Early phonetic repertoire and syllable structure in typically developing Kannada speaking children: 18-24 months

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"The power of God is with you at all times; through the activities of mind, senses, breathing and emotions; and is constantly doing all the work using you as a mere instrument."

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CHAPTER 1

INTRODUCTION

From the first smiles, gurgles, and coos to learning to say "amma" or "appa," babies love to communicate with their own form of baby talk. To a parent, this might be the most exciting thing about language acquisition and this promptly makes an entry into the 'milestones scrapbook'. The phonetic and the phonotactic abilities of the child that allow him/her to verbalise his first words are the result of complex motor, cognitive and linguistic processes that begins in infancy and continues through the early school years.

Preliminary studies of child language took the form of parental diaries. Some of the acclaimed work includes that of Preyer (1889), Grégoire (1937), Velten (1943) and Leopold's four-volume work (1939–1947). These works were mostly qualitative in nature and often focussed more than just language, because not much was known about children's behaviour in general. Diary studies focus on the development of one or two children; they are not very meticulous, and do not provide norms for acquisition. Gradually, with the advent of behaviourism, researchers became interested in systematic measurements of language development, and in norms for acquisition, which resulted in large sample studies such as those of Templin (1957), where 430 subjects participated. In the late 1970s and early 1980s, research concentrated on the study of speech skills that serve as prerequisite for production of first words. Since then the conception that early vocal behaviours are unimportant to the subsequent production of meaningful words was done away with.

The unique vocal productions of infants are separated into two general categories: reflexive vocalisations which are automatic responses that convey the physical state of the infant, including crying, coughing, burping and hiccupping: and non reflexive vocalisations which include voluntary productions such as cooing, babbling and playful screaming and yelling. (Oller, 1980)

As the child progresses from the stage of babbling to the production of meaningful speech, he moves from pre linguistic to linguistic phonological stage. The progression is gradual and does not have discrete boundaries. There is an overlap of a few weeks to several months in the use of babbled and meaningful productions. Children may even alternate between babbled and meaningful utterances (Branigan, 1977).

The linguistic phase commences when the first meaningful word is uttered. Owens (2001) defined the first word as an entity of relatively stable form that is consistently produced by the child in a particular context and is recognisably related to the adult like word form of a particular language. Children frequently use "invented words" (Locke, 1983) in a consistent manner thereby demonstrating that they seem to have meaning for the child. These vocalizations are called *proto words* (Menn, 1978), *phonetically consistent forms (PCF)* (Dore, 1976), *vocables* (Fergusson, 1976) and *quasi words* (Stoel Gammon and Cooper, 1984).

Followed by PCFs, comes the *first fifty word stage.* This stage covers the time from the first meaningful utterance at approximately 1 year of age to the time when the child begins to put two 'words' together at approximately 18 to 24 months. Some authors believe that the child learns word units as a whole, rather than learning individual speech sounds. Cruttenden (1979) identified two stages in early phonological development. Based on his ideas children learn words as wholes during item learning stage and in the system learning stage children begin to analyze their word productions and apply phonemic principles to their productions.

Children's pronunciation in the first 50 word stage appears to be constrained by their physiology, ambient language and child specific factors (Vihman, 1992). There is a lot of individual and phonetic variability during this stage (Grunwell, 1982). First words typically consist of one or sometimes two syllables and are of the following shapes; CV, VC, CVCV. Consonants produced at the front of the mouth predominate (eg. /p, b, t, d, m, n/) (Robb & Bleile, 1994). Final consonants are typically omitted or followed by a vowel.

A phonetic inventory comprises of all the sounds that are produced by the child irrespective of whether the sounds are correct as compared to the adult model. Children's phonetic inventories reflect the range of individual variability expected in development. The greatest clinical value of a phonetic inventory investigation is that it provides information on the number and types of consonants in phonetic inventories of children in the second and the third year of life (Dyson, 1988).

