REVALIDATION OF MALAYALAM DIAGNOSTIC ARTICULATION TEST

(5-6 YEARS)

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JUNE, 2011

CERTIFICATE

This is to certify that this dissertation entitled ***"Revalidation of Malayalam Diagnostic Articulation Test (5 – 6 years)"*** is the bonafide work submitted in part fulfillment for the degree of Master of Science (Speech - Language Pathology) of the student (Registration 09SLP035). This has been carried out under the guidance of a faculty of this institute and has not been submitted earlier to any other University for the award of any other Diploma or Degree.

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CERTIFICATE

This is to certify that the dissertation entitled ***"Revalidation of Malayalam Diagnostic Articulation Test (5– 6 years)"*** has been prepared under my supervision and guidance. It is also certified that this has not been submitted earlier in any other University for the award of any Diploma or Degree.

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DECLARATION

This is to certify that this dissertation entitled ***"Revalidation of Malayalam Diagnostic Articulation Test (5– 6 years)"*** is the result of my own study under the guidance of Dr. N. Sreedevi, Lecturer of Speech Sciences, Department of Speech-Language Sciences, All India Institute of Speech and Hearing, Mysore, and has not been submitted earlier in any other university for the award of any diploma or degree.

Mysore
June, 2011

Register No. 09SLP035

Dedicated to

Achu

&

Ammu

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Chapter 1

INTRODUCTION

Articulation, if proficient, makes speech intelligible and thus helps in communication. 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, etc. i.e. it refers to the totality of motor processes involved in the planning and execution of sequences of overlapping gestures that result in speech (Fey, 1992). It implies that learning of articulatory skills is an acquisitional process involving the gradual development of the ability to move the articulators in a precise and rapid manner.

Children acquire speech sounds in a fairly predictable sequence; however the age of onset for these sounds can vary from child to child. Articulation development follows an orderly sequence and developmental error patterns are to be expected at each stage in development. As sounds become more difficult to pronounce, increased coordination of the muscles in the lips, tongue, jaw and soft palate are required. A child will often delete or substitute sounds to simplify more complex sound combinations. Speech sound development involves a time dependent mastery of the motor responses (Winitz, 1969). Over the years, many investigators have tried to determine approximate ages of individual sound mastery in specific groups of children. They provided guidelines for determining if a child demonstrates “normal versus impaired articulatory acquisition”. These “mastery” studies are typically based on the results of testing large number of

children, setting a percentage for each age group for normal articulation of the speech sound in question, and finally establishing age levels that are considered to be time frame for acquisition of each sound.

A child is said to have an articulation delay when the sounds are acquired in the expected sequence but the developmental errors persist beyond the age we expect. According to Mc Donald (1980)' misarticulations are the production of speech sounds which are not adequate acoustic representations of the phonological sequence of the language or dialect. Also, the articulatory errors are viewed as failure on the part of a speaker to perceive the significant contrast between the standard sound and the sound which he produces.

Articulatory disorders are the most frequently occurring among all types of speech disorders. These deviances in articulation could be due to organic factors, emotional conflicts, acoustic and perceptual deficiencies, difficulties in phonetic discrimination, poor motor coordination, poor model or it may be functional. Evaluation of an individual's articulation involves description of his or her speech sound production and relating this to the normal or standard in the language and community. So, in order to evaluate the articulation of these patients, tests of articulation are essential

Traditionally an articulation test has been defined as a "technique employed to measure the general phonemic capacity of the individual" (Van Riper and Irwin, 1958). However, articulation tests can be used in a variety of ways:

- To set up norms for the normal development of phonology
- To determine the phonemic proficiency
- For purpose of screening
- For diagnosis
- To assess the developmental progress
- For prediction of the improvement in therapy
- To plan the therapy carefully
- To make prognostic statements relative to phonological change with or without intervention/ therapy
- To determine the causal factors that initiate the articulatory problem or contribute to its severity

Articulation tests can be of 4 types: (1) Screening articulation test, (2) Diagnostic articulation test, (3) Deep test of articulation and (4) Predictive screening test of articulation. Articulation tests are language specific and each language has its own phonological system. In a multilingual country like India, the more necessity arises for articulation tests in various Indian languages. In the past, articulation tests have been developed in several Indian language. These include Kannada Articulation Test (Babu, Bettagiri, and Rathna, 1972) and it was standardized by Tasneem Banu (1977), A Test of Articulation in Tamil (TAT, Usha, 1986), A Test of Articulation and Discrimination in Telugu (TADT, Padmaja, 1988), Screening Test for Articulation and Discrimination in Bengali (Arun Banik, 1988), Malayalam Articulation Test (Maya, 1990) and Restandardized Kannada Articulation Test (Deepa, 2010).

Present day children acquire speech sounds much earlier than before and therefore it is very important to re-establish the norms for the existing articulation tests. Recent studies on articulatory acquisition (Divya, 2010, Usha, 2010, Deepa, 2010) have revealed the earlier acquisition of speech sounds as compared to the previous norms. So it is important to remember that the existing articulatory acquisition norms need to be revised over a period of time to go with the changed patterns of development. Further Maya (1990) developed the Malayalam Diagnostic Articulation Test and standardized it on 240 children in the age range of 3 - 7 years. It has been more than 20 years the norms have been established for Malayalam Diagnostic Articulation Test. So there is an immediate need to study the articulatory acquisition in the present day children to revise the existing norms.

Also out of the 82 test words in the Malayalam Diagnostic Articulation Test, 15 were found to be obsolete and were no more in the colloquial usage (Divya, 2010). So these words have to be revised to update the test. Divya (2010) also reported that by 2.9 years children begin to produce clusters. In the existing test only fifteen consonant clusters are tested. Therefore there is a need for testing more commonly occurring consonant clusters to study the pattern of their acquisition.

Aim of the study: Aim of the study is to obtain norms for acquisition of articulatory skills in native Malayalam speaking children in the age range of 5- 6 years.

The specific objectives of the study are

1) To administer the modified Malayalam Diagnostic Articulation Test to typically developing Malayalam speaking children in the age range of 5 - 6 years to establish current norms. 100% criteria will be considered for single phonemes and 90% criteria for consonant clusters.
2) To revise the 15 test words which were found to be obsolete in the existing Malayalam Diagnostic Articulation Test
3) To compare the difference in the articulatory acquisition of phonemes in the initial and medial positions of the words.
4) To include more number of frequently occurring consonant clusters in the test
5) To compare the order of acquisition of initial and medial consonant clusters.
6) To compare the articulatory skills across age and gender.
7) To compare the data obtained with that of the earlier reported studies in both English and other Indian languages.

Brief Method of the Study

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 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 are 82 test words including fifteen consonant clusters and in the modified one there are 100 test words which include 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 5– 6 years. The subjects were sub divided into four groups with an inter age interval of three months (5 - 5.3, 5.4 - 5.6, 5.7 - 5.9 & 5.10 - 6) 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 color 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 relevant position. The response elicited was audio recorded using a laptop computer. 5% of the children were retested within a period of 3-7 days from the time of initial testing to test the reliability of the test.

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 score was given and the total score for each subject were calculated. Later a mean score was obtained for each of the four age groups studied. Inter judge reliability was calculated by considering 10 % of the sample from each group which was analyzed by two experienced speech language pathologists. The mean percentage of phoneme agreement between the two judges was calculated.

Implications of the study: The revised articulatory norms obtained will help us to identify and diagnose native Malayalam speaking children with articulation problems, 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 therapy.

Limitations

- Sample size is limited to 120 children
- Vowels were tested only in the initial position of the word
- Diphthongs in Malayalam (2 in number) were not tested
- All the clusters in Malayalam are not tested

CHAPTER II

REVIEW OF LITERATURE

The review will be covered under the following headings

- Articulatory acquisition of vowels and consonants
- Articulatory acquisition of consonant clusters
- Tests for articulatory acquisition
- Methods of testing articulation
- Articulation test battery in Malayalam

Children's acquisition of adult like speech production has fascinated speech language pathologists and the data gained from associated research have clued-up various aspects of speech-language pathology practice. Children acquire speech sounds in a fairly predictable sequence; however the age of onset for these sounds can vary from child to child. Speech sound development involves a time dependent mastery of the motor responses (Winitz, 1969). Over the years, many investigators have tried to determine approximate ages of individual sound mastery in specific groups of children. They provided guidelines for determining if a child demonstrates "normal versus impaired articulatory acquisition".

1) Articulatory acquisition of vowels and consonants

The phonological development in the young child involves the interaction of physical maturation and social experience. During the first six months of life, three stages of voluntary vocal behavior can be distinguished: the phonation stage, the cooing stage, and the expansion stage (Oller, 1980). He also identifies two stages in the second half of the first year, ***canonical*** and ***variegated babbling***. Considerable overlap exists between stages, and the ages assigned to each stage are only approximations.

1) In the phonation stage (birth to 1 month), speech-like sounds are rare. The largest number of "nonreflexive, nondistress sounds are the "quasi-resonant nuclei, which Oller characterizes as vocalizations with normal phonation but limited resonance, produced with a closed or nearly closed mouth. These elements give the auditory impression of a syllabic nasal.

2) In the "goo" or cooing stage (2 to 3 months), velar consonant-like sounds are produced with some frequency and "primitive syllabification" may be detected (Zlatin, 1975), but the rhythmic properties of adult syllables and the timing of the articulatory gestures for adult consonants have not yet been mastered. Acoustically, the cooing sounds are similar to rounded back vowels such as [u].

3) In the expansion stage (4 to 6 months), the child appears to gain increasing control of both laryngeal and oral articulatory mechanisms. He or she explores the vocal mechanism through the playful use of squealing, growling, yelling, and ‘rasp-berry'

vocalizations (bilabial trills). “Fully resonant nuclei” (adult-like vowels) begin to be produced in this period, as does "marginal babbling-," in which consonant-like and vowel-like features occur but lack the mature regular-syllable timing characteristics of canonical babbling.

The first probable evidence of adult language influence on production is manifested by the emergence of canonical babbling (Oller's Stage 4; also known as reduplicated babbling), typically at about 6 to 8 months. The sudden appearance of genuine syllabic production involving a true consonant and a "fully resonant nucleus" or vowel, often (though not exclusively) chained in repeated sequences such as [bababa], [dadada], or [mamama], constitutes the chief production milestone stone in the first year. The last babbling stage (Oller’s stage 5) is variegated babbling, in which continued use of adult like syllables is supplemented by the use of increasingly varied consonants and vowels within a single vocalization such as [te:kœ]. Acquisition of control over each new behavioral combination is the result of the interaction of maturation and experience or practice in using the new motor behavior.

Vowel production dominates infant vocalization throughout the first year and shows little change. Adult transcribers usually perceive the primitive vowels as mid front or central. Once the child has begun producing variegated babble, adult like stress patterns and intonation contours may also be used, giving the surface effect of adult language, but without content or meaning. The transition period is best defined by certain developmental events. It begins with the onset of comprehension of the adult language,

and it closes when word use begins to dominate babble, typically when the child is using about 50 different words spontaneously. For most children, the transition to speech will occur during the period from about 9 to 18 months.

Speech sound development involves a time dependent mastery of the motor responses (Winitz, 1969). Over the years, many investigators have tried to determine approximate ages of individual sound mastery in specific groups of children.

Wellman (1931) reported norms on 204 children ranging from 2-6 years of age. A total of 133 sound elements were tested in initial, medial and final positions of words. Responses were elicited spontaneously from children in response to questions and stimulus pictures. Mastery of sounds was assigned to the age levels at which at least 75 percent of the children mastered them in all three positions in words. All the sounds tested, except for the /θ/ and /hw/ was produced correctly by 75% of the children by the age of 6 years. He did not report data on the / ʃ/ and / ð/ sounds.

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.

Arlt and Goodban (1976) did an exploratory study on articulation of 240 children in the age three to six years. They were evaluated using the screening test of articulation developed as a subtest of a newly developed instrument; the Illinois Children's Language Assessment Test. The norms obtained from this investigation were compared with previously established norms of articulation. Results indicate that 43% of the sounds tested were produced correctly from six months to four and one-half years earlier than would be expected from previously established norms. These results indicate a need for new normative data consistent with the performance of children seen at the present time.

Prather, Hedrick and Kern (1975) used the Sequenced Inventory of Communication Development - SICD and included 147 children in their study ranging from 24 to 48 months. Twenty one children from each of the seven age groups constituted the sample. Photo articulation test was administered, consonant sounds were tested only in the initial and final positions only and vowels were tested in one context. The child was encouraged to name each picture spontaneously or by repetition. They assigned mastery of the sound to the level at which 75 % or more of the children produced it correctly in the 2 positions. Eliminating the medial positions apparently resulted in earlier age levels for nearly all the sounds. Their results indicated that children

were producing more sounds correctly at earlier ages than would be suggested by the classical articulation research.

Irwin and Wong (1983) studied phonological development of children between the ages of 18 to 72 to months. A total of 100 children participated in this study with 10 females and 10 males in each of the following age groups: 18 months, 2 years, 3 years, 4 years and 6 years. The results indicated that by the age of 3, individual children and total group of 20 produced all vowels and diphthongs with 99 - 100% of accuracy. At 2 years of age, all vowels and diphthongs were produced with at least 90% of accuracy with the exception /ɚ/ and /ɝ/. At 18 months of age only /a/, /u/, /i/ and /Λ/ were produced with atleast 70% of accuracy.

Stoel - Gammon (1985) investigated the phonetic inventories of 34 children (19 boys and 15 girls) between the ages of 15 and 24 months. Using spontaneous speech samples, she investigated the range and type of consonantal phones in the inventory of children using meaningful speech. The samples were collected every 3 months, at ages 15, 18, 21 and 24 months. Her criterion for meaningful speech was the spontaneous production of at least 10 identifiable words during a one-hour recording session. The following specific patterns were identified in this study.

