REVALIDATION OF MALAYALAM DIAGNOSTIC ARTICULATION TEST (3-4 YEARS)

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CERTIFICATE

This is to certify that this dissertation entitled ***"Revalidation of Malayalam Diagnostic Articulation Test (3 – 4 years)"*** is the bonafide work submitted in part fulfillment for the degree of Master of Science (Speech - Language Pathology) of the student (Registration 09SLP019). 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 (3– 4 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 (3– 4 years)"*** is the result of my own study and has not been submitted earlier in any other university for the award of any diploma or degree.

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CHAPTER I

INTRODUCTION

Articulation refers to the totality of motor process involved in the planning and execution of sequences of overlapping gestures that result in speech (Fey, 1992). The definition entails, first, that the learning of articulatory skills is a developmental process involving the gradual ability to move the articulation in a precise and rapid manner. Second, that error in articulation results from relatively peripheral disturbances of articulatory processes. Thus, articulation is a specific, gradually developing motor skill that involves mainly peripheral motor processes. 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. It is a series of overlapping ballistic movements which places varying degrees of obstruction in the path of the outgoing air steam and simultaneously modifies the size, shape and coupling of the resonating cavities" (Nicolosi, Hanyman & Krescheck, 1978).

The significance of articulation: Oral communication is important because it is the primary means of interacting with others, for expressing feelings and ideas, for venting anxieties and frustrations, for effecting change and for enabling one person to find out what another person is perceiving and thinking. This is complex because it involves understanding and using abstract, arbitrary symbols. It utilizes many

different combinations of phonemes, morphemes, words and inflections. The principal vehicle for conveying meanings, thoughts, ideas, concepts and attitudes through sounds, words, phrases and sentences is articulation. An oversimplified version is the adjustments and movements of speech structures and vocal tract necessary for modifying the breath stream for producing the phonemes and prosodic linguistic features of speech.

Psycholinguistic literature suggests that articulation is the mastery of phonologic rules and contrastive features that govern the production and perception of speech that is readily distinguishable speech mechanism adjustments that produce different speech sounds. Perkins (1977) describes articulation in terms of (1) how intelligible the speaker is (2) how well the speaker's speech meets the cultural standards (3) how appropriate are the speech with regard to the vocational goals and (4) how satisfied the speaker is with in speech. Articulation errors are typically classified according to the child's age, which translates into stages with in this developmental process. Younger children are at an earlier stage in this development; whereas older children are at a later stage or may have completed the process. Depending upon the age of the child, certain articulation errors may be considered to be typical (age appropriate errors) or atypical (non age appropriate errors).

Articulation errors are also viewed as failure on the part of a speaker to perceive the significant contrasts between the standard sound and the sound which he produces. 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 (eg: when a four year old continues to say ‘tar’ for car). A child is said to have an articulation disorder when their patterns and/or sound acquisition sequence deviate from those seen in most children of their age. Articulatory disorders are the most frequently occurring among all the types of speech disorders. Misarticulations occur normally during the early stages of speech development. Thus, when some articulation errors occur at certain age levels, the child is not considered to have an articulation disorder. Rather use of such articulation patterns is characteristic of normal phonological acquisition. The deviances in articulation could be due to organic factors, emotional conflicts, acoustic and perceptual deficiencies, difficulties in phonetic discrimination, poor motor co ordination, 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 patterns in the language community. Therefore, a speech language pathologist should be able to differentiate those with normal articulation from the abnormal. In order to evaluate the articulation of these patients, tests of articulation are essential. The test of articulation is a basic tool of the speech language pathologist.

Articulation tests are typically designed to:

i. Determine whether his or her speech sound system is sufficiently different from normal development to warrant intervention.

ii. Determine treatment direction including target behaviours and strategies to be used in the management of the client.

iii. Make prognostic statements relative to phonological change with or without intervention therapy.

iv. Monitor change in phonological perfomance across time

v. Identify the factors that may be related to the presence or maintenance of a phonological disability.

The purpose of articulation test varies and hence the nature and scope of articulation test inventory varies. If the purpose is to asses the general adequacy of articulation in order to determine whether a child will need speech correction, a screening test can be used. If a detailed description and analysis of articulation is desired in order to determine the direction the speech correction should take, a diagnostic test is needed. The value of information obtained from the articulation testing is related both to the precision of the instrument and to the sophistication of the examiner in its administration and interpretation. Articulation tests are language specific and each language has its own phonological system. Traditionally, Van Riper and Irwin (1958) define an articulation test as a technique employed to measure the general phonemic capacity of an individual. Articulation tests can be used in screening, diagnostic, predicting articulation disorders or deep testing.

Over the years, many investigators have developed and established norms using various articulation tests. In the past articulation tests have been developed in several

languages. The chronological development of articulation is a concept which has drawn a great deal of attention in the field of speech pathology. It is generally accepted that the ability to produce each of the sounds of a language is acquired at a particular age. Over the years, many investigators have tried to determine approximate ages of individual sound "mastery" in children speaking different languages. These guidelines are important when trying to separate normal from abnormal phonological development and when determining therapy goals. 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. 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.

Goodman (1976) had studied the acquisition in English and then compared to Templin (1957), Wellmann (1957) and Poole's (1934) studies. It was found that 33% of the sounds tested were produced one year earlier by 75% of the children. He concluded that the children of this generation are producing sounds correctly at an earlier age than a few years ago. This may be due to school, T.V, parents being more aware of speech problems of their children. Prather, Hedrick and Kern (1975) used the Sequenced Inventory of Communication Development - SICD and included 147 children in their study ranging from 24 to 48 months. Photo articulation test was administered, consonants were tested only in the initial and final positions and vowels were tested in one context. They assigned mastery of the sound to the level at which 75% or more of the children produced it correctly in two positions. Their results indicated that children were producing more sounds correctly at earlier ages than would be suggested by the classical articulation research.

Extensive normative data on the articulatory acquisition in Indian languages are limited. Divya (2010) found that all the vowels in Malayalam were found to be acquired by the age of 2.3 years except /u/ and /u: /. These two vowels reached 90% criteria by the age of 2.6 years. Most of the consonants were acquired by 3 years of age. However none of the clusters reached the 75 % criteria by the age of 3 years. Considering place of articulation, children acquired bilabials, labiodentals, dentals and velars first compared to alveolars, palatals, retroflex and glottal sounds.

Aim of the study: Aim of the study is to revalidate the norms for the existing articulation test in Malayalam in children aged 3 – 4 years.

The specific objectives of the study are

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

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

(3) To include more frequently occurring consonant clusters.

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

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

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

BRIEF METHOD: The study has conducted in 2 stages. Stage 1 included the revision of obsolete test words in Malayalam Diagnostic Articulation Test (Maya 1990) and selection of frequently occurring clusters. Stage 2 involved obtaining norms for the acquisition of articulatory skills in native Malayalam speaking children in the age range of 3 – 4 years.

Implications of the study: The revised articulatory norms obtained will help us to identify and diagnose native Malayalam speaking children with articulation problems. It can be used for planning intervention goals for communication disordered children and to document improvement in speech therapy.

Limitations

- Vowels were tested only in the initial position.
- Diphthongs, two in numbers in Malayalam were not tested.
- Sample size is limited.
- All the clusters occurring in Malayalam are not included in the test.
- The present study considered only one age range (3 – 4 years).

CHAPTER II

REVIEW OF LITERATURE

Children's acquisition of adult like speech production has fascinated speech language pathologists for over a century, and data gained from associated research have informed every aspect of speech – language pathology practice. The development of articulation has drawn a great deal of attention in the field of speech pathology. It is generally accepted that the ability to produce each of the sounds of a language is acquired at a particular age. Stoel – Gammon and Dunn (1985) indicate that phonetic or articulatory component of the sound system encompasses (a) the way sounds are formed by the speech mechanism, (b) their acoustic or physical components, and (c) their perception by the listener. Articulation is most often used to refer to physical movements and placement of the articulators and the motor abilities necessary for the production of the speech sounds.

Stages in phonetic development

Normative differences exist between reported studies, they may relate to methodology (Poole, 1934; Wellman and associates, 1931). For example these have been elicited spontaneously or imitatively. The mastery criterion also varied among studies, some researchers considered a sound mastered when 75% of children sampled produced correctly, whereas others require 90% and 100% correct for mastery.

Articulation develops quite orderly and systematically. It is probably the most orderly dimension of oral communication. Shortly after birth the child can be heard vocalizing vowels. The repertoire of vowels steadily increases until seventh month when the child is vocalizing all the vowels. In addition, the consonants /h/, /w/, /k/ as well as some non distinguishable sounds occurs at this age. Since vowels are acquired first, they are assumed to be the easiest sounds in one language. The first vowels are those usually made in front of the mouth, followed by the schwa vowel /a/; and finally those made in the back of the mouth. Most children learn to use all the vowels correctly, along with few consonants by 2 ½ years of age, totaling approximately 27 phonemes. Acquisition is not an all or nothing event; individual sounds are not acquired suddenly but rather gradually overtime with extended period during which the sounds are produced correctly and incorrectly.

Few authors indicate that the acquisition of specific pattern and the sounds may be greatly influenced by the words in which they occur. After the first year consonant acquisition exceeds vowel acquisition. Also gender differences in regard to rate of sound development slightly favour females. Following this first major stage of phonetic development is the appearance of the five or six diphthongs at around 3 ½ years of age. One reason they are learned a little later than most of the vowels is that they require a smoothly coordinated blending of two different articulator positions. The five centering diphthongs in English develop considerably later.

A speech language pathologist should be able to differentiate those with normal articulation from the abnormal. This is done by the administration of 'ARTICULATION TESTS', which can be used for detection, assessment, prediction, analysis, interpretation and research. In order to serve the above mentioned purposes, various types of articulation tests have been developed; viz: - screening, diagnostic, predictive and deep tests. Screening tests are used to identify the clients who are deviant in articulation. Diagnostic tests are used to evaluate the deviant articulation in detail and predictive whether the child will have deviant articulation or be normal without therapeutic intervention.

Deep tests of articulation tests the client's ability to articulate phonemes in specific phonetic environments. 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.

The deep test of articulation is available in two forms:-

1. Picture form
2. Sentence form

In the picture form, two different sets of picture cards are used simultaneously to 'deep test' the variety of phonetic contexts. In the sentence form, two different sets of sentences are used to deep test a variety of phonetic contexts. Currently the deep test of articulation in picture and sentence form is available in English (Mc Donald, 1964), Kannada (Rohini 1989 – sentence form), Malayalam (Maya, 1990 – sentence form) and Bengali (Animesh Barman, 1987). India is a multilingual country and articulation test is specific to the language. This dynamic variation necessitates the development of articulation tests in various languages.

Maya (1990) developed a deep test of articulation (sentence form) in Malayalam. She used eight key phonemes (/j/, /s/, s/, /S/, /r/, /L/, /l/, /R/) which were most commonly misarticulated by children. Simple meaningful sentences were used. The sentence length was 2- 3 words with these target phonemes tested in vowel – consonant and consonant – cluster environments. The test consists of 87 sentences including 27 sentences in which target phonemes were tested in cluster environment. 70 Malayalam speaking children in the age range of 5- 8 years were tested. Each child was instructed to read or repeat the sentence which was read by the examiner and the responses were recorded. Each correct articulation was given a score of one and the total correct response was found out. She reported a maximum of 95.86% at 7-8 years. Statistical analysis showed no significant difference between males and females. However, there was an increase in the total score with the increase in age and /s/ and retroflex /S/ were the most difficult items to articulate in all the age groups. She also found that /S/ was acquired by Malayalam speaking children only by 5 – 5.6

years, /r/ by 4.6 – 5 years and /s/ by 4- 4.6 years. She opined that this could be the reason why children had difficulty in producing /S/ correctly in the deep test of articulation.

Prathima (2009) studied articulatory acquisition in Kannada speaking children and the results indicated that children 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. Boys and girls acquired all the vowels and diphthongs by the age of 3-3.6 years with the exception of diphthong /ou/ in boys which was acquired by 3.6 – 4 years. All the consonants were acquired by 4 years except /r/and/h/. However, /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 boys by the age of 4 years. The clusters /ksta/ and /ble/ were acquired by the age of 3 - 3.6 years by 75% of the boys and girls; however the consonant cluster /ski/ was acquired by 90% of girls by 3 - 3.6 years. Prathima (2009) tested ten consonant clusters in Kannada, four in initial and six in medial position. She found that /ksa/ and /ble/ had 75% acquisition by 3 – 3.6 year old children. None of the other clusters among the 10 clusters tested were mastered by four years of age. The results of all these studies suggest that the articulation scores, which is a measure of sounds produced correctly, increase with age until maturity is reached by 6 years. They have also reported sex and socio economic status differences in the age of acquisition of articulation. Females exhibited superior articulatory skills when the data was compared to the male population in all the age groups though not

statistically significant (Usha, 1986; Padmaja, 1988; Arun Banik, 1988; Maya, 1990; Prathima, 2009). However, children are acquiring proficiency in articulatory skills at an earlier age than would be expected from previously established norms. Recent studies (Sreedevi & Shilpashree, 2008; Rahul, 2006; Bharathy, 2001) focusing on phonological processes have revealed suppression of most of the processes by the age of 3 – 4 years.

Divya (2010) and Usha (2010) also reported that children seemed to acquire most of the sounds at a younger age compared to the earlier reports of several languages. Divya (2010) found that all the vowels in Malayalam were acquired by the age of 2.3 years itself except /u/ and /u:/. These two vowels reached 90% criteria by the age of 2.6 years. Most of the singleton consonants were acquired by 3 years of age. However none of the clusters tested reached the 75 % criteria by the age of 3 years. Considering place of articulation, children acquired bilabials, labiodentals, dentals and velars first compared to alveolars, palatals, retroflex and glottal sounds. Usha (2010) in Telugu found that all the vowels were mastered by 90% of the children by 2.0-2.3 years itself and all the consonants except aspirated stops and affricates were acquired by 2.6 – 3.0 years. These results indicate a need for new normative data consistent with the performance of children seen at present.