Need for the study

The prevalence of speech sound disorders range from 2% to 24.6% in the age range of 5 to 8 years, with greater prevalence leaning towards the younger age group (Law, Boyle, Harris, Harkness & Nye, 2000; Shriberg, Tomblin & Mc Sweeny, 1999). Existing literature on early phonological development is primarily in English and other Asian languages such as Chinese and Arabic. Studies in Indian languages are limited especially in the early 1-2 year age period where the development of the phonological system is substantial. The present study aims to overcome this shortcoming and understand the speech sound development in the early phonological acquisition period. The findings of the study can be used as a frame of reference while assessing the clinical population of communication disorders at a very early age itself.

Aim of the study

To investigate the nature of phonetic inventory and syllable structures in typically developing Kannada speaking children in the age range of 18-24 months.

Objectives of the study

- To obtain the phonetic repertoire in terms of vowels and consonants in Kananda
- To obtain various syllable structures and word shapes
- To examine the preferential combination of vowels and consonants
- To analyze the emergence of consonantal clusters
- To study the existence and frequency of protowords and holophrastic words
- To compare the above mentioned measures across age groups and gender
- To make a cross linguistic comparison of early phonological aspects with reported studies in Indian languages and other languages of the world

Brief method of the study

Participants: Twelve typically developing Kannada speaking children in the age range of 18-24 months who are native speakers of Kannada were considered for the study. The children were divided into two groups with an age interval of 3 months that is, 18-21months and 21-24 months. Each group included 6 toddlers with an equal representation for males and females. The subjects were identified from immunization centres, neighbouring homes, hospitals and paediatric clinics in Mysore city of Karnataka. Participant selection criteria were:

- Were from native Mysore Kannada dialect speaking families
- Should not have any history of medical, speech, language, hearing, cognitive or any other motor difficulties. The participants were selected after a parental interview and an informal assessment of age appropriate skills based on the High Risk Register checklist developed by the Dept. of POCD, AIISH, Mysore.
- Should belong to middle socio-economic class.

Data recording Procedure: The data was recorded in the individual child's home in the presence of the mother/caretaker. Audio and video recordings of each child were obtained individually using a high quality digital audio and video recorder (Sony Full HD 1080 Handycam). A standard set of toys expected to be familiar to young children was used. (Venkatesan, 2011). However, other toys or objects which are of interest to the child were used during the recording. Mother or any other familiar adult was made to interact with the child to elicit speech sample. Speech stimulation strategies such as modelling, imitation, prompting etc were employed when necessary. In case of less than 75 utterances produced by the child, another consecutive recording was carried out to obtain a minimum of another fifty verbal utterances from the participant.

Implications of the Study

- This study will facilitate better understanding of early phonological acquisition in Kannada.
- The normative data will assist Speech Language Pathologists in making appropriate diagnostic and therapeutic decisions in this population considering the fact that in the recent years, there has been an increased professional

emphasis on the provision of Speech Language Pathology services to even infants as young as one year of age.

- The data obtained will facilitate cross linguistic comparison of early phonological development across Indian and other global languages.

Limitations

- A sample of approximately only 75 utterances from each participant was considered for the phonological analysis
- Due to methodological difficulties involved in the study, only 12 toddlers were considered
- Although longitudinal studies can provide more specific information about the course of phonological development of an individual child or a group of children, it could not be adopted in the present study due to time constraints.

A brief note on Kannada language

Kannada is a Dravidian language spoken by more than 20 million people in and around Karnataka State in South India. Like most other Dravidian languages, the phonological system contains a number of significant contrasts that are not found in English. The most conspicuous differences are the existence of retroflex consonants and the contrasts between short and long vowels. Spoken Kannada tends to eliminate the aspirated consonants and the sibilant contrasts to some extent; but in many dialects it exhibits consonants such as /f/ and /z/ and vowels such as /æ/ and /ɔ/ (primarily in Urdu or English loan words such as /fizu/ for 'fees'; /bænku/ for 'bank' and /lɔjar/ for 'lawyer' (Schiffman, 1979).