- At 15 months of age /b/, /d/ and /h/ were in the inventories of 50% of the subjects in initial positions. In the final positions no sound met the criterion

- At 18 months of age /b/, /d/, /m/, /n/, /h/ and /w/ were in the inventories of the 50 % of the subjects in the initial positions. In the final position, /t/ was the only phone in the inventory of 50 % of the subjects
- At 21 months of age /b/, /t/, /d/, /m/, /n/ and /h/ were in the inventories of the 50 % of the subjects in the initial positions. In the final position, only /t/ and /n/ were in the inventory of 50 % of the subjects
- At 24 months of age 50% of the children had /b/, /t/, /d/, /k/, /g/, /m/, /n/, /h/, /w/, /f/, and /s/ / in the initial position, and /p/, /t/, /k/, /n/, /r/, and /s/ in the final position of their inventories

Fudula and Reynolds (1986) conducted a normative study based on a sample of 5,122 children in the age range of 1.6 to 13.11 years. The subjects were drawn from four states in the western United States. They considered 90% mastery criterion to their data. The results indicated:

- The following vowels and diphthongs reached 90% criterion by the youngest age group of 1.6 to 1.11 years: /ə/, /Λ/, /ɛ/, /æ/, /ɔ/, /ʊ/, /a/, /I/, /i/, /u/, /ou/, /ai/, /ei/, and /au/
- The mid central vowel /ɝ/ and /ɚ/ did not reach the mastery criterion of 90% until 5.6 to 5.11years of age
- The rhotic diphthong also reached the mastery criterion at the 5.6 to 5.11 years with the exception of /ɛr/, which reached 90% acquisition level at the 4.6 to 4.11 years

Otomo and Stoel-Gammon (1992) investigated developmental patterns of acquisition of the unrounded American English vowels /i, I, e, e, ae, a/ by following 6 normally developing children from 22 to 30 months of age. The subjects were examined at approximately 22, 26, and 30 months of age. Results showed that, in general, /i/ and /a/ were mastered early and /I/ and /e/ were least accurate throughout the period of the study. Upon inspection of errors, the following three classes of production errors were identified: (a) intertrial production variability, (b) context-sensitive substitutions, and (c) context-free systematic substitution patterns, or articulatory processes. A decrease in production variability and in the occurrence of articulatory processes with age generally coincided with a gradual improvement in accuracy of production. However, substitutions of lower vowels for /I/ were persistent, and the pattern was observed even at 30 months of age. Individual variation was also evident in the production accuracy, the substitution patterns, and the manner of articulatory improvement.

Robb and Bleile (1994) studied the speech sample 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 showed that:

- The number of consonants in their inventories increased over time
- The number of consonants used in 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

Dodd and So (1995) studied phoneme repertoire and phonological error pattern used by 268 Cantonese children aged 2.0 to 6.0 as well as a longitudinal study of tone acquisition by four children aged 1.2 to 2.0. Procedure included was picture naming/ imitation/ storytelling. Fifty seven words used for picture naming task. These words sampled two examples of all Cantonese vowels, tones, and initial and final consonants. Results indicated that

- Children acquiring Cantonese make few vowels and tone errors, and seem to have mastered these aspects of their system by two years of age
- Un aspirated plosives and nasals were acquired before fricatives and affricates; un aspirated phonemes were acquired before their aspirated partners
- Both boys and girls acquired all 17 syllable-initial consonants and the two clusters by 5 years and all syllable-final consonants by 4.6. The girl's acquisition initially proceeded more rapidly than that of the boys, but by four years both had mastered 15 syllable-initial phonemes
- When compared to that of children learning English language, both the groups first acquired nasals, glides, bilabial and alveolar stops followed by /h/ and /k/. Aspirated plosives, affricates and voiced fricatives were acquired later
- However, Cantonese speaking children appeared to complete their phoneme repertoire more quickly than English-speaking children. 75% of Cantonese children completed their acquisition by 3.6 whereas 75% of English-speaking children do not complete their phoneme acquisition until after 4 years according to Prather, Hedrick & Kern (1975)

The age levels for the speech sound development according to various researchers in English are listed in Table 1.

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 1: *Age levels for the speech sound development according to various researchers in English. '*' indicates the mastery criteria considered*

Articulatory acquisition in Indian languages

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 results indicated that

- Among the consonants, the stop consonants were 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 retroflex sibilants
- Identical clusters were acquired earlier than the non identical clusters
- The children substitute identical clusters for the non-identical clusters of the adult speech. Sometimes a single sound is substituted for the non-identical clusters.
- Even at the completion of the study the children(2.11 years) were found to be in the process of acquiring phonemic contrast

Tasneem Banu (1977) studied articulatory acquisition in 180 Kannada speaking children in the age range of 3 - 6.6 years selected randomly from Mysore city. They were administered the diagnostic Kannada articulation test individually and it was scored on the basis of frequency of occurrence of a 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 to 5.6 years) and VI (5.7 - 6.0yeras) and also between VI (6.0 - 6.6 years) and VII (6.7 - 7.0 years)

- A definite pattern of acquisition was found and there was no significant difference between the scores of males and females
- The fricative /h/ was not acquired even at 6.6 years
- The children acquired most of the sounds earlier than English speaking children

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 Kannada diagnostic articulation test by Babu, Bettagiri and Rathna (1972) was administered to all the children. The findings revealed that

- There was a definite pattern of acquisition and all the children acquired the articulatory skills faster compared to the Western studies. Girls outperformed the 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 3-4 years the consonant /k/, /g/, /t/, /ʧ/, /d/, /n/, /p/, /b/, /j/, /v/, /s/ and /h/ were acquired by both boys and girls in the initial and medial positions.
- The acquisition of clusters just began in both groups by 4 years.
- By 4-5 years of age, boys acquired all the vowels and diphthongs including /au/. Girls acquired the consonant /ʃ/ in both initial and medial positions while the boys acquired /r/ and /ʃ/ by 5-6 years

- Girls were found to articulate triple consonant blends correctly by 6 years. But only 60% of the males of seven years had acquired the articulation of triple consonant blends

Usha (1986) studied the articulatory acquisition in 180 Tamil speaking children in the age range of 3 - 6 years. They were administered Tamil articulation test. Articulation development for a particular sound was assumed to be completed, if 90% of the children produced them correctly. The results indicated that

- There was a significant difference between males and females in terms of articulatory skills. Females exhibited superior articulatory skills compared to the male population in all the groups
- All the vowels and most of the consonants except /ʂ/, /ɭ/ and /r/ were acquired by the age of 3 years
- The fricative /ʂ/ was not acquired even at 6 years
- All the stops and nasals were acquired by the age of 3 years.
- Among laterals /l/ was acquired by 3 years, /ɭ/ was acquired earlier but not consistently produced till 6 years of age , and /l̠/ was not acquired even at the age of 6 years
- The flap /r/ was acquired in the initial position at the age of 5 years , but not in the medial and final positions until the age of six
- The children acquired most of the sounds earlier when compared to Western studies

Arun Banik (1988) conducted a study on screening test of articulation and discrimination on 165 Bengali speaking school going children in the age range of 2 - 8 years. 118 words were selected for the articulation test and 22 minimal pairs were considered for the phonemic discrimination test. The screening articulation test which included 118 words was administered individually for each child. The results indicated that

- There was a definite pattern in the acquisition of articulation. The children acquired most of the sounds earlier than English speaking children
- The differences between males and females in terms of articulatory skills were found to be significantly different. Females exhibited superior articulatory skills when compared to male subjects in all the age groups
- All the vowels were acquired by 2.5 years
- Most of the consonants were acquired by 3 years except fricative /ʃ/, flap /r/, trill /r/ and some of the clusters like /kr/, /ksha/, /sra/, /gl/, /bra/, /st/, /skr/

Padmaja (1988) developed the test of articulation and phonemic discrimination in Telugu and studied the acquisition of sounds in 160 Telugu speaking children in the age range of 2½ -4½ years. The results indicated that

- All vowels and most of the consonants except /r/, /s/, /ʃ/, /ṭ/, /ḍ/ and aspirated stops were acquired by 2.5 years of age
- All the nasals were acquired by 2.6 years of age

- The phonemes such as /s/, /r/ and aspirated consonants were acquired by 3.3 years of age and /l/, /ḷ/ and /ṣ/ by 3.6 years of age

- The phonemes such as /ṭ/, /ʃ/ and clusters were acquired by 3.5 years of age

Maya (1990) developed an articulation test battery in Malayalam which incorporated 86 words including all phonemes in Malayalam. The test was administered to 240 normal children in the age range of 3-7 years for obtaining the normative data.15 males and 15 females from each sub group (3.0 - 3.6; 3.7 - 4.0; 4.0 - 4.6; 4.7 - 5.0; 5.0 - 5.6; 5.7 - 6.0; 6.1 - 6.6; 6.7 - 7.0) were selected. The data for each group was statically analyzed. The results indicated

- The performance varied from one group to another. The articulation score was directly proportional to the age in that the score increased as age increased. However, even at the age of 7 years, 100 % score was not obtained
- When the total score of males and females were compared it was found that the females had greater scores in all the age groups except 3.7 to 4.0 years
- All the vowels were acquired by age 3
- Most of the consonants were acquired by age 3 except fricatives /s/, lateral /l/, trill /R/, flap /r/, and the aspirated phonemes
- The first acquired phonemes were un aspirated stops followed by fricatives, affricates and aspirated stops
- Compared to other studies, the articulatory development in Malayalam speaking children were earlier than non Malayalam speaking children

- They acquired the articulation of /s/, /r/, /l/, /f/, /c/ and /j/ at an earlier age of 3-3.6 years. While the un aspirated stops are acquired early (3 - 3.6 years), aspirated stops were acquired as late as 6 - 6.6 years

In the recent past, some researchers have attempted to revalidate the existing norms in the Indian languages. Prathima (2009) studied articulatory acquisition in Kannada speaking children to update the norms for the Kannada Articulation Test developed in 1972. Kannada Diagnostic Articulation test was administered to 120 children in the age range of 3 - 4 years. They were divided into 2 age groups (3 - 3.6 years and 3.6 - 4 years) with six months age interval. The mastery criteria for acquisition considered were 75% and 90% for the children producing phonemes of Kannada correctly. The total number of test items included was 62. Vowels and diphthongs were tested only in the initial position, consonants and clusters were tested in the initial and medial positions. Aspirated sounds were not tested as the test did not contain them. The results indicated that

- Children in the study acquired most of the sounds at a younger age compared to earlier studies in Kannada and English. There was no significant difference between the age groups (i.e. 3 - 3.6 vs. 3.6 - 4 years) as well as across gender

- Among the boys, all the vowels and diphthong /ai/ were acquired by the age of 3-3.6 years, diphthong /ou/ was acquired by the age of 3.6 - 4 years and most of the consonants were acquired by 90% of the children by the age of 3.6 - 4 years. However, /r/ and /h/ were exceptional, in that /r/ was acquired by 90% of the children

in medial position and not in the initial position and /h/ was not acquired even by 75% of the children by the age of 4 years.

- 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.

Divya (2010) studied the articulatory acquisition in Malayalam to obtain the current norms for the Malayalam Articulation Test (Maya, 1990) in the age range of 2- 3 years and to establish the ages at which 75 % and 90 % of the children produced the phonemes of Malayalam correctly. The Malayalam diagnostic articulation test was administered to 120 (60 males and 60 females) children in the age range of 2 - 3 years. Subjects were divided in to 4 groups with an inter-age interval of 3 months (2 - 2.3 years, 2.3 - 2.6 years, 2.6 - 2.9 years and 2.9 - 3 years). The test comprises of 10 vowels, 38 consonants and eight consonant clusters. The results were as follows

- All the vowels tested were found to be acquired by the age of 2.3 years itself. The exception was /u/ and /u:/. These two vowels reached 90% criteria by the age of 2.6 years.
- Some of the consonants such as /ŋ, /n/, /b/, /m/, /p/, /-nt/, /-t̪/, /-nth/, /-cj/, /-nd/ and /ʧ/ were acquired by 90 % of the children in all the positions tested by the age of 2.3 years itself.

- By the age of three years, the phonemes /k/, /ʤ/, palatal nasal/ɲ/, /g/, /v/, /-t̪y/, /ɭ/, /t/, /ɖ/, /t/, /d̪/, /j/, /ʧʰ/,/-nk/, /ʈ̪ ʰ/ and /ʈ̪/ were also acquired in all the positions tested by 90% of the children.
- None of the clusters reached the 75 % criteria by the age of 3 years; however one boy in the age range of 2.9 to 3 years produced /ʈ̪ra/, /sʈ̪a/ and /ska/ correctly in the medial position.
- Considering place of articulation, children acquired bilabials, labiodentals, dentals and velars first compared to alveolars, palatals, retroflex and glottal sounds.
- Considering the manner, mainly the fricatives, trill /R/, lateral /l/ and aspirated /p^h/ did not reach the criteria by 3 years also. Unaspirated sounds were acquired earlier compared to aspirated sounds.
- Both male and female children are following the same developmental trend for articulatory acquisition.

Similarly, Usha (2010) updated the articulatory norms for typically developing Telugu speaking children in the age range of 2-3 years using the Telugu Test of Articulation and Discrimination (Padmaja, 1988). The study intended to establish the ages at which 75% and 90% of the children produce the phonemes of Telugu correctly. It was administered to 120 typically developing Telugu speaking children in the age range of 2-3 years. They were subdivided into 4 age groups (2-2.3 years, 2.3-2.6 years, 2.6-2.9 years and 2.9-3 years) with three months age interval. 15 boys and 15 girls (30 subjects) for each group were selected randomly from Hyderabad city in the state of Andhra

Pradesh. 10 vowels were tested in all the three positions, 34 consonants and four clusters were tested in the initial and medial positions. The total number of test items was 80. The results indicated that

- All the vowels and nasals were acquired by 90% of the children by the age of 2-2.3 years and dipthong /ai/ reached 90% criteria by 2.6-2.9 years whereas /ou/ reached 90% criteria by 2.9-3 years.
- All the fricative continuants, laterals and plosives except the aspirated and retroflex stops were acquired with 90% accuracy by 2.3-2.6 years. The retroflex stops reached 90% criteria by 2.6-2.9 years whereas the aspirated stops were acquired only by 75% of the children by 2.9-3 years.
- The fricatives /s/ reached 90% criteria by 2.9-3 years and glottal /h/ by 2.6-2.9 years whereas palatal fricative /ʃ/ reached 75% criteria in medial position but not in the initial position by 2.9-3 years.
- The affricate /tʃ/ was acquired by 90% of the children by the age of 2.7-2.9 years but /dʒ/ reached only 75% criteria by 2.6-2.9 years and was not acquired by 90% of the children even by the age of 3 years.
- The retroflex and alveolar flaps /r/ and /ɽ/ were acquired by 75% of the children by the age of 2.9-3 years only in the medial position.
- None of the clusters tested reached 75% criteria even by 3 years of age.
- Though females exhibited superior articulatory skills compared to males in all the age groups on overall comparison, the difference was not statistically significant.

