-/ showed an improvement in scores while the scores for the remaining initial and medial clusters remained almost the same. Hence four among the initial and eight among the medial clusters met the 90% criteria. Although the percentage of clusters that achieved 90% were less, there was improvement in the scores when compared to the previous age range. The clusters that showed improvement in scores were /sk-/, /gl/, /kl-/, /tR-/, /sp-/, /kr-/, /bl-/, /gr/, /st^{h}/, /ʃv-/ and /kj-/ among the initial clusters and /-kr-/, /-t̪r-/ and /-st̪r-/ are among the medial clusters. Though there was no significant difference in scores

between boys and girls, it was noticed that girls had better scores than boys for initial and medial clusters. The errors noticed were cluster reduction and cluster simplification like epenthesis and coalescence. Also, clusters which were nearing 90% criteria had more of substitution errors (e.g. /bleṣə/ for braṣə).

Group IV (4.10-5 years): When compared to the previous age group, the initial clusters /kl-/, /tr-/, /bl-/ and /st^{h} / and the medial clusters /-sk-/, /-kra-/ and /-st-/ met the 90% criteria by this age range. Most of the clusters showed improvement in scores except for the initial clusters /sl-/, /pl-/ and /gr-/. The medial clusters which showed an improvement in scores were /-nd̪r-/, /-sk-/, /-kṣ-/, /-kr-/, /- st̪-/, /-t̪r-/, and/-st̪r-/. Hence, the number of initial and medial clusters which met the 90% criteria was 8 and 10 respectively. In this group also, girls performed better than boys in both initial and medial positions but there was no significant differences. The main errors noticed in this group were cluster simplification such as substitutions, epenthesis and coalescence. However, cluster reduction errors were also present.

	4 - 4.3 years		4.4 - 4.6 years		4.7 - 4.9 years		4.10 - 5 years	
Initial clusters (Word)	**Obtained % Boys**	**Girls**	**Obtained % Boys**	**Girls**	**Obtained % Boys**	**Girls**	**Obtained % Boys**	**Girls**
pr- (pravə)	66.66	60	73.33	73.33	80	80	93.33	93.33
sk- (sku:tar)	60	60	80	80	93.33	93.33	93.33	93.33
gl- (gla:ssɚ)	80	80	80	86.66	93.33	93.33	93.33	100
kl- (klo:k)	80	80	86.66	80	80	86.66	93.33	93.33
pl- (ple:tɚ)	80	80	86.66	86.66	86.66	86.66	86.66	86.66
tR- (tRəin)	60	60	66.66	73.33	73.33	80	93.33	93.33
sl- (slətɚ)	66.66	66.66	73.33	73.33	80	80	86.66	80
sp- (spu: ṇ)	46.66	46.66	46.66	53.33	66.66	66.66	80	73.33
kr- (kRiʃṇan)	13.33	13.33	20	26.66	26.66	33.33	33.33	40
br- (braṣɚ)	66.66	66.66	66.66	73.33	73.33	73.33	83.33	80
bl- (blædɚ)	66.66	66.66	73.33	80	86.66	93.33	93.33	100
gr- (gra:mam)	80	73.33	80	73.33	80	80	86.66	86.66
st^{h}- (st^{h}alam)	66.66	66.66	73.3	73.33	80	86.66	93.33	93.33
ʃv- (ʃva:sam)	40	40	40	46.66	46.66	53.33	60	53.33
kj- (kja:maRa)	86.66	86.66	93.33	93.33	93.33	93.33	100	100

Table 18: *Percentage of initial cluster acquisition for boys and girls (4 -5 years)*