Vowel sounds: There are five long and five short vowel phonemes in Kannada. Diphthongs /ai/ and /au/ also occur, but may be considered to consist of *a+y* and *a+v* respectively. In addition /æ/ and /ɔ/ may occur in foreign loan words. The vowels are as follows:

Table 1
Vowel classification according to tongue height and tongue advancement

		Front	**Central**	**Back**
High	Short	I		u
	Long	i:		u:
Mid	Short	E		o
	Long	e:, æ		o: ɔ
Low	Short		a	
	Long		a:	

Consonants: Kannada has a native Dravidian inventory of consonants, with a superimposed system of aspirated consonants and supplementary sibilants borrowed from Indo Aryan, and with /f/ and /z/ borrowed from Urdu and reinforced by borrowed words from English. In spoken Kannada, these borrowed phonemes tend to be replaced by similar 'native' phonemes (e.g., /f/ may be replaced by /ph/ or /p/, /z/ by /dz/ or /s/, aspirates by non aspirates etc) (Schiffman, 1979).

The consonants of spoken Kannada are as follows:

Table 2

Stops and Nasals in Kannada Language

	Voiceless (stops)		**Voiced (stops)**		**Nasals**
	unaspirated	aspirated	unaspirated	aspirated	Nasal
Velar	k	Kh	g	gh	Ŋ
Palatal	c	Ch	j	jh	ñ
Retroflex	T	Th	D	Dh	N
Dental	t	Th	d	dh	N
labial	p	Ph	b	bh	M

Table 3

Glides, Sibilants, Fricatives, Laterals and Continuants in Kannada Language

	Glides	**Sibilants**		**Fricatives**	**Laterals**	**Continuants**
	(voiced)	**(voiceless)**	**(voiced)**	**(voiceless)**	**(voiced)**	**(voiced)**
Pharyngeal				h		
Retroflex		S			L	
Apico-palatal	y	sh				
Alveolar		s	z		l	r
Labial	v			f		

CHAPTER 2

REVIEW OF LITERATURE

From the time children are born, they vocalise. As the infant grows, the primary reflexive crying behaviour gradually makes way for babbling and words. This development goes hand in hand with the important anatomical structures and their development and this development serves as prerequisite for sound production. Both the structure and the function of respiratory, phonatory, resonatory and articulatory mechanisms must advance unfalteringly before any regular articulatory processes can occur. These important changes which continue through early childhood are directly mirrored in the transformation from prelinguistic to linguistic sound productions. Bosma (1975), Kent (1997) and Kent and Murray (1982) present a broad outline of the development of the respiratory, phonatory, resonatory and articulatory systems during this time span.

The size, shape and composition of the respiratory system are considerably modified from infancy to adulthood. Newborns and infants are perfectly able to accumulate enough air pressure against a closed glottis to vocalise loudly. Though small when compared to adults, their lungs are proportionally large for their body structure. They have fairly good amount of sub glottal pressure and continues to be so throughout their childhood. Moreover, very few alveoli are present in the lungs of the newborn. At 7 years of age, the number of alveoli reaches the adult value (Kent, 1997). It is also at this time that the child's respiratory function demonstrates adult like patterns. At 10 years of age, there is a refinement of respiratory patterns and functional maturation is achieved. Rest breathing rate is 17-22 breaths/min. During 12-18 years, there is further increase in lung capacity especially in boys.

There are impressive changes in the phonatory and the resonatory systems as well. This anatomic-physiological development is necessary for their future secondary physiological function for articulatory purposes. In newborns, larynx and vocal tract serve just primary functions and are not able to fulfil any articulatory tasks. For example, the oral cavity (with tongue and lips) and the pharyngeal cavity are utilised primarily for sucking and swallowing actions. The tongue fills out the oral cavity entirely such that there is no space for the buccal area, the space between the outside of the gums and the inside of the cheeks. And encapsulated structure called the 'sucking pad' which facilitates the sucking action helps to fill out this space entirely. Thus, the production of speech sounds is highly constrained under such conditions. The ability to produce speech sounds is a highly complex process that depends on many anatomical-physiological changes that occur as a consequence of growth and maturation.