Deepa (2010) conducted a study on Re standardization of Kannada Articulation Test. The purpose of the present study was to re standardize the Diagnostic Kannada Articulation test and to establish new norms for the same. The Diagnostic Kannada

Articulation test was administered to 240 typically developing children in the age range of 2 - 6 years. They were divided into eight age groups 2- 2.6 years, 2.6 -3 years, 3 – 3.6 years, 3.6 - 4 years, 4 - 4.6years, 4.6 - 5 years, 5 - 5.6years, 5.6 – 6 years with six months age interval. The test was scored on the basis of correct responses. The results indicated that the mean scores increased from 2 years to 6 years of age. Girls had higher scores compared to boys except in 4 - 4.6 years of age and 5.6 - 6 years of age. Standard deviation was lower in girls compared to boys except at 3 - 3.6 years. Main effect of age revealed significant difference between the sub groups. Also, no significant difference was found between 5 - 5.6 years and 5.6 - 6 years. On the gender effect, significant difference was reported. Considering the order of acquisition of speech sounds, it was observed that most of the vowels, diphthongs, semivowels, dentals, bilabials were acquired by more than 90% of the children by the age of 2.6 years to 3 years.

According to the place of articulation, bilabials, labiodentals, dentals, were acquired much earlier than retroflex, palatals, velars and glottal sounds. In the recent study by Deepa(2010), it was found that all the bilabials, labiodentals, dentals and velars were acquired by the age of 2.6 years to 3 years; palatals by the age of 3.6 - 4 years; glottal /h/ was not acquired even by the age of 6 years. Palatal /d/ was acquired earlier than /t/. All the vowels and diphthongs were mastered by 90% of children by the age of 2 – 2.6 years. All the vowels, diphthongs, semivowels, bilabials, nasals, dentals, velars were achieved by 100% of the children by 3 years. In general all the stops were acquired by 3 - 3.6 years. Dental was acquired by the age of 4 – 4.6 years

and palatal /l̠/ was acquired by 90% of the children by the age of 3.6 – 4 years. Retroflex /ɳ/ was acquired by the age of 4 years by 90% of the girls and by the age of 4.6 years in boys. However, another salient observation was that the glottal fricative /h/ was not mastered even by 75% of children by 6 years.

Affricates were observed to be acquired by 90% of children by the age of 3- 3.6 years. In general it was noted that all the nasals /m/, /n/ were acquired by 2 years of age and /ɳ/ was acquired by 90% of the boys by 4 – 4.6 years and 90% of girls by 3.6 – 4 years. Clusters /st/, /sku/ was acquired by both girls and boys by 4 – 4.6 years and 3.6 – 4 years respectively. Similarly / skru/ and /dra/ was acquired by 4 -- 4.6 years and 5 – 5.6 years.

Studies on articulatory acquisition

Extensive studies on articulatory acquisition have been carried out in Indian context (Sreedevi, 1976; Tasneem Banu, 1977 and Prathima, 2009 in Kannada; Thirumalai, 1972; and Usha, 1986 in Tamil; Padmaja, 1988 in Telugu; Arun Banik, 1988 in Bengali; and Maya, 1990 and Divya, 2010 in Malayalam). They concluded that the acquisition followed the same pattern as in English but generally it was found that most of the sounds were acquired earlier in the Indian studies compared to the western context. The detailed description of the articulation tests in the Indian languages are as follows:

Bengali: Arun Banik (1988) developed a screening test of articulation and discrimination on 165 Bengali speaking school going children in the age range of 2 – 8 years. The children were divided into an age group of one year interval in each. 118 words were selected for the articulation test and 22 minimal pairs were taken for the phonemic discrimination test. The screening articulation test was administered individually for each child. The test cards were visually presented and the oral responses are noted. For the phonemic discrimination test, the minimal pair card was placed before subjects and he was asked to indicate the picture named and was required to point out the correct pair. The data for each group was statistically analysed. The results indicate the following: The perfomance varied from one group to another. As age increases scores also increased. 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 the terms of articulatory skills were found to be significantly different. Females exhibited superior articulatory skills when compared to males 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 /zh/, flap /r/, tril /r/, and some of the clusters like /kr/, /kl̥a/, /sra/, /gl/, /bra/, /st/, /skr/. Most of the misarticulated sounds were omitted or substituted. The errors such as distortion or addition were not observed. The age of acquisition of the sound and the ability to discriminate were correlated each other. The earlier they were able to discriminate the sound, earlier they were able to correct the articulation.

Malayalam: Maya (1990) developed an articulation test battery (screening, predictive and diagnostic tests) in Malayalam. Eighty six words including all the phonemes in Malayalam which were rated as highly familiar were considered for the diagnostic articulation test. The test was administered on 240 normal children in the age range of 3 – 7 years for obtaining the normative data 15 males and 15 females from each subgroup (3.0 – 3.6; 3.7 – 4 ; 4.0 – 4.6; 4.6- 5; 5.0 – 5.6 ; 5.7 – 6.0 ; 6.1 – 6.6; 6.7 – 7.0) were selected. The cards were presented visually one at a time and audio visual stimulation was kept at minimum. A score of one was given to each correct response. The data for each group was statistically analysed. The results indicated: The perfomance varied from one group to another. The articulation score was directly propotional 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 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 unaspirated 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/ , & /j/ at earlier age of 3 – 3.6 years. While the unaspirated stops are acquired at early (3 – 3.6 years), aspirated stops were acquired as late as 6 – 6.6 years. Divya (2010) found that all the vowels in Malayalam were

acquired by the age of 2.3 years itself except /u/ and /u:/. These two vowels reached 90% criteria by the age of 2.6 years. Most of the singleton consonants were acquired by 3 years of age. However none of the clusters tested reached the 75 % criteria by the age of 3 years. Considering place of articulation, children acquired bilabials, labiodentals, dentals and velars first compared to alveolars, palatals, retroflex and glottal sounds.

Tamil: Thirumalai (1972) studied the acquisition of phonology on 4.4 year old boy. The results indicated that child had acquired all the stop consonants, nasals and laterals among the consonants. Child substituted alveolars for retroflex nasals and retroflex laterals. This was generally found with regard to those words which have retroflex counterpart sounds in the speech of subject's parents. So he concluded that, the child was not encountering any difficulty in the production of the sounds of the language, and the difficulty was to produce them in appropriate environment.

Usha (1986) studied the articulatory acquisition in 180 Tamil speaking children in the age range of 3 – 6 years. They were divided into 6 age groups of six months interval. They were administered Tamil articulation test. The test score was based on the frequency of occurrence of the correct responses. The obtained data was statistically analysed. Articulation development for a particular sound was assumed to be completed, if 90% of the children produced them correctly. The results indicated that (a) there was a significant difference between males and females in terms of articulatory skills. Females exhibited a superior articulatory skills compared to the

male population in all the groups, (b) all the vowels and most of the consonants except /s/, /l/, /r/ were acquired by the age of 3 years. (c)The fricative /s/ was not acquired even at the age of six years. (d) All the stops were acquired by the age of 3 years. Among the stops the voiceless retroflex /t/ was acquired earlier at an earlier age compared to the western studies, (e) all the nasals were acquired by the age of 3 years, /l/ was acquired earlier but not consistently produced till 6 years of age, /l/ was not acquired even at the age of 6 years, (g) the flap /r/ was not acquired till 6 years which was completely late when compared to other studies. In initial positions it was found to occur at the age of 5 years but not in medial and final positions.

Telugu: Padmaja (1988) developed the test of articulation and discrimination in Telugu to study the acquisition of sounds in Telugu speaking children in the age range of 2.5 – 4.5 years. The children were divided in an age group of six months interval in each and each group consisted of 40 children. The test was administered to all the children and the response were elicited by picture naming/ repetition. The data for each group was statistically analysed.

The results are as follows: The perfomance varied from one group to another. The articulation score increased as age advanced. There was no significant difference between males and females in terms of articulatory skills in all groups. All vowels and most of the consonants except /r/, /s/, /l̩/, /t/, /d/ and aspirated stops were acquired by 2.5 years of age .All nasals were acquired by 2.6 years of age. The phonemes such as

/s/, /r/, /l/, /l/, s/ and aspirated consonants were acquired by 3.3years of age. The phonemes such as /ta/, /l̪/, and clusters were acquired by 3.5 years of age. Usha (2010) in Telugu found that all the vowels were mastered by 90% of the children by 2.0-2.3 years itself and all the consonants except aspirated stops and affricates were acquired by 2.6 – 3.0 years. These results indicate a need for new normative data consistent with the performance of children seen at present.

Kannada: Sreedevi (1976) studied the speech sound acquisition aspects of Kannada on four children (two boys and two girls) in the age range of 2; 3.5 to 2; 11.5 years. The utterances of children were recorded once in five weeks for every child and four recordings were done during the period of investigation. The data was collected for three days in every stage of recording. Elicitation, imitation and spontaneous speech was used to elicit responses. The data transcribed in the phonetic script and analysed. The results indicated the following: The distinction between voiced and voiceless feature was acquired earlier than the distinction between aspirated and unaspirated. The distinction between short and long vowel is acquired and stabilized in all children at the age of 2.3 years. Among the consonants, the stop consonants acquired more fully than sibilants, trills and laterals. Among the nasals, the bilabial and alveolar nasals were acquired than other nasals. Among the sibilants, the alveolar and palatal sibilants were acquired earlier than retroflex sibilants. Identical clusters were acquired earlier than non identical clusters.

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. The children were divided into seven age groups of six month interval. They were administered diagnostic Kannada articulation test individually and it was scored on the basis of the frequency of occurrence of phoneme. The results indicated the following: There was a significant difference in the articulation score for different age groups except between the groups V (5.1 – 5.6 years) and VI (5.7 – 6.0 years) and also between VI (6.0 – 6.6 years). A definite pattern of acquisition was found. There was a gradual but definite change as age advanced. The fricative /h/ was not acquired even at 6.6 years. The children acquired most of the sounds earlier than English speaking children. There was no significant difference between the scores of males and females.

Nataraja, Anil, Malini (1978) conducted a study of articulatory acquisition skills in 36 Kannada speaking children in the age range of 3- 7 years of age. The children were divided into four groups of one year interval in each. The Kannada diagnostic articulation test by Babu, Rathna and Bettagiri (1972) was administered to all children. The findings revealed the following: There was a definite pattern of acquisition and all the children acquired the articulatory skills faster compared to the western studies. Girls performed better than boys. The vowels /a/, /a:/, /i/, /i:/, /e/, /e:/, /o/, /o:/ were acquired by both girls and boys by 3-4 years. By 3-4 years the consonant /k/, /g/, /t/, /tɻ/, /d/, /p/, /b/, /j/, /v/, /s/ and /h/ were acquired by both boys and girls in initial and medial positions. Boys articulated the sound/dʒ/ in initial positions and

medial positions while girls could articulate only in initial positions. The girls acquired both the diphthongs tested (/ai/ and /au/), whereas boys substituted the sound /au/ by /o/. The acquisition of clusters just begun in both groups by age. By 4- 5 years of age, boys acquired all the vowels and diphthongs including /au/. Girls acquired the consonant /l̩/ in both initial and medial positions when the boys continued with the error. By 5 – 6 years males acquired /r/ and /l̩/. Girls were found to have articulate triple consonant blends correctly by 6 years. Only 60% of the males of seven years had the articulation of triple consonant blends.Prathima (2009) studied the acquisition of articulatory skills in 120 Kannada speaking children in the age range of 3-4 years of age. The children were divided into two groups of six months interval. Kannada articulation test was administered to all the children.

Tables 1 & 2 summarizes the age levels for speech sound development in Indian languages according to different Indian studies.

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

Table 1: *Shows age levels for speech sound development in Indian languages other than Malayalam according to different Indian studies.*

'-' indicates consonants not acquired. Empty space indicates speech sound not tested

Speech Sounds	Maya '90 (Mal)	Divya '10 (Mal)	
	75%	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	-	2.3-2.6
/**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
/**t**ʃ/	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 2: *Shows age levels for speech sound development in Malayalam according to different authors*
'-' indicates consonants not acquired. Empty space indicates speech sound not tested.

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

Table 3**:** *The age levels for the speech sound development in English*

Tests of articulation: This is important to evaluate the clients with articulation disorders. The purpose of an articulation test is to compare the phonemes that are actually used by an individual with the phonemic structure oh his language group. A test of articulation is a basic tool for speech pathologist. Articulation tests are typically designed to determine whether his or her speech sound system is sufficiently different from normal development to warrant intervention.

- Determine treatment direction, including target behaviours and strategies to be used in the management of the client.
- Make prognostic statements relative to phonological change with or without intervention/ therapy.
- Monitor change in phonological perfomance across time. Identify factors that may relate to the presence or maintenance of a phonological disability.

The purpose varies and hence the nature and scope of the test inventory also varies. Traditionally Irwin and Van Riper (1958) define an articulation test as a technique employed to measure the general phonemic capacity of an individual. Articulation tests can be used in variety of ways as follows:

Screening tests: screening tests consists of activities or tests that identify individuals who merit further evaluation. A screening procedure does not nearly enough data to establish a diagnosis; it only demands the need for further testing. Screening measures 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.

Diagnostic articulation test: In this type of articulation test, the phoneme tested is tested in many contexts in which it occurs in running speech, in order to analyse the correctness or incorrectness of the phoneme.

Predictive screening test of articulation: They mainly are responsible in helping the speech pathologist predict whether or not a client, having a particular speech defect, will outgrow his problem with age. It also helps in detecting whether speech therapy is required or not.