	4-4.3 years		4.4-4.6 years		4.7-4.9 years		4.10-5 years	
Word medial clusters	**Obtained % Boys**	**Girls**	**Obtained % Boys**	**Girls**	**Obtained % Boys**	**Girls**	**Obtained % Boys**	**Girls**
-nt- (pa:ntɚ)	100	100	100	100	100	100	100	100
-nṯ- (panṯɚ)	100	100	100	100	100	100	100	100
-ndʒ- (sanji)	100	100	100	100	100	100	100	100
-nd- (ti:vandi)	100	100	100	100	100	100	100	100
-nk- (kanka:ru)	100	100	100	100	100	100	100	100
-ṯj- (inṯja)	93.33	93.33	100	100	100	100	100	100
-nḏr- (ʧanḏran)	73.33	66.66	73.33	73.33	73.33	73.33	80	80
- sk- (biskattɚ)	73.33	73.33	73.33	73.33	80	80	93.33	93.33
-kṣ- (nakṣaṯra)	46.66	33.33	53.33	66.66	73.33	73.33	80	80
-lj- (kaljaṇam)	100	100	100	100	100	100	100	100
-kr- (ʧakram)	60	73.33	66.66	73.33	66.66	73.33	80	83.33
-sṯ- (pusṯakam)	73.3	60	73.33	80	80	80	93.33	93.33
-sṯr- (vasṯram)	66.66	60	66.66	73.33	73.33	80	86.66	86.66
-dj- (sadja)	80	80	80	80	93.3	100	100	100
-ṯra- (pa:ṯram)	66.66	66.66	66.66	73.33	73.33	80	80	80

Table 19: *Percentage of medial cluster acquisition for boys and girls (4 -5 years)*

From the results obtained, it is clear that medial clusters were acquired earlier when compared to initial clusters. This finding is in consonance with Vani Rupela in Kannada (2006), Neethipriya in Telugu (2007) and Prathima in Kannada (2010) who reported that medial clusters were mastered early compared to initial clusters. Kirk and Demuth (2005) also acknowledged that word final stop+/s/ clusters and nasal+/z/ clusters were produced more accurately than word initial clusters.

However, the obtained results was not supported by some of the Western studies, Stoel-Gammon (1985) stated that few consonant clusters were beginning to appear in her subjects at 24 months and word initial clusters occurred more frequently than word final clusters. This is possibly because the frequency of occurrence of initial clusters is more in English compared to Indian languages. Most of the words with clusters in the initial position in Malayalam are borrowed English words. In the present study, ten out of the 15 stimuli for testing initial clusters are borrowed English words which are used very frequently in Malayalam whereas only two out of 15 stimuli for medial clusters are borrowed English words.

Considering the acquisition pattern in consonant clusters, the results indicated that 18 (8 initial and 10 medial) out of 30 reached the 90% criteria by 4.10 - 5 years of age. Others which did not attain mastery where those which included /s/, /r/, /l/ or /ʃ/ as part of the cluster. As reported by several authors these sounds at singleton level also were acquired late as compared to other phonemes. Hence it is seen that the clusters involving these phonemes are also late in acquisition.

In the present study, the common cluster errors found were cluster reduction followed by cluster simplification such as epenthesis and coalescence. The common examples for cluster reduction seen are /kiʃn̪an/ for /kriʃn̪an/ or /naʃatram/ for /nakʃatram/, for epenthesis; /tʃakaram/ for /tʃakram/ or /tʃandaran/ for /tʃandran/ and for coalescence; /spu:n/ for /fu:n/. The reason for these errors can be that children substitutes earlier acquired phonemes for the late acquired phonemes within the

cluster. The children may be using epenthesis as a simplification process where they insert a vowel in between the cluster. This is to an extend is colloquially acceptable in Malayalam language. It was observed that in younger age, cluster reduction was more prevalent and as the age increased the occurrence of cluster reduction decreased. At higher age range, the errors that were frequently noticed were cluster simplification which included epenthesis and coalescence. This is in agreement with Greenlee's (1974) stages of cluster acquisition and report of Mc Leod (2001) which states that the occurrence of cluster reduction diminishes overtime, where as the occurrence of cluster simplification increases. Simultaneously, the occurrence of correct production increases, until eventually the production is mastered. Chart 2 shows the acquisition of consonant clusters as per 90% criteria in the age group of 4 -5 years for both boys and girls.