After the child acquires fifty words, around the first birthday, the speech mechanism undergoes further enlargement and changes in form. The laryngeal framework too undergoes a plethora of changes as a product of growth and maturation and the changes are summed up as follows:

1. The thyroid cartilage enlarges more than the cricoid cartilage
2. The epiglottis too enlarges and becomes more firm
3. The arytenoid cartilages which were relatively large in the early stages of this development, now changes little in size as they adapt structurally and functionally to the other laryngeal structures.

4. The vocal and ventricular folds lengthen. As a result, only some portion of the vocal fold length is stabilized by the arytenoid's vocal process and most of the vocal fold's muscular portion is now freed for normal vocal cord vibrations.

Skeletal enlargement of the skull and laryngeal areas during childhood occurs mostly in posterior and vertical dimensions. This provides more room for the velum and thus there is more mobility. However, the oral area is the site of the utmost changes in spatial arrangement and resulting mobility of the anatomical structures. Due to these skeletal changes, the tongue no longer completely crams the mouth. Moreover, the tongue and the lips become elongated and acquire further mobility. The refinement and coordination of the lip, mandible, tongue and velar movements for regular voice and speech production are now increasingly acquired.

As children's body structures develop as described above, this vocalisation paves way to intelligible speech and their perception and production systems become more sophisticated and in sync with their native language. By the end of this developmental process, children acquire adult like production of vowels, consonants syllable structures and prosody (including tones). There are 4 phases of speech acquisition (Bleile, 2004):

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

During the first year, the child produces sounds, first reflexively then more purposively. During this period, children cry, coo and babble and by the end of this time they utter their first words. During phase 2, children's communicative focus shifts from words to speech. During this period, they have a limited vocabulary with simplified phonological structure. Gradually they enter phase 3 (2 to 5 years) wherein they produce a vast array of speech sounds and syllable shapes as well as grammatical and syntactical structures. Ultimately, they transit to phase 4 whereby they master the finer nuances of speech production such as sophistication of timing, prosody and precise production of polysyllabic words and consonantal clusters.

2.1 Developmental summaries of early speech production

Infants enter the world being able to vocalise through crying. Gradually, their repertoire of sounds increases. Two developmental summaries are elucidated below:

(A) Stark's typology of Infant Phonations: The *Stark Assessment of Early vocal Development-Revised* is based on work by Stark and colleagues (Nathani, Ertmer and Stark, 2006) and this typology includes five levels of infant vocalizations.

1. *Reflexive (0 to 2 months):* Vegetative sounds, sustained crying/ fussing, quasi resonant nuclei.
2. *Control of phonation (1 to 4 months :* fully resonant nuclei (F), two or more Fs, closants (consonant like segments, raspberry, click, isolated consonants), vocants (vowel like segments), closant vowel combinations, chuckles or sustained laughter.
3. *Expansion (3 to 8 months) :* isolated vowels, two or more vowels in a row, vowel glide, ingressive sounds, squeals, marginal babbling
4. *Basic canonic syllables (5 to 10 months):* Single consonant-vowel syllable, canonical babbling, whispered productions, a consonant-vowel combination followed by a consonant-(CV-C), disyllables (CVCV)

5. *Advanced forms (9 to 18 months):* Complex syllables (e.g., VC, CCV, CCVC), jargon and diphthongs.

(B) Ingram *(*1989*)* posited six stages of phonological development that match up with Piaget's stages of cognitive and linguistic development. The first three stages which are described below are of relevance to the current study.

Stage 1: Pre linguistic (0:1 to 1:0 years)

Stages 1 and 2 of phonological development occur during Piaget's first cognitive stage, i.e. the *sensorimotor period* (birth to 18 months of age). It is at this time that children investigate objects and explore their properties and features, develop preverbal vocalizations (babbling) and perceptual skills and begin to express verbally through simplified speech. During the end of this period, speech like vocalizations or babbling predominates.