Deepa (2010) re-standardized the Kannada diagnostic articulation test by administering the test on two hundred and forty pre-school and school going children in the age range of 2-6 years. The results indicated that

- Girls had significantly better scores compared to boys.
- A definite pattern in the acquisition was found
- The fricative /h/ was not acquired even at 6 years of age by 75% of the children.
- All the vowels and diphthongs were acquired by 90% of the children by the age of 2 years
- Most of the consonants were acquired by the age of 2.6 years except /tʃ/, /dʒ/, /ʈ/, / ɖ/, / ŋ/, /r/, /l/, /ʃ/, /s/, /h/, ɭ/ and clusters
- According to the place of articulation, bilabials, labiodentals and dentals were acquired much earlier than retroflex, palatal, velar and glottal sounds

  Tables 2 and 3 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 (Beng) *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 2: *Shows age levels for speech sound development in Indian languages '-' indicates consonants not acquired. Empty space indicates speech sound not tested.'*' indicates the mastery criteria considered*

Speech Sounds	Maya '90 (Mal) *75%	Divya '10 (Mal) *75%	*90%
/m/	3-3.6	2-2.3	2-2.3
/n/	3-3.6	2-2.3	2-2.3
/ŋ/	3-3.6	2-2.3	
/p/	3-3.6	2-2.3	2-2.3
/f/	3-3.6	-	2.6-2.9
/h/	3-3.6	-	-
/k/	3-3.6	2-2.3	2-2.3
/b/	3-3.6	2-2.3	2-2.3
/d/	3-3.6	2-2.3	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	2-2.3	2.3-2.6
/t/	3-3.6	2-2.3	2.3-2.6,
/v/	3-3.6	2.3-2.6	2-2.3
/l/	3-3.6	-	2-2.3
/j/	3-3.6	2-2.3	2-2.3

Table 3*: Shows age levels for speech sound development in Malayalam according to different authors '-' indicates consonants not acquired. Empty space indicates speech sound not tested. '*' indicates the mastery criteria considered*

2) Acquisition of Consonant Clusters

The acquisition of consonant cluster has received little attention even though the consonant cluster is a common feature of speech. Its acquisition is one of the most protracted of all aspects of children's speech development, and the production of consonant clusters is one of the most common difficulties for children with speech

impairment. Consonant clusters occur when two or three consonants occur in a sequence in a word. Consonant clusters are difficult for children to produce, and they are not typically mastered until after 3 years of age (Smit, Hand, Freilinger, Bernthal, & Bird, 1990).

Children usually progress through a number of stages till the final correct production. These stages in the acquisition of clusters were first formalized by Greenlee (1974). In the first stage of cluster development, the entire cluster is deleted—for example, desk - [de]—although this is fairly rare. The second stage of cluster development involves reduction to a single consonant—for example, snake - [neIk] is very common and often persists for several months or more. In the 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]. Although children tend to move through a similar progression when acquiring consonant clusters, not all children pass through all these stages for each consonant cluster. Furthermore, there is usually some overlap in the various stages of cluster production such that reduction to a single consonant may be the predominant production pattern for one cluster type at the same time that a different cluster type typically undergoes substitution of one of its consonants (Ingram, 1976).

A review of the existing literature revealed scanty information on the development of consonant clusters. Research on the acquisition of consonant clusters in English has focused primarily on word-initial clusters. (e.g. Templin, 1957; Smit, 1993

Gierut, 1999; Barlow, 2001; McLeod, van Doorn & Reed, 2001; Pater & Barlow, 2003; Gnanadesikan, 2004).

Templin (1957) conducted a study on mastery of initial and final consonant clusters. The criterion for acquisition considered was when 75% of the subjects produced them correctly. Templin's findings revealed that

- By the age of 4.0, 75% subjects correctly produced /s + stop/, /s + nasal/, /stop + liquid/ and /stop + w/ initial clusters.
- Fewer final clusters have been mastered by the same age group, and the acquisition in terms of sound classes was less predictable.
- Mastery for 3 member clusters and clusters containing a fricative continues through the age of 8.

Stoel-Gammon (1985) carried out a longitudinal study collected at 3 months interval from 34 children between 9 and 24 months of age. She reported that a few consonant clusters were beginning to appear by 24 months and word initial clusters occurred more frequently than word final clusters.

Smit (1993) collected data on word-initial cluster production among 1049 children from the ages of 3 to 9 years residing in Iowa and Nebarska, the following results were found:

- On fourteen of the twenty seven initial clusters tested, a small percentage of children in the 8-9 year old group reduced two consonant clusters to a single element. These

clusters included /pl/, /kl/, /tw/, /gl/, /sl/, /kw/, /tr/, /dr/, /fr/, /sw/, /sm/, /sn/, /st/ and /sk/

- The consonant clusters /br/ and /θr/ demonstrated a higher frequency of consonant cluster reduction for children from ages five to nine years
- For the 5;6 to 7;0 year olds, consonant clusters that fell at 75% or below accuracy included /sl/, /br/, / θr/, /skw/, /spr/, /str/ and /skr/
- Epenthesis, or schwa insertion in consonant clusters, occurs frequently up to age eight. The nine year olds exhibited schwa insertion rarely

Table 4 shows the age of acquisition of word initial consonant clusters according to different Western authors.

Acquisition of word initial consonant clusters (75% criteria)				
Clusters	Smit et al. (1990)		Tempiln (1957)	Higgs (1968)
	Females	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	7;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 4a: *Acquisition of initial clusters according to different Western authors*

Lleo´ and Prinz (1996) examined longitudinal data from five German-speaking children between the ages 0;9–2;1. These children acquired word-final clusters several months before word-initial clusters, and word-final clusters were more accurately produced than word-initial clusters, although this difference was not significant. Levelt et al. (2000) examined syllable structure development in longitudinal data from 12 children learning Dutch (1;0–1;11 years at the outset of their study). They found that nine of the children acquired CVCC syllable structures before CCVC structures, while the remaining three children showed the reverse order of acquisition. These two studies point to a tendency for word-final clusters to be acquired before word-initial clusters, at least in these Germanic languages.

Levelt and Schiller (2000) have shown a relationship between the order of acquisition of different syllable types in Dutch and their frequency in child-directed speech. The children in their study acquired more frequent syllable types earlier than less frequent ones.

McLeod, van Doorn, and Reed (2001) examined consonant cluster production, looking specifically at the relationship between general trends and individual differences as children acquire these sounds. The spontaneous speech of 16 normally developing Anglo-Australian 2-year-olds was elicited monthly for 6 months, and the corpus of 96 samples was examined using independent and relational phonological analyses. Data demonstrated that 2-year-olds were able to produce a range of consonant clusters in word-initial and word-final position, but few of the younger participants could produce consonant clusters correctly. Only half of the participants showed an increase in the percent of consonant clusters produced correctly over the 6-month period; however, their developing phonological maturity was revealed in the increase in the range and diversity of their repertoire of consonant clusters and by their closer approximations to the adult target.

Mc Leod et al in 2001 reviewed the literature from the past 70 years on children's normal acquisition of consonant clusters and revealed 10 aspects of normal development that can be used in speech language pathologist's assessment and analysis of children's speech. They are

- Two-year old children can produce consonant clusters, but these clusters may not be of the same form as the ambient language.
- Word-final consonant clusters generally appear in inventories earlier than word-initial clusters. Children's production of word-final consonant clusters is increased by the emergence of grammatical morphemes (e.g., plurals and past tense) and consequently the creation of morpho-phonological consonant clusters (e.g., [-ts] as in cats).
- Two-element consonant clusters are generally produced and mastered earlier than three element clusters.
- Consonant clusters containing stops (e.g., /pl/, /kw/) are acquired generally before consonant clusters containing fricatives (e.g., /st/, /θr/).
- Young children typically delete one element of a consonant cluster (cluster reduction), and this deletion may be explained by principles of markedness and sonority.
- Homonymy occurs in young children's attempt to produce consonant clusters. It frequently occurs as a result of cluster reduction; however, homonyms can also occur as a result of cluster creation.
- There are a number of other non-adult realizations of consonant clusters; the most common is cluster simplification, with others including epenthesis and coalescence. Metathesis is rare.
- The acquisition of consonant clusters is gradual, and there is a typical developmental sequence.

- There is an interrelationship between cluster reduction, cluster simplification and correct productions of consonant clusters. Initially, most children reduce consonant clusters. Overtime, the occurrence of cluster reduction diminishes, where as the occurrence of cluster simplification increases. Simultaneously, the occurrence of correct productions increases, until eventually production is mastered.
- Despite there being a typical developmental sequence, the acquisition of consonant clusters is marked by reversals and revisions with considerable individual variation.

Zamuner, Gerken and Hammond (2004) used a nonword repetition task to investigate the role of the transitional probabilities of adjacent segments in the speech of English-speaking two-year-olds. The children in this study produced codas more accurately in non-words with high transitional probablilities, e.g. [sIg], than in non-words with low transitional probablilities, e.g. [*h*æg], thus showing sensitivity to the frequency with which segments co-occur.

Kirk and Demuth (2005) studied asymmetries in the acquisition of word initial and word final consonant clusters. The participants included were 12 two year old monolingual English speaking children in Rhode Island. The test items included picturable, monosyllabic English nouns and color adjectives with a consonant cluster in word initial position or word final position. The following clusters were targeted: word initial /s/ + stop, word initial /s/ + nasal, Word initial stop + /l/, word initial stop + /r/, word final nasal + /z/, word final stop + /s/, word final nasal + stop, word final /s/ + stop. Spontaneous productions and imitation were used to elicit the responses. All data were

transcribed off-line by two independent transcribers using broad phonetic transcription. When a child's response matched the standard adult pronunciation, it was classified as being produced correctly; otherwise, it was classified as an error. Following were the examples of productions classified as errors. [gʌv] for glove /glʌv/ (reduction), ["fwIn] for swing /swIn/ (substitution), ["fun] for spoon /spun/ (coalescence), ["toots] for toast /toost/ (metathesis), ["bvlu] for blue /blu/ (non-schwa epenthesis) and ["dE] for desk /dEsk/ (deletion). The results showed that word final stop + /s/ clusters and nasal + /z/ clusters were produced more accurately than word initial /s/ + stop clusters. Neither structural nor frequency factors were able to account for these findings.

Kirk (2008) studied 11 typically developing children aged between 1;5–2;7 who were from monolingual English-speaking homes to provide comprehensive examination of substitutions that occur at Greenlee's (1974) 3rd stage of cluster development. At this stage of cluster acquisition, children are able to produce the correct number of consonants but with one or more of these consonants being substituted for another. Consonant clusters in both word-initial and word-final position were elicited using a picture identification task. Although previous studies have suggested that most cluster substitutions can be predicted from the errors children make on the corresponding singletons, findings indicate that almost one third of substitutions in clusters are not predictable in this way. Furthermore, the majority of unpredictable substitutions produced by the children in this study resulted in clusters in which both consonants in the cluster shared the same place and/or manner of articulation. Thus, almost 70% of unpredictable

substitutions appear to be motivated by assimilation within the cluster. i.e. Ease of articulation provides the most convincing explanation for within-cluster assimilation.

Mc Leod and Hewett (2008) aimed to describe the extent of variability within children in the production of consonant clusters. Sixteen typically developing children aged between two and three years were studied monthly for 6 months. Spontaneous speech samples were used to construct variability profiles for repeated productions of words containing consonant clusters. Results showed variability between and within individuals prominently. i.e. half (53.7%, range 42.4-77.6%) of all the words that were repeated were produced variably. As the children became older, they increased the accuracy of their productions overall; however, variability between and within individuals continued to occur.

Mc Leod and Arciuli (2009) studied the acquisition of /s/ and /r/ word-initial consonant clusters across two elicitation modalities. Seventy-four typically developing children aged 5-12 years produced 2- and 3-element /s/ and /r/ consonant clusters in word-initial position. Stimuli were presented pictorially and as written words in separate trials. Results showed overall 94.5% of the consonant clusters were produced correctly. Two-element /r/ clusters were 94.0% correct, 2-element /s/ clusters were 96.8% correct, and 3-element clusters were 92.0% correct. The age of acquisition was typically younger than established by previous researchers. The characteristic non-adult production of /s/ consonant clusters was the substitution of /s/ with interdental or lateral phonemes, and of /r/ consonant clusters the substitution of /r/ with /w/. The last consonant clusters to be

mastered were: /thr/, /str/, /spr/ and /skr/. There were no significant differences in error rates across the modalities; although younger children required significantly more prompting when naming written words. i.e. the accuracy of production was not influenced by the elicitation modality.

Demuth and McCullough (2009) examined French-speaking children's longitudinal acquisition of clusters. Analysis of spontaneous speech productions from two French-speaking children between one and three years confirmed the earlier acquisition of initial clusters, even when sonority factors were controlled. The findings suggest that French-speaking children acquire complexity at the beginning of words before complexity appears word-finally.

Indian studies on acquisition of consonant clusters

Studies on the development of consonant clusters in Indian languages are scanty. Tasneem Banu (1977) studied articulatory acquisition in 180 Kannada speaking children in the age range of 3 - 6.6 years and found that the blends /bl/, /kr/ and /dr/ was acquired by 4.7-5 years of age; /sk-/,/-sk/, /-ks/ by 5.1-5.6 years and /-str/ by 5.7-6 years using 75% acquisition criteria. None of the other clusters were acquired until 6.6 years.

Nirmala Chervela (1981) attempted to trace the acquisition of consonant clusters in medial position by Telugu speaking children and was found that reduction, substitution and assimilation played major roles in cluster acquisition.

Padmaja (1988) tested the acquisition of clusters such as /bla/, /sla/, /ksha/, /sra/ in 160 Telugu speaking children in the age range of 2½ -4½ years and noted that all these were acquired by 3.6 years.

Maya (1990) reported that the consonant clusters were emerging only at the age of 4.7 years and the acquisition continued till the age of 7 years. She reported that /nḍ̪ra/, /pra/, /kra/ and /ṯ̪ra/ were acquired earlier by the age of 5 years followed by /sṯ̪a/ and /ska/ by 6 years, /sṯ̪ra/ by 6.5 years and the last acquired cluster was /kṣa/ by 7 years of age.

Vani Rupela (2006) studied the phonotactic development in Kannada speaking children in the age range of 0-5 years 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 sound clusters in the medial position were found to stabilized from 42 – 48 months onwards

Neethi Priya (2007) studied the phonotactics in 60 typically developing Telugu speaking children in the age range of 3-6 years. Spontaneous speech samples were

obtained. The results indicated that there is a gradual change in the percentage of occurrence of non-geminated clusters from 3 to 6 years of age supporting a developmental trend in the use of non- geminated clusters.