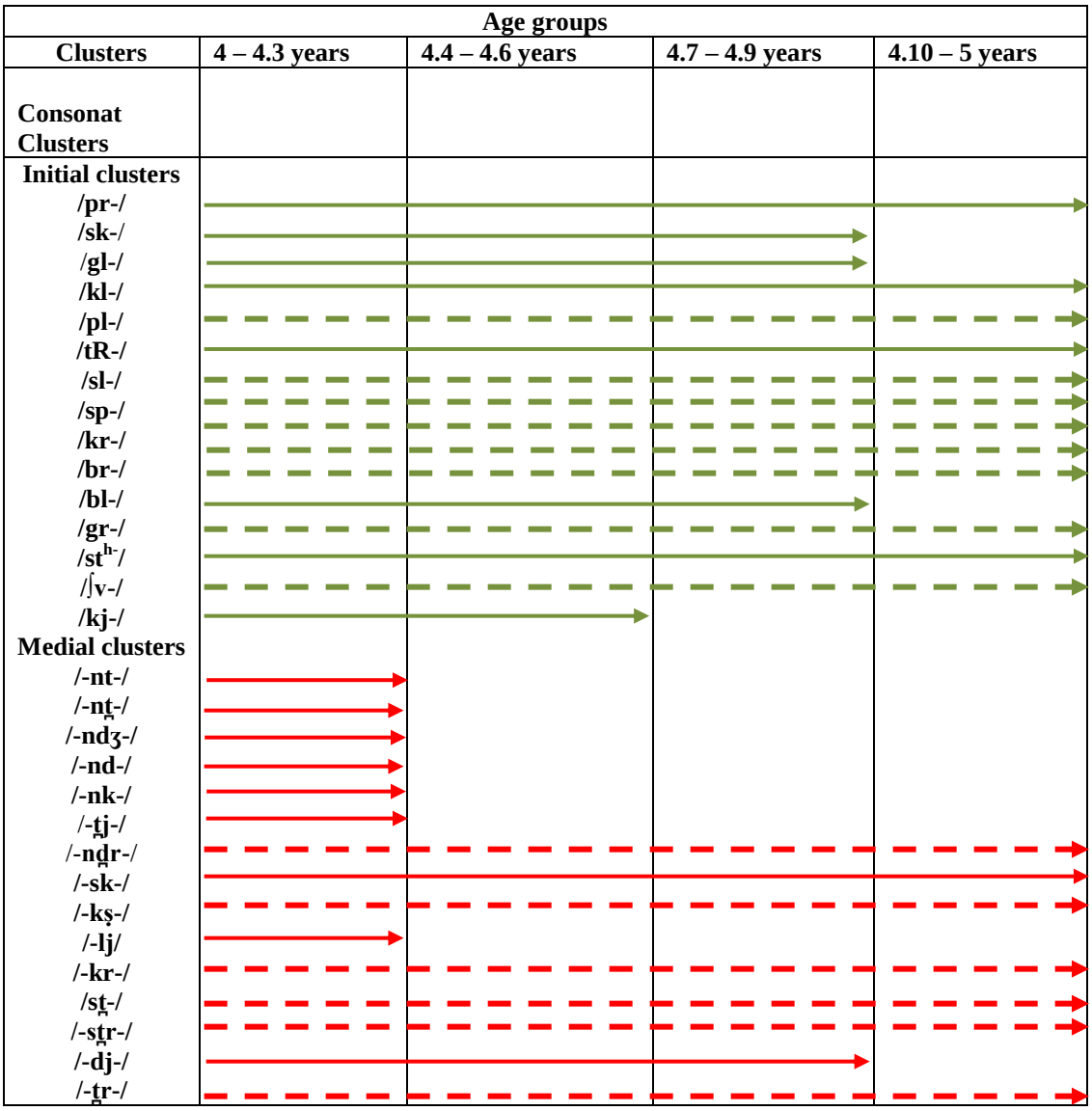


Chart 2: *Shows the age of cluster acquisition by 90% of the children in Malayalam*

Indicates clusters acquired by 90% of the children.
Indicates clusters not acquired by 90% of the children.

Inter-judge reliability

Inter-judge reliability for phoneme transcription was assessed by comparing the percentage of phoneme agreement between the transcriptions of the investigator and of the two judges on 10% of the samples randomly selected across the total 120 samples. The transcribed samples of the two testing were analyzed and compared and the mean percentage of phoneme agreement was calculated. The Cronbach's alpha value was 0.91, which shows there was good agreement between the two judges.

Tests re-test reliability

5% (6 subjects) of the children in each group were retested within a period of 3-7 days from the time of initial testing. The transcribed samples of the two testing were analyzed and compared and the mean percentage of phoneme agreement was calculated. The Cronbach's alpha value was 0.99, which shows there was good reliably between test 1 and test 2.

CHAPTER V

SUMMARY AND CONCLUSIONS

The aim of the present study was to revalidate the norms for Malayalam Diagnostic Articulation Test (Maya, 1990) in native Malayalam speaking children in the age range of 5-6 years.