Deep test of articulation: In this type of articulation test, the phoneme to be tested is tested in many contexts in which it occurs in running speech, inorder to analyse the correctness or incorrectness of the phoneme. Over the years, many investigators have developed and established norms using various articulation tests. Following Table 3 and 4 reviews various diagnostic tests available tests in Indian and English languages:

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

Table 4: *List of various diagnostic tests available in 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 & Logemann	1971	Fisher-Logemann test of articulatory competence	English	Provides a distinctive feature analysis of the client's phonological system. All the English phonemes are examined according to syllabic function - prevocalic, intervocalic, and postvocalic - with frequent reliability checks.	Analysis recognizes and accounts for regional and ethnic differences.	3-80 years
4	Khan & Lewis	1976	Khan-Lewis Phonological Analysis - 2nd Ed. (KLPA-2)	English	Evaluates phonological processes used in young children's specch.	Provides percentile rankings, and age equivalent scores.	2 - 21 years (1890)
5	Weiss	1980	Weiss comprehensive articulation test	English	Incorporate several methods for quantifying articulatory abilities and reveals the presence of articulation disorders, the type of articulation patterns	Norm-referenced test for persons of all ages. Scores obtained include articulation scores, age-equivalent scores, intelligibility scores, and stimulability scores.	3-8 years (4000)
6	Goldman & Fristoe.	1986	The Goldman - Fristoe Test of Articulation - 2nd Ed. (G-FTA-2)	English	Evaluation of speech sound use in all position of words and consonant blends; stimulability testing	Age-based standard scores with separate gender norms.	2-21 years (2350)
7	Hodson	1986	Assessment of phonological processes — Revised (APP-R).	English	Evaluates phonological processes used by children	Provides number and percentage of occurrence scores.	3-12 years (980)

Table 5a: *List of diagnostic articulation tests available in English languages*.

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

Table 5b: *List of diagnostic articulation tests available in English languages.*

Methods of testing articulation: Articulation of speech sounds is measured in spoken words and is measured in 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. in words uttered spontaneously. In a second the 8 children fo have marked speech defects after the examiner words which the produced incorrectly. None of the children corrected their speech merely by having a pattern to imitate. She concluded that articulation similar whether or not a pattern to imitate has been presented. A similar conclusion was arrived by Templin (1957). She also report similar results are obtained when the same sound is presented in different words. But the results of Siegel, Winitz, and Conkey (1963) and Kresheck and Socolofsky (1972), studies contradict with those of the above studies.

Siegel, et al. (1963) reported the results of an investigation of the articulation performance of normal children. An imitative and spontaneous method of item presentation was used for a sample of 100 kindergarten children. Results suggest that there is an effect on the articulation in the imitative method of item presentation responses of normal children.

Kresheck and Socolofsky (1972) assessed the articulation of four year old children using the imitative and spontaneous elicitation methods, on the 87 words from the Templin-Darley Tests of Articulation. The results indicated a significant difference between the two methods of

stimulus presentation in the children's total articulation scores. The imitative method produced more correct responses. Their results also showed that there Their results also showed that there appeared to be little tendency for a child who had numerous misarticulation to be more influenced by an imitative model .Anthony and others (1971) tested three to five year old children an< no statistically significant difference in the results from the two methods.

Paynter and Bumpas (1977) found no significant difference between the two methods with 3 to 3.6 year old children. 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.

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 examiner. Stimulability testing can be done 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 be used (visual cues, kinesthetic cues). The information obtained from the stimulability testing is clinically significant in that it helps the clinician identify the kind of cues and prompts that can be used in therapy to facilitate correct production of

sound. Stimulability data are obtained because of their prognostic value. Farquhar (1961) reported that children with mild articulation are more likely to make the error sound correctly following stimulation on the basis of data obtained by from 100 kindergarten children. Fifty children were classified as having mild articulation problems and fifty with severe articulation problems.

Analysis and scoring of errors: The study of children's speech sound error is an important aspect of the larger area of children acquisition of language. Articulation scores are characterized by the omission, distortion, substitution, addition and/ or incorrect sequencing of speech sounds. Such Motorically – based errors are usually consistent. Since the sounds produced are notably different from normative productions, errors are described as phonetic in nature (Bauman – Waengler, 2000). Because the scoring and analysis procedures that accompany a test instrument determine the type of information obtained from the instrument, they are obtained from the instrument; they are important considerations in test selection. Different instruments currently available are designed to facilitate one or more of the following analysis:

1. Phonetic and/ or phonemic analysis of consonants and vowels in language.
2. Sound productions in a variety of word positions and phonetic contexts.
3. Place manner, voice analysis.
4. Phonological pattern/ process analysis.

5. Age appropriateness of phonological productions.

Standardization: some articulation tests are not standardized scores are not available as outcome measures therefore the results obtained fro a client cannot be compared to the perfomance of other children of similar age. If it is important that the results of an articulation test yield standardized scores, tests should be selected accordingly. Norm referenced standardized tests help the clinician to determine whether a child's score is like or unlike those of a group of individuals believed by the clinician to possess similar characteristics. When a child's perfomance falls outside the range of scores received by most of the individuals in the normative study the child may be said to show significantly different and non – normal speech or language behavior. Thus monitoring changes in child's articulatory and phonological abilities and perfomance across time and age is very important. Such articulatory acquisition norms are available in several languages. It is also important to remember that such existing norms need to be revised over a period of time to go with changed patterns of development.

Diagnostic articulation test is used when a detailed description and analysis of a child's articulation is required. ' such a test may be used when a detailed description and analysis of a child needs speech correction, but more frequently used with child who is already identified as having articulatory problems to aid in prescribing an adequate intervention.

Computerized articulation Tests:

The Computerized Articulation and phonology Evaluation System (CAPES-2002). This is a computer based program that was developed to elicit and analyzed phonological productions. CAPES include an online single-word (SW) elicitation task that is tailored to the client's phonological level. The SW task begins with a profile of 47 words. The client's responses to those words are analyzed in order to select an additional set of words, the Individual Phonological Evaluation (IPE), for presentation. IPEs represent different phases of phonological development, from the earliest word structures and phonemes at Level 1 to complex multisyllabic word at Level 4.

Client's responses may be automatically recorded and digitalized for later transcription or can be transcribed online with or without recording. After transcriptions are entered, CAPES performs both independent and relational analysis. This software accessed for word shapes, word length, stress pattern, consonants and vowels. Data regarding consonants and vowels may be viewed on the basis of individual segments, phonology simplification process, place/voice/ manner feature, and/or nonlinear features. CAPES also contain lists of potential treatment goals based on the results of the independent and relational analysis. Such goals presented based on word shape, segment, or feature level of organization.

In Indian context, a computer based assessment of phonological process in Malayalam (CAPP – M) was developed by Merin John (2010) in 30 children in the age range of 3 – 3.6 years. The aim of the study was to develop indigenous computer based software to assess the phonological processes in native Malayalam speaking children. The test material used was Malayalam articulation test (MAT; Maya, 1990). Ramadevi (2006) developed a phonological profile in children with hearing impairment using the phonological profile and developed a computerized module for the presentation of stimuli in the administration of Phonological profile in Kannada for phonological assessment. The assessment tool incorporates 92 pictures, reading 103 words with clusters and eliciting spontaneous speech from one of the seven story charts.

Acquisition of consonant clusters: Consonant clusters are a feature of many of the world's languages. In a study of 104 world languages, based on the work by few authors during 1990's, calculated that 39% had word initial clusters only, 13% had final clusters only, and the remaining 48% had clusters in both word initial and final positions. In English one third of monosyllables begin with a consonant cluster, and consonant clusters predominate in word final position. This predominance in word final position is attributable to the addition of the phonemes /s/, /z/, /t/, /d/ to indicate grammatical morphemes. When such morphophonemic clusters are excluded, only 18% of English monosyllables end in consonant clusters. Some languages such as Italian have more consonant clusters than English does, and other languages such as Cantonese, Catalan, Portuguese and Turkish have fewer (Greenberg, 1978; Swan and

Smith, 1987). For example Cantonese has only two consonant clusters, namely /kw/ and /khw/ (So and Dodd, 1995).

Children learning to produce consonant clusters in any language have a challenging task, and those learning English have a uniquely complex situation. The large variety of clusters permissible in English, both at the beginning and at the end of the syllables, makes even monosyllables extraordinarily complex in words such as strength. A further complicating factor is that morphological endings create even more complex phoneme sequences eg: Sixths. Consequently, the acquisition of clusters is one of the long lasting aspects of speech acquisition in normally developing children. Children as young as 2 years of age produce some consonants correctly (Stoel – Gammon, 1987). Yet some 8 – 9 year olds are still mastering consonant clusters (Smith et al, 1990; Templin, 1957). Because of the protracted acquisition of consonant clusters, gradual developmental gains can be identified and described in greater detail than in the acquisition of single ton a consonant which is essentially completed much earlier (Smith et al, 1990). Knowing about consonant clusters and their development is important for speech language pathology practice because it can help determine whether the children's speech development is progressing normally and can assist in selecting targets for intervention.

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 between their first

attempts at consonant clusters and the final correct production. These stages in the acquisition of clusters were first formalized by Greenlee (1974). In Greenlee's earliest stage of cluster development, the entire cluster is deleted—for example, desk [de]—although this is fairly rare. In contrast, Greenlee's second stage of cluster development, which involves reduction to a single consonant—for example, snake [neIk]—is very common and often persists for several months or more. In Greenlee's third stage of cluster acquisition, the number of elements in the cluster is preserved but with substitution of one or more of the consonants in the cluster—for example, frog [fwAG]. Finally, children achieve full accuracy in producing clusters. 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).

Why do children learning to talk delete consonant clusters?

By age 4 ½ years /t/, /d/, /k/, and /g/ are learned. Their production requires a somewhat higher level of neuromuscular integrity than those sounds previously mentioned. By age 5 years /f/, /v/ and /j/ are learned followed by /th/, /dh/ and /l/ by 5 ½ years. Between 6 ½ years and 7 years of age the remaining sounds are learned. These include /r/, /s/, /a/, /S/, /Z/, /l̩/, /ʒ/, /t l̩/ and /dʒ/ all centering diphthongs and all of the consonant blends or clusters. In children with physical, psychologic, neurologic problems there is an exception in the acquisition. Few deletions of final consonants are present after 3 years of age. Deletions of unstressed syllables occur up to 4 years of age. When deletions by reduction of clusters occur, they show predictable patterns, as do deletions of marked members of a cluster. Greenlee (1974) gave the following example of how a child reduced or simplified the consonant cluster in the word 'play'. The following predictable patterns were observed.

Stage 1: deletion of entire consonant cluster /ey/

Stage 2: reduction of consonant cluster to one member /pey/

Stage 3: Use of consonant clusters with substitution for one of the members /pwey/

Stage 4: Correct articulation /play/.

Studies pertaining to acquisition of consonant clusters

A review of the existing literature revealed very little information on the development of consonant clusters. Templin (1957) conducted a study on mastery of

initial and final consonant clusters. The criterion for acquisition considered when 75% of the subjects produced them correctly. Templin's finding revealed that by age 4.0, 75% subjects 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 and word initial clusters occurred more frequently than word final clusters. In Smit's study on the acquisition of speech sounds in children residing in Iowa and Nebraska, the following results were found:

- On fourteen children 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/, /sm/, /sn/, /st/ and /sk/.
- The consonant clusters /br/ and /ər/ demonstrated a higher frequency of consonant clusters reduction for children from ages five to nine years.
- For the 5;6 to 7;0 year olds, consonant clusters that fell at 75 percentage or below accuracy included /sl/, /br/, / ər/, /skw/, /spr/, /str/ and /skr/.
- Epenthesis, or schwa insertion in consonant clusters, occurs frequently up to age 8.0. The 9 year olds exhibited schwa insertion rarely.

Dyson (1988) studied phonetic inventories in 20 children in the age range of 2-3 years. Two speech samples were taken approximately 5-6 months apart which ranged

from 53-250 words. Results indicated that the clusters were produced quite frequently by these children, no subject produced less than four different clusters, the initial cluster that was produced by 5 children were /fw/, and word final clusters were slightly less common than word initial clusters. Authors reported that the production of consonant clusters [-nd], [-ts], [-nt], [-nz] by the age of 2.9 and [-nk] by the age of three years. Dyson (1988) reported that the only word final cluster used by over half of the two to three year old subjects was [-ts] and transitional clusters included were [-nk, -ps, -nt∫, -nts, -ns]. In languages other than English, the word final clusters are reported to be acquired before word initial clusters.

Kirk and Demuth (2005) studied asymmetries in the acquisition of word initial and word final consonant clusters. The participants included were 12 year olds monolingual English speaking children in Rhode Island. The test items included picturable, monosyllabic English nouns and colour adjectives with a consonant cluster in word initial or word final position. The following clusters were targeted: word initial /s/ + stop, word initial /s/+ nasal, word initial stop + /l/, word initial +/r/, word final nasal+/z/, word final stop+/s/, word final nasal + stop, word final /s/ + stop. Spontaneous productions and limitations were used to elicit responses. The results showed that word final stop+ /s/ clusters and nasal + /z/ clusters were produced more accurately than word initial /s/ + stop clusters.

A preliminary typology of initial clusters in acquisition revealed that Acquisition research, whether from normal or disordered development, has shown

there is not a true order of acquisition of specific initial consonant clusters in English. Children in terms of which individual cluster is acquired first, and which is acquired last. This is not surprising, since the same has been found to be true with the development of singletons. Consider the acquisition of /s/-clusters relative to other clusters of English. According to some studies, they are acquired relatively early (e.g. Stoel-Gammon and Dunn, 1985), but according to others they are acquired relatively late (e.g. Smith, 1973; Smit, 1993).