- Medial clusters occurred predominantly with 60- 70 % of frequency and within medial clusters, geminated clusters occurred more frequently with a percentage of occurrence between 30-40%. This frequency was maintained across all age groups
- Medial non-geminated clusters occurred with a frequency of 45-55%. Nasal + homorganic stops (/nt/, nd/, /nk/, /mt/ etc) were predominantly noticed in the samples followed by fricatives + plosive combination (-st-).
- Initial and final clusters occurred with a frequency of less than 3% and typically occurred in loan words across all age groups. Among them frequently used words were ‘school’, ‘slate’, ‘class’, ‘first’, ‘park’, ‘scooter’.
- Three consonant clusters occurred medially with combination of nasal + stop + liquid combination (-ntl). However frequency of such clusters was less than 3 % and fell under ‘rare’ category across all the age groups from 3-6 years.

Prathima (2009) tested ten consonant clusters in Kannada, four in initial and six in medial position. In girls, /ski/ had 90% acquisition, /ksha/ and /ble/ had 75% acquisition by 3-3.6 years. An unusual observation was that clusters /sku/ and /ksha/ was found to be acquired by 75% of children in the younger age group (3-3.6 years) and the percentage reduced in the older age group (3.6-4 years). i.e. /sku/ was achieved 70% and /ksha/ 73.33%. A similar observation was found among boys in whom the clusters /ksha/ and

/ble/ were acquired by the age of 3-3.6 years by 75% of the children and reduced in percentage by 3.6-4 years, /ksha/ (73.33) and /ble/ (73.33%). Clusters like /ski/ and /kra/ was acquired by 90% of the boys by 4 years of age.

Usha (2010) administered Telugu Test of Articulation and Discrimination (Padmaja, 1988) to 120 typically developing Telugu speaking children in the age range of 2-3 years. In that 4 clusters were tested**,** 2 clusters (/kʃa/, /ʃra/) were tested in medial position and 2 clusters (/bl/, /sk/) in initial position. None of the clusters were acquired with 75% accuracy even by 3 years of age in both boys and girls. All the clusters crossed approximately 50% criteria by 3 years.

Divya (2010) studied the acquisition of eight consonant clusters (/nḏ̪ra/**,** /kra/, /ṯ̪ra/, /sṭ̪a/ and /sṯ̪ra/ that occur in medial positions and /pra/, /ska/ that occur in both the initial & medial positions.) in Malayalam using The Malayalam Articulation Test (MAT, Maya, 1990). The results indicated that none of the clusters tested reached 75% criteria by 3 years of age. Only a single boy in the age range of 2.9 - 3 years produced /ṯ̪ra/, /sṭ̪a/, and /ska/ in medial position. However during data collection it was observed that 60 % of the children were substituting one of the consonants of the clusters by 2.9 years. Therefore it was inferred that by 2.9 years children begin to produce clusters but they have substitution errors. The clusters with substitution errors seen in this study were /ʃṭ̪a/ for /sṭ̪a/ and /ʃka/ for /ska/. That is, a palatal fricative was used for a dental fricative. This

finding was convincing because by 2.9-3 years, palatal /ʃ/ was achieved by 73.33 % of the children whereas dental /s/ was achieved by only 53.33 % of the subjects. Hence it was inferred that in the process of acquisition of clusters, the early achieved palatal phoneme was used as a substitution.

Deepa (2010) studied 8 clusters (/st/, /sku/, /dra/, /rtʃi/, /kra/, /kʃa/, /ble/ and /skru/) in its naturally occurring positions in Kannada. Clusters /st/, /dra/ were tested in initial and medial positions. The results were as follows

- Clusters /sku/ and /st/ were acquired by both boys and girls by 3-4 and 4-4.6 years respectively.
- Similarly /skr/ and /dra/ were acquired by 4-4.6 and 5-5.6 years by both boys and girls.
- /dra/ in medial position was acquired earlier than in initial position.
- Cluster / rtʃi/ was not acquired by 90% of the children even at the age of 6 years.

Table 4b shows the age of acquisition of consonant clusters in Indian languages according to various researchers

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						
-sʈ-	6.0	-sʈ-	>3						
-sʈr-	6.5	-sʈr-	>3						

Table 4b: *Age of acquisition of consonant clusters in Indian languages according to various researchers. '*' indicates the mastery criteria considered*

The review of the existing literature revealed relatively little information on the development of consonant clusters in Indian languages and indicates the need for more research in this area.

3) Tests for Articulatory Acquisition

A child is said to have an articulation delay when the sounds are acquired in the expected sequence but the developmental errors persist beyond the age we expect. According to Mc Donald (1980)' Misarticulations are the production of speech sounds

which are not adequate acoustic representations of the phonological sequence of the language or dialect. So, in order to evaluate the articulation of these patients, tests of articulation are essential. Traditionally an articulation test has been defined as a "technique employed to measure the general phonemic capacity of the individual" (Van Riper & Irwin, 1958). However, articulation tests can be used in a variety of ways:

- To set up norms for the development of phonology
- To determine the phonemic proficiency
- For purpose of screening
- For diagnosis
- To assess the developmental progress
- For prediction of improvement in speech therapy
- To plan speech therapy carefully
- To make prognostic statements relative to phonological change with or without intervention/ therapy

That is, the purpose of articulation test varies and hence the nature and scope of the articulation test inventory varies. Articulation tests can be of 4 types: (1) Screening Test, (2) Diagnostic Articulation Test, (3) Deep Test of Articulation and (4) Predictive Screening Test of Articulation

Screening tests are used to identify the clients who are deviant in articulation. It consists of activities or tests that identify individuals who merit further evaluation. A screening procedure does not collect nearly enough data to establish a diagnosis; it only demonstrates the need for further testing. Screening tests can be formal or informal.

Formal measures include elicitation procedures which often have normative data and cut off scores. Informal measures are typically devised by the examiner and may be directed toward a particular population or age level

Predictive screening test of articulation are responsible to predict whether or not a child will outgrow the speech defect with age. It helps in detecting whether therapeutic intervention is required or not.

Deep tests of articulation tests the client's ability to articulate phonemes in specific phonetic environment. Here, each sound is tested in all the possible phonetic contexts i.e. ., a sound is tested in a variety of phonetic contexts as the sound is followed and preceded by each of the other consonants. The purpose of deep test of articulation is to permit evaluation of speech sounds as audible end products of a series of overlapping, ballistic movements to provide a test long enough to permit observation of the degree of variability present in the speaker's production of the sound.

Diagnostic articulation test gives us detailed description and analysis of a child's articulation. A diagnostic test of articulation should provide detailed information about a child's ability to produce a wide range of speech sounds in a variety of positions and phonetic contexts. (Templin & Darley, 1960). They have also suggested that the diagnostic tests may be used in the following ways:

- To compare the individual's results with the norm

- To analyze the error types (omissions, substitutions and distortions)
- To determine the consistency of misarticulation
- To determine whether the errors are corrected when stimulated with the correct production of the sound
- To determine the resistance to training as shown by those sounds most consistently erred
- To identify those factors related to the misarticulations (such as distinctive features of errors which are common to most phonemes) and
- To determine the relationship between sound errors on the test and sound errors in connected speech

Over the years, many investigators have developed and established norms using various articulation tests. Tables 5 and 6 (a, b, c & d) review various diagnostic tests available in Indian languages and in English respectively. In all the tests described in Table 4, use of speech sounds in all positions of the words is evaluated and the scoring is provided based on the frequency of occurrence of the correct responses.

Sl No	Author	Year	Name of the test	Language	Age Range/No of subjects
1	Babu, Ratna & Bettagiri	1972	Kannada Articulation Tesr (KAT)	Kannada	3-6.6years (180)
2	Usha	1986	Tamil Articulation test (TAT)	Tamil	3-6years (180)
3	Kacker, Basavaraj, Thapar, Menon & Vasudeva	1989	Test of Articulation in Hindi (HAT)	Hindi	3-6years (180)
4	Arun Banik	1988	Articulation test in Bengali (screening and discrimination test)	Bengali	2-8years (165)
5	Padmaja	1988	Articulation test in Telugu	Telugu	3-6years (160)
6	Maya	1990	Articulation test battery in Malayalam (MAT)	Malayalam	3-7 years (240)
7	Deepa	2000	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	3-3.6years (30)

Table 5**:** *Articulation tests in various Indian Languages.*

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 & Logeman n	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.	3-8 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)

Table 6a: *Standardized Articulation tests in English*

Sl No	Author	Year	Name of the test	Langu-age	Test Description/ skills assessed	Score provided	Age Range/ No of Subjects
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, 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)
8	Bankson and Bernthal	1990	Bankson-Bernthal Test of Phonology (BBTOP)	English	Assesses phoneme use in words. Standardized scores are provided for Word Inventory, Consonant Inventory, and Phonological Processes Inventory	Standard scores, and percentile rank scores are available	3–9 years (1000)

Table 6b: *Standardized Articulation tests in English*

Sl No	Author	Year	Name of the test	Langu-age	Test Description/ skills assessed	Score provided	Age Range/ No of Subjects
9	Kresheck & Tattersall	1993	Structured Photographic Articulation Test 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 are provided for both females and males	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 development al age equivalents; percentile rankings and standard scores (based on means and SD)	1.5 - 18 years. (5500)

Table **6c:** *Standardized Articulation tests in English*

Sl No	Author	Year	Name of the test	Langu-age	Test Description/ skills assessed	Score provided	Age Range/ No of Subjects
13	Secord & Donohue	2002	Clinical Assessment of Articulation and Phonology (CAAP)	English	Quickly 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 percentage of each of the 11 major phonological deviations described by Hodson (2004)	Pre-school and high school children

Table 6d: *Standardized Articulation tests in English*

4) Methods of testing articulation

Articulation of speech sounds is measured in spoken words and they are elicited in a variety of ways. In testing the articulation of preschool children and children in primary classes a measurement problem arises and most of the time they will have to be asked to repeat the test item after the examiner. Some investigators have reported that imitation does not have any effect on the articulatory responses of these children.

Templin (1957) used picture naming task, comparing the percent correct responses when children named the pictures spontaneously with the percent correct during

repetition task. She found no significant difference between spontaneous and imitatively produced speech. She also reported that similar results were obtained when the same sound is presented in different words. Anthony and others (1971) tested 3-5 year old children and reported no statistically significant difference in the results from the two methods. In 1977, Paynter and Bumpas also found no significant difference between scores for the two methods with 3 to 3.6 year old children. The imitative and spontaneous production of consonant clusters of 10 children in the age range of 2.3-3.8 was compared by Bond and Korte (1983) and found no apparent difference between the two modes of production. But the results of Siegel, Winitz, and Conkey (1963) and Kresheck and Socolofsky (1972) studies contradict with those of the above studies. They found that there is an effect on the articulation in the imitative method of item presentation responses of normal children. The imitative method produced more correct responses.

In view of these diverse findings, an equitable compromise on test procedure may be that the spontaneous method is preferable as a means of eliciting a representative sample from older children, but equivalent result may be expected from the two methods with younger children - probably through kindergarten and first grade. These findings also indicate the importance of the picture stimuli utilized to elicit responses.

Obtaining the speech sample

Speech sample can be obtained either using single word naming, connected speech or spontaneous conversation. Decisions regarding the selection of procedure revolve

around multiple dimensions, including time efficiency, ease of use and administration of the procedure in assessing a child's speech production. Clinicians and researchers alike have long been familiar with the general strengths and weakness of the two methods of speech elicitation.

a) Single word naming

Single word productions have been a common method for determining whether or not particular sounds are produced correctly by an individual. Single words provide a discrete, identifiable unit of production that examiners can usually readily transcribe. The efficiency of analyzing sound productions from single word samples has resulted in wide spread usage of such samples. The customary way to elicit single-word productions is through the administration of a single word articulation tests (sometimes called as a speech sound inventory) where the client names single words in response to picture stimuli. The commonly used speech sound tests are based on single word productions, and sometimes referred to as phonetic or speech sound inventory. Such instruments typically sample consonants (initial, medial and final positions of words), consonant clusters, and occasionally vowels and diphthongs. By focusing on particular word productions, the examiner knows what the child is attempting to say and the client will produce (or attempt to produce) a particular set of sound production. It is usually simple and easy to administer and the comparison between children or in one child longitudinally is possible, because data are based on a single measure. These measures may include both monosyllabic and multisyllabic words. The use of multisyllabic words

may make more demands on the child's productions and elicit more errors than would monosyllabic words or the words used in a child's own spontaneous speech.

b) Spontaneous speech

Spontaneous speech samples allow one to observe phoneme productions in a variety of phonetic contexts, to observe error patterns, and to judge the intelligibility of the speaker in continuous discourse. Sounds produced in connected speech may also be studied in relation to other factors such as speech rate, intonation, stress and syllable structure. In addition, it allows for multiple productions of sounds across lexical items and also other language analysis can also be done. But many individuals with severe phonological problems may be almost unintelligible, and it may be impossible or very difficult to reliably determine what they are attempting to say in a conversational speech sample. Also some children may be reluctant to engage in conversational dialogue with an adult they do not know and hence it will be difficult to collect the sample.

Stimulability refers to the client's ability to make a correct or improved production of a misarticulated sound when given a model or additional stimulation by the examiner. Stimulability has been repeatedly researched as a prognostic indicator of spontaneous remission and, on a more limited basis, of therapeutic responsiveness. Stimulability testing can be done of sounds in isolation, or in syllables, words, or sentences. Although currently there is no standard for what type of stimulation should be provided during stimulability testing, most examiners minimally assess the client's improved production after the clinician's model. However, other types of stimulation can also be used (visual cues, kinesthetic cues). The information obtained from

stimulability testing is clinically significant in that it helps the clinician identify the kinds of cues and prompts that can be used in therapy to facilitate correct production of a sound. Stimulability data are obtained because of their prognostic value.

Transcription and scoring procedures

The type of response recording system employed by the examiner will determine the type of analysis the clinician is able to do with the sample obtained. In the least sophisticated scoring level, phonological productions are simply scored as correct or incorrect, based on the examiner's perception of whether the sound produced is within the acceptable adult phoneme boundary for the sound. A second scoring level is to identify error productions as substitutions, distortions or omissions (deletions). The most common and the useful transcription system is the International Phonetic Alphabet (IPA), which includes a different symbol for each phoneme.

5) Articulation Test Battery in Malayalam

Maya (1990) developed an articulation test battery in Malayalam which included Diagnostic Picture Articulation Test in Malayalam, Deep Test of Articulation in Malayalam: Sentence Form and Predictive Screening Test of Articulation in Malayalam.

