

**ARTICULATORY ACQUISITION IN KANNADA SPEAKING
URBAN CHILDREN: 3-4 YEARS**

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CERTIFICATE

This is to certify that this dissertation entitled “*Articulation Acquisition in Kannada Speaking Urban Children: 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 No. 07SLP013). 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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DECLARATION

This is to certify that this dissertation entitled “*Articulation Acquisition in Kannada Speaking Urban Children: 3-4 Years*” is the result of my own study under the guidance of Dr. N. Sreedevi, Lecturer of Speech Sciences, Department of Speech-Language Sciences, All India Institute of Speech and Hearing, Mysore, and has not been submitted earlier in any other university for the award of any diploma or degree.

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CHAPTER I

INTRODUCTION

Speech sounds are produced by precisely graduated movements of the peripheral articulators: lips, tongue and palate. The simultaneous movements of the jaw, larynx, and pharyngeal walls are equally important. Articulation, if proficient, makes speech intelligible and thus helps in communication.

Articulation refers to the totality of motor processes involved in the planning and execution of sequences of overlapping gestures that result in speech (Fey, 1992). According to Fey (1992), this definition implies that, first the learning of articulatory skills is an acquisitional process involving the gradual development of the ability to move the articulators in a precise and rapid manner. Second, the definition implies that errors in articulation must be seen as relatively peripheral disturbances of articulatory processes.

The acquisition of individual speech sounds in preschool and early school age children has been extensively studied since the 1930s. Several large-scale investigations have been conducted to gain a better understanding of the ages at which children can be expected to master certain speech sounds. Many of these now classic studies set out to develop group norms of articulation using the cross-sectional research method. Other studies have used the longitudinal method to assess the phonological development of individual children.

Over the years, many investigators have tried to determine approximate ages of individual sound “mastery” in specific groups of children. (Wellman’31, Poole’34, Templin’57 and Prather, Herdrick & Kern’75). The results of all these studies suggest that the articulation scores, which is a measure of the sounds, produced correctly, increases with age until maturity is reached by 8 years. They have also found sex and socio-economic status differences in the age of acquisition of articulation. These guidelines regarding the speech sound development is important when trying to separate normal from abnormal phonological development and when determining therapy goals.

Extensive normative data on the articulatory acquisition in Indian languages are limited. However, a number of attempts have been made in some of the Indian languages also which are summarized in Tables 1 & 2 below. In Kannada, the articulation test was developed by Babu, Rathna and Bettagiri in 1972, but the norms for the same was established by Tasneem Banu in 1977.

Thirumalai '72- Tamil	Kumudavalli '73- Kannada	Sreedevi '76- Kannada
No. of subjects considered: one Age: 4.4 years old. Results- <ul style="list-style-type: none"> • All the stop consonants were produced and • Substituted alveolars for retroflex sounds 	No. of subjects considered: 105 school going children Age range: 4 to 8 years. Results- <ul style="list-style-type: none"> • Alveolar and retroflex sounds were acquired last. 	No. of subjects considered:4 children Age range: 2 to 2.6 years. Results- <ul style="list-style-type: none"> • All the stop consonants were acquired by the age of 2.6 years. • The laterals, sibilants and trills were not fully established.

Table 1: Speech sound development according to different Indian studies.

Speech sounds	Tasneem Banu '77 (Kannada) 75%*	Usha'86 (Tamil) 75%*	Padmaja'88 (Telugu) 75%*	Arun Banik'88 (Bengali) 90%*	Maya'90 (Malayalam) 75%*
m	3	3	2.6	2.5	3-3.6
n	3	3	2.6	2.5	3-3.6
ŋ	+	+	+	2.5	3-3.6
p	3	3	2.6	2.5	3-3.6
f	+	+	2.9	+	3-3.6
h	+	+	2.6	3	3-3.6
w	+	+	+	+	+
y	3	3	2.6	2.5	3-3.6
k	3	3	2.6	2.7	3-3.6
b	3	3	2.6	2.5	3-3.6
d	+	3	2.6	3	3-3.6
g	3	3	2.6	3	3-3.6
r	4.6	+	3.9	4	3.7-4
s	3	3	3.3	+	3.6-4
ʃ	5.1	6	3.6	3	5-5.6
tʃ	3.7	3	2.6	3	3-3.6
t	+	3	2.6	3	3-3.6
tʃ	3	+	+	3	3-3.6
v	+	3	2.6	+	3-3.6
l	3	3	2.6	3	3-3.6
tʃH	+	+	+	3	+
z	+	+	+	+	+
zH	+	+	+	4	+
j	3	3	2.6	3	3-3.6
hw	+	+	+	+	+

Table 2: Age levels for the speech sound development according to different Indian studies. '+' indicates sound not tested. * Criteria for the sound to be considered as acquired

Need for the study

More recently, researchers have been concerned with the validity of the 'classical' data with respect to modern day living with its earlier and more extensive educational programs and the expanding effects of television on children. In view of the fact that the study on articulatory acquisition in Kannada was conducted 30 years back (Tasneem

Banu, 1977) and that recent studies focusing on phonological processes have revealed suppression of most of the processes by the age of 3- 4 years, there is an immediate need to study the articulatory acquisition in the present day children to verify this observation and apply it in the clinical set up.

Aim of the study

The aim of the study was to revise the norms for the articulatory acquisition in typically developing native Kannada speaking urban children.

The objectives of the study were:

1. To revise the norms for the Kannada Articulation Test (1972) and to establish the ages at which 75% and 90% of the children produce the phonemes of Kannada correctly.
2. To compare the articulatory acquisition across age and gender.
3. To compare the difference in the articulatory acquisition of phonemes in the initial and medial positions of the words.
4. To compare the data obtained with that of the earlier reported studies in both English and other Indian languages.

Brief Methodology

The Diagnostic Kannada Articulation Test (Babu, Rathna and Bettagiri'72) was administered to 120 children. The children were selected randomly from different localities of Mysore city. The children were in the age range of 3-4 years (3-3.6 years and

3.6-4 years). The test comprises of three parts, part I, part II and part III. The part I and part II comprises of 52 items and the part III has 10 items. The sounds tested were vowels, diphthongs, consonants and clusters. The subjects were encouraged to name the item in the picture card. The response obtained was audio recorded using Olympus digital recorder and the data was transcribed using broad and narrow IPA transcription. Test retest reliability was checked by re-administering the Diagnostic Kannada articulation test (Babu, Rathna and Bettagiri'72) on 3% of the boys and girls in both the age groups considered (3-3.6 years and 3.6-4 years).

Implications of the study

The revised articulatory norms obtained will help us to quickly inventory the articulation abilities in young native Kannada speaking children. It can be used for articulatory assessment and planning intervention goals for communication disordered children.

Limitations of the study

- Only two age groups were considered in the present study (3-3.6 years and 3.6-4 years) and intergroup interval (6 months) considered was broad. The articulatory skills could have been studied with the intergroup interval of 3 months to obtain a more precise age at which speech sounds are developed.
- Aspirated sounds were not tested as the Diagnostic Articulation Test (Babu, Rathna and Bettagiri'72) does not include these sounds.

- Some of the words are obsolete, needs to be modified in the Diagnostic Kannada Articulation Test (Babu, Rathna and Bettagiri'72). Children were not aware of words like /post8abaksu/, /st8ampu/, /t5akkad8i/, /re]d8ijo/, /rupa]ji/ and /vima]na/ and required repetitions by the examiner. This is probably due to the reduced usage of such words in urban Kannada at present.
- All the clusters occurring in Kannada language are not tested.

CHAPTER II

REVIEW OF LITERATURE

Articulation, in the simplest form can be defined as “a modification of the interrupted air stream into different sounds by the movements of articulators such as tongue, lip, 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 stream and simultaneously modifies the size, shape and coupling of the resonating cavities” (Nicolosi, Harryman and Krescheck, 1978).

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 speech 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 specific groups of children. These guidelines are important when trying to separate normal from abnormal phonological development and when determining therapy goals.

The order of acquisition of phonemes and age norms in speech development have been the subject of many studies as they pertain to the area of clinical phonology. Speech-language pathologist would like to know the order of normal acquisition so that they can detect phonological disorder and plan therapy. Generally, large group studies have focused on the articulatory correctness of sounds. Investigators usually test the

consonantal phonemes and report the percentage of children who produce the adult target sounds accurately at a specific age. The order of acquisition of sounds demonstrates the same pattern over and over again: stops, nasals, and glides are mastered earlier and are followed by liquids, fricatives, and affricates.

Although there are remarkable similarities in the order of acquisition of sounds among these studies, differences in terms of the age norms are also observed. This lack of agreement among the studies is partly due to the criteria used to define acquired. Some studies (Templin, 1957 & Prather, 1975) considered a sound as acquired when it is produced correctly by 75% of the subjects at any age level. On the other hand, Poole (1934) considered 100% as the criteria. Another difference observed is the word position considered. For example, Templin (1957) required accuracy in all three word positions (initial, medial and final), whereas, Prather (1975) looked at only initial and final positions.

Yet another reason for the divergences comes from the fact that different researchers require different degrees of phonetic accuracy of the production. As mentioned by Ingram (1974), /s/ provides a good example: if strict criterion for phonetic accuracy were applied, /s/ would be considered a late acquisition, as children take some time for a fully accurate production of this phoneme.

The variables that may contribute to the lack of agreement among studies are-the type of utterances used in testing-isolating words, connected speech, length of words,

stress patters, word familiarity, number of word tested for each word position, the effect of sounds in words such as consonant harmony, and conditions of data collection-are potentially influential factors in the resulting generalizations.

Although general tendencies in the order of acquisition of sound classes are mentioned, it is worth noting that there seem to be differences due to the position of the sound in the word. However, Stoel-Gammon (1984) did not find any evidence supporting the final position for earlier fricative acquisition. What does seem to hold is that prevocalic position is favored by voiced sounds and final position is favored by voiceless sounds.

The literature reveals that the development of articulatory skills has been studied extensively in the English speaking children such as the classical studies by Wellman, (1931), Poole (1934) and Templin (1957). Wellman (1931) used pictorial stimuli and questions to elicit 133 sounds of English including 66 consonant elements (initial, medial and final), 48 consonant blends, 15 vowels and 4 diphthongs. The 204 children ranged in age from 2-6 years, who were drawn from higher socio economic level. For a sound to be assigned to an age level, 75% of the children were required to have mastered it in all three positions (initial, medial and final).

Poole (1934) studied the articulation of 140 children aged 2.6-8.6 years on 62 items, testing 23 consonants in the initial, medial and final positions. Most test words were spontaneously uttered in response to questions about pictures, objects or actions; but

if necessary, the child was asked to repeat the desired word after the examiner. In Poole's study, the assignment of a sound to an age level required its correct usage in all three positions by 100% of the children.

Jakobson (1941) put forth a hypothesis about universality of patterns of acquisition of phonology. His main argument is that, restrictions are placed on the structures of the world's language by certain universal conditions, which he calls "universal invariants". For example there is no language in the world which possesses /k/ without at the same time /t/, yet there are languages with /t/ but no /k/.

According to Jakobson, in the first stage of language development, the acquisition of vowels starts with a wide vowel /a/ and, at the same time, the acquisition of consonants by a forward articulation stop, generally a labial. The first consonantal opposition is that of nasal and oral stop (eg. Mama-papa), which is followed by the opposition of labials and dentals (eg. Papa-tata; mama-nana). According to Jakobson, these two oppositions are followed by the first vocalic oppositions: a narrow vowel is opposed to a wide vowel, that is, /a/ and /i/ appear in the child's vowel system. The vowel /e/ appears in the beginning as a variant of /a/ which is optimal. In the stage following this, the child's vocalic system introduces either a splitting of the narrow vowel into a palatal or velar, e.g., papa-pipi-pepe. The result of these two processes leads to a system of the language of the world.

The fricatives are acquired only after the acquisition of stops in all the languages of the world. The child first changes fricatives to the corresponding stops /f/ to /p/, /s/ to /t/ and /ʒ/ and /ʃ/ to /k/.

The acquisition of back consonants takes place after the acquisition of front consonants, i.e., labials and dentals. In particular, the back oral and nasal stops are acquired after the front oral and nasal consonants, similarly the back fricatives are acquired only after the front fricatives. At first, the child replaces dental /n/ for both the back nasal consonants and generally the back oral consonants are replaced by the corresponding dentals. Thus, dental /t/ is substituted both for /k/ and /tʃ/.

With a few isolated and doubtful exceptions, the back oral stops are replaced only by velars, whereas the back nasal consonants are more frequently replaced by palatals. The front fricatives are replaced by dentals and the back fricatives by palatals. If, in the languages of the world or in child language, the fricative consonants are limited to a single phoneme, this phoneme is, as a rule, represented by /s/ and Jakobson calls it as “indefinite fricative phoneme”.

An affricate is acquired by the child only after the fricative of the same series. Before the child acquires affricates, he substitutes either corresponding stops or fricatives for them, e.g. /t/ or /s/ for /tʃ/ and /p/ or /f/ for /pf/.

A differentiation of rounded vowels according to degree of aperture cannot arise in child language until the same differentiation for the unrounded vowels is acquired. The pair /u/-/o/ cannot therefore precede the pair /i/-/e/. Rounded palatal vowels arise only after the unrounded palatal vowels of the same degree of aperture appear.

Oppositions which occur rarely in the language of the world are among the latest phonological acquisitions of the child. The number of languages with a single liquid (whether /l/ or /r/) is extraordinarily large, and the child has only a single liquid for a long time and acquires the other liquid only as one of his last speech sounds. So far the phonological universals put forth by Jakobson were described and according to him any child belonging to any linguistic community commonly follows the order mentioned in the acquisition of phonology.