In Smith's (1973) diary study of normal phonological development, acquired the /s/-clusters later than most other clusters. From case studies of disordered development, some children acquired all the /s/-clusters before other clusters. However, Smith (1996) reported on one child who acquired non-/s/-clusters first, while another child acquired both types of clusters at the same time. Order of acquisition is one factor that determines relative markedness of sounds and clusters in language. Specifically, children are expected to acquire unmarked properties of language first. Because of this unusual behaviour of /s/-clusters, it is difficult to determine if they are marked or not. If /s/-clusters are acquired early, then it would be reasonable to assume that they are unmarked relative to other clusters. However, if they are acquired later, one would assume that they are marked relative to other clusters. Gierut (1999) addressed this puzzle with a treatment study. She determined that treatment on /s/ 1 stop clusters resulted in within-class learning only, such that generalization was limited. This type of generalization is characteristic of learning patterns associated with treatment on unmarked aspects of sound systems. This has

been shown in many other independent studies on a variety of aspects of sound systems, and suggests that the /s/ 1 stop clusters are unmarked.

Another means for determining markedness in clusters involves an appeal to sonority. Accounts of consonant clusters in fully developed systems typically appeal to the sonority hierarchy, which ranks sounds according to their relative degree of sonority. There is also an appeal to the sonority sequencing principle (SSP), which requires that onsets (initial clusters) rise in sonority and codas (final clusters) fall in sonority. Minimal distance constraints are posited which appeal to the sonority distance between two sounds. The greater the sonority distance between segments in a cluster, the less marked the cluster. Thus, if a language has clusters with smaller sonority distance, it is expected that the same language will also have clusters with greater sonority distance. In acquisition, it is expected that those clusters with greater sonority distance emerge first, while those with smaller sonority distance emerge later. However, this prediction is not borne out in those cases where /s/ 1 stop and /s/ 1 nasal clusters, for example, which have smaller sonority distance, emerge prior to those clusters with greater sonority distance.

The /s/-clusters are equally problematic for theoretical accounts of English and other languages with /s/-clusters. First, /s/ 1 stop clusters violate the SSP, in that they have a falling sonority slope. Secondly, clusters /sl-/, /sn-/ and /st-/ violate a phonotactic constraint on initial clusters in English which prohibits homorganic clusters. Thirdly, /s/ is the only sound that may be followed by a nasal or a stop in

initial clusters. Finally, /s/ is the only sound that may occur at the beginning of a three-element cluster such as /str-/ or /spl-/. All these facts reveal the special status of /s/-clusters.

Two lawful relationships involving word-initial onset clusters have been advanced in the acquisition literature; namely, that clusters imply and that liquid clusters imply a liquid .The study Precursors to onset clusters in acquisition evaluated and extended the validity of these implicational laws in a population of 110 children (aged 3; 0 to 8; 6) with functional phonological delays who contributed extended speech samples for computational analyses. Results indicated that, for the most part, the composition of children's sound systems were in compliance with the proposed laws; however, there were noted asymmetries and apparent exceptions in the data.

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

Table 6: *Shows the comparison of age of acquisition of consonant clusters*

Smit et.al (1990) reported that 75% of normally developing children produce a consonant cluster consisting of a stop + /w/ (eg, queen) by age 3.6, clusters containing /l/ (eg, play) excluding /sl-/ by age 4.5 to 5.6, clusters containing /s/ (eg, sweep, stop) and /θr/ (through) by age seven. Several studies have also been conducted, by considering the age of acquisition of specific consonants. Arlt and Goodban (1976) assessed six consonant clusters, but did not report age of acquisition findings in their study. They reported that /gr/ and /br/ were produced six months later by their subject's than by Templin's (1957). Higgs (1968) studied the age acquisition of consonant clusters such as /sp/, /st/ and /sk/. She concluded that there was a steady increase in the percentage of consonant clusters correct from ages 2.6 to 5 years. At the age of 2.6, the percentage of consonant clusters correct for /sp/, /st/, and /sk/ were 38, 38 and 37 respectively. At the age of five, the percentage of consonant clusters for /sp/, /st/, and /sk/ were 84, 84 and 84. These results obtained in Higgs (1968) were

lower than those obtained by Templin (1957), indicating that Templin's (1957) subjects developed the consonant clusters earlier than the study by Higgs. Paynter and Petty (1974) found that 57% of 2.5 year old girls produced /st/ correctly, but less than 50% of boys could produce this.

Acquisition of Consonant Clusters in Indian languages

There are few studies on the acquisition of consonant clusters in Indian languages. Chervela (1981) attempts to trace the acquisition of medial consonant clusters by Telugu children. Phonemic inventories are given for each of the children for a clear picture of their acquisitional stage. It was found that reduction, substitution and assimilation played major roles in cluster acquisition. Co-occurrence restrictions and hierarchical application of the three phonological processes were noted.

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

- The medial clusters /-nt-/, /-nṯ-/, /-nt/, /-nd-/, /-nk-/ were acquired by 3 – 3.6 years , /-ṯy/ by 3.7 – 4 years and /- nḏra/
- The other consonant clusters /- nḏr-/, /pr-/, /-kr-/, /- ṯra-/ were acquired by 4.7 to 5 years.

- /- sṯa-/ was acquired by 5 - 5.6 years whereas /-ska-/ by 6 – 6.6 years.
- /- sṯra-/ and /- kṣ-/ were acquired by 6 - 6.6 and 6.7 – 7 years respectively.

Sameer (1991) studied the phonological processes in 3 - 4 year old Malayalam speaking children and reported the occurrence of cluster reduction in them. Jayashree (1999) studied phonological process in normal Kannada speaking children in the age range of four-five years old. She found that even by 5 years of age, there were processes that persist in child's phonology. The persisted processes were cluster reduction, fronting, stopping and the processes which completely disappeared were metathesis, epenthesis, prevocalic voicing and palatalization.

Arun Banik (1988) studied the articulation and phonemic discrimination in Bengali language and found that cluster sounds like /kr/, /ksha/, /sra/, /gl/, /st/, /skr/ were not acquired the age of 3 years. 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 sounds 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 and found that medial clusters occurred predominantly with 60- 70 % of frequency and within medial clusters, geminated clusters occurred more frequently with the percentage of occurrences between 30-40 %. This frequency was maintained across all age groups.

Prathima (2009) tested ten consonant clusters in Kannada, four in initial and six in medial position. She found that /ksa/ and /ble/ had 75% acquisition by 3 – 3.6 year old children. There were also unusual observation in the group, i.e., clusters /sku/ and /ksa/ in girls and the clusters /ksa/ and /ble/ in boys was found to be acquired by 75% in younger age group (3 – 3.6 years) and the percentage reduced in older age groups.

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

- None of the clusters reached 75% criteria by three years of age.
- Only a single boy in the age range of 2.9 to 3 years produced /**ʈ̪ra/**, /s**ʈ̪a/**, and /ska/ in medial positions.

- At 2.9 years children begin to produce clusters but they have substitution errors. The clusters with substitution errors seen in this study were /ʃ**ʈ**a/, for /s**ʈa** / and /ʃka/ for /ska/. The palatal fricatives were used for dental fricatives.

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

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
-n**ʈ**	3.6	-n**ʈ**	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 7: *Age of acquisition of consonant clusters in Indian languages according to various researchers*

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

CHAPTER III

METHOD

The aim of the present study was to revalidate the norms for Malayalam Diagnostic Articulation Test (Maya, 1990) in native Malayalam speaking children in the age range of 3.0 -4.0 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 3 - 4 years.

Phase 1: Modification of Malayalam Diagnostic Articulation test

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

another fifteen words with common clusters and 3 words with aspirated stops were incorporated in the present test material.

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

i) Target words selection

ii) Picture selection for the target words

i) Target words selection

To replace the 15 obsolete words, five new words with the test phoneme in the same position as in the obsolete words were selected for every obsolete word. So a new word list comprising a list of 75 words (15 x 5) were made. For eg. the word /di:pam/ was found to be outdated. Hence 5 new 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 rated the existing words as familiar compared to the new words presented.

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

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

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

ii)Selection of pictures for the target words

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

Phase 2: Obtaining norms

Subjects: Malayalam speaking typically developing children in the age range of 3 – 4 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 (3 - 3.3, 3.4 - 3.6, 3.7 - 3.9, 3.10 - 4.0 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

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

For consonant clusters, scoring was based on Greenlee's (1974) stages of cluster development which are described above :A score of 0.5 was given to errors such as coalescence, cluster simplification, metathesis and epenthesis because they involved the reduction of consonant cluster to a single consonant or simplification into a form were a part of the cluster is preserved, for example; /tʃandran/ as /tʃandaran/. A score of 0.75 was given when the number of elements in the cluster is preserved but with substitution of one or more of the consonants in the cluster, for example /st^{h}alam/ as /skalam/. Finally the total score for each subject was calculated. Recent study by Divya (2010) in Malayalam reported that 90% of the singleton consonants were acquired by children by 3 years of age. Hence a criterion of 100% correct response was considered in the present study for singleton consonants. In the same study it was reported that the clusters emerge by 2.9 years of age. Hence 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 present study was to revalidate the norms for Malayalam Diagnostic Articulation Test (Maya, 1990) in native Malayalam speaking children in the age range of 3.0 -4.0 years. The newly developed test material was administered to 120 typically developing Malayalam speaking children in the age range of 3 – 4 years. Subjects were divided into four groups with an inter age interval of 3 months (3– 3.3years, 3.4 – 3.6years, 3.6 – 3.9years, 3.10 – 4years). All the responses of the subject were recorded and analysed and scores were allotted to the responses. The total score for each subject were calculated.

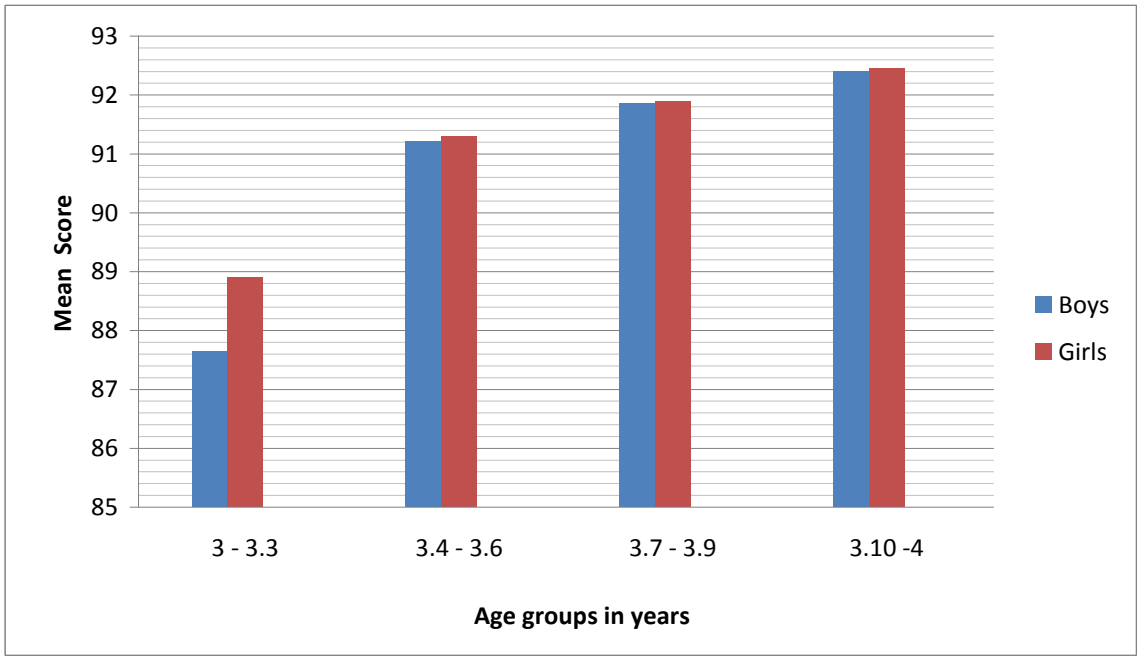
The data was subjected to appropriate statistical analysis using SPSS (17- ver). Descriptive statistics was used to find the mean and standard deviation for all the four age groups. The maximum score expected in the modified test is 100. On observation it is found that the overall mean articulatory scores linearly increased with age in both boys and girls. The overall mean and standard deviation scores are shown in Table 9.

Gender	Age	Mean (Std.Dev)	N
Boys	Group I (3 -3.3 years)	87.65 (2.44)	15
	Group II(3.4- 3.6 years)	91.21 (1.08)	15
	Group III(3.6 – 3.9 years)	91.86 (1.11)	15
	Group IV (3.10 – 4 years)	92.40 (0.38)	15
	Mean Total scores	90.78 (2.34)	60
Girls	Group I (3 -3.3 years)	88.90 (1.54)	15
	Group II(3.4- 3.6 years)	91.29 (1.61)	15
	Group III(3.6 – 3.9 years)	91.90 (0.99)	15
	Group IV (3.10 – 4 years)	92.45(1.00)	15
	Mean Total scores	91.13 (1.87)	60
Combined scores	Group I (3 -3.3 years)	88.27(2.20)	30
	Group II(3.4- 3.6 years)	91.25(1.34)	30
	Group III(3.6 – 3.9 years)	91.88(1.03)	30
	GroupIV(3.10– 4 years)	92.42(0.74)	30
	Mean Total scores	90.96 (2.12)	120

Table 9: *Overall mean articulation scores and SD (parenthesis) in different age groups across gender*

Graph 1 shows the overall comparison of scores across age and gender. In the youngest age group (3 – 3.3 years) girls had higher articulatory scores compared to

boys. However the other three age groups did not show a visible difference in the mean articulatory scores across gender. The variability in articulation scores reduced from Group I to Group IV indicating better precision in articulation as age increased. The mean articulation scores excepted for typically developing Malayalam speaking children in the age range of 3 – 4 years old children using the modified Malayalam diagnostic articulation test is shown in APPENDIX II.