Diagnostic Picture Articulation Test in Malayalam was the most commonly used test. It incorporated 82 words including all phonemes in Malayalam. For that a list of 350

words having all phonemes of Malayalam in the naturally occurring positions were selected and was given for familiarity check to ten Malayalam speaking adults. Words which were marked as most familiar by 80% of the judges formed the items of the test and they were picturized. Fifteen clusters in their naturally occurring positions were also included. The test was administered to 240 normal children in the age range of 3-7 years for obtaining the normative data.15 males and 15 females from each sub group (3.0 - 3.6; 3.7 - 4.0; 4.0 - 4.6; 4.7 - 5.0; 5.0 - 5.6; 5.7 - 6.0; 6.1 - 6.6; 6.7 - 7.0) were selected. Responses were elicited through the visual presentation of picture cards. Responses were recorded on the response sheet as correct response (CR) substitutions (S) with the substituted sound, distortions (D) omissions (O) and other type of articulatory deviation (∩). Test-Retest-Reliability was tested by administering the test to sixteen children (one male and one female from each group) using the same procedure within a span of 2 months. Validity was checked by administering the same to four children having functional articulation disorder. The data for each group was statically analyzed. The results indicated

- The performance varied from one group to another. The articulation score was directly proportional to the age in that the score increased as age increased. However, even at the age of 7 years, 100 % score was not obtained
- When the total score of males and females were compared it was found that the females had greater scores in all age groups except 3.7 to 4.0 years
- All the vowels were acquired by age 3
- Most of the consonants were acquired by age 3 except fricatives /s/, lateral /l/, trill /R/, flap /r/, and aspirated phonemes

- The first acquired phonemes were un aspirated stops followed by fricatives, affricates and aspirated stops
- Compared to other studies, the articulatory development in Malayalam speaking children were earlier than non Malayalam speaking children
- They acquired the articulation of /s/, /r/, /l/, /f/, /c/ and /j/ at earlier age of 3-3.6 years. While the un aspirated stops are acquired early (3 - 3.6 years), aspirated stops were acquired as late as 6 - 6.6 years
- The test was found to be reliable and valid.

It is evident from the review of literature on articulation acquisition that the existing articulatory acquisition norms need to be revised over a period of time to go with the changed patterns of development. Present day children acquire speech sounds much earlier than before because of extensive stimulation and opportunities and therefore it is very important to re-establish the norms for the existing articulation tests.

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 5.0 -6.0 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 5 - 6 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/, /ʃaŋkə/, /pʰalam/, /ʧʰaːja/, /kaṯ̪ʰakaḷi/, /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 e.g. the word /di:pam/ was found to be outdated. Hence 5 new picturable words (/dipa:vali/, /de:vi/, /ɖo:ʃa/, /dili:p/ & /de:ham/) were selected. 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 /ɖo:ʃa/ was rated as very familiar by the judges and hence this word was selected as the target stimuli for the consonant /ɖ/ 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 are less. Judges also suggested the existing words as more 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 5 - 6 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 (5 - 5.3, 5.4 - 5.6, 5.7 - 5.9, 5.10 - 6.0 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 7 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 7: *Number of positions tested for the target phonemes (I–Initial, M–Medial, IM– Initial, Medial; MF – Medial, Final;IMF – 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 allotted 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 90% criteria for the consonant cluster acquisition were considered 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 were also tabulated and subjected to suitable statistical analysis using the 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

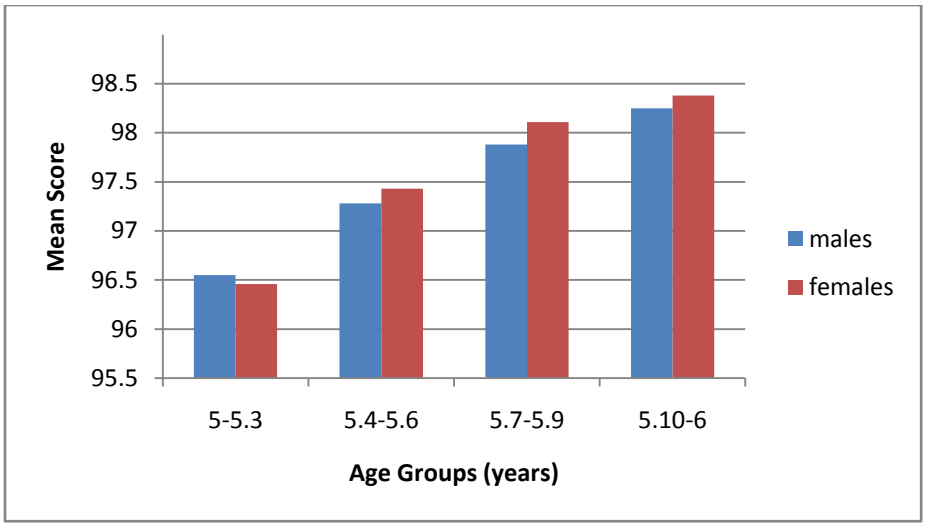
The aim of the study was to obtain norms for acquisition of articulatory skills in native Malayalam speaking children in the age range of 5 - 6 years. The modified Diagnostic Malayalam articulation test was administered to 120 typically developing Malayalam speaking children in the age range of 5 - 6 years. Subjects were divided into four groups with an inter age interval of 3 months (5 - 5.3 years, 5.4 - 5.6years, 5.7 - 5.9years, 5.10 - 6years). All the responses of each subject were recorded and analyzed and scores were allotted to the responses. The score for singleton consonants, clusters in initial position, clusters in medial position and the total score for each subject was calculated. The data obtained was subjected to appropriate statistical analysis.

In the present study, in order to calculate the mastery of the consonants and consonant clusters, two separate criteria were considered. The criteria for consonants were to calculate the age level at which 100% of the children produced all the sounds in the initial, medial and final positions and for consonant clusters , 90% of the children should correctly produce them in the initial and medial positions. This criterion was adopted because Divya (2010) reported that most of the singleton consonants acquire 90% mastery by 3 years and also the consonant clusters emerge by this age in Malayalam. Hence in the present study, as it considered an older age group of 5-6 years, higher mastery criteria were considered for consonants and consonant clusters.

Using descriptive statistics, mean and standard deviation of the articulatory scores were obtained for all the four age groups. This is presented in Table 8 and Graph 1 depicts the total overall articulatory scores (including vowels, singleton consonants and consonant clusters) for the four age groups. The maximum score expected is 100 for individual children. From Table 8, it can be noted that mean articulatory score for the youngest age group was 96.51 while the mean for the oldest age group was 98.32. That is, the scores increased as the age advanced. Also from Graph 1, it can be noted that girls had higher articulatory scores than boys in all the age groups except the lowest age group.

Gender	**Age**	**Mean (Std. Deviation)**	**N**
Boys	Group I (5.0- 5.3 years)	96.55 (1.27)	15
	Group II (5.4- 5.6 years)	97.28 (1.20)	15
	Group III (5.7- 5.9 years)	97.88 (0.81)	15
	Group IV (5.10- 6.0 years)	98.25 (0.85)	15
	Mean Total Score	97.49 (1.22)	60
Girls	Group I (5.0- 5.3 years)	96.46 (1.64)	15
	Group II (5.4- 5.6 years)	97.43 (1.16)	15
	Group III (5.7- 5.9 years)	98.12 (1.29)	15
	Group IV (5.10- 6.0 years)	98.38 (1.02)	15
	Mean Total Score	97.60 (1.47)	
Combined Scores	Group I (5.0- 5.3 years)	96.51 (1.44)	30
	Group II (5.4- 5.6 years)	97.36 (1.17)	30
	Group III (5.7- 5.9 years)	98.00 (1.07)	30
	Group IV (5.10- 6.0 years)	98.32 (0.92)	30

Table 8: *Overall mean articulation scores and SD (in parenthesis) in different age groups*



Graph 1: *Overall mean articulation scores in different age groups for males and females*

Two way ANOVA was carried out to find the significant difference in overall articulatory scores between different age groups (Group I: 5 - 5.3 years, Group II: 5.4 - 5.6years, Group III: 5.7 - 5.9 years and Group IV: 5.10 - 6 years). The results indicated that there was a significant difference [$F(3) = 13.618$, $(p < 0.05)$] across the age groups. The articulation score was directly proportional to age, in that the scores increased as the age advanced. Results of different age groups of children are discussed below.

Group I (5.0 - 5.3 years): When Group I was compared with the other three age groups, there was a significant difference with Group II, Group III and Group IV.

Group II (5.4 – 5.6 years): When Group II was compared with Group III and Group IV, there was a significant difference with Group III and IV.

Group III & Group IV (5.7 - 5.9 and 5.10 - 6 years): When Groups III and IV were compared there was no significant difference across them for the scores obtained.

The results indicated that there was a gradual increase in the development of articulatory skills during the period of 5 to 5.9 years following which there was no significant change in the articulatory developmental scores. All the vowels and most of the consonants were acquired by 100% of the children by 5- 5.3 years of age. The consonants not achieved by 100% of the children by 5- 5.3 years were the aspirated phonemes /ʧʰ/, /ɖ̪ʰ/, /ʈʰ/, /ʈ̪ʰ/, /bʰ/, /gʰ/ and /kʰ/ and also unaspirated dental /ɖ̪/ and glottal /h/ in the medial position. Most of the consonant clusters were acquired by 75% of the children by 5- 5.3 years of age

The findings of the earlier Western classical studies (Wellman'31, Poole'34, Templin'57, Mecham'62, Arlt and Goodban'76) and some of the Indian studies (Tasneem Banu'77; Usha'86; Padmaja'88; Arun Banik'88; Maya'90, Prathima 2009, Divya 2010, Usha, 2010 and Deepa 2010) indicated that phoneme development is correlated with age and some sounds are acquired earlier than others. The results of the present study confirm with those of the above studies. It is evident that with neuromuscular maturity, all motor skills improved as age advanced and so also the articulation skills.

Further, the results are discussed under the following headings.

1) Vowel Acquisition
2) Singleton Consonant Acquisition
3) Consonant Cluster Acquisition

1) Vowel Acquisition

In the present study, 10 vowels (/a/, /a:/, /i/, /i:/,/u/, /u:/, /e/, /e:/, /o/ and /o:/) were tested in the initial position. The results indicated that all the vowels were acquired by 100% of the children by the age of 5.0- 5.3 years. Studies on Western languages (Irwin and Wong, 1983; Fudula and Reynolds, 1986; Otomo and Stoel-Gammon, 1992) as well as various Indian languages (Tasneem Banu'77; Usha'86; Padmaja'88; Arun Banik'88; Maya'90, Prathima 2009, Divya 2010, Usha, 2010, Deepa 2010) have reported that all the vowels are mastered by 3 years itself. Since the present study considered children of older age range, the results cannot be compared with the previous studies and hence is not noteworthy.

2) Singleton consonant Acquisition

The modified Malayalam articulation test consists of 35 test consonants out of which three aspirated phonemes were newly added. Among the 35 singleton consonants, 17 of them are in the initial and medial positions, two are in medial and final positions (/ḷ/ and /ṇ/), three sounds (/r/, /R/ and /m/) are tested in all the positions and eight in medial and five in initial positions only. So based on the position of occurrence of these sounds, the acquisition pattern for each phoneme was noted for both males and females separately.

The acquisition of singleton consonants are discussed under the following headings

a) Age vs. Speech sound acquisition
b) Gender vs. Speech sound acquisition
c) Order and position of acquisition of the sounds
d) Acquisition based on place, voicing and manner features

a) Age vs. Speech sound acquisition

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 scores for Group I was 67.75 and that for Group VI was 68.71. That is, there was a gradual increase in the articulatory acquisition scores as the age increased. The variability of the scores linearly 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 and hence the variability is reduced. Table 9 depicts the articulatory scores for singleton consonants including vowels for the different age groups.

Age	Mean (Std. Deviation)	N
Group I (5.0-5.3 years)	67.75 (0.93)	30
Group II (5.4-5.6 years)	68.15 (0.93)	30
Group III (5.7-5.9 years)	68.61 (0.91)	30
Group IV (5.10-6 years)	68.71 (0.89)	30

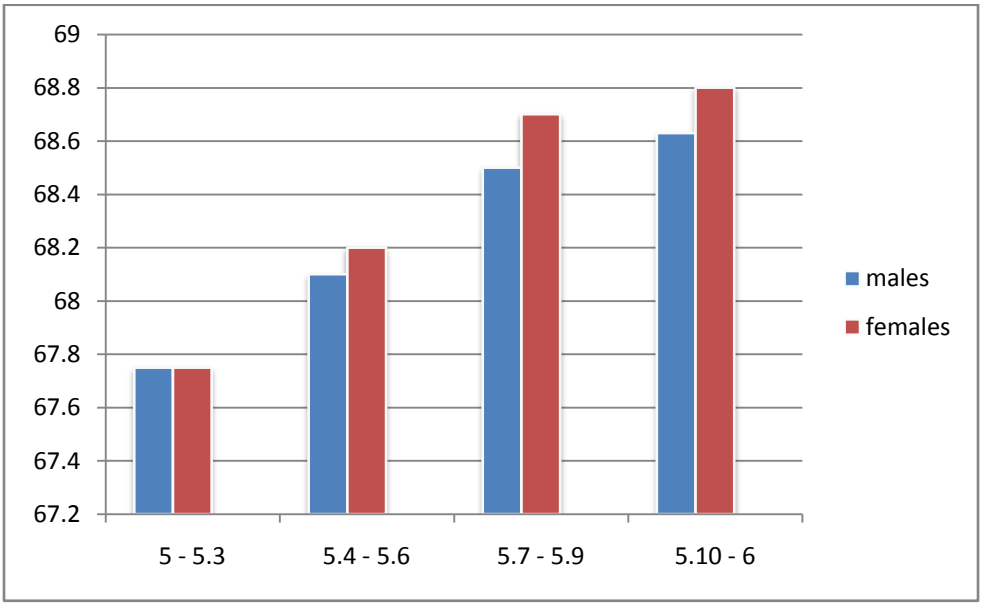
Table 9: *Mean and SD (in parenthesis) of articulation scores for singleton consonants (including vowels) in different age groups Maximum score is 70*

b) Gender vs. Speech sound acquisition

As Two-way ANOVA indicated no gender differences in articulatory scores, no further test was administered to observe the significant difference across gender in each of the four age groups. But in general girls seemed to have higher scores compared to boys in all the age groups. However the difference was not significant. Table 10 and Graph 2 show the mean articulation scores for singleton consonants including vowels in different age groups for males and females. From Graph 2, it can be inferred that girls outperformed boys in articulatory acquisition of singleton consonants in all the age groups except in Group I even though no significant difference was observed.