Templin (1957) tested 480 children for 176 sound elements. The age range studied was 3-8 years with eight discrete age levels (3.0, 3.6, 4.0, 4.6, 5.0, 6.0, 7.0 & 8.0 years) with 30 boys and 30 girls in each group. The preschool children repeated the test words or spontaneously named the stimulus pictures. The children from 6-8 years read the test words or repeated them after the examiner. Templin used the three positions, 75% criteria in assigning age levels.

The results of these studies suggests that the articulation score which is the measure of the sounds produced correctly, increases with age until maturity is reached by

8 years. The age levels for the speech sound development according to different authors have been listed in Table 3.

Olmsted (1971) tested 100 children in the age range of 1.3 years to 4.6 years. Using spontaneous speech samples he developed an order of acquisition of speech sounds by considering a sound as acquired if it was produced correctly by more than 50% of the children than those who misarticulated it. Despite very different kinds of data and measures of acquisition, both Templin (1957) and Olmsted (1971) show very similar results concerning sounds acquired over this period.

Prather, Hedrick and Kern (1975) used the Sequenced Inventory of Communication Development- SICD to test the articulatory skill of 147 Caucasian children between the ages of 2 and 4 years. 44 pictures using consonants in the initial and final positions were presented to the children. Naming and if necessary repetition tasks were involved in the study and in SICD, the percentage correct is the average of the percentages of the correct responses for the two positions tested. Age norms were established at 75% level.

Speech sounds	Wellman'31 75%*	Poole'34 100%*	Templin'57 75%*	Sander'72 75%*	Prather'75 75%*	Arlt'76 75%*	Fudala (1986)- 90%*	
							IP	FP
m	3	3 ½	3	Below 2	2	3	2	2
n	3	4 ½	3	Below 2	2	3	2	2
h	3	3 ½	3	Below 2	2	3	1 ½	
p	4	3 ½	3	Below 2	2	3	2	3
f	3	5 ½	3	3	2-4	3	2 ½	3
w	3	3 ½	3	Below 2	2-8	3	1 ½	
b	3	3 ½	4	Below 2	2-8	3	2	3
N		4 ½	3	2	2	3		3
j	4	4 ½	3 ½	3	2-4		3	
k	4	4 ½	4	2	2-4	3	2 ½	3
g	4	4 ½	4	2	2-4	3	2 ½	3
l	4	6 ½	6	3	3-4	4	5	5
d	5	4 ½	4	2	2-4	3	2 ½	2 ½
t	5	4 ½	6	2	2-8	3	3	4
s	5	7 ½	4 ½	3	3	4	11	11
r	5	7 ½	4	3	3-4	5	5 ½	
tΣ	5		4 ½	4	3-8	4	5 ½	5 ½
v	5	6 ½	6	4	4	3 ½	5 ½	5 ½
z	5	7 ½	7	4	4	4	11	11
ʒ	6	6 ½	7	6	4	4		
θ		7 ½	6	5	4	5	6	6
ʃ		6 ½	4 ½	4	3-8	4 ½	5 ½	5 ½

Table 3: Age levels for the speech sound development according to different authors in English.

* Criteria for the sound to be considered as acquired. IP: Initial position, FP: final position. Empty space indicates speech sounds not tested.

Studies pertaining to acquisition of vowels

Very little information is available regarding the order and the rate of vowel acquisition. However, reports by many researchers show that children acquire all of the English vowels by the age of 3 (Templin, 1957).

Irwin and Wong (1983) conducted a study on 100 children in the age range of 18-72 months. 10 boys and 10 girls in each of the following groups were considered for the study: 18 months, 2 years, 3 years, 4 years and 6 years. Results indicated that-

- At 18 months of age only /a/, /u/, /i/ and /ʌ/ were produced with atleast 70% accuracy.
- At 2 years of age all the vowels and diphthongs were produced with atleast 80% accuracy with the exception of /ə/ and /ɜ/.
- At 3 years of age all the subjects produced all the vowels and diphthongs with 99-100% accuracy.

Fudala and Reynolds (1986) collected normative data on acquisition of vowels, which is based on a sample of 5,122 children in the age range of 1.6 years to 13.11 years. The subjects were selected from four states in the western United States. The authors used 90% criteria for the sound to be considered as acquired. Results of the study indicated that-

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

Studies pertaining to acquisition of single phonemes

Sander (1972) reinterpreted the data of Wellman (1931) and Templin (1957) as-

- Age of customary production: It is the age at which 50% of the children produced the sound correctly in atleast two positions.
- Age of routine production: It is the age at which 75% of the children produced the sound correctly in all the three positions
- Age of mastery: It is the age at which 90% of the children produced the sound correctly in all the three positions.

Age levels for the development of speech sounds in English according to different authors (Wellman'31, Templin'57 and Sander'72,) are depicted in the Table 4.

Age	Consonants customarily produced	Consonants mastered
< 2 years	p, b, m, n, w, h*	
2 years	t, d, k, g, ŋ	
3 years	f, s, r, l, j	P, m, n, w, h
4 years	v, z, dʒ, tʃ, ʃ	b, d, k, g, f, j
5 years	θ, ð	
6 years		t, r, l, ŋ
7 years		θ, dʒ, tʃ, ʃ
8 years	ʒ#	v, ð, s

Table 4: Age levels for the development of speech sounds according to different authors. * Acquired by 70% of children at 2 years of age, # not mastered by 90% of children even by the age of 8 years.

Stoel-Gammon (1985) in her longitudinal study using spontaneous speech sample on 34 children, 19 boys and 15 girls in the age range of 15 to 24 months. The samples were collected every 3 months, from 9 months to 24 months. Only the meaningful speech

production of at least 10 identifiable words during a 1- hour recording session was analyzed and the results indicated that-

- By 15 months of age- voiced stops, nasals and glides were produced in the word initial position.
- By 24 months of age- voiceless stops, velars, and few fricatives were produced in the initial position.
- Voiceless stops and alveolar consonants were produced in the word final position.
- Voiced stops appeared first in the initial position.
- /t/ and /r/ appeared first in the word final position.

Fudala and Reynolds (1986) studied the acquisition of single phonemes and the results indicated that, the age of acquisition of /s/ and /z/ appears to be quite late compared to earlier studies i.e. from 6 to 6.5 years. As the group got older the percentage of children who produced correctly got decreased to less than 90% (as low as 62% for the 7 to 7.11 years) then the percentage began to gradually increase again at 8 to 8.11 years and by the age of 11 to 11.11 years 98.4% of children produced it correctly. Similar results were obtained for final /-z/ and /-s/.

Studies pertaining to acquisition of consonant clusters

Templin (1957) considered a consonant cluster to be mastered when it is produced by 75% of children. Her results on consonant clusters revealed that-

- By the age of 4 years /s + stop/, /s +nasal/, /stop + nasal/, /stop + liquid/ (except /gr/) and /stop + w/ were produced in the initial position.
- Only fewer final clusters were produced by the same group of children.
- 3 member clusters and clusters containing fricatives continued to be mastered till the age of 8 years.

Studies pertaining to articulatory acquisition in other languages

The phonological development of children learning English as their first language has been well described (Ferguson & Farwell, 1975; Ingram, 1981). However, as Ingram, 1989 points out, ‘despite numerous studies on language other than English we know relatively little about phonological development in other languages’. Few crosslinguistic studies available have provided evidence bearing on some major theoretical issues in child phonology.

Pye, Ingram & List, 1987 studied five children learning Quiche, a Mayan language, suggested that their early phonetic inventories included sounds (/tʃ/, /l/) not acquired until later by English speaking children, i. e. the order of acquisition differed.

Mowrer & Burger’s (1991) studied 70 Xhosa speaking children aged 2-6 years and found that their subjects mastered the 20 phonemes held in common by Xhosa and English earlier than English-speaking children control group did, and earlier than English-speaking children reported in the literature. The Xhosa-speaking children had

mastered 31 of the 41 consonants of their language by 3 years of age, including some affricates (/ts, tʃ/) and clicks. However, those sounds acquired last and those sounds most frequently misarticulated by Xhosa-speaking children e.g. /s/, /ʃ/, /r/ are the same phonemes English, German and Swedish children find difficult. The Xhosa-speaking children made half the number of errors made by the English speaking group but the two groups were shown to use similar substitution patterns for affricates and liquids in a taxonomic analysis.

Cantonese phonology differs from that of English in a number of different ways. It is a tone language where the change in tone of a syllable can lead to the change in meaning. There are six contrastive tones: high level, high rise, mid level, low fall, low rise low level; and three entering tones that are allotones of the three level tones. Cantonese has 17 initial consonants and two syllable-initial consonant clusters, eight final consonants and vowel phonemes. The syllable structure of Cantonese is relatively simple: there are syllabic nasals /m/ and /ŋ/, and all other syllables have the following structure: {[C]-[Glide]}-V-[C/Glide]. The number of segments can vary from one to four with a vowel being an obligatory segment.

There have been three previous studies on aspects of phonological acquisition by Cantonese-speaking children. Tse (1978) carried out a 30 month longitudinal study of his son's acquisition of tone, showing that the perception of tonal contrasts precedes their production. He divided the acquisition of tone production into three stages: in stage I (1.2-1.4), high level and low falling tones were acquired; in stage 2 (1.5-1.8), mid level,

high rising and three entering tones; and in stage 3 (1.9), low rising and low level tones. Thus, tone appears to be mastered very early and well before segmental phonology.

Similar findings for the acquisition of tone were made by Tse (1982). He collected six speech samples from a girl aged 1.7 to 2.8, plus cross-sectional samples from two children aged 1.8 and 2.0. These samples were analyzed to describe the children's phonological processes; however, no consistent patterns emerged. The samples were also analyzed to describe the children's phonetic inventories. At least two of the subjects had acquired the following segments- /m, n, ŋ, p, t, k, tʃ, s, h, j/. Repertoires for English-speaking children of the same age include no affricates, but the size of the consonant inventory is about the same- /m, n, p, b, t, d, k, g, f, s, h, w/ (Ingram, 1984). The Cantonese speaking children used unaspirated voiceless stops whereas English speaking children commonly aspirate voiceless stops. Aspiration is a contrastive feature in Cantonese, but not in English. The fact that Cantonese-speaking children do at the same aspects of phonological acquisition are not universal, but are influenced by the phonological structure of the language being learned.

In contrast, Tse's (1991) longitudinal case study of a Cantonese-speaking boy aged 1.3-2.6 found evidence for universal trends in the sequence of phoneme acquisition. The types of phonological error identified included assimilation, cluster reduction and systemic simplification (e.g. stopping, fronting). Most of these errors can be found in the developmental errors of English-speaking children.

Lydia & Dodd (1995) studied 268 Cantonese-speaking children in the age range of 2-6 years, who attended child care centers in Hong Kong. Fifty seven words were selected for inclusion in a picture-naming test. These words sampled two examples of all Cantonese vowels, tones, and initial and final consonants. Results indicate that-

- Vowels and syllable final errors were small in comparison, but tended to rise across the age span as the number of syllable initial errors decreased.
- The number of unclassified errors remained low for all age groups except the children aged 4.6-4.11 years.
- Both boys and girls acquired all 17 syllable-initial consonants and the two clusters by 5 years and all syllable-final consonants by 4.6. The girl's acquisition initially proceeded more rapidly than that of the boys, but by four years both had mastered 15 syllable-initial phonemes.
- Unaspirated plosives and nasals were acquired before fricatives and affricates; unaspirated phonemes were acquired before their aspirated partners.
- When compared to that of children learning English language, both the groups first acquired nasals, glides and bilabial and alveolar stops followed by /h/ and /k/. Aspirated plosives, affricates and voiced fricatives were acquired later.
- However, Cantonese speaking children appeared to complete their phoneme repertoire more quickly than English-speaking children. 75% of Cantonese children completed their acquisition by 3.6 whereas 75% of English-speaking children do not complete their phoneme acquisition until after 4 years according to Prather, Hedrick & Kern (1975).

- All vowels were being used contrastively by 90% of the children in the youngest age group and all other groups. Only 15 children (5.6%) made two or more vowel errors, representing only 4.5% of total errors.
- Only two children studied made tone errors and by two years of age most children had mastered tonal contrasts.

Amayreh and Dyson (1998) conducted a study on Jordanian children aged 2-6.4 years from Amman to find the age at which each of the consonants of Arabic is acquired. The following 12 consonants were reported not to be acquired by the oldest age group (6-6.4): /ʃ/, /ð/, /θ/, /z/, /ʒ/, /dʒ/, /j/, /t=/, /d=/, /s=/, /ð=/, /q/. With the exception of /t=/, /s=/, /z/, /j/ and /ʒ/, all of these late consonants have dialectal forms that are commonly used in Jordanian Spoken Arabic (JSA). The author concluded that Standard Arabic consonants would be eventually acquired by approximately 8.6-9.0 years.

Amayreh (2007) studied 100 normally developing children (50 boys and 50 girls) from middle socio economic status, with a mean age of 6.4 years were randomly selected from two schools in Amman. Modified version of Amayreh's articulation test was used. The test consists of 65 picturized words that allow for the production of standard Arabic consonants in initial, medial and final positions, with the exception of /ð/. Delayed imitation was applied only when the subjects used a dialectal variant of Standard Arabic (SA) form. Results indicated that-

- Spontaneous productions of Standard Arabic consonants shows that 22 consonants were produced correctly at least 90% of the time. Percentage of

accuracy of the remaining 6 consonants i.e. /d=/, /q/, /ð/, /θ/, /ð=/, and /dʒ/ ranged from 43 to 60%.

- When delayed imitation was applied, the percentage of accuracy increased, ranging between 58% for /d=/ and 83% for /q/.
- On applying 75% criteria, 22 consonants, /b/, /d/, /t/, /t/, /k/, /f/, /s/, /z/, /s=/, /Σ/, /Ⓜ/, /Ξ/, /≠/, /□/, /h/, /m/, /n/, /l/, /r/, /j/ and /w/ were acquired by the age 6.4 years.
- The subject's low performance on the 6 Standard Arabic consonants is interesting to observe that at this stage the production is difficult in Standard Arabic which is not associated with a particular place or manner of articulation. It is because, the Jordanian preschool children have sporadic exposure to Standard Arabic, and the low accuracy of these consonants is attributed to their low frequency of occurrence in this variety.