Graph 1: *Overall mean articulatory scores in different age groups in boys and girls*

Two – way ANOVA was carried out to obtain the significant difference in overall articulatory scores between different age groups (Group I: 3 – 3.3 years, Group II: 3.4 – 3.6 years, Group III: 3.7 – 3.9 years, Group IV: 3.10 – 4 years). The

results indicated that there was a significant difference {df = 3, F- 53.098, ($p < 0.05$)} across the age groups. The articulation score was directly propotional to age in that the scores increased as the age advanced.

When age wise comparison was made, all the four groups showed significant difference in terms of articulatory acquisition. The results indicated that the articulatory development increased linearly with age. All the vowels were acquired by 100% of the children by the age of 3 – 3.3 years. Most of the consonants were also acquired by 90% of the children by the same age of 3 – 3.3 years.

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'09; Divya'10 & Usha'10) indicated that phoneme development is correlated with age and some sounds are acquired earlier than others. The results of the present study confirm those of the above studies. It is evident that with neuromuscular maturity, all motor skills increased as the age advanced and also the articulation skills.

The results are further discussed under the following three main headings.

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

1) Vowel acquisition

In the present study, Modified Malayalam Diagnostic articulation test tests 10 vowels in the initial position and the results indicated that the vowels were acquired much earlier than consonants. The vowels /a/, /a: /, /i/, /i: /, /e/, /e: /, /o/ and /o: / were acquired by 100 % of the children by 3 – 3.3 years itself. Divya (2010) also supports this view that by 2.3 years itself 75% of the children acquired the vowels correctly and exception was found for /u/ and /u: /. By 2.6 years of age 90% of the children produced /u/ and /u: / correctly, whereas 100% scores was reached by 2.9 years of age in her study. Hence the present results are not exceptional.

The Indian studies (Tasneem Banu'77; Usha'86; Padmaja'88; Arun Banik'88; Maya'90; Prathima'09) mainly focused on the age groups older than 2.5 years and the results were that most of the vowels achieved by 3 years itself. The present study is in coherence with the above studies also.

2) Consonant acquisition

Modifie**d** Malayalam articulation test tests 35 consonants in which 17 are in the initial and medial positions, two in medial and final positions, eight in medial

position, three in initial, medial and final position and five consonants in initial position only.

The results are being discussed under the following sub headings:

a) Age and Gender.

b) Order and position of consonant acquisition.

c) Acquisition based on place, voicing and manner features.

a) Age and Gender

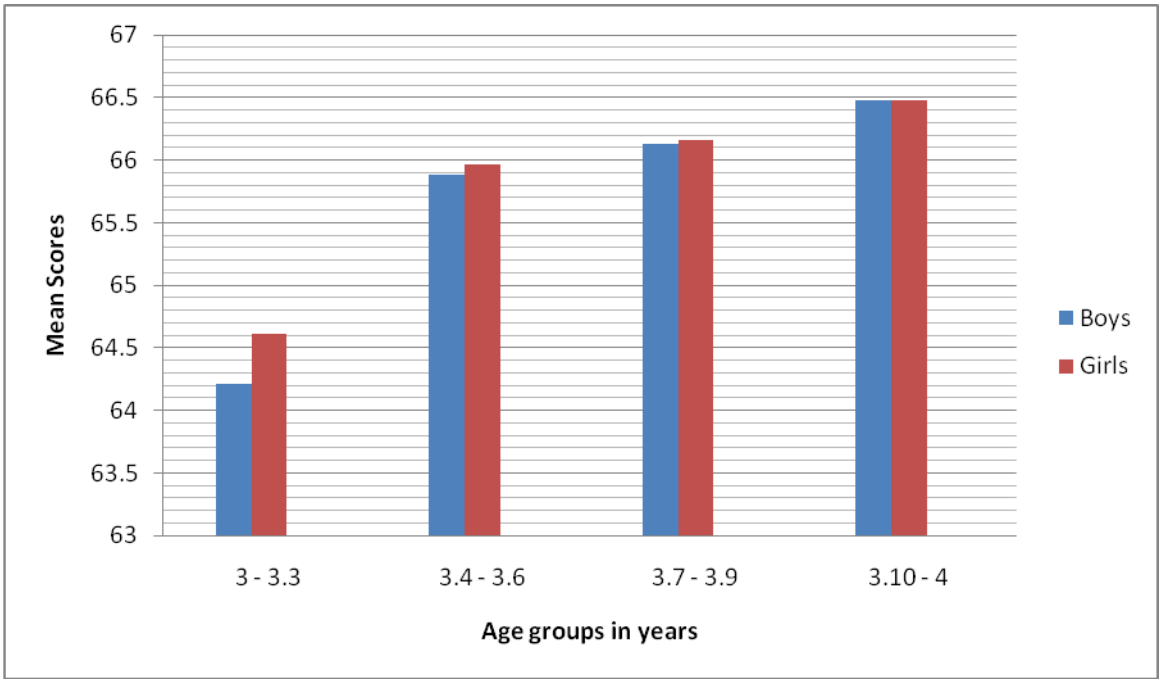
Descriptive statistics was used to find the mean and standard deviation of single phonemes for both boys and girls across age groups. The maximum score expected in the modified test for singleton consonants including vowels is 70. On observation it was seen that the mean articulatory scores linearly increased from one group to other across age groups for both boys and girls. The mean and standard deviation scores are shown in Table 8. Variability in articulation scores of single phonemes reduced from Group I to Group IV indicating better precision in articulation as age increased.

Gender	Age	Mean (Std.Dev)	N
Boys	Group I (3 -3.3 years)	64.21 (1.56)	15
	Group II(3.4- 3.6 years)	65.88 (1.03)	15
	Group III(3.6 – 3.9 years)	66.13 (0.54)	15
	Group IV (3.10 – 4 years)	66.48 (0.37)	15
	Mean Total scores	65.67 (1.30)	60

Girls	**Group I (3 -3.3 years)**	**64.61 (0.61)**	**15**
	Group II(3.4- 3.6 years)	**65.97 (1.44)**	**15**
	Group III(3.6 – 3.9 years)	**66.16 (0.52)**	**15**
	Group IV (3.10 – 4 years)	**66.48 (0.37)**	**15**
	Mean Total scores	**65.81 (1.09)**	**60**
Combined scores	**Group I (3 -3.3 years)**	**64.41(1.18)**	**30**
	Group II(3.4- 3.6 years)	**65.92 (1.23)**	**30**
	Group III(3.6 – 3.9 years)	**66.15(0.52)**	**30**
	Group IV (3.10 – 4 years)	**66.48(0.36)**	**30**
	Mean Total scores	**65.744(1.24**	**120**

Table 10: *Mean articulatory scores for consonants and vowels in different age groups in boys and girls*.

Graph 2 shows the comparison of mean scores across age and gender. In the youngest age group (3 – 3.3 years) girls had higher articulatory scores. However the other three older age groups did not show a visible difference in the mean articulatory scores for singleton consonants between genders.



Graph 2: *Mean articulation scores for consonants and vowels in different age groups in boys and girls*

A two-way ANOVA was carried out to find significant difference in single phonemes (vowels and singleton consonants) across age groups in both boys and girls. The results indicated that there is a significant difference {df- 3, F = 29.295, (P< 0 .05)} in articulatory acquisition.

Group I (3- 3.3 years): On comparing Group I with Group II, Group III and Group IV there was a significant difference in terms of articulatory acquisition. The mean articulatory score for Group I is 64.41.

Group II (3.4 – 3.6 years): Comparison of Group II with Group III and Group IV revealed that Group II is significantly different from Group IV. The mean articulatory

scores for Group II is 65.97 and for Group IV is 66.48. Group II was not statistically significant from Group III and the mean articulatory score for Group III is 66.15.

Group III (3.7 – 3.9 years): On comparing Group III with Group IV significant difference was not seen.

Group IV (3.10 – 4 years): Group IV was compared with other three age groups and it revealed there is significant difference between Group I and Group IV, Group II and Group IV. But there was no significant difference between Group III and Group IV.

The findings reveal that the articulatory scores did not change from Group III (3.7- 3.9 years) to Group IV (3.10 – 4 years) in both boys and girls. On comparison of the mean articulatory scores among gender, no significant difference in scores was noted.

a) Order and position of acquisition of consonants.

In the present study, in order to calculate the mastery of the sound production the criteria used was the age level at which 100% of the children produced all the sounds in initial, medial and final in all the positions. This is because Divya (2010) reported that by the age of 3 years 90% of the children acquired the speech sounds in all the word positions in Malayalam.

Group I (3 – 3.3 years): The consonants which acquired 100% criteria in all the positions tested were /k/, /p/, /v/.The phonemes /g/, /m/, /j/ in the initial position and /l/ in medial position also reached 100% production. The phonemes which achieved above 90% are /t/, /ḍ/, /ṭ/, /d̲/, /n/, /l/ in initial position and t̲/, /f/, /l̩/ in word final position. The other consonants including the aspirated sounds reached less than 75% criteria.

It is observed that glottal h/ was produced correctly by 10% of the children only. The aspirated sounds were acquired late compared to unaspirated sounds. Among the aspirated consonants, /dʰ/ and /kʰ/ in medial position is found to have higher scores and /ʈʰ/ and /ṭʰ/ attained least scores. So it is observed that out of the 35 consonants tested, 11consonants reached criteria of 100% during this age group.

Group II (3.4 – 3.6 years): In addition to the consonants that reached 100% criteria in the previous age group, the newly acquired ones are the alveolar /n/ in initial position and /b/ and /m/ in medial position. The phonemes which acquired criteria above 90% are /t/, ḍ/ /f/ in initial position, /l/ in initial and final position and finally the consonant /t̲/ in medial position. The rest of the singleton consonants reached less than 75% of correct production. The difference in production of aspirated sounds continued in this age group also. Among the aspirated sounds tested in medial position /dʰ/ attained higher scores and /ʈʰ / and /ṭʰ/ obtained poorer score, as in the previous group. However scores increased compared to previous Group. The number

of consonants which reached 100% criteria is 12 in number and is found to be same in both boys and girls.

Group III (3.7 – 3.9 years): The consonants which reached a 100% criteria in this age group are similar to the Group II findings. In addition, semivowel /j/ in medial position was produced correctly by 100% of the children. Among the aspirated sounds which were tested in medial position /dʰ/ has higher scores and /ʈʰ/ had poorer score. The findings were similar for both boys and girls. The aspirated consonants showed the same pattern as in the previous age group; however the individual scores of the single phonemes increased. Comparing the acquisition of /h/ with the previous age groups there was no improvement in the scores noticed. It was maintained at 10%. So it is observed that out of the 35 consonants tested, 14 consonants reached criteria of 100%.

Group IV (3.10 – 4 years): The consonants which acquired 100% criteria in this age group are /t̪/ in initial position, /l/ in medial position. The scores for all other singleton consonants have shown an improvement in the articulatory scores. Tables 8, 9, 10 and 11 depict the percentage of the single phonemes along with the aspirated sounds. The scores for aspirated phonemes also increased as age increased. But none of them attained 100% criteria by 4 years of age. Hence by 4 years of age out of the 35 consonants tested, 14 consonants reached 100% criteria. Findings reveals that the

number of single phonemes achieved mastery remains the same in Group III and Group IV, however there was an increase in mean articulatory scores.

When 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)Malayalam) and it was observed that the order of acquisition of the consonants was the same.

The present study revealed that fricatives and trills are acquired late (< 75% by 4 years) as reported by most of the Indian studies. This observation is common with many studies in English also. According to Fudala and Reynolds (1986) Linears (1981) stated that the age of acquisition of /s/ and /z/ appears to be quite late. Dodd and So (1995) also reported that the first acquired consonants were nasals, glides, bilabial and alveolar stops whereas aspirated plosives, affricates and voiced fricatives were acquired later.

Speech sounds	Tasneem Banu'77 (Kannada) 75%*	Usha' 86(Tamil) 75%*	Padmaja '88 (Telugu) 75%*	Arun Banik' 88 (Bengali) 90%*	Maya' 90 (Malayalam) 75%*	Prathima' 2009 (Kannada) 90%*	Divya 2010 (Malayalam) 75% *	90 %*	Present Study 2011 100%*
m	3	3	2.6	2.5	3-3.6	3-3.6	2-2.3	2-2.3	3 – 3.3
n	3	3	2.6	2.5	3-3.6	3-3.6	2-2.3	2-2.3	3 – 3.3
ɳ				2.5	3-3.6		2-2.3	2-2.3	3.4 – 3.6
p	3	3	2.6	2.5	3-3.6	3-3.6	2-2.3	2-2.3	3 – 3.3
f			2.9		3-3.6		-	-	3.4- 3.6
h			2.6	3	3-3.6	-	-	-	-
k	3	3	2.6	2.7	3-3.6	3-3.6	2-2.3	2.3-2.6	3 - 3.3
b	3	3	2.6	2.5	3-3.6	3-3.6	2-2.3	2-2.3	3 - 3.3
d	3.6	3	2.6	3	3-3.6	3-3.6	2-2.3	2.3-2.3	3.4 - 3.6
g	3	3	2.6	3	3-3.6	3-3.6	2.3-2.6	2.6-2.9	3.4 - 3.6
r	4.6		3.9	4	3.7-4	-	2.6-2.9	-	-
s	3	3	3.3		3.6-4	3-3.6	-	-	-
ʃ	5.1	6	3.6	3	5-5.6	3.6-4	-	-	-
ʧ	3.7	3	2.6	3	3-3.6	3-3.6	2-2.3	2-2.3	-
t		3	2.6	3	3-3.6	3-3.6	2-2.3	2.3-2.6	3.4- 3.6
v	-	3	2.6		3-3.6	3-3.6	2.3-2.6	2.6-2.9	3.4 - 3.6
l	3	3	2.6	3	3-3.6	3-3.6	-	-	3.4 -3.6
j	3	3	2.5	3	3-3.6	3-3.6	2-2.3	2.3-2.6	3 - 3.3

Table 11: *Shows comparison of the present study with some Indian studies*
- Indicates consonants not acquired. Empty space indicates speech sound not tested

** indicates the criteria considered for acquisition*

On comparison of the present study with recent 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 10% acquired /h/ by the age of 3.10- 4 years.