Gender	Age	Mean (Std. Deviation)	N
Boys	Group I (5-5.3 years)	67.75 (0.93)	15
	Group II (5.4-5.6 years)	68.10 (0.91)	15
	Group III (5.7-5.9 years)	68.51 (0.76)	15
	Group IV (5.10-6 years)	68.63 (0.92)	15
	Mean Total Score	68.25 (0.92)	60
Girls	Group I (5-5.3 years)	67.75 (0.98)	15
	Group II (5.4-5.6 years)	68.20 (0.98)	15
	Group III (5.7-5.9 years)	68.70(1.06)	15
	Group IV (5.10-6 years)	68.80(0.94)	15
	Mean Total Score	68.36 (1.06)	60

Table 10: *Mean and SD (in parenthesis) of articulation scores for singleton consonants (including vowels) in different age groups*



Graph 2: *Mean articulation scores for singleton (including vowels) in different age groups for males and females*

c) Order and position of acquisition of the sounds

Group I (5 – 5.3 years): 100 % of the children acquired most of the consonants in all the positions by 5- 5.3 years of age. The exemptions were the aspirated phonemes (**/ʧʰ/, /t̪ʰ/, /ʈʰ/**, /kʰ/, /dʰ/, /bʰ/, /gʰ/) and also palatal nasal /ɲ/, dental voiced plosive /d̪/ and glottal /h/ in medial position. The percent acquisition of /ɲ/ in girls as well as in boys is 93.33%. 80% and 53.33% of the children acquired the phoneme /d̪/ and /h/ in the medial position respectively. Most of the children substituted /k/ for /h/ and very few children substituted /b/ for /h/ in the medial position (e.g.: /simkam/ or /simbam/ for /simham/).

Considering the aspirated phonemes, /kʰ/ was acquired by 80% of the children in initial position. Other aspirated phonemes **(/ʧʰ/, /t̪ʰ/, /ʈʰ/**, / dʰ/, / bʰ/, / gʰ/) were acquired by 60-70% of the children. Tables 11 and 15 show the acquisition of un aspirated and aspirated speech sounds respectively as per 100% criteria for boys and girls (5 -5.3 years) in initial, medial and final positions. So it is observed that, out of the 35 singleton consonants tested, 25 consonants reached 100% criteria by this age range.

Group II (5.4 – 5.6 years): The phoneme /ɲ/ which was acquired by 93.33% in Group 1, attained the 100% criteria by this age. But the phoneme /d̪/ in medial position attained 86.66% by both genders. An increase in the percentage of acquisition of /h/ was found

among both boys and girls which were 66.67% and 60% respectively. Among the aspirated phonemes, /ʧʰ/, /kʰ/ and /bʰ/ were produced by 80 to 90% of the children. The other aspirated sounds (/t̪ʰ/, /ʈʰ/, /dʰ/, /gʰ/) were found to have the same percentage of acquisition as that of the previous age group (60 – 70 %). Tables 12 and 16 show the acquisition of un aspirated and aspirated speech sounds respectively as per 100% criteria for boys and girls (5.4-5.6 years) in initial, medial and final positions. By this age range, 26 out of the 35 singleton consonant clusters reached the 100% criteria.

Group III (5.7 - 5.9 years): The percentage of acquisition of /d̪/ in medial position and the aspirated phonemes /ʧʰ/, /kʰ/ and /bʰ/ was same as that of the previous group. Acquisition of /h/ showed an increment to 93% by both the genders. The phonemes /t̪ʰ/**,** /ʈʰ/ and /dʰ/ crossed 80% while /gʰ/ crossed 70% of acquisition. Tables 13 and 17 show the acquisition of un aspirated and aspirated speech sounds respectively as per 100% criteria for boys and girls in initial, medial and final positions. Hence by this age range also, only 26 out of 35 consonants met the 100% criteria. However the phonemes which did not meet the 100% criteria attained improved scores compared to the previous age groups.

Group IV (5.10 - 6 years): 90% of the children acquired /d̪/ in medial position and /kʰ/ in the initial position by this age range. But the acquisition of /h/ showed a decline to

86.6% in both the genders. **/ʧʰ/, /ʈʰ/, /ʈʰ/**, /dʰ/, /bʰ/ and /gʰ/ could not meet the 100% criteria even by this age range. Tables 14 and 18 show the acquisition of unaspirated and aspirated speech sounds respectively as per 100% criteria for boys and girls (5.10 - 6 years) in initial, medial and final positions. The interesting observation is that, even by 6 years of age children reached 100% criteria for 26 out of 35 consonants only. This is because of the more number of aspirated sounds in the present test. However, as said earlier, these phonemes which did not reach 100% criteria were produced by more number of children in this age group

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	93.33		
t	100	100				
ḍ	100	100	100	100		
ṇ	100	100	100	100	100	100
t̪	100	100	100	100		
d̪	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
ɭ			100	100	100	100
v	100	100	100	100		
h			53	53		
f	100	100				
t̲	100	100	100	100		
s	100	100	100	100		
r	100	100	100	100		
ʃ	100	100	100	100		
l̲			100	100		
R	100	100	100	100	100	100
ʂ	100	100	100	100		

Table 11: *Percentage of articulatory acquisition in boys and girls (5- 5.3 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		
ɡ	100	100				
ŋ	100	100	100	100		
ʧ	100	100	100	100		
ʤ	100	100	100	100		
ɲ	100	100	100	100		
t	100	100				
ḍ	100	100	100	100		
ṇ	100	100	100	100	100	100
ẗ	100	100	100	100		
ḍ̈	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			66.67	60		
f	100	100				
t̲	100	100	100	100		
s	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		

Table 12: *Percentage of articulatory acquisition in boys and girls (5.4- 5.6 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		
ɡ	100	100				
ŋ	100	100	100	100		
ʧ	100	100	100	100		
ʤ	100	100	100	100		
ɲ	100	100	100	100		
t	100	100				
ḍ	100	100	100	100		
ṇ	100	100	100	100	100	100
ẗ	100	100	100	100		
ḍ̈	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			93	93		
f	100	100				
t̲	100	100	100	100		
s	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		

Table 13: *Percentage of articulatory acquisition in boys and girls (5.7- 5.9 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		
ɡ	100	100				
ŋ	100	100	100	100		
ʧ	100	100	100	100		
ʤ	100	100	100	100		
ɲ	100	100	100	100		
t	100	100				
ḍ	100	100	100	100		
ṇ	100	100	100	100	100	100
t̪	100	100	100	100		
d̪	100	100	93.3	93.3		
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
ɭ			100	100	100	100
v	100	100	100	100		
h			86.6	86.6		
f	100	100				
t̲	100	100	100	100		
s	100	100	100	100		
r	100	100	100	100		
ʃ	100	100	100	100		
l̲			100	100		
R	100	100	100	100	100	100
ʂ	100	100	100	100		

Table 14: *Percentage of articulatory acquisition in boys and girls (5.10- 6 years) Empty space indicates sound not tested*

Speech sounds	Initial position		Medial position	
	Obtained %		Obtained %	
	Boys	Girls	Boys	Girls
ʧʰ	60	66.67		
ʈʰ			60	66.6
ʈʰ			60	60
kʰ	80	80	80	73.33
dʰ			66.6	60
bʰ	66.6	60		
gʰ			60	60

Table 15: *Percentage of articulatory acquisition of aspirated phonemes for boys and girls (5-5.3 years)*
Empty space indicates sound not tested

Speech sounds	Initial position		Medial position	
	Obtained %		Obtained %	
	Boys	Girls	Boys	Girls
ʧʰ	86.66	80		
ʈʰ			66.6	66.6
ʈʰ			60	60
kʰ	86.67	80	80	73.33
dʰ			60	66.6
bʰ	80	86.67		
gʰ			60	66.6

Table 16: *Percentage of articulatory acquisition of aspirated phonemes for boys and girls (5.4 -5.6 years*
Empty space indicates sound not tested

Speech sounds	Initial position		Medial position	
	Obtained %		Obtained %	
	Boys	Girls	Boys	Girls
ʧʰ	86.6	80		
t̪ʰ			80	86.67
ʈʰ			80	80
kʰ	86.67	80	80	73.33
dʰ			80	80
bʰ	80	86.67	80	86.67
kʰ			73.33	73.33

Table 17: *Percentage of articulatory acquisition of aspirated phonemes for boys and girls (5.7 -5.9 years) Empty space indicates sound not tested*

Speech sounds	Initial position		Medial position	
	Obtained %			
	Boys	Girls	Boys	Girls
ʧʰ	86.6	86.6		
t̪ʰ			86.6	86.6
ʈʰ			80	80
kʰ	93.3	93.3	86.6	80
dʰ			80	80
bʰ	80	86.67		
gʰ			73.33	80

Table 18: *Percentage of articulatory acquisition of aspirated phonemes for boys and girls (5.10 - 6 years) Empty space indicates sound not tested*

The results of the present study were compared with Western (Wellman ’31; Templin’57; Poole’34; Fudala and Reynolds’86) and Indian studies (Tasneem Banu’77, Prathima, 2009 and Deepa, 2010 in Kannada, Padmaja’88and Usha, 2010 in Telugu, Usha ’86 in Tamil; Maya’90 and Divya, 2010 in Malayalam,) to observe whether the

order of acquisition was similar. It was observed that all the sounds were acquired much earlier. However the order of acquisition of the consonants was 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. That is 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. This is possibly because these western norms were established much earlier. In the present study, it was observed that all these sounds were acquired by 100% of the children in the first age group (5-5.3 years) itself.

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 only 53.33% acquired /h/ by the age of 5 - 5.3 years. Divya (2010) also reported that /h/ reached only 0% by 3 years of age. This finding is also similar to the reports of Tasneem Banu (1977) and Pratima (2009) in Kannada.

Divya (2010) reported that dental /d̪/ in medial position was acquired by 100% of the children by the age of 3 years. Maya (1990) and Prathima (2009) also reported that /d̪/ was acquired by the age of 3 - 3.6 years. But in the present study, only 80% of the children acquired /d̪/ in the medial position by the age of 5 - 5.3 and 93.3% by the age of 5.10 - 6 years. This could be because the stimulus used for testing /d̪/ in the medial position was a multisyllabic word (/dʒaladoʃam/, meaning common cold). Literature

reports that the use of multisyllabic words may make more demands on the child's production and elicit more errors than would monosyllabic words.

The aspirated sounds were acquired late compared to the un-aspirated sounds. Among the aspirated sounds only /kʰ/ in the initial position reached the 90% criteria by the age of 6. All the remaining aspirated sounds crossed 80% by the age of 6 years except /gʰ/ in the medial position which was acquired by 73.33% of boys and 80% of the girls by the age of 6 years. Maya (1990) reported that the acquisition of aspirated phonemes /ʧʰ/, /t̪ʰ/, /d̪ʰ/, /ʈʰ/ and /kʰ/ continued till the age of 6 - 7 years. Presently it was also observed that, on modeling and repetition of the aspirated sounds, they were produced correctly by most of the children. This may be because aspirated sounds are not colloquially used in Malayalam and hence the children did not use them in their day to day life. The present results agree with the results of Dodd and So (1995) and the results of Padmaja (1988) and Maya (1990) which reported the early acquisition of un aspirated plosives compared to their aspirated cognates. However there are certain discrepancies noticed in the age of acquisition of aspirated phonemes when compared to Divya (2010) where it is reported that aspirated /ʈʰ/ was acquired earlier by 2.3 years itself (86.66%), followed by /ʧʰ/ and /d̪ʰ/ in all the positions and /kʰ/ in medial position by 2.6 years and in initial position by 3 years of age. This result is of interest and it is hypothesized that it is due to the dialect difference of the subjects considered for both the studies. Divya (2010) considered

children from Wayanad district (Northern Kerala) while in the present study children from Thiruvananthapuram (Southern Kerala) are considered.

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 all the reported studies in the western context that are available are carried out from early thirties to the late nineties or so. It is an accepted routine observation by the speech language pathologists that the present day children are much ahead in their articulatory acquisition compared to their earlier counterparts due to increased exposure and stimulation in their environment. Hence comparison of the present sound acquisition data with the much earlier reports may not be strictly appropriate.

d) Consonant acquisition based on place, voicing and manner features

i) Place feature: Based on the place of articulation, un aspirated phonemes of Malayalam can be classified as bilabials (/p/, /b/ and /m/), labiodentals (/v/), dentals (/t̪/, /d̪/ and /n̪/), alveolars (/t̪/,/s/, /l/, /r/ and /R/), retroflex (/ɖ/,/ɳ/,/ɭ/ and /ʂ/), palatals (/ʧ/, /ʤ/ ,/j/,/ʃ/, /l̠/, and /ɲ/), velars (/k/, /g/ and /ŋ/) and glottal (/h/) sounds. The stimuli words of the test phonemes are presented in Appendix 1.

On considering 100% criteria, the bilabials, dentals, labiodentals, alveolars, retroflex, palatals and velars except the glottal /h/ and aspirated sounds were acquired by 5- 5.3 years. Among the palatals, /ɲ/ attained 100% criteria by 5.4-5.6 years. Glottal /h/ was found to be the most difficult singleton consonant for the children it did not attain the 100% criteria even at 6 years of age. The present results agreed with Deepa (2010) who reported that /h/ was not acquired even at 6 years of age by 75% of the children in Kannada. But this finding contradicts with that of Maya (1990) and Divya (2010) in Malayalam and Usha (2010) in Telugu, who reported that /h/ was attained by 90% of the children by 3 and 3-3.6 years of age respectively. It is possible that in the present study, samples from southern part of Kerala (Thiruvananthapuram) were considered where the colloquial usage of /h/ is less because of Tamil influence.

ii) Voicing feature: In the present study, the voice less and the voiced phonemes are acquired by 5- 5.3 years of age by 100% of the children. 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/. Also another two ongoing studies by Neenu (2011) and Vipina (2011) in Malayalam in the age range of 3-4 and 4-5 years respectively reports that voiceless sounds were first achieved compared to its voiced cognates.

iii) **Manner of articulation:** When considering the manner of acquisition it was observed that nasals, unaspirated stops and semivowels (/j/ & /v/) were acquired first compared to laterals, fricatives, affricates, flaps and trills followed by aspirated phonemes. In the present study all the phonemes except the aspirated ones, the glottal /h/ and the dental /d̪/ attained 100% mastery by 5 – 5.3 years of age. However the percentage of acquisition increased with increase in age for these phonemes which did not reach the 100% criteria. Chart 1 shows the age of phoneme acquisition by 100% of the children in Malayalam

Sounds	Age groups			
	5- 5.3 years	5.4-5.6 years	5.7- 5.9 years	6 years
Plosives				
/k/	→			
/g/	→			
/ʈ/	→			
/ɖ/	→			
/p/	→			
/b/	→			
/t/	→			
/θ^h/	- - →	- - →	- - →	- - →
/k^h/	- - →	- - →	- - →	- - →
/$ʈ^h$/	- - →	- - →	- - →	- - →
/f/	→			
/ɖ/	→			
/d^h/	- - →	- - →	- - →	- - →
/b^h/	- - →	- - →	- - →	- - →
/g/	- - →	- - →	- - →	- - →
Fricatives				
/s/	→			
/ʃ/	→			
/ʂ/	→			
/h	- - →	- - →	- - →	- - →
Affricates				
/ʧ/	→			
/$ʧ^h$/	- - →	- - →	- - →	- - →
/ʤ/	→			
/ŋ/	→			
Nasals				
/m/	→			
/n/	→			
/ŋ/	→			
/ɳ/	→			
Glides				
/j/	→			
/v/	→			
Trills				
/l/	→			
/ɭ/	→			
/l̲/	→			
Flaps				
/r/	→			
Trill				
/R/	→			
Semivowels				
/v/	→			
/j/	→			

Chart 1: Shows the age of phoneme acquisition by 100% of the children in Malayalam

→ Indicates sounds acquired by 100% of the children.