Studies pertaining to articulatory acquisition in Indian languages

Extensive information about the articulatory acquisition in Indian languages are scanty. However, a handful of attempts have been made to study the same, which include:

In Tamil, Thirumalai (1972) described the acquisition of phonology of a 4.4 year old boy. The results indicated that among the consonants, the subject had acquired all the stop consonants like /k/, /tʃ/, /t/, and /p/ and the subject 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. This led to a hypothesis that, the subject was not encountering any difficulty in the production of sounds of the language, and the difficulty was to produce them in appropriate environment.

Kumudavalli (1973) studied the relationship between articulation and discrimination of Kannada speech sounds in terms of distinctive features. The subjects were 105 school children in the age range of 4-8 years. The discrimination test comprised of a list of 17 minimal pairs. Results indicated

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

Sreedevi (1976) studied the acquisition aspects of Kannada language in 2+ year old children. 4 children, 2 males and 2 females were studied. The speech samples were recorded once in 5 weeks and in total 4 recordings for each child were done by using elicitation and imitation techniques. Results indicated that all the 4 subjects had acquired most of the vowel distinction, such as, long and short vowel distinction which is found in the adult speech. The stop consonants had been uniformly acquired. Aspirated counterparts were not acquired during the course of the study. The laterals, sibilants and trills were not fully established till the stage of the completion of the study. The

distinction between the nasals was not fully made during the course of the study. All the children continued to substitute their own clusters for most of the non identical clusters and there was no difference between the sexes in the acquisition of phonology and she also found regularity in the order of acquisition of phonology.

Tasneem Banu (1977) studied the articulatory acquisition in Kannada speaking children by using the Diagnostic Kannada articulation test (Babu, Rathna & Bettagiri, 1972) which was administered to 180 school children in the age range of 3 to 6.6 years where in 7 groups were made with 6 months age interval. Results indicated that-

- There was a significant difference in the articulation scores for different age groups.
- A definite pattern in the acquisition of articulation was found. There was a gradual but definite change from age to age.
- The children seemed to acquire most of the sounds earlier than the English speaking children.
- There was no significant difference between girls and boys for articulation scores in any of the age groups considered.

Usha (1986) studied 180 Tamil speaking typically developing children in the age range of 3-6 years. Results revealed that-

- The articulation score was directly proportional to the age in that the scores increased as the age advanced.

- Girls exhibited superior articulatory skills compared to boys in all the age groups.
- All the vowels and most of the consonants except /σ8/ (voiceless retroflex), /l8/ (retroflex lateral), /l/ (voiced retroflex palatal lateral) and /r/ (voiced alveolar flap) were acquired by the age of 3 years. In general all the stops and nasals were acquired by the age of 3 years. Where as the fricative /s/ was acquired at the age of 6 years. Flap /r/ was not acquired till the age of 6 years.

Arun Banik (1988) studied articulation and phonemic discrimination in Bengali language and established the norms for the same to enable to test and suggest further management procedures for Bengali speakers with articulation disorder. Seven vowels, twenty eight consonants and eighteen clusters of Bengali were selected. Three hundred and eighty-four words with these sounds in various positions such as initial, medial and final positions were compiled. The test was administered to Bengali speaking school going children in the age range of 2-8 years. Results indicated that-

- As the age increased, scores also increased. There was a definite pattern in the acquisition of articulation. There is a gradual but definite change from age to age.
- The children in the study acquired sounds earlier than English speaking children.
- The difference between boys and girls in terms of articulatory skills were found to be significantly different. Females exhibited superior articulatory skills when compared to males in all the age groups.

- It was observed that all the vowels were acquired by the age of 2.5 years. Also, most of the consonants were acquired by the age of 3 years except fricative /zh/, flap /r/, trill /r/ and some of the cluster sounds like /kr/, /ksha/, /sra/, /gl/, /st/, /skr/.
- Most of the misarticulated sounds were either substituted or omitted. No errors of distortions or addition were observed.
- The age of acquisition of the sound and the ability to discriminate seemed to correlate with one another. Earlier they were able to discriminate the sound, the earlier they were able to acquire the correct articulation.
- When compared to the western studies it was noticed that the Eastern population acquired speech sounds earlier. The early articulatory acquisition in Bengali speaking children was attributed to the cultural differences.

Maya (1990) studied 240 Malayalam speaking children in the age range of 3-7 years with an age interval of 6 months. Picture cards were visually presented in order to elicit the response. Results revealed that the

- Articulation score was directly proportional to the age in that the scores increased as the age advanced. However, even at the age of 7 years, 100 percent score was not obtained.
- Among the phonemes in this test, first to be acquired were unaspirated stops, followed by fricatives, affricates and aspirated stops.
- The articulatory development in Malayalam speaking children is earlier than in non-Malayalam speaking children. They acquire the articulation of /s/, /r/, /l/, /f/,

/tʃ/, /j/ at an earlier age of 3-3.6 years. While the unaspirated stops are acquired early (3-3.6 years), aspirated stops are acquired as late as 6-6.6 years.

- There was no significant difference between males and females except in the age group 3-3.6 years, in terms of articulatory skills.

Age levels for the speech sound development according to different Indian studies are depicted in Table 5.

Speech sounds	Tasneem Banu '77 in Kannada 75%	Usha '86 in Tamil 75%	Padmaja'88 in Telugu 75%	Arun Banik'88 in Bengali 90%	Maya'90 in Malayalam 75%
m	3	3	2.6	2.5	3-3.6
n	3	3	2.6	2.5	3-3.6
ŋ	+	+	+	2.5	3-3.6
p	3	3	2.6	2.5	3-3.6
f	+	+	2.9	+	3-3.6
h		+	2.6	3	3-3.6
w	+	+	+	+	+
y	3	3	2.6	2.5	3-3.6
k	3	3	2.6	2.7	3-3.6
b	3	3	2.6	2.5	3-3.6
d	3	3	2.6	3	3-3.6
g	3	3	2.6	3	3-3.6
r	4.6	+	3.9	4	3.7-4
s	3	3	3.3	+	3.6-4
ʃ	5.1	6	3.6	3	5-5.6
tʃ	3.7	3	2.6	3	3-3.6
t	3	3	2.6	3	3-3.6
tʃH	+	+	+	3	3-3.6
v		3	2.6	+	3-3.6
l	3	3	2.6	3	3-3.6
z	+	+	+	+	+
zH	+	+	+	4	+
j	3	3	2.6	3	3-3.6
hw	+	+	+	+	+

Table 5: Age levels for the speech sound development according to different Indian studies '+' indicates speech sounds not tested. Empty space indicates speech sounds not acquired.

Vani Rupela (2006) studied the phonotactic development in Kannada speaking children in the age range of 0-5 years. The speech sample was elicited by imitation task and spontaneous speech which was collected through natural interaction of the child, family members and investigator. The presence of different syllable and word shapes were calculated in terms of percentage of occurrence. Results indicated that-

Syllable shape:

- CV syllables were the most commonly occurring syllables from 0-18 months thereafter remained stable.
- VC syllables occurred occasionally from 0-54 months but were more frequent from 54 months onwards.
- CVC syllables emerged at 12 months and gradually increased in frequency by 56-60 months.

Clusters:

- Medial geminated clusters were first to be acquired and were present in the age range of 12-18 months and gradually decreased at the age of 54 months.
- Medial non geminated clusters appeared at 18-24 months, more frequent at the age of 30-36 months and became predominant at the age of 30-36 months.
- Initial clusters were stabilized by 24-30 months.
- Three sound clusters in the medial position were found to stabilize from 42-48 months onwards.

Word shapes:

- Disyllabic words appeared at 6-12 months, predominant at 18 months and then gradually declined at the age of 48 months.
- Monosyllabic words appeared at 24-30 months however very rare compared to other syllable types.
- Both tri and multisyllabic words occurred occasionally at 18-24 months and steadily increased till 54-60 months.
- Trisyllabic words were frequently used compared to multisyllabic words.

Neethipriya (2007) studied the phonotactics in 60 typically developing Telugu speaking children in the age range of 3-6 years. Equal number of males and females were included and they were divided into six groups, 10 children in each group. Spontaneous speech samples were obtained from the subjects. Percentage occurrence of syllable shapes, word shapes and clusters were calculated. Her findings indicated that

1. Syllable shapes: CV syllables were 'predominant', having 62% of occurrence on an average and were most commonly occurring syllables compared to others.

- The frequency of occurrence of CVC syllables was 30% falling under status of frequent occurrence.
- The occurrence of VC and V syllables were below 10% and thus can be said to fall under 'rare' category.
- There was no significant change in the percentage of syllable shapes across ages 3-6 years.

- The predominance of CV syllable shape is consistent across age groups. CVC syllable shape have shown slight increase in frequency till 4.5 years and thereafter stabilized suggesting children have acquired syllable shapes by 3 years of age itself and then were maintained till 6 year of age.
2. Consonant clusters: medial clusters occurred predominantly with 60-70% of frequency and within medial clusters geminated clusters occurred more frequently with a percentage of occurrences between 30-40%. This frequency was maintained across all age groups.
- Medial non geminated clusters occurred with a frequency of 45-55%. Nasal + homorganic stops (/nt/, /nd/, /nk/, /mt/ etc) were predominantly noticed in the samples followed by fricatives + plosive combination (-st-).
 - Initial and final clusters occurred with a frequency of less than 3% and typically occurred in loan words across all age groups.
 - Three consonant clusters occurred medially with combination of nasal + stop + liquid combination (-ntl-). However frequency of such clusters was less than 3% and fell under 'rare' category across all the age groups from 3-6 years.
 - Percentage of occurrence of non-geminated clusters seemed to increase from 45% in 3.1-3.5 year group to 55% in 5.1-5.5% year group.
3. Word shapes: When analyzed for word shapes, monosyllabic, disyllabic, trisyllabic and multisyllabic words were found in the samples. Monosyllabic words were least occurring type in the samples.

- Disyllabic words were predominant in 3.1-3.5 years age group with frequency of occurrence around 50% and there was a gradual decrease in frequency to 30% in 5.6-6.0 years age groups.
- Trisyllabic words averaged between 25-30%, thus falling under 'occasional' category. This percentage was maintained across age groups.
- Multisyllabic words gradually increased from 'occasional' category (23%) in 3.1-3.5 years to 'frequently' occurring category (42%) in 5.6-6.0 years. The maximum number of syllables averaged around 4-5 till 5 years and later increased to 5-6 syllables.

Studies on phonological processes in different languages

The series of phonological processes appear and disappear at different stages during the developmental period. However there are not many reports focusing on age norms.

Dyson and Paden (1983) investigated the elimination of the following five phonological processes by 40 2-year old children: gliding, cluster reduction, fronting, stopping and final consonant deletion. Using 36 words to provide the opportunity for the occurrence of these five processes, they tested the children at 3-week intervals beginning at 2 years and ending 7 months later. During the initial testing, the order for the frequency of occurrence was: gliding, cluster reduction, fronting, stopping, and final-consonant deletion. During the last testing, at the age of 2.7 years, the order remained the same.

However final consonant deletion was almost completely eliminated, fronting and stopping were infrequent, and gliding and cluster reduction were still common.

Lowe, Knutson, and Monson (1985) studied the incidence of fronting in 1,048 preschool children between the ages of 2.7 months and 4.6 months. They observed fronting in 60% of the study participants and noted that velar fronting was more common than palatal fronting. They also noted that palatal fronting did not occur in the absence of velar fronting. They stated that fronting infrequently occurred after the age of 3.6 months.

Stoel-Gammon and Dunn (1985) reviewed studies of processes occurrence and identified those processes, which typically are deleted by age three and those that persist after three years. Their summary is presented below-

Processes disappearing by 3 years

Unstressed syllable deletion
Final consonant deletion
Consonant assimilation
Reduplication
Velar fronting
Prevocalic voicing

Processes persisting after 3 years

Cluster reduction
Epenthesis
Gliding
Vocalization
Stopping
Depalatalization
Final devoicing

Haelsig and Madison (1986) investigated the occurrence of 16 phonological processes in 3, 4 and 5 year old children. 50 children were divided into five 6-month age groupings, resulting in the participation of 10 children in each group. Results revealed that-

- The 3.0 year age group used final-consonant deletion, weak syllable deletion, glottal replacement, cluster reduction, labial assimilation, vocalizations, and gliding of liquids in at least 20% of possible occurrences.
- The 3.6 year age group used weak-syllable deletion, glottal replacement, cluster reduction, alveolar assimilation, stopping, vocalizations, and gliding of liquids in at least 20% of possible occurrences.
- The number of processes used at least 20% of the time significantly decreased in the 4.0 age group. The processes that met the criteria in this age group were weak-syllable deletion, vocalizations, and gliding of liquids.
- The 4.6 year age group used only one process in at least 20% of the time: weak-syllable deletion.
- The 5.0 year age group did not use any processes in at least 20% of possible occurrences.
- Several processes were rarely used by any of the age groups, including fronting, final consonant devoicing, velar assimilation, prevocalic voicing, gliding of fricatives, affrication, and denasalization.

Stoel-Gammon (1987) studied 34 (19 boys and 15 girls) 2 year old children longitudinally. All subjects were from the monolingual English speaking homes. Two 30 minute speech samples were gathered while the subjects interacted with the caretaker and played with various sets of toys. Results indicated that-

Word and syllable shapes:

- Monosyllabic words shapes CV and CVC were present in the samples of all subjects.
- Disyllabic word shapes CVCV and CVCVC occurred less frequently but were present in half the speech sample.
- 58% of subjects produced atleast 2 different clusters in initial position
- While 48% of them produced 2 or more final clusters.
- In medial position, only 30% of subjects produced 2 or more clusters.