Also Divya (2010) reported that /h/ did not reach 75% criteria even at the age of 3 years in Malayalam. This finding is also similar to the reports of Tasneem Banu (1977) and Pratima (2009) in Kannada.

Considering the position, retroflex /ɭ/ and /ɳ/ were first acquired in medial, followed by final position. However dental /l/ was achieved first in medial and final position compared to initial position. The retroflex /R/ was found to be acquired first in medial and initial position than compared to final position. When considering the phonemes that were tested in initial and medial positions, the results showed that /g/, /ʤ/, /ɲ/, /ɖ/, /r/, /ʃ/, /ʂ/, /s/ and /kʰ/ were acquired in medial position of words whereas /v/, /j/, /d̪/, and /t̪/ in initial positions.

Prathima, (2009) in Kannada reported similar findings that /r/ appeared earlier in medial position than in the initial position of words. The results also correlate with Stoel-Gammon's (1984) study which stated that the phoneme /r/ appeared word finally well before it occurred word initially. Tables 8, 9, 10, 11 show percentage of articulatory acquisition in the age range of 3 – 4 years in both boys and girls.

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 seventies 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.

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	73.33	73.33		
D			86.67	86.67		
ʧ	53.33	53.33	60.0	60.0		
ʤ	73.33	73.33	73.33	73.33		

ɲ	80	93.33	60.0	60.0		
t	86.67	93.33				
ɖ	80	93.33	80	80		
ɳ			66.67	73.33	73.33	86.67
t̲	86.67	100	73.33	73.33		
d̲	80	73.33	60.0	26.6		
n	93.33	100				
p	100	100	100	100		
b	86.67	100	93.33	100		
m	100	100	86.67	100	100	100
j	100	100	86.67	86.67		
l	93.33	93.33	100	100	93.33	93.33
l̪			73.33	80	66.6	73.33
v	100	100	100	100		
h			10	10		
-t̲			93.3	93.33		
s	73.33	73.33	66.67	66.67		
pʰ	93.33	93.33				
r	66.67	73.33	73.33	80		
ʃ	80	80	73.33	73.33		
l̲			53.33	53.33		
R	53.33	53.33	60	60	73.33	73.33
ʂ	73.33	73.33	66.67	66.67		
ʧʰ	33.33	33.33				
ʈʰ			20	20		
ɖʰ			26.67	20		
kʰ	33.33	33.33	40	33.33		
dʰ			40	40		
bʰ	33.33	33.33				
gʰ			26.67	26.67		

Table 12: *Percentage of articulatory acquisition of boys and girls in 3 – 3.3 years*
Empty space indicates sounds not tested

Speech sounds	Initial position Obtained %		Medial position Obtained %		Final position Obtained %	
	Boys	Girls	Boys	Girls	Boys	Girls
k	100	100	100	100		
g	100	100	73.33	73.33		
ɳ			100	100		
ʧ	53.33	53.33	60.0	60.0		
ʤ	73.3	73.33	73.33	73.33		
ɲ	86.67	93.33	66.67	60.0		
t	93.33	93.33				
ḍ	93.3	93.33	86.67	86.67		
ṇ			80	80	86.67	86.67
t̲	86.67	100	73.33	73.33		
d̲	40	73.33	53.33	40		
n	100	100				
p	100	100	100	100		
b	100	100	100	100		
m	100	100	100	100	100	100
j	100	100	86.67	86.67		
l	93.33	93.33	100	100	93.33	93.33
ḷ			86.6	86.6	66.6	66.6
v	100	100	100	100		
h			10	10		
-t̲			93.33	93.33		
s	73.33	73.33	73.33	66.67		
pʰ	93.33	93.3				
r	73.33	66.67	80	73.33		
ʃ	80	73.33	73.33	73.33		
l̲			60	66.67		
R	53.33	53.33	60	60	73.33	73.33
ṣ	73.33	73.33	66.67	73.33		
ʧʰ	33.33	40				
ṭʰ			26.66	26.67		
ṭʰ			26.67	26.67		
kʰ	33.33	33.33	33.33	40		
dʰ			53.33	53.33		
bʰ	40	40				
gʰ			26.66	40		

Table 13: *Percentage of articulatory acquisition of boys and girls in 3.4 – 3.6 years*

Empty space indicates sounds not tested

Speech sounds	Initial position		Medial position		Final position	
	Obtained %		Obtained %		Obtained %	
	Boys	Girls	Boys	Girls	Boys	Girls
k	100	100	100	100		
g	100	100	73.33	73.33		
ɖ			100	100		
ʧ	53.33	53.33	60.0	60.0		
ʤ	73.33	73.33	73.33	73.33		
ɲ	66.67	86.67	60.0	60.0		
t	93.33	93.33				
ḍ	93.33	93.33	86.67	86.67		
ṇ			80	80	86.67	86.67
t̲	100	100	73.33	73.33		
d̲	93.33	93.33	60.0	53.33		
n	100	100				
p	100	100	100	100		
b	100	100	100	100		
m	100	100	100	100	100	100
j	100	100	86.67	86.67		
l	100	100	100	100	100	93.33
ḷ			86.67	86.6	66.67	66.67
v	100	100	100	100		
h			10	10		
-t̲			93.33	93.3		
s	73.33	73.33	66.67	66.67		
pʰ	93.33	93.33				
r	73.33	73.33	80	80		
ʃ	80	73.33	73.33	73.33		
l̲			53.33	53.33		
R	60	66.67	73.33	73.33	80	80
ṣ	73.3	73.33	66.67	66.67		
ʧʰ	53.33	53.33				
ṭʰ			40	33.33		
ṭʰ			26.67	33.33		
kʰ	40		40	40		
dʰ			53.33	60		
bʰ	40	53.33				
gʰ			33.33	33.33		

Table 14: *Percentage of articulatory acquisition of boys and girls in 3.7 – 3.9 years*

Empty space indicates sounds not tested

Speech sounds	Initial position		Medial position		Final position	
	Obtained %		Obtained %		Obtained %	
	Boys	Girls	Boys	Girls	Boys	Girls
k	100	100	100	100		
g	100	100	73.33	73.33		
ɖ			100	100		
ʧ	53.33	53.33	60.0	60.0		
ʤ	73.33	73.3	86.67	73.33		
ɲ	93.33	73.33	60.0	66.67		
t	93.33	93.33				
ḍ	93.33	93.33	86.67	86.67		
ṇ			80	86.67	86.67	86.67
t̲	100	100	73.33	80		
d̲	73.33	93.33	26.67	60.0		
n	100	100				
p	100	100	100	100		
b	100	100	100	100		
m	100	100	100	100	100	100
j	100	100	93.33	86.67		
l	100	100	100	100	100	100
ḷ			86.67	86.67	66.67	80
v	100	100	100	100		
h			10	10		
-t̲			93.33	93.33		
s	73.33	73.33	66.67	66.67		
pʰ	93.33	93.33				
r	80	80	80	80		
ʃ	80	80	73.33	73.33		
l̲			53.33	53.33		
R	66.67	66.67	73.33	73.33	80	80
ṣ	73.33	86.67	66.67	73.33		
ʧʰ	53.33	53.33				
ṭʰ			40	40		
ṭʰ			26.67	26.67		
kʰ	40		40	53.33		
dʰ			53.33	53.33		
bʰ	40	53.33				
gʰ			33.33	40		

Table 15: *Percentage of articulatory acquisition of boys and girls in 3.9 – 4 years*

Empty space indicates sounds not tested

C) Acquisition based on place, voicing and manner features

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

On considering the 100% criteria, unaspirated bilabials, dentals and velars were acquired by 3 – 3.3 years. Alveolars, retroflex and palatals were the late acquired phonemes. Among alveolars, /t/ was acquired earlier (3- 3.3 years). Among the palatals, velar /ɲ/ acquired 93.33% by 4 years of age. The dentals reached above 90% acquisition by 4 years of age. Retroflex /Ʂ/ achieved above 80% production in the present study by 4 years of age. Glottal /h/ did not reach the 100% correct production by 4 years of age. This is in support by an ongoing study by Vrinda (2011) that the glottal /h/ did not attain the 100% criteria by 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. The results of the present study agreed with Jacobson and Halle's (1956) and Dyson (1986), which reported that the first consonants acquired were labials, most commonly /p/ or /m/ followed by /t/ and /k/ indicating that these sounds are typically mastered at an earlier age.

B. Voicing feature: In the present study, the voiceless stop /p/, /k/ followed by /b/ and /g/ (initial position) reached the correct production by 3- 3.3 years of age. The findings reveal that the voiceless phonemes were acquired earlier than voiced phonemes. The voiceless /t/ acquired 100% criteria in the age range of 3 – 3.3 years, whereas its voiced cognate /d/ reached above 90% production by 3 – 3.3 years of age and remained till 4 years of age. Divya (2010) reported that voiceless sounds were first achieved compared to its voiced cognates. Most of the classical western studies reports the same findings as voiceless cognates acquired earlier than its voiced cognates. Two ongoing studies by Vipina (2011) and Vrinda (2011) in Malayalam in the age range of 4 – 5 and 5 – 6 years respectively reports that voiceless sounds are achieved first compared to their voiced cognates.

C. Manner feature: Generally when considering the manner of acquisition it was observed that nasals, un aspirated stops, semivowels (/j/ & /v/) were acquired first compared to laterals, fricatives, affricates, flaps and trills.

Plosives: The present study findings reveal that most of the unaspirated plosives were acquired by the age of 3- 3.3 years itself. The sounds /p/, /b/, /t̪/ were acquired earlier by 3 – 3.3 years. The plosives/ʤ/, /ʈ/, /ɖ/, /ḍ/ achieved above 80% production by 4 years. Divya (2010) reported that all the unaspirated plosives reached 90% criteria by 2.9 years itself and by 3.6 years as reported by Maya (1990).

Nasals: The findings revealed that the nasals /m/ and /n/ reached 100% by 3 – 3.3 years of age. /ɲ/ reached correct production of above 90% by 3.4 – 3.6 years. When comparing the present results with Western (Irwin etal'82 and Fudala & Reynolds, 2000) and Indian studies (Padmaja'88 and Arun Banik'88) similar pattern of acquisition was seen, in which the nasals achieved 100% criteria by 3.4 -3.9 years itself than other sounds. When compared with the results by Maya (1990) all the nasals were acquired one year and three months earlier. The findings of the present study correlated well with Pratima's (2009) in Kannada where she reported 100% acquisition of nasals by 3- 3.6 years. However Divya (2010) reported that nasals achieved 90% criteria by 2 – 2.3 years. This is because Divya has considered a younger age group (2 – 3 years).

Fricatives: None of the fricatives tested (/s/, /ɭ/, /Ṣ/ and /h/) met 100% criteria by 4.0 years. The findings of the present study is that fricative /Ṣ/, /ʃ/ reached 80% of correct production by 4 years of age. The dental fricative /s/ acquired less than 80% and the glottal /h/ reached only 10% by 4.0 years of age. These results are in consonance with many of the classical western studies as well as the earlier and recent Indian studies.

Affricates: The three affricates tested included /ʤ/, /ʧ/ and /ʧʰ/. The results indicated that none of these achieved 100% criteria by 4 years of age. The unaspirated one was acquired earlier compared to the aspirated affricate. The voiceless affricative /ʧ/ in initial and medial positions, voiced affricate /ʤ/ in initial position reached correct production above 80%. Whereas /ʤ/ in medial position reached a score of less than 75%. Considering the aspirated affricates both voiced and voiceless reached 60% of correct production. Contrary to this, Divya (2010) found acquisition of affricates by 3 years itself.

Laterals: The three laterals tested included are the alveolar lateral (/l/), retroflex lateral (/ɭ/) and palatal lateral (/l̠/). Results revealed that voiced retroflex lateral was acquired earlier (3 – 3.3 years) by 100% of the children; where as voiced alveolar lateral, voiced palatal lateral did not reach 100% of correct production by 4 years of age. On comparison with Maya's (1990) findings, voiced retroflex lateral was acquired almost one year earlier in the present study. Divya (2010) also reported that voiced retroflex lateral was acquired earlier (2.9 years) than the other laterals.

Flaps: The results revealed that the flap /r/ reached 80% of correct production by 4 years of age. This is contrary to Divya's (2010) result where 75% children acquired the flap /r/ by 3 years of age.

Trills: The trills were not mastered by 100% of children by 4 years. The percent of acquisition of trill was higher in final positions (80%), followed by medial (73.33%),

and in initial position (60%) for both boys and girls. This is in coherence with Divya's (2010) findings as she reported that the trill scores were higher for final position than in the initial position. Prathima'09 reported that trills scored higher score in word medial position.

Semivowels: /j/ and /v/ reached 100% criteria by 3 – 3.3 years of age itself. This study correlates with Divya's study where she reported 90% acquisition for /v/ at the age of 2.9 years. This finding is well supported by Mowrer and Berger's (1991) study which indicated the early acquisition of glides before 3+ years itself. The present study is found to be in correlation with Maya's results also. Chart 1 shows the age of phoneme acquisition by 100% of the children in Malayalam according to manner of articulation.