The study was conducted in two phases. Phase 1 included the modification of Malayalam Diagnostic Articulation Test (Maya 1990). For this, 15 new words to replace the existing obsolete words, another fifteen words incorporating common clusters and three words incorporating aspirated stops were selected to include in the test material. So a new wordlist incorporating the phonemes to be tested was given to three judges to check the familiarity of these words. For each phoneme to be tested, the words which were rated as very familiar by the judges were considered as the new test words. In the existing test (Maya, 1990) there are 82 test words including fifteen consonant clusters and in the modified one there are 100 test words which included 30 consonant clusters. All the 100 target words were picturized.

Phase 2 involved obtaining norms for the acquisition of articulatory skills in native Malayalam speaking children in the age range of 4 - 5 years. The subjects were sub divided into four groups with an inter age interval of three months (4 - 4.3, 4.4 - 4.6, 4.7 - 4.9 & 4.10 - 5 years). Each of the four groups comprised a total of 30 subjects including 15 boys and 15 girls. So a total of 120 subjects were considered

for the study. The subjects were asked to name the target pictures that were presented through a laptop computer. The responses elicited were audio recorded using a laptop computer.

The data obtained from the 120 subjects were analyzed sound-by-sound on a response sheet and score was given. For singleton consonants, a score of '1' was given to each correct response, a score of '¾' for distortion error; a score of '½' for substitution error, and '0' for omission error was allotted. For consonant clusters, scoring was based on Greenlee's (1974) stages of cluster development. If the entire cluster is deleted a score of zero was given. For errors such as cluster reduction, coalescence, cluster simplification, metathesis and epenthesis, a score of 0.50 was given. For errors where number of elements in the cluster is preserved but with substitution of one or more of the consonants in the cluster was scored 0.75 and for the correct production of clusters, a score of one was given. Finally total score for each subject was calculated. The maximum score that could be obtained was 100. i.e. when all the test phonemes were correctly produced.

The data for each age group was statistically analyzed. The results indicated that, there was a significant difference in articulatory scores across age groups. As age increased, the scores also increased indicating improved articulatory abilities due to neuromuscular maturation. However there was no significant difference across gender.

All the vowels and most of the consonants were mastered by 100% of the children by 4- 4.3 years of age. The consonants not achieved by this age were the aspirated phonemes /ʧʰ/, /d̪ʰ/, /ʈʰ/, / ʈ̪ʰ/, /bʰ/, / gʰ/ and /kʰ/ and a few unaspirated phonemes /ɲ/, /d̪/, and /h/ in the medial position.

Considering the acquisition of clusters, it was found that medial clusters were acquired earlier than initial clusters. The common cluster errors found were cluster reduction, followed by cluster simplification (epenthesis and coalescence). Errors such as metathesis were rare. The clusters which acquired 90% criteria by 5 years of age were /pr-/, /sk-/, /gl-/, /kl-/, /sl-/, /bl-/, /stʰ-/ and /kj-/ in the initial position and /-nt-/, /-nʈ̪-/, /-ndʒ-/, /-nd-/, /-nk-/, /-ʈ̪y-/, /-sk-/, /-lj/, /-sʈ̪-/ and /-dj-/ in the medial position. i.e. 8 out of 15 initial clusters and 10 out of 15 medial clusters met the 90% criteria by the upper age limit considered in the present study (4.9 - 5 years) .

As reported in the recent studies, the present study also observed earlier acquisition of all phonemes including clusters by the present day children. This may be attributed to differences in lifestyle, greater exposure to speech and language environment or the effects of bilingualism and increased educational opportunities at younger age itself. So it is recommended that the clinicians use the revalidated norms of the Modified Malayalam Diagnostic Articulation Test for their diagnostic and therapeutic purposes henceforth for native Malayalam speaking children.