Phonetic inventories:

Consonantal phones occurring in 50% of the inventories, by position with in the word are listed in Table 6

Sound class	Initial position	Final position
Stop	/b, t, d, k, g/	/p, t, k/
Nasal	/m, n/	/n/
Fricative	/f, s/	/s/
Liquid, glide	/w, l/	/r/

Table 6: Consonants occurring in 50% of inventories in initial and medial position. (Stoel-Gammon'87)

Percentage of consonants correct:

- The mean PCC for the samples was 70% with a range of 43% to 91%.
- Comparison of the PCC scores with the inventory size (no. phones in the initial and final inventories) revealed a positive correlation of moderate strength.

Dyson (1988) studied phonetic inventories in 20 children in the age range of 2 to 3 years. Two speech samples were taken approximately 5-6 months apart which ranged from 53 to 250 words. Results indicated that-

Word Initial inventories:

- All stops were present in both the age groups.
- The voiceless palatal fricative /ç/ appeared to be emerging, it was transitional at the first, third and fourth observations.
- A full repertoire of nasals and glides and liquid /l/ were present.

Word final inventories:

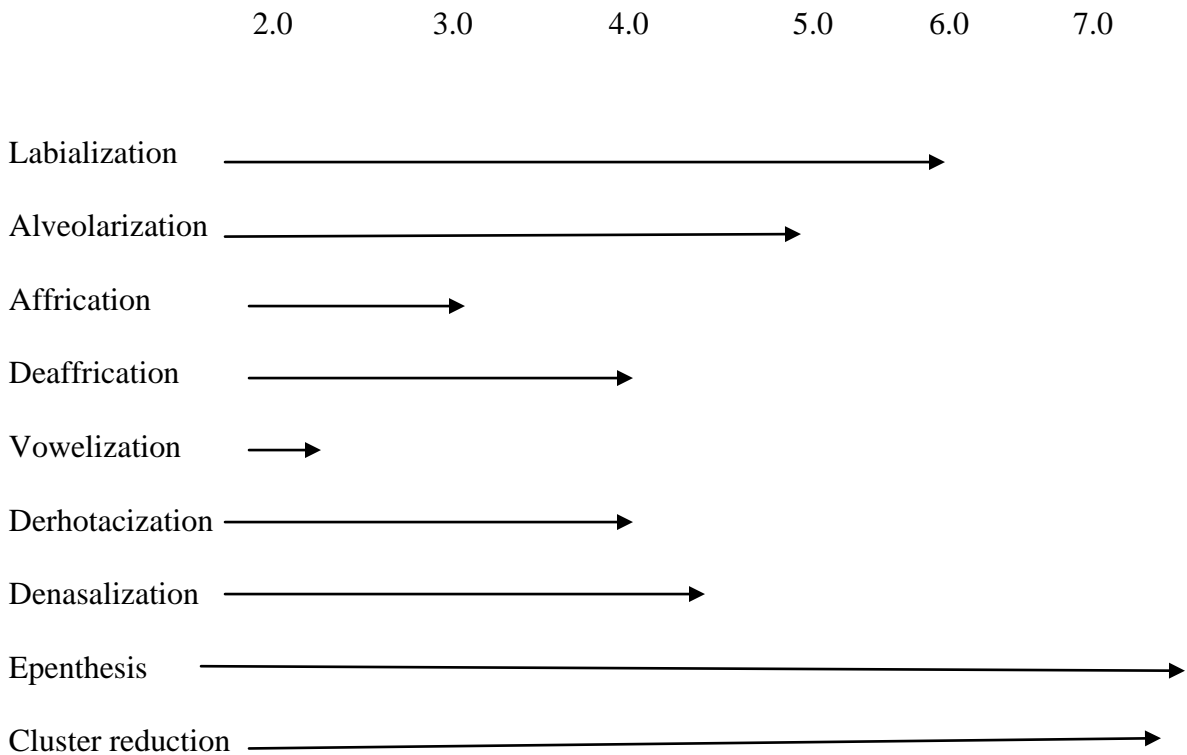
- The 4 inventories of word final segments were present. The voiceless stops were always present.
- Voiced stops appeared to be emerging.
- Word final affricates were common than word initial affricates.
- Nasals were well established.

Cluster production:

- Clusters were produced quite frequently by these children.
- No subject produced less than 4 different clusters.
- The initial cluster that was produced by 5 children were /fw/
- Word final clusters were slightly less common than word initial clusters.

Robert, Burchinal and Footo (1990) investigated the phonological skills of children between 2.5 years and 8 years by testing them at varying times throughout the course of their study. They noted a noticeable decline in the use of phonological processes between the ages of 2.5 years and 4 years. They reported that by age 4 only cluster reduction, liquid gliding, and deaffrication had an occurrence level of at least 20%.

Age of suppression for several processes (Smith, 1993; Lowe, 1996) is presented below.



Topbas (1997) studied phonological acquisition in 22 Turkish speaking children in the age range of 1.3-3 years and two of these children were observed longitudinally.

The spontaneous speech data were obtained in a 30 minute play session in the home environment of the children. A live phonetic transcription was made simultaneously and complete transcription was made soon after the session. In order to determine the frequency of a process a criterion was used. A process had to be used at least in 4 different words and occurred in at least 20% of the overall target process occurrences.

Results showed that-

- The plosives /b, d, k, t/ and nasals /m, n/ was acquired before age 1.6 yrs.
- /p, tʃ, ʃ, dz, l/ were acquired by the age 1.8-2.2 yrs.
- Fricatives /v, f, s, z/ - 2.4-2.8 yrs.
- /h/- 2.9-2.11 yrs and /r/ was seen in only one subject.
- In children acquiring Turkish had certain processes which appear to be more prominent than others. These are consonant deletion and liquid deviation which were used by almost all of the subjects.

Hua and Dodd (1998) studied phonological acquisition of 129 monolingual Putonghua (Modern standard Chinese) speaking children; aged from 1.6 to 4.6 yrs. Putonghua syllables have four possible elements: tone, syllable initial consonants, vowels, and syllable final consonant. The child's error suggested that Putonghua speaking children mastered these elements in the following order:

- Tones were acquired first
- Then syllable final consonants and vowels
- Syllable initial consonants were acquired last.

- Phonetic acquisition of 21 syllable initial consonants was complete by 3.6 yrs for 75% of children.
- By 4.6 yrs the children were using the syllable initial consonants correctly on two thirds of occasions.
- Simple vowels emerged early in development.
- Triphthongs (iao, uei) and diphthongs (ua, ao) were prone to systematic errors.
- Tone errors were rare because of their role in distinguishing lexical meaning.

Goldstein (2001) studied phonological skills in a single child of age 4.10 years, Spanish and English speaking girl. She was tested in both the languages. Both independent and relational analysis was computed. The independent analysis consisted of charting the sounds produced in initial and final positions, the length of words, and the syllable types. The relational analysis entailed detailing substitutions, omissions, distortions, and additions and percentage of occurrence of phonological processes.

Results indicated that-

In Independent analysis: there was similar phonetic inventory in both the languages.

- She did not produce velars in syllable initial position in either language although she did produce them in final position.
- Also exhibited limited number of fricatives /f/ and /s/ in Spanish and only /f/ in English.
- Word length (number of syllables in each word): The majority of words in Spanish were two syllable words compared with one syllable word in English.

- In both the languages, the majority of syllable types was CV, although she did produce more CVC types in English than in Spanish

Relational analysis: Revealed a moderate to severe phonological disorder on a PCC of 62% in English and 65% in Spanish.

- Overall, the child showed similar substitution patterns in both the languages.
- Glides substituted for the liquids in English.
- /n, d, h, l/ was substituted for liquids in Spanish.
- This varying substitution patterns shows that the child is using the two languages separate by exhibiting different patterns for the same targets.
- In both the languages, the four most commonly occurring processes were cluster reduction, initial consonant deletion, syllable reduction and liquid simplification.
- The other two processes final consonant devoicing and final consonant deletion were markedly different in each language i.e. higher percentage of occurrences in English compared to that of Spanish.

Studies on phonological processes in Indian languages

Sameer (1991) studied phonological processes in normal Malayalam speaking children in the 3-4 years age group. The data was analyzed in terms of processes persisting, decreased processes and non existing processes. Table 7 shows persisting, decreased and non-existing phonological processes before 4 years of age.

Persisting processes	Decreased processes	Non existing processes before age 4 years
<ul style="list-style-type: none"> • Cluster reduction • Final consonant deletion • Epenthesis • Affrication 	<ul style="list-style-type: none"> • Deaffrication, Stopping • Fronting, Stridency deletion • Fronting, Reduplication • Palatalization, CR, medial consonant deletion, backing of fricatives, Denasalization and articulatory shift 	<ul style="list-style-type: none"> • Atypical cluster reduction and Deaffrication

Table 7: Phonological processes persisting, decreased and non-existing before age 4 years.

Jayashree (1999) studied phonological processes in normal Kannada speaking children in the 4-5 years age group. She found that even by 5 years of age there were processes persisting in child's phonology. The persisted processes were cluster reduction, fronting, stopping, while the processes which completely disappeared were metathesis, epenthesis, prevocalic voicing & palatalization.

Bharathy (2001) studied phonological process in typically developing Tamil speaking children by using Tamil articulation test (Usha, 1986) which was administered to 30 children in the age range of 3-4 years divided into 3 groups, i.e. 3-3.4 years, 3.5-3.8 years and 3.9-4 years. Results indicated that-

- Frequency of usage of different phonological processes was different among the different age groups.
- As the age advanced from 3 to 4 years there was decrease in phonological processes.
- In the age group of 3-3.4 years, there were more number of phonological processes and frequency of usage was also more. More frequently occurring phonological processes were-cluster reduction, epenthesis, stopping of liquids, stopping of

fricatives, nasal assimilation, voicing assimilation, initial consonant deletion, unstressed syllable deletion, final consonant deletion and affrication and Less frequently occurring - gliding, backing, fronting and deaffrication.

- In the age group of 3.5-3.8 years, there was decline in some processes, few yet persisted. Persisting were-cluster reduction, epenthesis, nasal assimilation, voicing assimilation, initial consonant deletion, affrication and deaffrication. Stopping of liquids, stopping of fricatives, unstressed syllable deletion, final consonant deletion, backing and affrication were decreasing.
- In the age group 3.9-4 years, phonological processes cluster reduction, epenthesis and voicing assimilation were frequently occurring. Stopping of liquids, stopping of fricatives, nasal assimilation, initial consonant deletion, unstressed syllable deletion, final consonant deletion and affrication, gliding, backing, fronting and deaffrication were least occurring ones.

Santhosh (2001) studied development of phonological processes in 20 normal Hindi speaking children in the 3-4 years age group. Results indicated that-

- As the age advanced from 3-4 years some phonological processes persisted-cluster reduction, epenthesis and fronting.
- Some decreased in the frequency of occurrence like- stopping, final consonant deletion, weak syllable deletion, affrication, denasalization, deaffrication and final consonant devoicing.

- Some processes like-gliding, metathesis, nasalization, velar assimilation, alveolar assimilation, labial assimilation and coalescence tend to be suppressed in 3.6- 4 years of age.
- Some uncommon processes like-initial consonant deletion, backing were also seen.

Sreedevi, Jayaram and Shilpashree (2005) studied phonological processes in 2-3 year old children Kannada speaking normal children. They were subdivided in two groups (2-2.6 years and 2.7-3 years). Both groups included thirty male and thirty female subjects. 49 simple Kannada words which occur in the utterance of the normal young children were selected for the study. The target word was picturized and the responses were recorded. Results showed that there were 24 phonological processes in the age range of 2-2.6 years and 13 in the age range of 2.6-3 years. Phonological processes, its frequency of occurrence and % of total error are depicted in Tables 8 & 9.

Percentage of phonological processes in 2-2.6 years

Sl.no	Phonological processes	Frequency of Occurrence	% of total error
1.	Retroflex Fronting	14	61
2.	Trill deletion	8	38
3.	Vela Fronting	12	20
4.	Depalatalization	2	17
5.	Affrication	8	15
6.	Stopping	13	13
7.	Trill Substitution	8	13
8.	Lateralization	29	10
9.	Cluster reduction	15	8
10.	Semivowel deletion	7	7
11.	Vowel unrounding	5	7
12.	Dental replacing liquids	19	4
13.	Liquid assimilation	19	4
14.	Vowel raising	5	3
15.	Lateral deletion	11	3
16.	Nasalization	29	3
17.	Nasal deletion	13	3
18.	Initial consonant deletion	13	3
19.	Cluster substitution	15	2
20.	Vowel rounding	10	2
21.	Vowel lowering	10	2
22.	Backing	31	2
23.	Retroflex deletion	14	1
24.	Vowel deletion	15	1

Percentage of phonological processes in 2.6-3 years

Sl.no	Phonological processes	Frequency of occurrence	% of error
1.	Retroflex Fronting	14	43
2.	Trill deletion	8	13
3.	lateralization	8	20
4.	Depalatalization	2	8
5.	Initial consonant deletion	7	7
6.	Affrication	8	6
7.	Liquid assimilation	11	5
8.	Retroflex replacing trill	8	4
9.	Cluster reduction	15	3
10.	Stopping	13	3
11.	Vowel raising	5	3
12.	Vowel rounding	10	3
13.	Nasalization	24	2

Tables 8 & 9: Phonological Processes and its frequency of occurrence.