3) Consonant Cluster Acquisition

In the modified Malayalam diagnostic articulation test, 15 initial and 15 medial consonant clusters were tested. The present study used 90% criteria for the acquisition of consonant clusters since Divya (2010) reported that the consonant clusters were found to be emerging by the age of 2.9 years itself. The results are discussed under the following headings:

a) Age and gender
b) Position of Clusters (Initial and Medial)

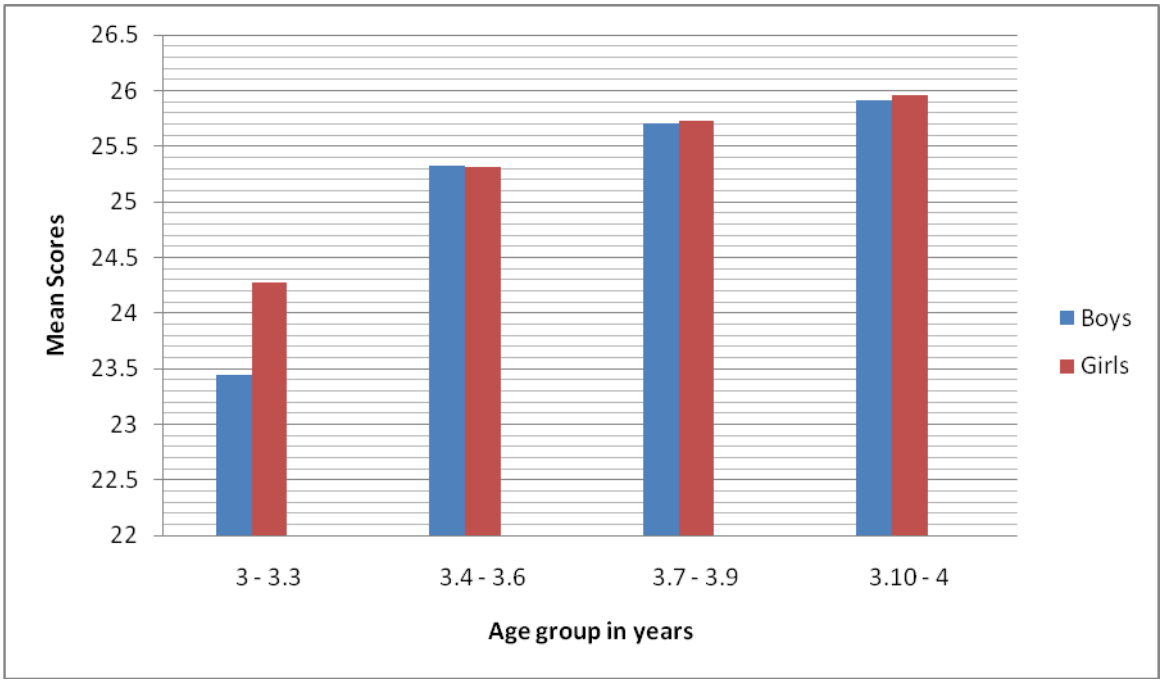
a) Age and Gender

Descriptive statistics was carried out to obtain the overall mean and standard deviation scores for consonant clusters. The maximum expected score for clusters is 30. On observation it was seen that the mean scores increased linearly as age increased. The variability in cluster scores reduced from Group I to Group IV indicating better articulatory precision as age increased. The mean and standard deviation for consonant clusters for boys and girls in different age groups are shown in Table 16.

Gender	Age	Mean (Std.Dev)	N
Boys	**Group I (3 -3.3 years)**	**23.44 (1.53)**	**15**
	Group II(3.4- 3.6 years)	**25.33 (0.87)**	**15**
	Group III(3.6 – 3.9 years)	**25.70 (0.80)**	**15**
	Group IV (3.10 – 4 years)	**25.91 (0.27)**	**15**
	Mean Total scores	**25.09 (1.37)**	**60**
Girls	**Group I (3 -3.3 years)**	**24.28 (1.32)**	**15**
	Group II(3.4- 3.6 years)	**25.31 (0.66)**	**15**
	Group III(3.6 – 3.9 years)	**25.73 (0.71)**	**15**
	Group IV (3.10 – 4 years)	**25.96 (0.78)**	**15**
	Mean Total scores	**25.32 (1.10)**	**60**

Table 16**:** *Mean and Standard deviation (parenthesis) of overall articulatory scores for consonant clusters.*

Graph 3 shows the overall comparison of cluster scores across age and gender. In the youngest age group (3 – 3.3 years) girls had higher articulatory scores. However the other three age groups did not show a visible difference in the mean articulatory scores for consonant clusters across gender.



Graph 3**:** *Overall mean cluster scores in different age groups in boys and girls.*

A two – way MANOVA was carried out to find the significant difference in consonant clusters across age groups for both boys and girls separately. The results indicated that there is a significant difference {df- 3, F = 29.295, (P < 0.05)} in the consonant cluster acquisition.

When age wise comparison was made, all the four groups showed significant difference in terms of consonant cluster acquisition. On comparing Group I with other three groups there was a significant difference in the mean scores. Group I achieved a score of 23.44 for boys and 24.28 for girls out of a total of score of 30. Group II attained a score of 25 and surprisingly this score continued to be the same until Group

IV. On gender wise comparison in each age group, girls performed better in Group I. But there was no gender difference seemed for the three higher age groups.

b) Position of consonant clusters

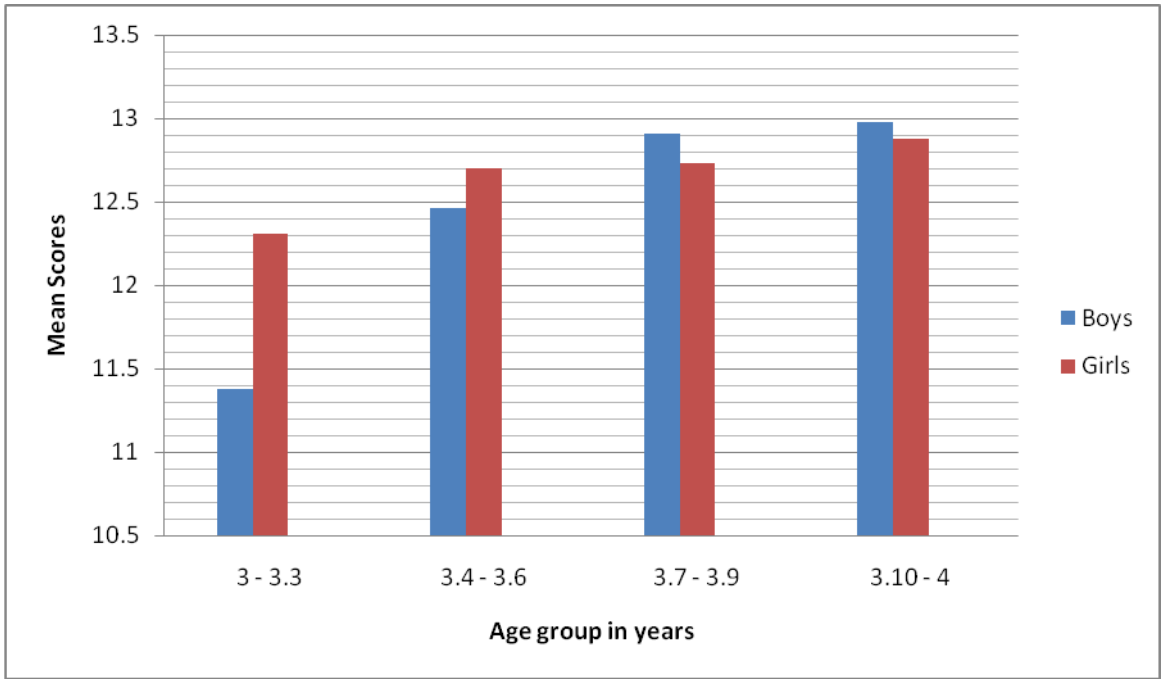
(i) Initial Clusters

Descriptive statistics was carried out to find the mean scores for initial clusters. The maximum expected score for initial clusters is 15. On observation it is seen that the mean increased linearly as age increased. Overall variability in articulation scores reduced with age groups indicating better articulatory precision. Table 17 shows the mean and standard deviation scores for initial clusters for boys and girls.

Gender	Age	Mean (Std. Dev)	N
Boys	Group I (3 -3.3 years)	11.38 (0.90)	15
	Group II(3.4- 3.6 years)	12.46 (0.71)	15
	Group III(3.6 – 3.9 years)	12.91 (0.77)	15
	Group IV (3.10 – 4 years)	12.98 (0.25)	15
	Mean Total scores	12.43 (0.94)	60
Girls	Group I (3 -3.3 years)	12.31 (0.78)	15
	Group II(3.4- 3.6 years)	12.70 (0.54)	15
	Group III(3.6 – 3.9 years)	12.73 (0.35)	15
	Group IV (3.10 – 4 years)	12.88 (0.44)	15
	Mean Total scores	12.65 (0.58)	60

Table 17**:***Mean and SD (parenthesis) of initial clusters in different age groups for boys and girls.*

Graph 4 shows the comparison of initial cluster scores across age and gender; it was found that the mean cluster scores was higher for females in the first two younger age groups (3 – 3.3 years and 3.4 – 3.6 years). But for the other two older age groups (3.7 – 3.9 years and 3.10 – 4 years) boys showed higher cluster scores than girls.



Graph 4: Mean scores for initial clusters in different age groups in boys and girls

Two way – MANOVA was carried out to find significant difference in the initial cluster scores among age groups. The results indicated significant difference {df = 3, F – 17.574, (P < 0.05)} in initial clusters for all the age groups. On comparing Group I with other three age groups there was a significant difference in the mean articulation scores specifically for boys. The mean scores of boys in Group I is 11.38 and the scores improved from 12.46 to 12.91 and 12.98 for Group II, Group III and Group IV respectively. But for girls there was no significant difference for initial cluster scores across age It is observed that there exists a significant gender difference in the acquisition of initial clusters in the younger age group (3 – 3.3 years) considered, where girls performed better than boys.

Group I (3 – 3.3 years): With reference to age on comparing Group I with other three groups there was a significant difference in the mean scores. The initial clusters reached less than 60% of correct production in this age group. /gl-/ and /kj-/ acquired a higher score of 53.33% in boys. The initial cluster /sl-/ reached a correct production of 53.33%, which was the highest score attained in girls. The cluster which obtained a lowest score is for /kr-/ (10%).

Group II (3.4 – 3.6 years): All the initial clusters reached less than 75% of correct production. Among these, /kl-/ acquired highest score of 60% in boys and /gl-/, /kl-/ reached correct production of 66.66% in girls. The initial cluster /kr-/ continued to maintain the same score (10%) as in the previous group.

Group III (3.7 – 3.9 years): In this group, the clusters which obtained higher scores in girls are /br-/, /bl-/ and /sth-/ (53.33%). For boys /pl-/, /sth-/, /br-/ reached a correct production of 53.33% which was the highest score. However other clusters showed an improvement in the mean scores than in the previous group.

Group IV (3.10 – 4 years): The initial clusters /kj-/ and /kl-/ reached above 80% production in both boys and girls. Remaining 13 initial consonant clusters reached less than 75% of correct production. The lowest score was found for the cluster /kr-/ in /kriʃn̪an/ (13.33%) which was observed to be similar across age groups and across

gender. By 4 years of age it was observed that girls acquired a higher cluster score of 80 % for most of the initial clusters (/gl-/, /kl-/, /pl-/, /gr-/ and /kj-/).

The type of initial cluster errors which were observed in boys and girls in the four age groups were found to be cluster reduction and cluster simplification. Among these errors cluster reduction was most dominant in children in all the groups. For eg: /kja:mara/ as /kamara/. Cluster simplification errors were found to be relatively few which were mainly coalescence errors eg: /gla:ssə/ as /gila:ssə/.

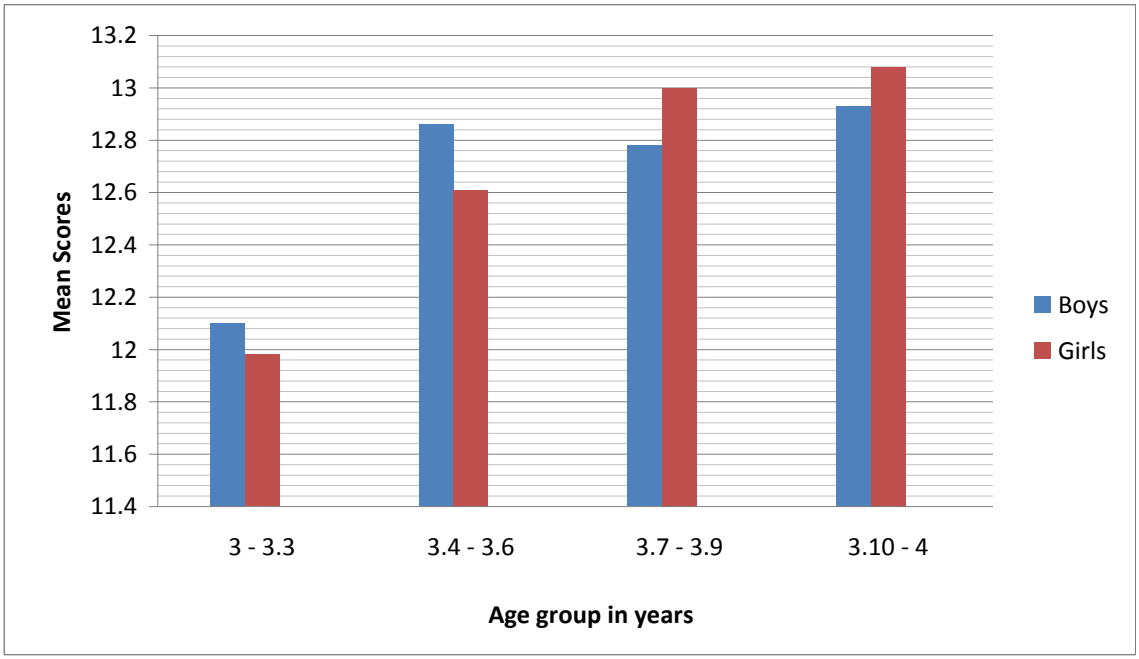
(ii) Medial clusters

Descriptive statistics was carried out to obtain the mean and standard deviation scores for medial clusters. The maximum expected score for medial clusters is 15. It is found that the mean scores increased linearly as age increased. Overall variability in medial cluster scores reduced across age groups indicating better articulatory precision as age increased. Table 18 shows the mean and standard deviation scores for medial clusters.