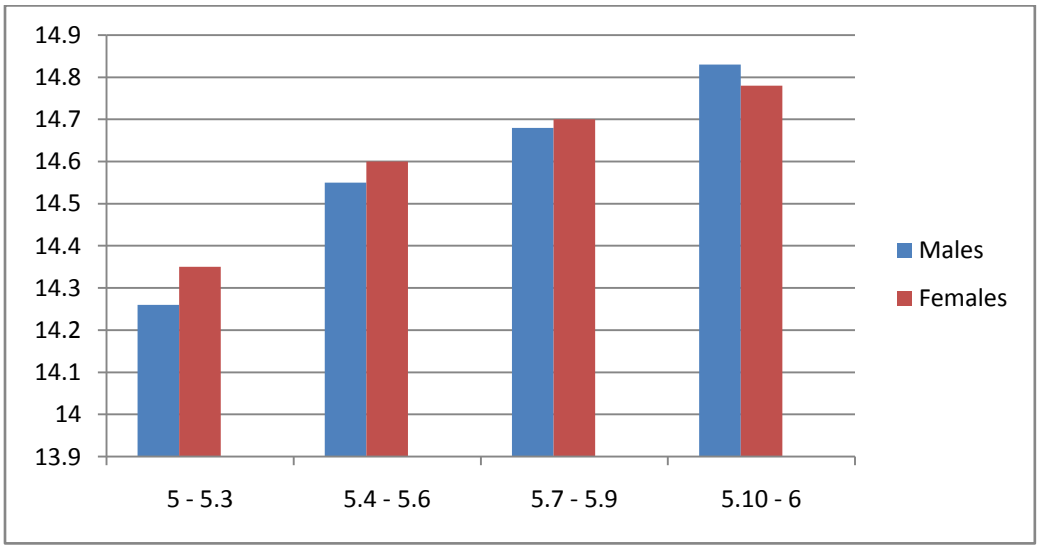
- - → Indicates sounds not acquired by 100% of the children.

3) Acquisition of Consonant clusters

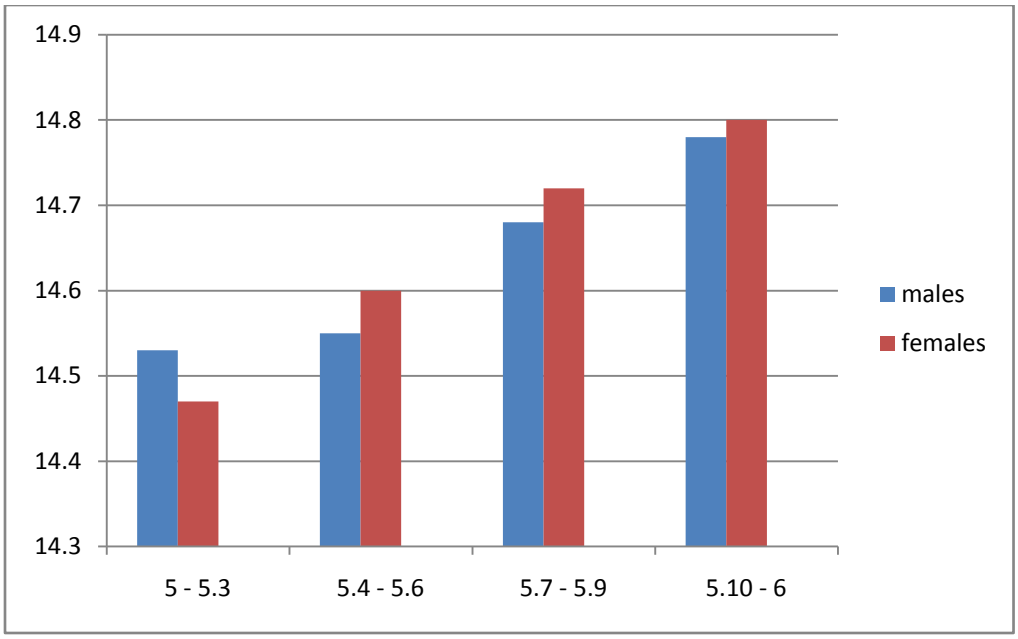
In the present study, 30 consonant clusters were tested which included 15 clusters in the word initial position and 15 in the word medial position. The word initial clusters included /pr-/, /sk-/, /gl-/, /kl-/, /pl-/, /tR-/, /sl-/, /sp-/, /kr-/, /br-/, /bl-/, /gr-/, /st^{h-}/, /ʃv-/, /kj-/ and the word medial clusters included /-nt-/, /-nt̪-/, /-ndʒ-/, /-nd-/, /-nk-/, /-t̪y-/, /-nd̪r-/, /-sk-/, /-kṣ-/, /-lj-/ /-kr-/, /-t̪r-/, /-st̪-/, /-dj/ and /-st̪r-/. Using descriptive statistics, mean and standard deviation of the articulatory scores for clusters were acquired for all the four age groups (Table 19 and Graphs 3 & 4). Maximum expected score for cluster production is 15 each in initial and medial positions respectively for individual children. The mean scores obtained by boys and girls in Group I for the initial clusters were 14.27 and 14.35 respectively and for Group IV they were 14.83 and 14.78 respectively. From Table 19 and Graph 3, it can be noted that the score for initial cluster was higher for girls in the first three groups where as boys performed better in the 5.10 – 6 years group. The mean obtained by boys and girls in Group I for medial clusters were 14.53 and 14.46 respectively and for Group IV, they were 14.78 and 14.80 respectively. From Table 17 and Graph 4, it can also be noted that the boys outperformed girls in the youngest age group (5 - 5.3 years) and the girls performed better in all the other age groups. The variability of the scores linearly reduced from the youngest to the oldest group in both males and females. This is because of better articulatory skills for cluster production as age increased.

Gender	Age Groups	Mean (Std. Deviation) Initial Cluster	Mean (Std. Deviation) Medial Cluster	N
Boys	Group I (5-5.3 years)	14.27 (0.55)	14.53 (0.29)	15
	Group II (5.4-5.6 years)	14.55 (0.41)	14.63 (0.28)	15
	Group III (5.7-5.9 years)	14.68 (0.29)	14.68 (0.24)	15
	Group IV (5.10-6 years)	14.83 (0.24)	14.78 (0.24)	15
	Mean Total Score	14.58 (0.44)	14.65 (0.27)	60
Girls	Group I (5-5.3 years)	14.35 (0.50)	14.46 (0.39)	15
	Group II (5.4-5.6 years)	14.60 (0.39)	14.63 (0.31)	15
	Group III (5.7-5.9 years)	14.70 (0.38)	14.71 (0.29)	15
	Group IV (5.10-6 years)	14.78 (0.27)	14.80 (0.25)	15
	Mean Total Score	14.60 (0.42)	14.65 (0.34)	60

Table 19*: Mean articulation scores and SD (in parenthesis) of consonant clusters in different age groups for males and females*



Graph 3: *Mean articulation scores for initial clusters in different age groups for males and females*



Graph 4: *Mean articulation scores for medial clusters in different age groups for males and females*

Two way MANOVA was carried out to find the significant difference between different age groups at 0.05 level of significance in initial and medial clusters seperately. The result indicated that there was a significant difference [F (3) = 10.785, ($p<0.05$) among some of the age groups for the initial clusters.

Initial clusters: When Group I was compared with the older three age groups, there was a significant difference with all the groups. When Group II was compared with Group III and Group IV, there was no significant difference observed. When Groups III and IV were compared; there was no significant difference across them for the scores obtained.

Medial clusters: There was a gradual improvement in the scores obtained, but when Groups I, II, III and IV were compared across each other, there was no significant

difference across them for the scores obtained. The acquisition pattern for each cluster was analyzed for both males and females in each group.

Group I (5- 5.3 years): Among girls nine out of 15 consonant clusters in the initial position met the 90% criteria of acquisition. They were /pr-/, /sk-/, /gl-/, /kl-/, /pl-/, /sl-/, /bl-/, /kj-/ and /st^{h-}/. In boys eight consonant clusters in the initial position met the 90% criteria of acquisition. They were /sk-/, /pl-/, /tR-/, /sl-/, /br-/, /bl-/, /st^{h-}/ and /kj-/. Considering the acquisition of medial clusters, boys acquired 11 and girls acquired 10 meeting the 90% criteria. They were /-nt-/, /-nt̪-/, /-ndʒ-/, /-nd-/, /-nk-/, /-t̪j-/, /-nd̪r-/, /-sk-/, /-lj-/, /-st̪-/, and /-st̪r-/ in boys and /-nt-/, /-nt̪-/, /-ndʒ-/, /-nd-/, /-nk-/, /-t̪y-/, /-sk-/, /-lj-/ and /-st̪-/ in girls. On observation it can be inferred that more number of medial clusters were mastered earlier compared to initial clusters. The least acquired clusters in this group were /kr-/ (53.33% of boys & 60% of girls) in the word /kriʃṇan/ and /ʃv-/ (66.67% of boys & 60% of girls) in the word /ʃva:sam/ among the initial clusters and /-kṣ-/ (40% of boys & 53.33% of girls) in the word /nakṣatram/, among the medial clusters.. All the other clusters in the initial and medial positions were acquired by at least 80% of the children in both the genders. The most common error found in this age group was cluster reduction (e.g. /ga:ssə/ for /gla:ssə/). Coalescence error /fu:ṇ/ for /spu:ṇ/ was also observed in few children. Clusters which were nearing 90% criteria had more of substitution errors (e.g. /bleṣə/ for braṣə).

Group II (5.4-5.6 years): Among the clusters which did not reach 90% criteria in the previous group, the initial clusters /br-/in the word / braṣə/ and /sp-/in the word /spu:ṇ/ and the medial cluster/-str-/ in the word /vasṭram/ and /-dj-/ in the word /sadja/ met the 90% criteria in this age range while the acquisition of /gr-/ in the word /gra:mam/ remained the same (86.67% in both genders). Here substitution error was observed where /r/ in the cluster was substituted by /j/ (/gja:mam/ for /gra;mam/) /-kṣ-/ was acquired by just 50% while /-kr-/ was acquired by 86.67% of the children. For /-kr-/ substitution (/tʃaθram/ for /tʃakram/) and also epenthesis errors (/tʃakaram/ for /tʃakram/) were found, while for/-kṣ-/ only reduction error was found (/naṣatram/ for /nakṣaṭram/). Also /ʃv-/ was acquired by 66.67% of both boys and girls and /kr-/ was acquired by 66.67% and 80% of the boys and girls respectively. In both these clusters, reduction errors were observed (/kiʃṇan. for /kriʃṇan/ & /ʃa:sam/ for /ʃva:sam/). So by this age, 12 out of the 15 clusters in the initial position and 13 out of the 15 in the medial position tested reached the 90% criteria.

Group III (5.7-5.9 years): Among the initial clusters only /kr-/, gr-/ and /ʃv-/ did not meet the 90% criteria. Scores for /gr-/ remained the same as that of the previous group (86.67% in both genders). Among the medial clusters /-kṣ-/ maintained the same scores (53.3%) as in group II and also the same scores were maintained by boys for /-kr-/ (66.67%) while the girls attained 93.3%. Reduction errors persisted in this age range also. However, substitution errors became more common during this age. Here though there

was no additional mastery of clusters in this age range, there was a marked increase in scores compared to the previous age range for those clusters which did not meet the 90% criteria.

Group IV (5.10-6 years): 73.33% of the boys and 86.67% of the girls in this group acquired /kr-/ while 93.33% of the boys and 73.33% of the girls acquired /ʃv-/. For boys the acquisition of medial /-kr-/ and /-kṣ-/ remained the same (86.67 & 53.33 respectively) as in the previous group. But girls were ahead. 100% and 66.67% of girls acquired /-kr-/ and /-kṣ-/ respectively. Cluster substitution errors were observed more in this age group. All the other clusters reached the 90% criteria by this age. Among the 30 clusters tested, the three clusters /kr-/, /ʃv-/ and /-kṣ-/ were the most difficult ones. So by this age 14 out of the 15 clusters in both initial and medial position met the 90% criteria. Tables 20 and 21 depict the acquisition of clusters by 90% of the boys and girls through 5 - 6 years.