Rahul (2006) studied phonological processes of 28 typically developing Hindi speaking children in the age range of 2-3 years (2-2.6 years and 2.6-3 years). A list of 70 simple Hindi words which commonly occurred in the utterances of normal young children were selected. Responses were tape recorded and was transcribed by 4 Speech language pathologists and the results indicated presence of 25 phonological processes in the younger group and 20 phonological processes in the higher group. In this study, the percentage of the subjects using a particular process was calculated and not the number of occurrence of each processes. Accordingly less than 20%, 20 to 60 percent and more than 60% of the subjects using the phonological processes are listed in Tables 10 and 11.

2-2.6 years

<20%	20-60%	>60%
<ul style="list-style-type: none"> ▪ Vocalization ▪ Velar Fronting 	<ul style="list-style-type: none"> ▪ Initial vowel deletion ▪ Backing ▪ Vowel lowering ▪ Assimilation ▪ Final consonant deletion ▪ Initial consonant deletion ▪ Nasal substitution ▪ epenthesis 	<ul style="list-style-type: none"> ▪ Retroflex fronting ▪ Affrication ▪ Deaffrication ▪ Denasalization ▪ /h/ deletion ▪ Monothongization ▪ Stopping ▪ Devoicing ▪ Final consonant reduction ▪ vowel shortening ▪ Velar fronting, Initial consonant reduction, l/r substitution, gliding, /r/ deletion

2.6 – 3 years

<ul style="list-style-type: none"> ▪ Velar fronting ▪ Gliding 	<ul style="list-style-type: none"> ▪ Initial consonant reduction ▪ Velar fronting ▪ Vowel shortening ▪ Assimilation ▪ Final consonant deletion ▪ Nasal substitution ▪ epenthesis 	<ul style="list-style-type: none"> ▪ Retroflex fronting ▪ Affrication ▪ Deaffrication ▪ Denasalization ▪ /h/ deletion ▪ Monothongization ▪ Stopping ▪ Devoicing ▪ FCR, ▪ l/r substitution ▪ /r/ deletion
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Tables 10 & 11: Phonological processes in two age groups of subjects in Hindi language.

Sreedevi (2008) studied 8 children in the age range of 1.6-2 years. Results revealed that production of retroflex was difficult i.e. retroflex fronting was present. Trills were deleted and fricatives were substituted by stops and clusters were still in the process of acquisition.

From the above studies on phonological processes, it is evident that phonological processes like cluster reduction, deaffrication, affrication, stopping and liquid gliding were common in the age range of 3-4 years. So it can be concluded that the clusters, fricatives, affricates and liquids were late to be acquired.

From the review of literature it is evident that there is no recent study carried out on the acquisition of speech sounds in Kannada speaking children between the age range of 3-4 years. More recently, researchers have been concerned with the validity of the 'classical' data with respect to modern day living with its earlier and more extensive educational programs and the expanding effects of television on children. In view of the fact that the study on articulatory acquisition in Kannada was conducted more than 30 years back (Tasneem Banu, 1977) and that recent studies focusing on phonological processes have revealed suppression of most of the processes by the age of 3- 4 years, there is an immediate need to study the articulatory acquisition in the present day children to verify this observation. The present investigation was taken up to study the acquisition of Kannada speech sounds in the age range of 3-4 years which is of much relevance in the clinical set up for evaluating children with communication disorders.

CHAPTER III

METHOD

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 speech 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 specific groups of children. These guidelines are important when trying to separate normal from abnormal phonological development and when determining therapy goals.

The aim of the study was to revise the norms for the acquisition of articulatory skills in typically developing native Kannada speaking urban children.

The objectives of the study were-

1. To revise the norms for the Kannada Articulation Test (1972) and to establish the ages at which 75% and 90% of the children produce the phonemes of Kannada correctly.
2. To compare the articulatory skills across age and gender.
3. To compare the difference in the articulatory acquisition of phonemes in the initial and medial positions of the words.
4. To compare the data obtained with that of the earlier reported studies in both English and Kannada.

Subjects: Kannada speaking typically developing urban children in the age range of 3-4 years were selected randomly from different localities in Mysore city as subjects. They were sub divided into two groups with an inter age interval of six months (3-3.6 and 3.6-4 years). Each group comprised a total of 60 subjects including 30 boys and 30 girls. So a total of 120 subjects were considered for the present study. The subjects were selected based on the following criteria:

1. Native speakers of Kannada, being reared in an urban ambient environment of Kannada and belonging to middle socio economic status. The subjects were exposed to some amount of English language also in the kindergarten set up.
2. Parents/teachers report and informal chronological age-level performance on selected speech, language, hearing and developmental tests was used to establish typical development. The Assessment Checklist for Speech and Language skills (Geetha, Rajkumar and Divya, 2006) and Developmental Screening Test (Bharathraj, 1981) were utilized for this purpose.

Test Material: The Diagnostic Kannada Articulation Test by Babu, Ratna and Bettagiri (1972) was used as the test material. (The recording sheet of the test is given in Appendix I). This test comprises of four parts; Part I includes items to test 10 vowels, 2 diphthongs and 22 consonants in Kannada. Part II is similar to Part I but has different words with the same sounds being tested for test-retest reliability. Part III tests 10 clusters and Part IV includes a paragraph for older children. In the present study Part I and Part III were utilized. Vowels and diphthongs were tested only in the initial position. All the

consonants were tested in both initial and medial positions except the phoneme /ʃ/ which was tested only in initial position and phonemes /vʃ/ and /λʃ/ which were tested only in the medial position. Four clusters were tested in the initial position and six in the medial position. The target words were picturized on white cards of 4 x 6" size in color. The picture cards were arranged in order as per the sequence of Kannada alphabets. One target phoneme in one position i.e. either in the initial or medial position was tested with each picture card.

Data Collection Procedure: Each individual subject was brought into a noise free room and seated opposite to the examiner. Once the rapport was established, the examiner presented the target pictures one after another. The subjects were encouraged to name the item in the picture card. The response obtained was audio recorded using Olympus digital recorder WS-100. If any of the subjects failed to identify a target word, additional cues were presented by the examiner. In spite of the additional cues, if the child failed to name the target picture, the child was asked to repeat the target word after the examiner.

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. Correct responses (CR), substitutions (S), indicating the substituted phoneme, omissions (O), distortions (D), additions (A) or any other type of articulatory deviation (Ao) was recorded on the response sheet.

Test –Retest-Reliability: Reliability of the responses was tested by “test retest” method. 10% of the subjects from each age group were selected randomly and tested using the same material on the same day or with in a span of three days.

Data Analysis: The detailed analysis for obtaining the articulatory norms was carried out in the following manner:

1. Identification of the phonemes uttered correctly by each subject in both the positions and a score of “one’ was assigned to each correct item
2. From the scores obtained for the correct articulatory production, mean, standard deviation and range of scores were calculated for each age group and independently for boys and girls in initial and medial positions
3. Identification of phonemes which are produced correctly by 75% and 90% of the subjects in each age group in the initial and medial positions separately. An analysis of the phonemes substituted or distorted in production is discussed in detail.

CHAPTER IV

RESULTS AND DISCUSSION

The purpose of the present study was to re-examine the articulatory norms for the Diagnostic Kannada Articulation test (Babu, Rathna, and Bettagiri, 1972). This test was administered to 120 typically developing children in the age range of 3-4 years. They were divided into 2 age groups (3-3.6 years and 3.6-4 years) with six months age interval. The test was scored individually and the data was statistically treated by obtaining the mean and standard deviation. Two-way ANOVA was carried out to find the significance difference in articulatory scores between the 2 age groups as well as across gender. In general it was found that there was no significant difference in articulatory acquisition scores between the 2 age groups considered as well as across gender.

The results are discussed under the following 5 main headings.

1. Age vs. acquisition.
2. Gender vs. acquisition.
3. Order of acquisition of the sounds.
4. Speech sound acquisition vs. word position.
5. Test-retest reliability.

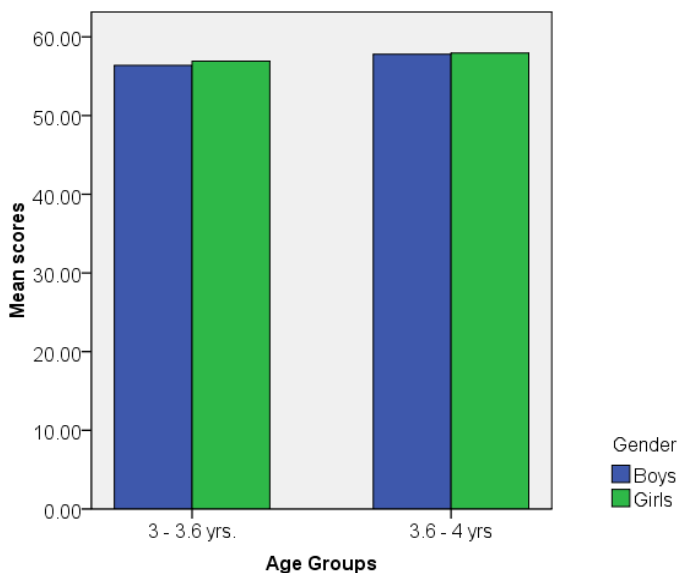
1. Age vs. Articulatory acquisition

Two-way ANOVA was carried out to find the significant difference in articulatory scores between different age groups (3-3.6 years and 3.6-4 years). The results

revealed that there was no significant difference ($p>0.05$) in articulation scores across the two age groups tested. This can be attributed to the acquisition of most of the consonants by the age of 3-3.6 years itself, and the inter group interval considered was broad (6 months). All the vowels, diphthong /ai/ and most of the consonants were acquired by 90% of the children by 3-3.6 years of age. The exceptional consonants were /d/, /r/, and /h/ in both initial and medial positions. Phonemes /r/ and /h/ were not acquired by 90% of the children by 3.6-4 years also. Table 12 and Graph 1 show the mean articulation scores in the two age groups considered in the study.

Gender	Age	Mean	Std. Deviation	N
Boys	3 - 3.6 yrs.	56.3917	4.38340	30
	3.6 - 4 yrs	57.8000	3.36974	30
	Total	57.0958	3.94079	60
Girls	3 - 3.6 yrs.	56.9167	2.96992	30
	3.6 - 4 yrs	57.9500	3.37358	30
	Total	57.4333	3.19390	60
Combined Scores	3 - 3.6 yrs.	56.6542	3.72153	60
	3.6 - 4 yrs	57.8750	3.34382	60

Table 12: Mean articulation scores & SD in different age groups.



Graph 1: Mean articulation scores in different age groups (3-3.6 years and 3.6-4 years) in boys and girls.

The findings of Wellman (1931) Poole (1934) and Templin (1957) indicated that the “phoneme” development correlated with age, that is some sounds are mastered earlier than others. The results of the present study are also in consonance with the above reports. It is evident that with neuromuscular maturity all motor skills increased as the age advanced and so also the articulation skills.

2. Gender vs. Articulatory articulation

Two-way ANOVA revealed no significant difference ($p>0.05$) between boys and girls in terms of articulatory acquisition in both the age groups (shown in Table 12 & Graph 1). Tables 13 and 14 show the development of vowels, diphthongs and consonants in 3-3.6 and 3.6-4 year old Kannada speaking children in boys and girls respectively. Articulatory acquisition in terms of 75% and 90% of acquisition by the children was considered as carried out in the Western studies. In the present study, articulatory development for a particular speech sound was assumed to be completed, if 90% of the children articulated them correctly in the initial and medial positions of the target word.

In accordance with the present study, Roe and Milisen (1942) reported no significant difference between articulatory skills of males and females. Perkins (1977) and Winitz (1969) stated that gender is a minor variable in the development of articulatory skills. Perkins stated the results are conflicting, differences reported are small and they are virtually non-existent in well controlled studies. Perkins (1977) states that, the sex of a child does not appear to be a significantly major factor.

Templin (1963) has suggested that “in articulation development, girls consistently are found to be slightly accelerated... in all instances the differences are relatively small and often are not statistically significant”. In the present study, the difference between boys and girls was not significant and this may be accounted to the equal opportunity in the speech environment for both boys and girls in the present day scenario especially in the urban population.

Boys												
Speech sound	3-3.6 years						3.6-4 years					
	Initial position			Medial position			Initial position			Medial position		
	75%	90%	obtained	75%	90%	obtained	75%	90%	obtained	75%	90%	obtained
a	+	+	100%				+	+	100%			
a ^l	+	+	100%				+	+	100%			
i	+	+	100%				+	+	100%			
i ^l	+	+	100%				+	+	100%			
u	+	+	100%				+	+	100%			
u ^l	+	+	100%				+	+	100%			
e	+	+	100%				+	+	100%			
e ^l	+	+	100%				+	+	100%			
ai	+	+	100%				+	+	100%			
o	+	+	100%				+	+	100%			
o ^l	+	+	100%				+	+	100%			
ou	+	-	86.6%				+	+	90%			
k	+	+	93.3%	+	+	93.3%	+	+	100%	+	+	100%
g	+	+	93.3%	+	+	93.3%	+	+	100%	+	+	100%
tΣ	+	+	86.6%	+	+	83.3%	+	+	96.6%	+	+	100%
dZ	+	+	83.3%	+	+	90%	+	+	93.3%	+	+	100%
t8	+	+	90%	+	+	96.6%	+	+	93.3%	+	+	96.6%
d8	+	+	93.3%	+	+	93.3%	+	+	90%	+	+	90%
n8				+	+	93.3%				+	+	93.3%
t5	+	+	100%	+	+	100%	+	+	100%	+	+	100%
d5	+	+	100%	+	+	100%	+	+	96.6%	+	+	100%
n5	+	+	100%	+	+	100%	+	+	100%	+	+	100%
p	+	+	100%	+	+	100%	+	+	100%	+	+	100%
b	+	+	100%	+	+	100%	+	+	100%	+	+	100%
m	+	+	100%	+	+	100%	+	+	100%	+	+	100%
j	+	+	100%	+	+	100%	+	+	100%	+	+	100%
r	-	-	46.6%	+	-	76.6%	+	-	83.3%	+	+	90%
l	+	+	96.6%	+	+	100%	+	+	100%	+	+	100%
v	+	+	73.3%	+	+	100%	+	+	83.3%	+	+	86.6%
Σ	+	+	96.6%	+	-	86.6%	+	+	100%	+	+	93.3%
s	+	+	93.3%	+	+	93.3%	+	+	100%	+	+	100%
h	-	-	36.6%	-	-	43.3%	-	-	66.6%	-	-	70%
λ8				+	+	100%				+	+	93.3%
st8a	+	-	83.3%	-	-	70%	+	-	80%	-	-	73.3%
sku	+	-	80%				+	-	76.6%			
ski				+	-	86.6%				+	+	96.6%
d5ra				-	-	60%				-	-	60%
rtΣi				-	-	66.6%				+	-	83.3%
kra				-	-	70%				+	+	90%
ks8a				+	-	70%				-	-	73.3%
ble	+	-	76.6%				-	-	73.3%			
skru	-	-	43.3%				-	-	26.6%			

Table 13: Age of articulatory acquisition by 75%, 90% and obtained % of the boys. ‘+’ indicates sound acquired, ‘-’ indicates sound is not acquired. Empty space indicates sound not tested.