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Appendix- I (Sample of the scoring sheet)

Name: **Age/Gender:**

Sl no	phoneme	position	Check word	CR	S	O	D	A	Ao	Score
1	**a**	initial	aɳɳa:n							
2	**a:**	initial	a:na							
3	**i**	initial	ila							
4	**I:**	initial	i:ʧa							
5	**u**	initial	uḻḻi							
6	**u:**	initial	u:ɲɲa:l							
7	**e**	initial	eli							
8	**e:**	initial	e:ɳi							
9	**o**	initial	onnə							
10	**o:**	initial	o:la							
11	**k**	initial	kuda							
12		medial	ʈa:ko:l							
13	**g**	initial	ga:ndidʒi							
14		medial	ba:gə							
15	**ŋ**	medial	ma: ŋa							
16	**ʧ**	initial	ʧi:ppə							
17		medial	Pu:ʧa							
18	**ʤ**	initial	ʤannal							
19		medial	ra:ʤa:və							
20	**ɲ**	initial	ɲandə							
21		medial	u:ɲɲa:l							
22	**t**	initial	tajaR							
23	**ɖ**	initial	ɖo:kta:r							
24		medial	ro:də							
25	**ɳ**	medial	kiɳar							
26		final	fo: ɳ							
27	**ʈ**	initial	ʈaʈa							
28		medial	mo: ʈiram							
29	**ɖ**	initial	ɖo:ʃa							
30		medial	ʤaladoːʃam							
31	**n**	initial	nakṣaʈram							
32	**p**	initial	pu:və							
33		medial	uduppə							
34	**b**	initial	bassə							

35		medial	Riban							
36	**m**	initial	ma:la							
37		medial	a:ma							
38		final	maram							
39	**j**	initial	je:ʃu							
40		medial	mujal							
41	**l**	initial	lo:ri							
42		medial	alama:ra							
43		final	viral							
44	**ɭ**	medial	vaɭa							
45		final	va: ɭ							
46	**v**	initial	vi:də							
47		medial	ʧevi							
48	**h**	medial	simham							
49	**-ʈ**	medial	pu:mpa:ʈa							
50	**s**	initial	su:rjan							
51		medial	kas:era							
52	**f**	medial	fa:n							
53	**r**	initial	ra:ʤa:və							
54		medial	ʧeruppə							
55	**ʃ**	initial	ʃivan							
56		medial	me:ʃa							
57	**ʟ**	medial	ko: ʟi							
58	**R**	initial	Re:dio							
59		medial	uRumpə							
60		final	ca:R							
61	**ʂ**	initial	ʂartə							
62		medial	braʂə							
63	**ʧʰ**	initial	ʧʰ:ja							
64	**ʈʰ**	medial	ra ʈʰam							
65	**ʈʰ**	medial	mi ʈʰa:ji							
66	**kʰ**	initial	kʰagam							
67		medial	mukʰam							
68	**dʰ**	medial	madʰuram							
69	**bʰ**	initial	bʰaraɳi							
70	**gʰ**	medial	me:gʰam							
71	**gl-**	initial	gla:ssə							

72	**kl-**	initial	klo:k							
73	**pl-**	initial	ple:tə							
74	**tr-**	initial	tRəin							
75	**sl-**	initial	slətə							
76	**sp-**	initial	spu: ɳ							
77	**kr-**	initial	kRi ʃ ɳan							
78	**br-**	initial	braṣə							
79	**bl-**	initial	blædə							
80	**gr-**	initial	Gramam							
81	**st^{h}-**	initial	st^{h}alam							
82	**ʃv-**	initial	ʃva:sam							
83	**pr-**	initial	pravə							
84	**sk-**	initial	sku:tar							
85	**kj-**	initial	kja:maRa							
86	**lj-**	medial	kalja:ɳam							
87	**dj-**	medial	sadja							
88	**-nʈ-**	medial	panʈə							
89	**-nt-**	medial	pa:ntə							
90	**-nj-**	medial	sanji							
91	**-nd-**	medial	ti:vandi							
92	**-nk-**	medial	kanka:ru							
93	**-ʈj-**	medial	inʈja							
94	**-nɖr-**	medial	ʧanɖran							
95	**-kr-**	medial	ʧakram							
96	**-ʈr-**	medial	pa:ʈram							
97	**-sʈ-**	medial	puʂʈakam							
98	**-sk-**	medial	biskattə							
99	**-str-**	medial	vasʈram							
100	**-kʂ-**	medial	nakʂaʈram							

Appendix II

Mean articulation scores expected for typically developing Malayalam speaking children in the age range of 4- 5 years using the Modified Malayalam Articulation Test

Age	Scores for typically developing children
4.0 – 4.3 years	**92.90 ± 0.65**
4.4 – 4.6 years	**93.33 ± 0.47**
4.7 – 4.9 years	**95.36 ± 0.58**
4.10 – 5.0 years	**95.36 ± 0.58**

Maximum Score - 100