	5-5.3 years		5.4-5.6 years		5.7-5.9 years		5.10-6 years	
Initial clusters (Word)	**Obtained % Boys**	**Girls**	**Obtained % Boys**	**Girls**	**Obtained % Boys**	**Girls**	**Obtained % Boys**	**Girls**
pr- **(pravə)**	86.6	100	100	100	100	100	100	100
sk- **(sku:tar)**	100	100	100	100	100	100	100	100
gl- (gla:ssə)	86.6	100	100	100	100	100	100	100
kl- (klo:k)	86.6	100	100	100	100	100	100	100
pl- (ple:tə)	93.3	100	100	100	100	100	100	100
tR- (tRəin)	93.3	100	93.3	933	93.3	93.3	100	100
sl- (slətə)	93.3	100	100	100	100	100	100	100
sp- (spu: ṇ)	80	100	93.33	93.33	93.3	93.33	100	93.3
kr- (kRiʃṇan)	53.33	60	66.67	80	66.67	86.67	73.33	86.667
br- (braṣə)	93.3	80	100	100	93.3	100	100	100
bl- (blædə)	93.3	100	100	100	100	100	100	100
gr- (gra:mam)	86.67	86.67	86.67	86.67	86.67	86.67	100	93.3
st^{h}- (st^{h}alam)	93.3	93.3	93.3	93.3	93.3	93.3	100	100
ʃv- (ʃva:sam)	66.67	60	66.67	66.67	66.67	60	93.33	93.33
kj- (kja:maRa)	100	100	100	100	100	100	100	100

Table 20*: Percentage of acquisition of initial clusters by boys and girls (5-6 years)*

	5-5.3 years		5.4-5.6 years		5.7-5.9 years		5.10-6 years	
Word medial clusters	**Obtained % Boys**	**Girls**	**Obtained % Boys**	**Girls**	**Obtained % Boys**	**Girls**	**Obtained % Boys**	**Girls**
-nt- (pa:ntə)	100	100	100	100	100	100	100	100
-nʈ- (panʈə)	100	100	100	100	100	100	100	100
-ndʒ- (sandʒi)	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
-ʈj- (**i**nʈja)	100	100	100	100	100	100	100	100
-nɖr- (ʧ**a**nɖran**)**	93.3	80	93.33	100	93.3	100	100	100
- sk- (biskattə)	100	100	100	100	100	100	100	100
-kʂ- (nakʂ**a**ʈram **)**	40	53.33	53.33	53.33	53.33	53.33	53.33	66.67
-lj- (kaljaɳam)	100	100	100	100	100	100	100	100
-kr- (ʧakram)	80	80	86.67	86.67	86.67	93.3	86.67	100
-sʈ- (pusʈakam)	93.3	100	93.3	100	100	100	100	100
-sʈr- (vasʈram)	80	73.33	93.3	100	93.3	93.3	100	100
-dj- (sadja)	80	100	100	100	100	100	100	100
-tr- (pa:tram)	100	93.3	100	100	100	100	100	100

Table 21: *Percentage of acquisition of medial clusters of boys and girls (5- 6 years)*

The results indicated that medial clusters were acquired earlier than initial clusters in general. This finding is in agreement with Vani Rupela in Kannada (2006) Neethipriya in Telugu (2007) and Prathima in Kannada (2010). They reported that medial clusters were mastered early in the articulatory acquisition 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, which also supports the present study of medial cluster acquisition earlier than the initial clusters.

However, the present study 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 some of the clusters reached 100% criteria by 5- 5.3 years of age (/sk-/, /kj-/, /-nt/, /-nʈ-/, /-ndʒ-/, /-nd-/, /-nk-/, /-ʈy-/, /-sk-/ & /-lj-/). Others which did not meet the 90% criteria where those which included /s/, /r/, /l/ or /ʃ/ as part of the cluster. As reported by several authors (Wellmann, 1931; Poole, 1933; Fudala and Reynolds 1986; Smit, 1990; Maya, 1990; Prathima, 2009; Deepa, 2010 and Divya, 2010), these sounds at singleton level also were acquired late as compared to other phonemes.

In the present study, the common cluster errors found were cluster reduction followed by epenthesis and substitution errors. The common examples for cluster reduction included /kiʃɳan/ for /kriʃɳan/ or /naʃatram/ for /nakʃatram/, for epenthesis; /tʃakaram/ for /tʃakram/ or /tʃandaran/ for /tʃandran/ and for substitution; /tʃaklam for /tʃakram/ or /gja:mam/ for /gra:mam/. The reason for this substitution error can be that they are substituting an earlier acquired phoneme with the late acquired phoneme 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. Errors such as coalescence and metathesis were rare. The examples for coalescence is /fu:n/ for /spu:n/ and for metathesis the example is /kolk/ for /klo:k/.

In general, it was also observed that younger groups had more of cluster reduction and as age increased, reduction diminishes and cluster simplification and substitution errors increased. This is in total agreement with Greenle's (1974) stages of cluster acquisition. It is also in consonance with Mc Loed (2001) which states that the occurrence of cluster reduction diminishes overtime, where as the occurrence of cluster simplification increases. Simultaneously, the occurrence of correct productions increases, until eventually the cluster production is mastered.

The early acquired initial clusters were /pr-/, /sk-/, /gl-/, /kl-/, /pl-/, /sl-/, /bl-/, /st^{h-}/, /tR-/, /br-/, /st^{h-}/ and /kj-/ and those in the medial position were /-nt-/, /-nt̪-/, /-ndʒ-/, /-nd-/, /-nk-/, /-ʈy-/, /-nɖr-/, /-sk-/, /-lj-/, /-st̪-/ and /-st̪r-/. That is these clusters acquired

90% criteria by 5- 5.3 years of age. The initial clusters /kr-/ and the medial clusters /-kṣ-/ did not meet the 90% criteria even at 6 years of age. This is possibly because phonemes /s/ and /r/ are late learnt sounds and this effect is seen in clusters also involving these sounds. Maya (1990) reported similar findings that the last acquired cluster was /-kṣ-/, by 7 years of age. But considering /-kṣ-/ as in the word /nakṣatram/ the production of /naṣatram/ is colloquially accepted. In the present study, among the triple consonant clusters /-nḏr-/ and /-sṯr-/, /-nḏr-/ were acquired early as compared to /-sṯr/.The earlier cited reason holds good here also. Chart 2 shows the age of cluster acquisition by 90% of the children in Malayalam

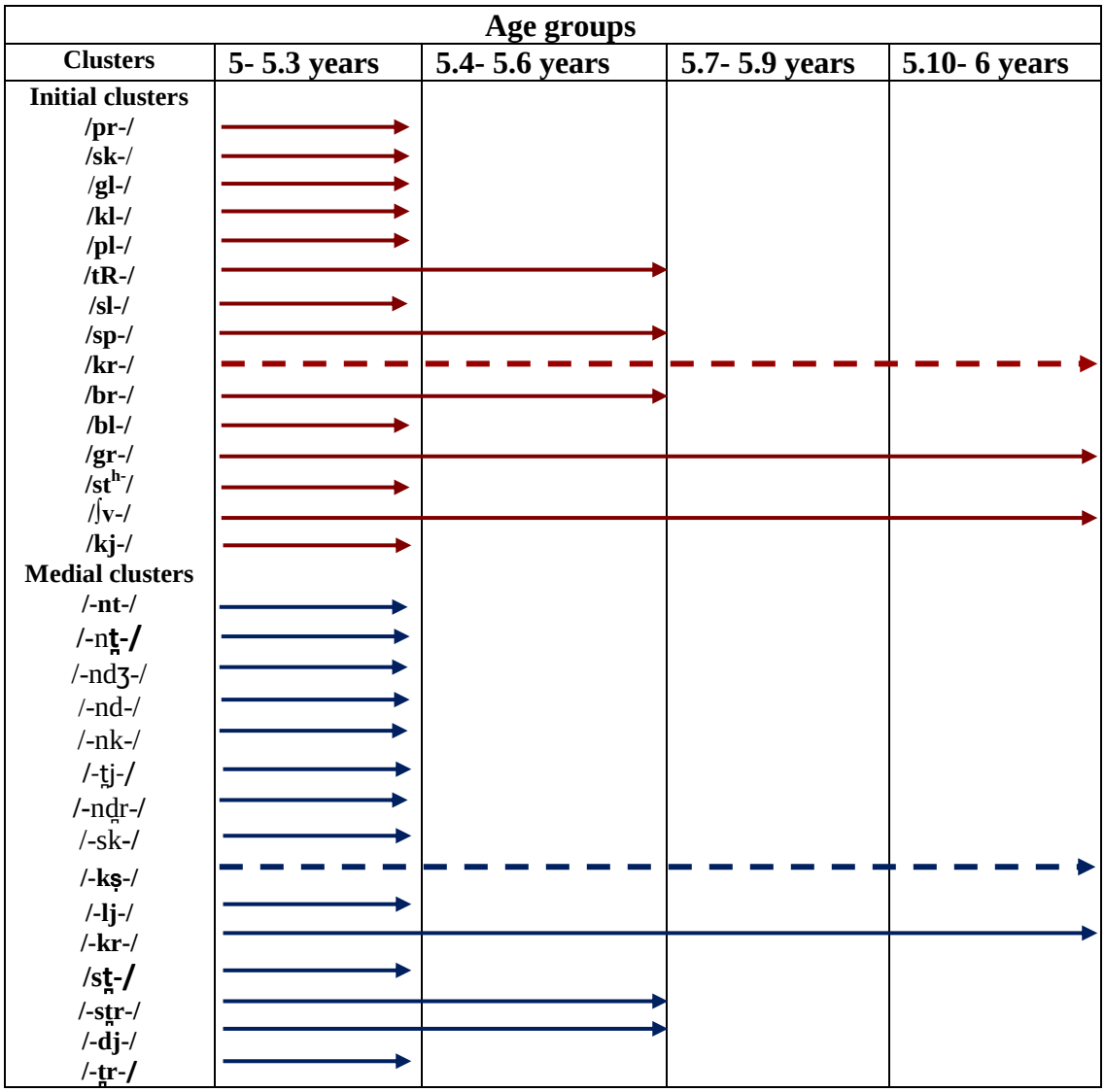


Chart 2: Shows the age of cluster acquisition by 90% of the children in Malayalam

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 phoneme agreement between the transcriptions of the two judges on 10% of the samples randomly

selected across the total 120 samples. Cronbach's coefficient reliability test was administered. The results showed a high reliability of α (0.98), (0.8) and (0.96) for singleton consonants, initial clusters and medial clusters respectively

Test-retest reliability

Cronbach's coefficient reliability test was administered by randomly selecting the stimuli of 5% of the children. The results showed an α of 0.98 which shows a high reliability.

In general, the results of the present study indicated that the articulatory acquisition including the clusters was much earlier compared to the former reports in several languages. There was a steady increase in the articulatory scores across age groups but no significant gender effect was found. Unaspirated phonemes were acquired early compared to their aspirated cognates. Also voiceless phonemes were mastered earlier than their voiced cognates. Medial clusters were acquired earlier than initial clusters.

Based on the scoring obtained from the present study, typically developing Malayalam speaking children should obtain mean scores as shown in Table 22 using the Modified Malayalam Diagnostic Articulation Test. As no significant gender difference was observed, combined articulation scores are presented for each age group.

Age	Scores expected for typically developing children
5.0- 5.3 years	**96.51 ± 1.44**
5.4-5.6 years	**97.36 ± 1.17**
5.7- 5.9 years	**98.00 ± 1.07**
5.10- 6.0 years	**98.32 ± 0.92**

Table 22: *Articulation scores expected for typically developing Malayalam speaking children in the age range of 5- 6 years* ***Maximum Score - 100***

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 the existing 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 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 5– 6 years. The subjects were sub divided into four groups with an inter age interval of three months (5 - 5.3, 5.4 - 5.6, 5.7 - 5.9 & 5.10 - 6 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 color pictures that were presented through a laptop computer. The response elicited was audio recorded using a laptop computer. 5% of the children were retested within a period of 3-7 days from the time of initial testing to test the reliability of the test

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 the 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 were calculated. The maximum score that can be obtained is 100. i.e. when all the test phonemes are correctly produced.

The data for each age group was statistically analyzed. Two-way ANOVA was administered at a confidence level 0.05 to obtain the presence of significant difference across age and gender. The results indicated that, there was a significant difference across age groups. As age increased, the scores also increased indicating improved articulatory

abilities with age due to neuromuscular maturation. However there was no significant difference present across gender.

All the vowels and most of the consonants were acquired by 100% of the children by 5- 5.3 years of age. The consonants not achieved by this age were the aspirated phonemes /ʧʰ/, /d̪ʰ/, /ʈʰ/, / ʈ̪ʰ/, /bʰ/, / gʰ/ and /kʰ/ and also /d̪/ and /h/ in the medial position.

Considering the acquisition of clusters, it was found that medial clusters were acquired earlier than initial clusters in general. Statistical analysis indicated that there was a significant difference among some of the age groups. The common cluster errors found were cluster reduction followed by epenthesis and substitution. The clusters which acquired 90% criteria by 5- 5.3 years of age were /pr-/, /sk-/, /gl-/, /kl-/, /pl-/, /sl-/, /bl-/, /st^{h-}/, /tR-/, /br-/, /st^{h-}/ and /kj-/ in the initial position and /-nt-/, /-nʈ̪-/, /-ndʒ-/, /-nd-/, /-nk-/, /-ʈ̪y-/, /-nɖ̪r-/, /-sk-/, /-lj-/, /-sʈ̪-/ and /-sʈ̪r-/ in the medial position. By 6 years of age 14 out of the 15 clusters met 90% criteria in both initial and medial position of words.

The present study also observed earlier acquisition of all phonemes including clusters by 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 Articulation Test for their diagnostic and therapeutic purpose henceforth.

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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	aṇṇa:n							
2	**a:**	initial	a:na							
3	**i**	initial	ila							
4	**I:**	initial	i:ʧa							
5	**u**	initial	uḷḷi							
6	**u:**	initial	u:ɲɲa:l							
7	**e**	initial	eli							
8	**e:**	initial	e:ṇi							
9	**o**	initial	onnə							
10	**o:**	initial	o:la							
11	**k**	initial	kuda							
12		medial	t̪a: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	**ṭ**	initial	ṭo:kta:r							
24		medial	ro:də							
25	**ṇ**	medial	kiṇar							
26		final	fo: ṇ							
27	**t̪**	initial	t̪at̪a							
28		medial	mo: t̪iram							
29	**ḍ̪**	initial	ḍ̪o:ʃa							
30		medial	ʤalado:ʃam							
31	**n**	initial	nakṣat̪ram							
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	**ɻ**	medial	vaɻa							
45		final	va: ɻ							
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	**ɭ**	medial	ko: ɭi							
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	braʂə							
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	puspakam							
98	**-sk-**	medial	biskattə							
99	**-str-**	medial	vastram							
100	**-kʂ-**	medial	nakʂaʈram							

Appendix II

Articulation scores expected for typically developing Malayalam speaking children in the age range of 5- 6 years using the Modified Malayalam Articulation Test

Age	Scores expected for typically developing children
5.0- 5.3 years	96.51 ± 1.44
5.4-5.6 years	97.36 ± 1.17
5.7- 5.9 years	98.00 ± 1.07
5.10- 6.0 years	98.32 ± 0.92

Maximum Score - 100

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