Girls					
Speech	3-3.6 years			3.6-4 years	
	Initial position		Medial position	Initial position	

sound	75%	90%	obtained	75%	90%	obtained	75%	90%	obtained	75%	90%	obtained
a	+	+	100%				+	+	100%			
a]	+	+	100%				+	+	100%			
i	+	+	100%				+	+	100%			
i]	+	+	100%				+	+	100%			
u	+	+	100%				+	+	100%			
u]	+	+	100%				+	+	100%			
e	+	+	100%				+	+	100%			
e]	+	+	100%				+	+	100%			
ai	+	+	100%				+	+	100%			
o	+	+	100%				+	+	100%			
o]	+	+	100%				+	+	100%			
ou	+	+	96.6%				+	+	90%			
k	+	+	100%	+	+	100%	+	+	100%	+	+	100%
g	+	+	100%	+	+	100%	+	+	100%	+	+	96.6%
tΣ	+	+	96.6%	+	+	96.6%	+	+	100%	+	+	100%
dZ	+	+	96.6%	+	+	96.6%	+	+	96.6%	+	+	96.6%
t8	+	+	96.6%	+	+	96.6%	+	+	96.6%	+	+	93.3%
d8	+	-	83.3%	+	-	86.6%	+	+	90%	+	+	86.6%
n8				+	+	93.3%				+	+	96.6%
t5	+	+	96.6%	+	+	100%	+	+	96.6%	+	+	100%
d5	+	+	100%	+	+	100%	+	+	100%	+	+	96.6%
n5	+	+	100%	+	+	100%	+	+	100%	+	+	100%
p	+	+	100%	+	+	100%	+	+	100%	+	+	100%
b	+	+	100%	+	+	100%	+	+	100%	+	+	100%
m	+	+	100%	+	+	100%	+	+	100%	+	+	100%
j	+	+	100%	+	+	100%	+	+	100%	+	+	100%
r	-	-	53.3%	+	-	80%	-	-	70%	+	-	80%
l	+	+	100%	+	+	100%	+	+	100%	+	+	100%
v	+	+	90%	+	+	100%	+	+	93.3%	+	+	100%
Σ	+	+	96.6%	+	+	100%	+	+	100%	+	+	100%
s	+	+	96.6%	+	+	100%	+	+	100%	+	+	100%
h	-	-	53.3%	-	-	30%	-	-	66.6%	-	-	43.3%
λ8				+	-	86.6%				+	+	93.3%
st8a	-	-	70%	-	-	63.3%	+	-	80%	-	-	66.6%
sku	+	-	86.6%				-	-	70%			
ski				+	+	100%				+	+	96.6%
d5ra				-	-	46.6%				-	-	60%
rtΣi				-	-	60%				-	-	56.6%
kra				-	-	63.3%				+	-	76.6%
ks8a				+	-	80%				-	-	73.3%
ble	+	-	83.3%				+	-	80%			
skru	-	-	43.3%				-	-	46.6%			

Table 14: Age of articulatory acquisition by 75%, 90% and obtained % of the girls. ‘+’ indicates sound acquired, ‘-’ indicates sound is not acquired. Empty space indicates sound not tested.

3. Order of acquisition of sounds

It was generally observed that all the vowels and most of the consonants except /r/, /h/ /Σ/ /d8/ and /λ8/ were acquired by the age of 3-3.6 years. The results of the present study were compared with the studies of (Templin'57 and Wellman '31 in English and Tasneem Banu'77 in Kannada, Padmaja in Telugu'88 and Usha in Tamil'86) to observe whether the order of acquisition was similar. The comparison between the present study and other studies in English is given in Table 15. Table 16 presents the comparison between the present study and other studies of speech sound acquisition in some of the Indian languages.

Speech sounds	Wellman '31 75%	Poole '34 100%	Templin '57 75%	Sander'72 75%	Prather'75 75%	Arlt'76 75%	Fudala'86 90%		Present study 90%
m	3	3 ½	3	Below 2	2	3	2	2	3-3.6
n	3	4 ½	3	Below 2	2	3	2	2	3-3.6
h	3	3 ½	3	Below 2	2	3	1 ½		-
p	4	3 ½	3	Below 2	2	3	2	3	3-3.6
f	3	5 ½	3	3	2-4	3	2 ½	3	
w	3	3 ½	3	Below 2	2-8	3	1 ½		
b	3	3 ½	4	Below 2	2-8	3	2	3	3-3.6
ŋ		4 ½	3	2	2	3		3	3-3.6
j	4	4 ½	3 ½	3	2-4		3		3-3.6
k	4	4 ½	4	2	2-4	3	2 ½	3	3-3.6
g	4	4 ½	4	2	2-4	3	2 ½	3	3-3.6
l	4	6 ½	6	3	3-4	4	5	5	3-3.6
d	5	4 ½	4	2	2-4	3	2 ½	2 ½	3.6-4
t	5	4 ½	6	2	2-8	3	3	4	3-3.6
s	5	7 ½	4 ½	3	3	4	11	11	3-3.6
r	5	7 ½	4	3	3-4	5	5 ½		-
tʃ	5		4 ½	4	3-8	4	5 ½	5 ½	3-3.6
v	5	6 ½	6	4	4	3 ½	5 ½	5 ½	3-3.6
z	5	7 ½	7	4	4	4	11	11	
ʒ	6	6 ½	7	6	4	4			
θ		7 ½	6	5	4	5	6	6	
dʒ			7	4	4	4	5		3-3.6
ʃ		6 ½	4 ½	4	3-8	4 ½	5 ½	5 ½	3.6-4

Table 15: Shows comparison of the present study with other Western studies. ‘-’ indicates not acquired. Empty space indicates speech sound not tested.

Speech sounds	Tasneem Banu'77 (Kannada) 75%	Usha'86 (Tamil) 75%	Padmaja'88 (Telugu) 75%	Arun Banik'88 (Bengali) 90%	Maya'90 (Malayalam) 75%	Present study'09 (Kannada) 90%
m	3	3	2.6	2.5	3-3.6	3-3.6
n	3	3	2.6	2.5	3-3.6	3-3.6
ŋ				2.5	3-3.6	
p	3	3	2.6	2.5	3-3.6	3-3.6
f			2.9		3-3.6	
h			2.6	3	3-3.6	-
k	3	3	2.6	2.7	3-3.6	3-3.6
b	3	3	2.6	2.5	3-3.6	3-3.6
d	3.6	3	2.6	3	3-3.6	3-3.6
g	3	3	2.6	3	3-3.6	3-3.6
r	4.6		3.9	4	3.7-4	-
s	3	3	3.3		3.6-4	3-3.6
ʃ	5.1	6	3.6	3	5-5.6	3.6-4
tʃ	3.7	3	2.6	3	3-3.6	3-3.6
t		3	2.6	3	3-3.6	3-3.6
v	-	3	2.6		3-3.6	3-3.6
l	3	3	2.6	3	3-3.6	3-3.6
tʰ				3	6-6.6	
zʰ				4		
j	3	3	2.6	3	3-3.6	3-3.6

Table 16: Shows comparison of the present study with that of other Indian studies. ‘-‘ indicates speech sounds not acquired. Empty space indicates speech sound not tested.

On examination of the Tables 15 & 16, at the outset it appears that the age of acquisition of different speech sounds in Indian languages are relatively faster compared to Western studies. However this observation needs to be interpreted with much caution because 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 older reports may not be truly appropriate.

Comparing the present study with that of study by Tasneem Banu (1977) in Kannada language, there are certain discrepancies noticed. She reports that the fricative /ʃ/ was acquired by 75% of children at the age of 5.1 years and in the present study, considering 90% criteria it is acquired by 3.6-4 years among boys and by 3-3.6 years in girls. Another salient observation is that the semivowel /v/ is not acquired by 75% of children even at the age of 6.6 years in the earlier report, where as in the present study it is acquired by 90% of girls and boys by the age of 3-3.6 years.

When comparing the present study with that of other Indian studies, there is no much discrepancy observed. In Tamil /ʒ/ is acquired by the age of 6 years and this late acquisition is attributed to the phonetic system of the language itself as /s/ is a borrowed phoneme (Usha, 1986). Most of the speech sounds of Malayalam language are acquired by the age of 3 years itself (Maya, 1990). In Malayalam, /s/ is acquired by 75% of children by the age of 3.6-4 years and /ʒ/ by the age of 5-5.6 years which is comparatively late compared to the present study (3- 3.6 years). Padmaja's study (1984) in Telugu reveals that most of the speech sounds are acquired by 75% of children by the age of 2.6 years and in Bengali (Arun Banik, 1988) 90% of children had acquired most of the speech sounds by 2.5-3 years of age.

The speech sounds acquired are also discussed separately in terms of Place, Voicing and Manner features.

Place feature

According to place of articulation, un aspirated speech sounds of Kannada language can be classified as bilabials (/p/, /b/, /m/), labiodentals (/v/), dentals (/t5/, /d5/, /n5/), retroflex (/ʈ8/, /ɖ8/, /ʋ8/, /ɭ8/), palatals (/tɕ/, /dʒ/), velars (/k/, /g/) and glottal (/h/) sounds. In the present study, all the bilabials, labiodentals, dentals, palatals, velars and retroflex except /ɖ8/ and /ɭ8/ were acquired by the age 3-3.6 years; glottal /h/ was not acquired even by the age of 4 years.

Voicing feature

In the present study, voiced sounds such as /ɖ8/ and /ɭ8/ were acquired late i.e by the age of 3.6- 4 years considering the 90% criteria. Sounds such as /h/ and /r/ were not acquired by 90% of the children even by the age of 4 years. /r/ was achieved in the medial position by 90% of the boys. Where in /r/ remained not acquired even by 75% of children in the initial position in the older group (3.6-4 years).

Manner of articulation

Vowels and Diphthong: All the vowels and diphthong /ai/ were mastered by 90% of the children by the age of 3-3.6 years. Here there is a great possibility that all the vowels

were achieved by 3 years or soon after 3 years itself. But because of the relatively large age interval (6 months) considered in this study, it is only possible to say vowels were mastered by 3-3.6 years. Diphthong /ou/ was acquired by the age of 3.6-4 years. This is similar to the reports in Western studies.

Plosives: In general, all the stops in this study were acquired by the age of 3-3.6 years. Similar results are reported in Templin's (1957) and Wellman's (1931) studies. However, among the stops, the voiceless retroflex /ʈʂ/ was acquired at an earlier age of 3-3.6 years in the present study when compared to the studies of Templin (1957; 4.6 years) and Wellman (1931; 5 years).

Fricatives: Dental /s/ (initial and medial positions) and palatal /ʃ/ (initial position) was acquired by 90% of the children by the age of 3-3.6 years. Retroflex /ʂ/ (medial position) was acquired by the age of 3.6-4 years by 90% of the girls and 87% of the boys. It is observed that the acquisition of fricatives is much earlier compared to the studies of Templin (1957) at 4.5 years and Tasneem Banu (1977) at 5.1 years. This earlier mastery can be attributed to the better exposure and stimulation available to the present day children.

However, another salient observation was that the glottal fricative /h/ was not mastered by even 75% of the children by 4 years also. This is because in colloquial Kannada, usage of /h/ is minimal. For example, the word /hasu/ (meaning cow), is generally uttered as /asu/ and it is considered as normal production. Earlier also in

Kannada, Tasneen Banu (1977) reports that /h/ is not acquired by 75% of children even by the age of 6.6 years owing to the same reason.

Affricates: There are two affricates in Kannada language /tʃ/ and /dʒ/. It is observed that both the sounds are acquired by 90% of the children by the age of 3-3.6 years, which is much earlier compared to the western studies, as per Sander'72, 4 years, Prather'75, by 3-3.8 years and Fudala'86 , by the age of 5.6 years. On comparison with the other Indian languages, there is no difference found in the acquisition of affricates in Kannada (the present study), Malayalam, Telugu and Bengali, where in it is found to be acquired by the age of 3 years. The previous study in Kannada language by Taseem Banu (1977) indicated that affricates were acquired by the age of 3.7 years and also the percentage considered for the sound to be considered as acquired was 75% where as in the present study it is 90%.

Nasals: In general it was noted that all the nasals were acquired by 3-3.6 years, which is similar to the Western studies.

Laterals: There are two laterals in Kannada language, voiced alveolar lateral /l/ and voiced retroflex lateral /ɭ/. /l/ occurs in initial and medial positions and /ɭ/ occurs only in medial position in Kannada language. /l/ was found to be acquired earlier (3-3.6 years) when compared to English speaking children. In the present investigation, retroflex /ɭ/ was mastered in girls earlier (3- 3.6 years) than boys (3.6- 4 years).