Gender	Age	Mean (Std.Dev)	N
Boys	Group I (3 -3.3 years)	12.10 (0.78)	15
	Group II(3.4- 3.6 years)	12.86 (0.56)	15
	Group III(3.6 – 3.9 years)	12.78 (0.54)	15
	Group IV (3.10 – 4 years)	12.93 (0.29)	15
	Mean Total scores	12.67 (0.65)	60
Girls	Group I (3 -3.3 years)	11.98 (0.76)	15
	Group II(3.4- 3.6 years)	12.61 (0.61)	15
	Group III(3.6 – 3.9 years)	13.00 (0.67)	15
	Group IV (3.10 – 4 years)	13.08 (0.56)	15
	Mean Total scores	12.67 (0.77)	60

Table 18: *Mean and SD (parenthesis) scores for medial cluster in different age groups in boys and girls.*

Graph 5 shows the overall comparison of scores across age and gender. On observation it was found that the mean medial cluster scores was higher for boys in the first two age groups (3 – 3.3 years and 3.4 – 3.6 years). But for the other two older age groups (3.7 – 3.9 years and 3.10 – 4 years) girls showed higher scores than boys. This is an interesting finding since for the initial clusters girls scored higher values in the younger age groups whereas in the older age groups boys performed better.



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

Two way – MANOVA was carried out to find significant difference in medial clusters across age groups. The results indicated significant difference {df = 3, F – 14.764, (P < 0.05)} in medial clusters for Group I with Groups II, III and IV across boys and girls.

Group I (3 – 3.3 years): The medial clusters which acquired 90% criteria in this youngest age group considered are /-nt-/, /-nt̪- /, /-nj- /.The interesting aspect is that /-nk-/ achieved 100% in this age group. The medial clusters which acquired above 80% of correct production are /-nd-/ and /-lj-/ respectively. All other medial clusters achieved a score less than 75%, among this /- kl̩/ scored only 10%. The type of errors noticed in this younger age group is more of cluster reduction, ie complete deletion of the cluster. This is in support of Greenlee's (1974) stages of cluster development. So it is observed that 5 out of 15 medial clusters have been acquired by this age.

Group II (3.4 – 3.6 years): The clusters which acquired 90% criteria are same as in the previous age group. In addition to these the cluster /-ly-/ reached a score of 90% from 80%. The only cluster which acquired 80% of correct production in this age group is /-ty-/ in /intya/. Remaining of the medial clusters attained less than 75% of scores. The type of errors noticed is same as that of the previous age group. A total of 6 medial clusters acquired 90% criteria out of the 15 clusters tested in this age group.

Group III (3.7 – 3.9 years): In this age group the clusters which reached 100% of correct production are /- nt-/, /-nt̪-/, /-nj-/, /-nd-/, /-nk-/. The medial clusters /-ly/ and /-ty-/ reached criteria of 90% when compared to the previous group. All the other medial clusters achieved a score less than 75%. /- kl̩-/ continued to be produced correctly by only 10% of the children. So when compared to the other two groups, the children in this age group acquired 7 medial clusters out of the 15 tested. The type of errors moved to more of cluster simplification.

Group IV (3.10 –4years): As observed there is no increase in the number of medial clusters which reached a 90% criteria. However it is noticed that there was an improvement in the scores compared to the previous group. The rest of the medial clusters reached 75% of correct production. The cluster /- kl̥-/ continued to maintain a score of 10%. Out of the 15 medial clusters 7 medial clusters were mastered in this age group. The exact percentage of acquisition of medial clusters is provided in Table 17. The type of errors changed from cluster reduction to cluster simplification like coalescence and metathesis.

The type of medial cluster errors seen in children from Group I to Group IV continued to be the same. The most prominent type of errors exhibited is of cluster reduction in all the groups. However in Group III to Group IV cluster simplification errors were observed in addition to cluster reduction. Cluster simplification errors like epenthesis is noticed.

This finding is in accordance with the study by Vani Rupela and Manjula (2006) in Kannada where in medial clusters were first to be acquired and appeared by the age of 18-24 months and, more frequent and predominant at the age of 30-36 months. On the same lines, Pratima (2009) also reported early acquisition of medial clusters by 3- 3.6 years in Kannada. Kirk and Demuth (2005) also acknowledged that word final stop+/s/ clusters and nasal+/z/ clusters were produced more accurately than word initial /s/+stop clusters in English.

However, 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 probably because the frequency of occurrence of initial clusters is more in English compared to Indian languages. Most of the initial clusters in Indian languages are borrowed English words.

One of the interesting finding of the present study is that /-kʃ-/ remained at 10% of acquisition from Group I to Group IV. The results of the present study agree with the earlier and recent Indian studies (Tasneem Banu'77; Arun Banik'88; Maya'90; Prathima'09; Divya'10) which say that the clusters are acquired later compared to singleton consonants and vowels.

	3- 3.3 years		3.4 – 3.6 years		3.7 – 3.9 years		3.10 – 4 years	
Initial clusters (Word)	Obtained % Boys	Girls	Obtained % Boys	Girls	Obtained % Boys	Girls	Obtained % Boys	Girls
Pr- **(pravə)**	26.6	33.33	40	53.3	53.3	53.33	53.3	66.66
Sk- **(sku:tar)**	26.66	20	26.66	26.66	33.33	33.33	60	60
gl- (gla:ssə˞)	53.33	60	53.33	66.66	73.33	73.33	73.33	80
kl- (klo:k)	60	66	60	66.66	73.33	73.33	80	80
pl- (ple:tə˞)	40	46.6	40	46.66	53.33	53.33	73.33	80
tR- (tRəin)	26.66	33.33	26.66	33.3	46.66	46.66	60	60
sl- (slətə˞)	46.66	53.33	46.66	53.3	60	60	66.66	66.66
Sp- (spu: ɳ)	20	20	20	33.3	33.33	40	33.33	46.66
Kr- (kRiʃɳan)	10	10	10	10	10	10	13.33	13.33
Br- (braʂə˞)	40	40	40	40	53.33	53.33	66.66	66.66
bl- (blædə˞)	33.33	40	33.33	46.66	53.33	53.33	66.66	66.66
Gr- (gra:mam)	46.66	46.66	46.66	53.3	66.66	73.33	73.33	80
st^{h-} (st^{h}alam)	26.66	33.33	26.66	40	53.33	53.33	66.66	66.66
ʃv- (ʃva:sam)	26.66	26.66	26.66	26.66	33.33	33.33	40	40
Kj- (kja:maRa)	53.33	46.66	53.33	53.33	73.33	66.66	86.66	86.66

Table 19: *Percentage of acquisition of initial clusters in boys and girls (3 -4 years)*

	3- 3.3 years		3.4 – 3.6 years		3.7 – 3.9 years		3.10 – 4 years	
Word medial clusters	**Obtained % Boys**	**Girls**	**Obtained % Boys**	**Girls**	**Obtained % Boys**	**Girls**	**Obtained % Boys**	**Girls**
-nt- (pa:ntə)	93.33	93.33	100	100	100	100	100	100
-nʈ- (panʈə)	93.33	93.33	100	100	100	100	100	100
-ndʒ- (sanji)	93.33	93.33	93.33	93.33	100	100	100	100
-nd- (ti:vandi)	100	100	100	100	100	100	100	100
-nk- (kanka:ru)	80	80	93.33	93.33	93.33	93.33	100	100
-ʈj- (inʈja)	46.66	80	80	80	93.33	93.33	93.33	93.33
-nɖr- (ʧanɖran)	46.66	46.66	60	53.3	60	60	66.66	73.33
- sk- (biskattə)	26.66	60	60	66.66	66.6	66.66	73.33	73.33
-kʂ- (nakʂaʈra)	60	53.33	66.66	60	66.66	66.66	73.33	80
-lj- (kaljaṇam)	53.3	60	66.66	60	66.6	60	66.66	66.66
-kr- (ʧakram)	10	10	10	10	10	10	10	10
-sʈ- (pusʈakam)	80	80	93.33	93.33	100	100	100	100
-sʈr- (vasʈram)	73.33	80	73.33	80	73.33	80	80	93.33
-dj- (sadja)	53.33	26.66	33.33	33.33	40	46.6	46.66	46.66
-tr- (patram)	46.66	40	53.33	53.33	60	66.66	66.66	66.66

Table 20: *Percentage of acquisition of medial clusters in boys and girls (3- 4 years)*

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 initial testing. The transcribed samples was analysed and the mean percentage of phoneme agreement was calculated. Overall test – retest reliability was found to be 0.99 i.e, it was found to be 99%.

Inter-judge reliability

Inter-judge reliability for phoneme transcription was assessed by comparing the percentage of phoneme agreement between the transcriptions of the investigator and of the two judges on 10% of the total samples was randomly selected across the total 120 samples. The reliability co efficient alpha (α) was calculated for singleton consonants, cluster initial and cluster medial and this was found to be 99%.

To conclude with the results and discussion of the present study it is observed that children mastered the vowels by the age of 3 years itself. In terms of singleton consonants most of the consonants acquired 100% criteria by 4 years of age. Considering the manner, place and voicing feature it is observed that voiceless cognates are acquired earlier than voiced cognates. Labials, dentals and velars acquired 100% criteria by 3- 3.3 years of age. It is found that unaspirated phonemes

were acquired earlier than aspirated phonemes. Considering the cluster acquisition, medial clusters are acquired earlier than initial clusters. Gender effect was found only in Group I for initial clusters and was absent for medial clusters.

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 3-4 years and to establish the ages at which 100% of the children produced the phonemes of Malayalam correctly. The study also focused on the consonant cluster acquisition, and to establish the ages at which 90% of the children produced them correctly.

The modified Malayalam diagnostic articulation test was administered to 120 (60 males and 60 females) children in the age range of 3 – 4 years. Subjects were divided into 4 groups with an age interval of 3 months (3– 3.3years, 3.4 – 3.6years, 3.6 – 3.9years, 3.10 – 4years). The test comprises of 10 vowels, tested only in the initial position; 35 singleton consonants and 30 consonant clusters (15 initial and 15 medial). Considering the consonants, 17were tested in the initial and medial positions, two in medial and final positions, three in all the three positions, eight in medial only and five in initial position only. The total number of test items amounted to 100. The 100 test stimuli were depicted as coloured pictures and only one phoneme was tested with each picture.

The subjects were asked to name the coloured pictures that were presented through a laptop computer screen. Responses were recorded on the response sheet provided. A score of '1' was given to each correct response; a score of '0.75' for distortion error, a score of '0.5' for substitution error, and '0' for omission error was allotted. The maximum score that could be obtained was 100, i.e. when all the test phonemes were correctly produced. A score of 0.5 was given to errors such as, coalescence, cluster simplification, metathesis and epenthesis because as 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; /spu:n/ as /fu:n/. A score of 0.75 was given were in the number of elements in the cluster is preserved but with substitution of one or more of the consonants in the cluster, for example /sthalam/ as /skalam/.

The data for each group was stastically analysed. 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 for the singleton consonants and consonant clusters but a significant difference was found for cluster initial scores for the younger age group (3 – 3.3 years) considered for boys and girls.

All the vowels tested were found to be acquired by the age of 3 – 3.3 years. Most of the consonants acquired 100% criteria by the age of 4 years. None of the initial clusters reached 90% criteria by 4 years of age. But few of the medial

consonant clusters reached a correct production of above 90% by 3 – 3.3 years of age itself. Considering the place of articulation, children first acquired bilabials, labiodentals, dentals, and velars first compared to alveolars, palatals, retroflex and glottal sounds. Considering the manner of articulation, mainly the fricatives, trill /R/, lateral /l/, /l̲/ and aspirated /kh/, /bh/, /dh/ did not reached 100% by 4 years of age. Unaspirated sounds were acquired earlier compared to aspirated sounds.

The present study shows most of the singleton consonants, consonant clusters especially medial clusters seemed to acquire at the age of 3 – 3.3 years. Thus showing the evidence of early acquisition of phonemes in children. But this is not exceptional. The early articulatory acquisition in the present study may be attributed to differences in lifestyle and a change in norms, over years because of greater exposure to speech and language environment. Along with this the test has been revalidated, so a newer version of Malayalam Diagnostic Articulation Test, with more number of stimulus words especially providing a chance for the testing of consonant clusters in much detail than the previous test material. Hence it is recommended to use the modified test material for testing articulation.

Future directions

- Vowels can be tested in all positions.
- Acquisition of diphthongs can be studied.
- Acquisition of clusters can be studied in detail.

- Younger groups can be studied so that to find the exact age of acquisition of clusters and older groups can be studied to find the age of acquisition of un achieved consonants and clusters.

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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	nakʂat̪ram							
32	**p**	initial	pu:və							
33		medial	uduppə							

34	**b**	initial	bassə							
35		medial	Riban							
36	**m**	initial	ma:la							
37		medial	a:ma							
38		final	maram							
39	**j**	initial	je:ʃu							
40		medial	mujal							
41	**l**	initial	lo:ri							
42		medial	alama:ra							
43		final	viral							
44	**ɭ**	medial	vaɭa							
45		final	va: ɭ							
46	**v**	initial	vi:də							
47		medial	ʧevi							
48	**h**	medial	simham							
49	**-ʈ**	medial	pu:mpa:ʈa							
50	**s**	initial	su:rjan							
51		medial	kas:era							
52	**f**	medial	fa:n							
53	**r**	initial	ra:ʤa:və							
54		medial	ʧeruppə							
55	**ʃ**	initial	ʃivan							
56		medial	me:ʃa							
57	**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	puʂʈakam							
98	**-sk-**	medial	biskattə							
99	**-stʀ-**	medial	vasʈram							
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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