Trills: Voiced alveolar trill /r/ was not mastered till 4 years of age which is relatively late compared to the other phonemes in Kannada. Also the observation was that the percent acquisition of trills was higher in the medial position than in the initial position for both boys and girls. The late mastery is due to the difficulty in production of /r/.

Semivowels: In the present study, /v/ and /j/ were acquired by 3-3.6 years which was much earlier compared to that of Templin's (1957), by 6 years, Wellman's (1931) by 5 years and in Tasneem Banu's (1977) data, it was not acquired till the age of 6.6 years.

Clusters: In the present study, 4 clusters (/st8a/, /sku/, /ble/ and /skru/) were tested in the initial position and other six (/st8a/, /ski/, /d5ra/, /rtΣi/, /kra/ and /ks8a/) were tested in the word medial position. In girls, /ski/ had 90% acquisition, /ks8a/ and /ble/ had 75% acquisition by 3-3.6 years. There were also few unusual observations in this group, i.e. clusters /sku/ and /ks8a/ was found to be acquired by 75% of children in the younger age group (3-3.6 years) and the percentage reduced in the older age group (3.6-4 years), /sku/ (70%), /ks8a/ (73.33%).

Similarly among boys, the clusters /ks8a/ and /ble/ were acquired by the age of 3-3.6 years by 75% of the children and reduced in percentage by 3.6-4 years, /ks8a/ (73.33%) and /ble/ (73.33%). Clusters like /ski/ and /kra/ was acquired by 90% of the boys. The finding that /kra/ and /ski/ are mastered by 90% of the children is in accordance with the study by Curtis & Hardy, 1957 where in /r/ is produced correctly

more often in stop blends than in fricative blends. So stops facilitate correct production of /r/ /s/ and /z/ but only when they precede /r/ and follow /z/ and /s/.

Charts 1 & 2 indicate the manner of speech sound acquisition by 90% of the boys and girls and Charts 3 & 4 indicate the acquisition of clusters by 90% of boys and girls observed in the present study.

- > Indicates sounds acquired by 90% of the children.
- - -> Indicates sounds not acquired by 90% of the children.
-> Indicates sounds acquired in medial position but not in the initial position.
- ◀————> Indicates unusual pattern

Boys		
Manner of articulation	3-3.6 years	3.6-4 years
Vowels		
/a/	—————>	
/a:/	—————>	
/i/	—————>	
/i:/	—————>	
/u/	—————>	
/u:/	—————>	
/e/	—————>	
/e:/	—————>	

/o/		
/o:/		
Diphthongs		
/ai/		
/ou/		
Plosives		
/k/		
/g/		
/tʃ/		
/dʒ/		
/tʃ/		
/dʒ/		
/p/		
/b/		
Affricates		
/tʃ/		
/dʒ/		
Fricatives		
/s/		
/ʃ/		
/h/		
Nasals		
/m/		
/nʃ/		
/nʒ/		
Glides		
/j/		
/v/		
Trills/laterals		
/r/		
/l/		
/lʃ/		

Chart 1: Shows the manner of speech sound acquisition by 90% of boys.

Manner of articulation	Girls	
	3-3.6 years	3.6-4 years
Vowels		
/a/		
/a:/		
/i/		
/i:/		
/u/		
/u:/		
/e/		
/e:/		
/o/		

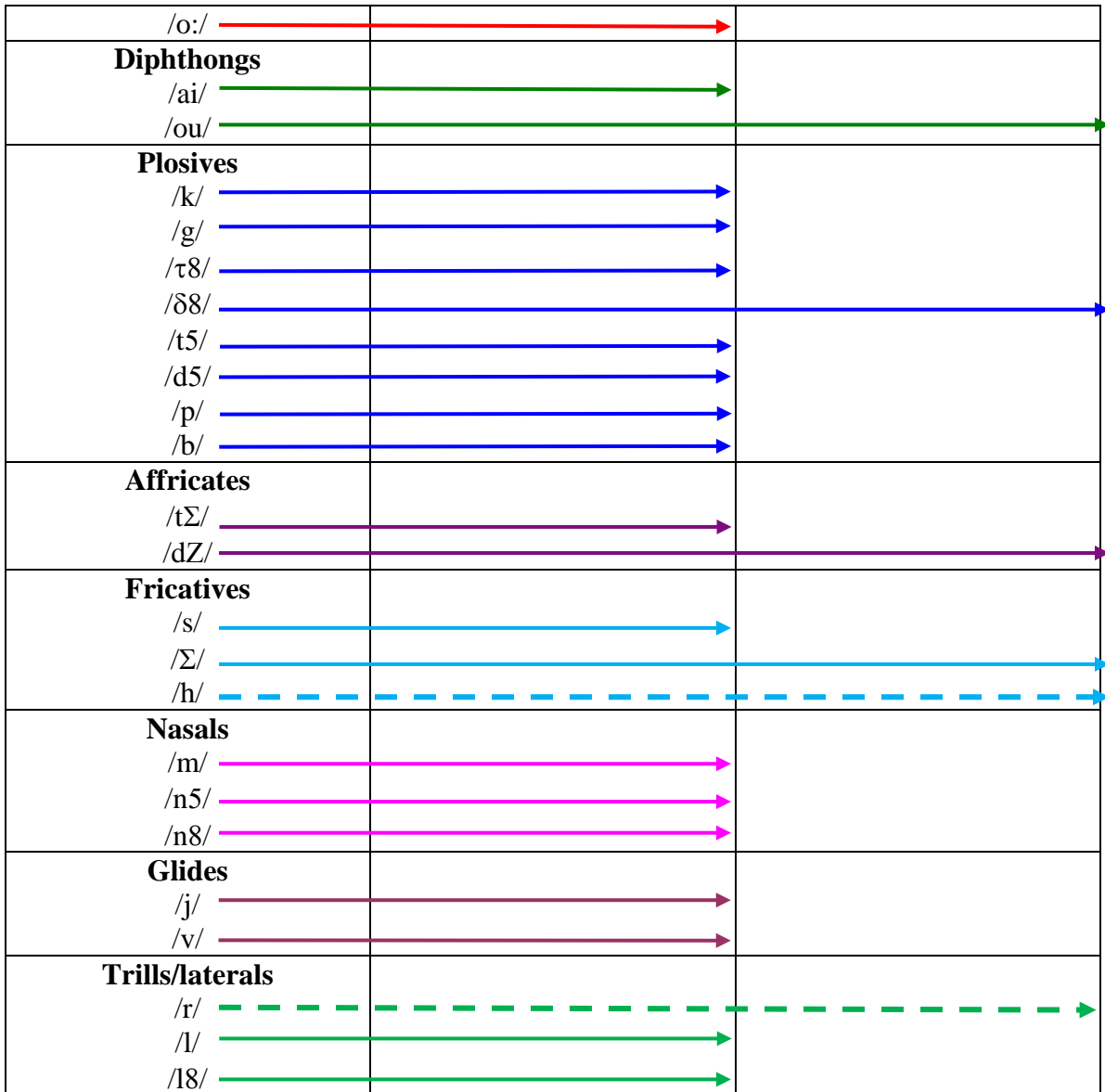
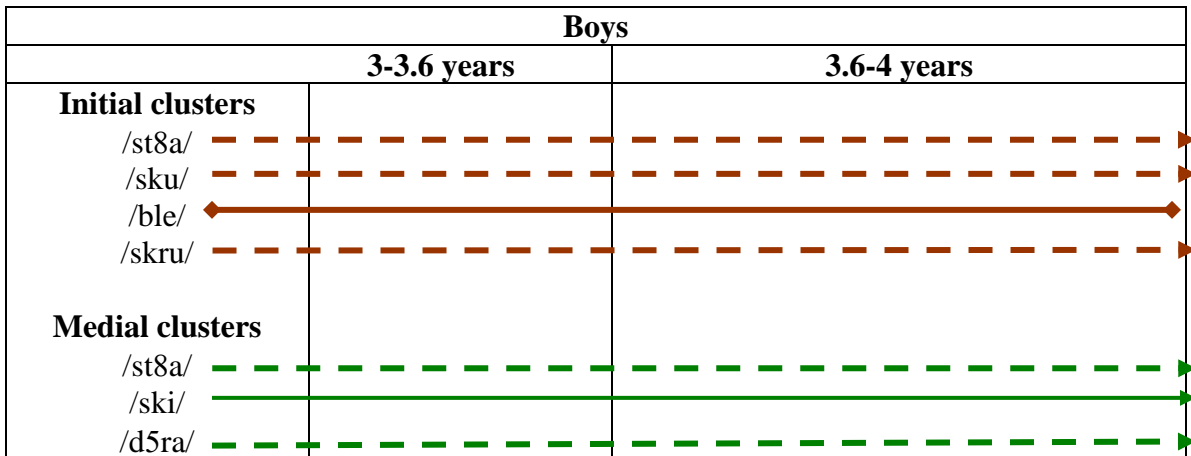


Chart 2: Shows the manner of speech sound acquisition by 90% of girls.



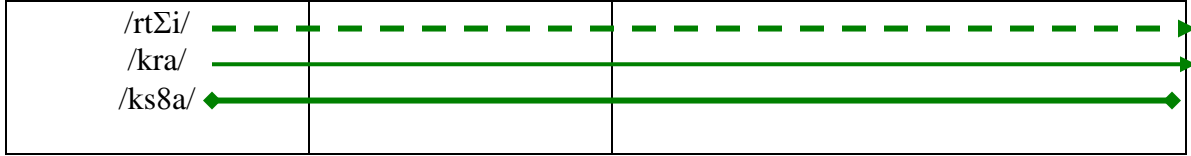


Chart 3: Shows the age of mastery of clusters by 90% of boys.

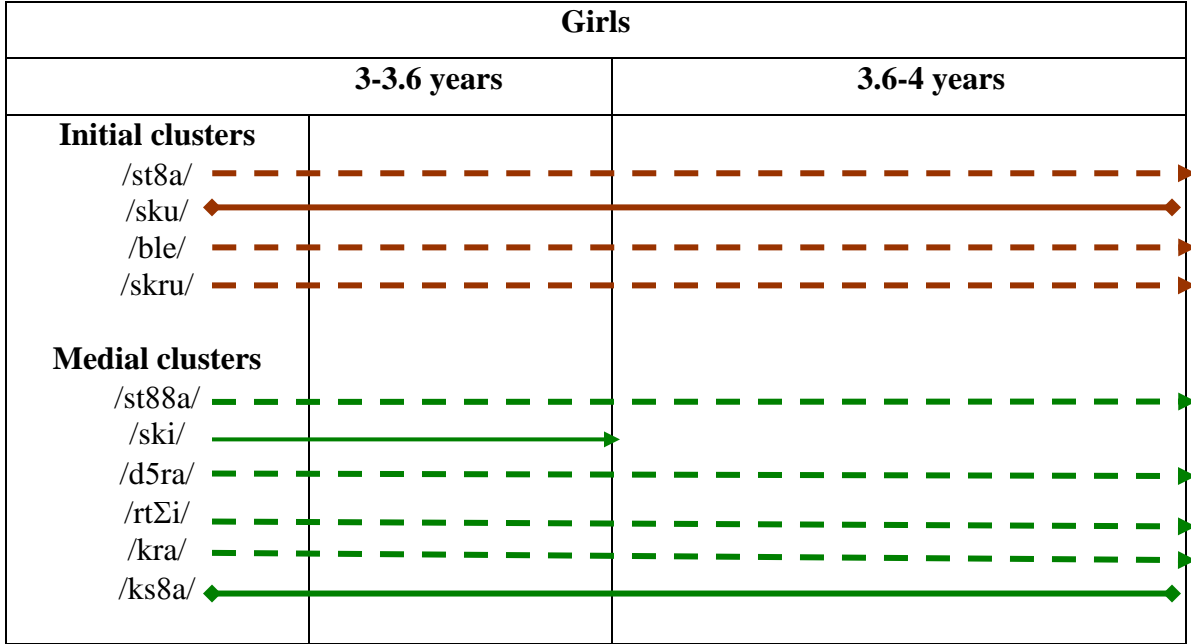


Chart 4: Shows the age of mastery of clusters by 90% of girls.

- ▶ Indicates sounds acquired by 90% of the children.
- ▶ Indicates sounds not acquired by 90% of the children.
-▶ Indicates sounds acquired in medial position but not in the initial position.
- ◀———— Indicates unusual pattern

Based on the scoring obtained from the present study, typically developing Kannada speaking urban children should get a score of **56.39 ± 4.3 (boys)** and **56.91 ± 2.9 (girls)** in the age range of 3-3.6 years. **57.80 ± 3.36 (boys)** and **57.95 ± 3.37 (girls)** in the age range of 3.6-4 years. Maximum score is **62**. Articulation scores expected for typically developing children in the age range of 3-4 years in boys and girls are depicted in the Table 17.

Age	Gender	Scores expected for typically developing children
3-3.6 years	Boys	56.39 ± 4.3
3.6-4 years	Girls	56.91 ± 2.9
3-3.6 years	Boys	57.80 ± 3.36
3.6-4 years	Girls	57.95 ± 3.37

Table 17: Articulation scores expected for typically developing children in the age range of 3-4 years

4. Speech sound acquisition vs. word position

In the present study, boys acquired voiced affricate /dʒ/ earlier in the medial position by the age of 3-3.6 years and later in the initial position. Trill sound /r/ was first acquired in the medial position by 90% of the boys by the age of 4 years and was not acquired by 90% in the initial position even by the age of 4 years. Among girls, there was no such variation present in terms of position however only /r/ was acquired by 75% of girls in word medial position first (3-3.6 years) and less than 75% of children produced it in the initial position. Such positional variations are reported in other studies also.

Templin's (1957) data is apparent that some consonants (/p/, /s/, /θ/) are acquired in all three positions at a single age level, where as others (/t/, /l/, /dʒ/) are acquired first in one or two positions but much later in another position. In general, consonants in final position, particularly voiced stops are shown to be mastered later than consonants in other positions. Studies have suggested that fricatives (Farwell, 1977) and velars (Ingram, 1974) may appear first in final position.

Stoel-Gammon's (1984) study reveals one consistent difference between initial and final position: the phoneme /r/ appeared word finally well before it occurred word

initially. This finding is similar to the present study, where in /r/ appeared earlier in medial position than in the initial position of words.

In the present study, medial clusters (/ski/ and /kra/) were acquired earlier compared to initial clusters. This finding is in accordance with the study by Vani Rupela and Manjula (2006) 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.

5. Test-retest reliability

Reliability of articulations scores were tested by administering the Diagnostic Kannada articulation test on 3 % of the children with in a span of 3 days. Reliability coefficient Alpha was calculated and there was 98% reliability found between the scores of the first and the second test administration. Table 18 shows the mean articulation scores between first and second administration scores.

3-3.6 years		3.6-4 years	
First administration	Second administration	First administration	Second administration
54.50	54.00	60.00	59.50
56.00	56.00	59.50	59.50
56.00	56.00	57.00	55.50
57.50	56.00	60.00	60.00
60.50	61.00	59.50	59.00
60.00	60.00	57.00	56.50

Table 18: Shows the mean articulation scores in the first and second administration of Diagnostic Kannada Articulation Test.

So, from the results obtained, it can be concluded that-

- There is no significant statistical difference in the articulation scores obtained for children in the two age groups considered (3-3.6 years and 3.6-4 years).

- There is also no significant statistical difference in the articulation scores across boys and girls.
- All the vowels and diphthong /ai/ are acquired by the age of 3-3.6 years, diphthong /ou/ is acquired by the age of 3.6-4 years and most of the consonants are acquired by the age of 3.6- 4 years except /r/ and /h/. /r/ was acquired by 90% of the children in medial position but not in the initial position and /h/ was not acquired in both the positions even by the age of 4 years. Among clusters, medial clusters (/ski/ and /d5ra/) are acquired by the age of 3.6-4 years.
- Based on the scoring obtained, typically developing Kannada speaking urban children should get a score of **56.39 ± 4.3 (boys)** and **56.91 ± 2.9 (girls)** in the age range of 3-3.6 years. **57.80 ± 3.36 (boys)** and **57.95 ± 3.37 (girls)** out of a total score of **62** in the age range of 3.6-4 years.
- Reliability of articulation scores was found to be 98% between the first and second administration of the test.

CHAPTER V

SUMMARY AND CONCLUSIONS

The aim of the present investigations was to re-examine the norms for the Kannada Articulation Test (1972) in the age range of 3-4 years and to establish the ages at which 75% and 90% of the children produce the phonemes of Kannada correctly.

The Diagnostic Kannada Articulation test (Babu, Rathna, and Bettagiri, 1972) was administered to 120 children in the age range of 3-4 years. 30 boys and 30 girls from

each sub group (3-3.6 years and 3.6-4years) were selected randomly. Vowels and diphthongs were tested only in the initial position, consonants and clusters were tested in the initial and medial positions. Aspirated sounds were not tested as the test did not contain them. The number of test items amounted to 62. The 62 test items were depicted as colored pictures and only one phoneme was tested with each picture.

The picture cards were presented visually one at a time. Responses were recorded on the response sheet provided. A score of '1' was given to each correct response, a score of $\frac{3}{4}$ for distortion error; a score of $\frac{1}{2}$ for substitution error, and '0' for omission error was allotted. The maximum score that could be obtained was 62. i.e. when all the test phonemes were correctly produced.

The data for each age group was statistically analyzed. Two-way ANOVA was administered at a confidence level 0.05 to obtain the presence of significant difference across age and gender. The results indicated that there was no significant difference between the age groups as well as across gender. The test retest reliability on 10% of the subjects was found to be 98%.

Among boys, all the vowels and diphthong /ai/ were acquired by the age of 3-3.6 years, diphthong /ou/ was acquired by the age of 3.6-4 years and most of the consonants were acquired by 90% of the children by the age of 3.6-4 years. However, /r/ and /h/ were exceptional, in that /r/ was acquired by 90% of the children in medial position and not in

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

Among girls, all the vowels and diphthongs were found to be acquired by 90% of the children by the age of 3-3.6 years. Most of the consonants were acquired by the age of 4 years except /r/ and /h/ in both the positions tested. Among the clusters only /ski/ was acquired.

Another salient feature observed was that, the children in the present study seemed to acquire most of the sounds at a younger age compared to the earlier reports in English and Kannada. The early articulatory acquisition in the present study compared to earlier report by Tasneem Banu'77 may be attributed to the cultural differences or a change in norms, over years because of greater exposure to speech environment.

Future directions

- Younger age groups should be studied on similar lines.
- The articulatory acquisition can be studied with the intergroup interval of 3 months or lesser to obtain a more precise age at which speech sounds are acquired.
- More number of clusters should be considered.
- The effect of multilingualism on articulation scores can be studied.

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9	ai	aid5u	✓						1										
10	o	ond5u	✓						1										
11	o	o _l le	✓						1										
12	ou	ouΣad5Ha	✓						1										
13	k	kannad8ak a	✓						1										
14	k									pust5aka	✓								1
15	g	gad8ija _l ra	✓						1										
16	g									mu _l gu	✓								1
17	tΣ	tΣamatΣa	✓						1										
18	tΣ									ba _l tΣan8ige	✓								1
19	dZ	dZad8e	✓						1										
20	dZ									su _l dZi	✓								1
21	t8	t8o _l pi	✓						1										
22	t8									kit8aki	✓								1
23	d8	d8abbi	✓						1										
24	d8									bled8u	✓								1
25	n8								1	gin8i	✓								1
26	t5	t5akkad8i	✓						1										
27	t5									ko _l t5i	✓								1
28	d5	d5a _l limbe	✓						1										
29	d5									kud5ure	✓								1
30	n5	n5a _l ji	✓						1										
31	n5									kannad8i	✓								1
32	p	pennu	✓						1										
33	p									tΣappali	✓								1
34	b	ba _l gilu	✓						1										
35	b									ombat5t5u	✓								1
36	m	mu _l ru	✓						1										
37	m									emme	✓								1
38	j	jama	✓						1										
39	j									rupa _l ji	✓								1
40	r	re _l d8ijo							½										
41	r									ka _l ru		lu							½
42	l	la _l ri	✓						1										
43	l									ka _l lu	✓								1
44	v	vima _l na				✓			0										
45	v									ba _l vut8a	✓								1
46	Σ	Σartu	✓						1										
47	Σ									braΣ	✓								1
48	s	su _l rja	✓						1										
49	s									bassu	✓								1

50	h	hat5t5u			√				0								
51	h								simha			√					0
52	l8								kol8i	√							1
53	st8a	st8a mpu	√														1
54	st8a								po st8aba k su			√					0
55	sku	sku t8ar	√														1
56	ski								biskit5t5u	√							1
57	d5r a								tand5ra	√							1
58	rtΣi								kurtΣi	√							1
59	kra								tΣakra	√							1
60	ks8 a								a t8oriks8a	√							1
61	ble	ble d8u	√														1
62	skr	skru			√												0

Correct responses (CR-score 1), substitutions (S-score 1/2) indicating the substituted phoneme in the respective block, omissions (O- score 0), distortions (D-score 3/4), additions (A- score 0) any other type of articulatory deviation (Ao).

This subject obtained a Total score of 56/62.

Appendix-II: Normative data for acquisition of sounds in Kannada for boys obtained in the present study.

Boys												
Speech sound	3-3.6 years						3.6-4 years					
	Initial position			Medial position			Initial position			Medial position		
	75%	90%	obtained	75%	90%	obtained	75%	90%	obtained	75%	90%	obtained
a	+	+	100%				+	+	100%			
a	+	+	100%				+	+	100%			
i	+	+	100%				+	+	100%			
i	+	+	100%				+	+	100%			
u	+	+	100%				+	+	100%			
u	+	+	100%				+	+	100%			
e	+	+	100%				+	+	100%			
e	+	+	100%				+	+	100%			
ai	+	+	100%				+	+	100%			
o	+	+	100%				+	+	100%			
o	+	+	100%				+	+	100%			
ou	+	-	86.6%				+	+	90%			
k	+	+	93.3%	+	+	93.3%	+	+	100%	+	+	100%
g	+	+	93.3%	+	+	93.3%	+	+	100%	+	+	100%
tΣ	+	+	86.6%	+	+	83.3%	+	+	96.6%	+	+	100%
dZ	+	+	83.3%	+	+	90%	+	+	93.3%	+	+	100%
t8	+	+	90%	+	+	96.6%	+	+	93.3%	+	+	96.6%
d8	+	+	93.3%	+	+	93.3%	+	+	90%	+	+	90%
n8				+	+	93.3%				+	+	93.3%
t5	+	+	100%	+	+	100%	+	+	100%	+	+	100%
d5	+	+	100%	+	+	100%	+	+	96.6%	+	+	100%
n5	+	+	100%	+	+	100%	+	+	100%	+	+	100%

p	+	+	100%	+	+	100%	+	+	100%	+	+	100%
b	+	+	100%	+	+	100%	+	+	100%	+	+	100%
m	+	+	100%	+	+	100%	+	+	100%	+	+	100%
j	+	+	100%	+	+	100%	+	+	100%	+	+	100%
r	-	-	46.6%	+	-	76.6%	+	-	83.3%	+	+	90%
l	+	+	96.6%	+	+	100%	+	+	100%	+	+	100%
v	+	+	73.3%	+	+	100%	+	+	83.3%	+	+	86.6%
Σ	+	+	96.6%	+	-	86.6%	+	+	100%	+	+	93.3%
s	+	+	93.3%	+	+	93.3%	+	+	100%	+	+	100%
h	-	-	36.6%	-	-	43.3%	-	-	66.6%	-	-	70%
λ8				+	+	100%				+	+	93.3%
st8a	+	-	83.3%	-	-	70%	+	-	80%	-	-	73.3%
sku	+	-	80%				+	-	76.6%			
ski				+	-	86.6%				+	+	96.6%
d5ra				-	-	60%				-	-	60%
rtΣi				-	-	66.6%				+	-	83.3%
kra				-	-	70%				+	+	90%
ks8a				+	-	70%				-	-	73.3%
ble	+	-	76.6%				-	-	73.3%			
skru	-	-	43.3%				-	-	26.6%			

Appendix-III: Normative data for acquisition of sounds in Kannada for girls obtained in the present study.

Girls												
Speech sound	3-3.6 years						3.6-4 years					
	Initial position			Medial position			Initial position			Medial position		
	75%	90%	obtained	75%	90%	obtained	75%	90%	obtained	75%	90%	obtained
a	+	+	100%				+	+	100%			
a	+	+	100%				+	+	100%			
i	+	+	100%				+	+	100%			
i	+	+	100%				+	+	100%			
u	+	+	100%				+	+	100%			
u	+	+	100%				+	+	100%			
e	+	+	100%				+	+	100%			
e	+	+	100%				+	+	100%			
ai	+	+	100%				+	+	100%			
o	+	+	100%				+	+	100%			
o	+	+	100%				+	+	100%			
ou	+	+	96.6%				+	+	90%			
k	+	+	100%	+	+	100%	+	+	100%	+	+	100%
g	+	+	100%	+	+	100%	+	+	100%	+	+	96.6%
tΣ	+	+	96.6%	+	+	96.6%	+	+	100%	+	+	100%
dZ	+	+	96.6%	+	+	96.6%	+	+	96.6%	+	+	96.6%
t8	+	+	96.6%	+	+	96.6%	+	+	96.6%	+	+	93.3%
d8	+	-	83.3%	+	-	86.6%	+	+	90%	+	+	86.6%
n8				+	+	93.3%				+	+	96.6%
t5	+	+	96.6%	+	+	100%	+	+	96.6%	+	+	100%
d5	+	+	100%	+	+	100%	+	+	100%	+	+	96.6%
n5	+	+	100%	+	+	100%	+	+	100%	+	+	100%
p	+	+	100%	+	+	100%	+	+	100%	+	+	100%
b	+	+	100%	+	+	100%	+	+	100%	+	+	100%
m	+	+	100%	+	+	100%	+	+	100%	+	+	100%
j	+	+	100%	+	+	100%	+	+	100%	+	+	100%

r	-	-	53.3%	+	-	80%	-	-	70%	+	-	80%
l	+	+	100%	+	+	100%	+	+	100%	+	+	100%
v	+	+	90%	+	+	100%	+	+	93.3%	+	+	100%
Σ	+	+	96.6%	+	+	100%	+	+	100%	+	+	100%
s	+	+	96.6%	+	+	100%	+	+	100%	+	+	100%
h	-	-	53.3%	-	-	30%	-	-	66.6%	-	-	43.3%
λ8				+	-	86.6%				+	+	93.3%
st8a	-	-	70%	-	-	63.3%	+	-	80%	-	-	66.6%
sku	+	-	86.6%				-	-	70%			

Age	Gender	Scores expected for typically developing children
3-3.6 years	Boys	56.39 ± 4.3
3.6-4 years	Girls	56.91 ± 2.9

ski				+	+	100%				+	+	96.6%
d5ra				-	-	46.6%				-	-	60%
rtΣi				-	-	60%				-	-	56.6%
kra				-	-	63.3%				+	-	76.6%
ks8a				+	-	80%				-	-	73.3%
ble	+	-	83.3%				+	-	80%			
skru	-	-	43.3%				-	-	46.6%			

Appendix-IV: Articulation scores expected for typically developing Kannada speaking children in the age range of 3-4 years.

3-3.6 years	Boys	57.80 ± 3.36
3.6-4 years	Girls	57.95 ± 3.37

Maximum Score: 62