Stage 2: First Words (1:0- 1:6 years)

Meaningful speech production emerges and the child eventually has a repertoire of 50 words. Syllable shapes are mostly CV, CVC and CVCV. Stops, nasals and glides are the most commonly produced consonants. The words seem more like whole word units rather than those comprising of individual phonemes or sounds.

Stage 3: Phonemic development (1:6-4:0 years)

Piaget's cognitive stage 2, *the period of concrete operations* (1.5. to 4 years of age) is marked with the advent of symbolic representations, symbolic play and the concepts of past and future. During this stage of cognitive development, production of single morphemes is on the rise. During phonological stage 3, word productions which were earlier whole word units now consist of phonemes. The inventory of speech sound expands. The number of different sound classes, phonemes and syllable structure increases, phonological patterns become more complex as consonant clusters and multisyllabic words get added to the speech inventory. During this linguistic stage, the child gradually ceases applying some phonological processes (Ingram, 1989).

2.2 Babbling and speech

Babbling dominates infant vocalisations during the later phases of the prelinguistic stage. It serves as a transition between early vocalisations and meaningful speech. Children's babble comprises of a series of consonants and vowels. There have been contrasting opinions regarding the contribution by babbling to children's speech acquisition. Contradicting to Roman Jakobson's discontinuity hypothesis (1968) that there is no relation between babbling and early speech forms, recent literature has shown continuity between the two (e.g., Vihman, Ferguson, & Elbert, 1986; Vihman, Macken, Miller, & Simmons, 1985). Output patterns continue to persist in output patterns of first word. Locke (1983) investigated three studies of consonant production involving a total of 131 English-learning infants at the age of 0;11–1;0. In terms of median percentages, high relative frequencies were observed for [h] (21%), coronal stops (22%), labial stops (18%), dorsal stops (14%), labial and coronal nasals (9%) and glides (20%). Fricatives, affricates and liquids were extremely rare. He reported that these same set of consonants were used most often in early word production Mid and low front and central vowels [ɛ], [e], [a], [æ], [ə], [ʌ] are most often reported in both transcription studies (Kent & Bauer,1985; Davis & MacNeilage, 1990; Stoel-Gammon, 1990) and acoustical studies (Bickley, 1983; Buhr, 1983; Kent & Murray, 1982). Most frequent syllable types are consonant vowel (CV) syllables either occurring alone or in series.

Davis and Mac Neilage (1990), proposed “Frames, then Content” to describe the spatio-temporal and bio-mechanical characteristics of babbling and early speech. In a transcription-based case study of a child between 14 and 20 months old, they found co-occurrence patterns between consonants and vowels to be maintained during a period in which the subject developed from 25 to 750 words. Consonant-vowel co-occurrences were found for alveolar consonants with front vowels, labial consonants with central vowels, and dorsal consonants with back vowels.

2.3 Transition from babbling to speech

Vihman and Greenlee (1987) have suggested two different learning styles for children learning to speak. Vihman and Greenlee (1987) conducted a comprehensive longitudinal study comparing the speech development of 10 typically developing children between 8 and 17 months, and then examined them again at age 3. They reported wide individual variation particularly for specific segment substitutions and cluster reductions. The authors opined that there were two different learning styles that were evident in their children at one year and remained until three years of age. Children with learning Style1 were described as having word oriented, having intelligibility, a segmental emphasis and consistent pronunciation across word tokens. In contrast, children with learning Style 2 were described as intonation oriented, having low intelligibility, a suprasegmental emphasis and variable pronunciation across word tokens.

A standard view of the period between onset of canonical babbling and first word use is of an initial stage of reduplicated babbling, consisting of sequences of identical CV syllables, followed by variegated babbling in which different segments occur in successive syllables (Elbers, 1982; Oller, 1980, 1986; Roug, Landberg, & Lundberg, 1989; Stark, 1980). On the other hand, Smith, Brown-Sweeney, and Stoel-

Gammon (1989) and Mitchell and Kent (1990) found no clear separation between use of reduplicated and variegated babbling in subjects before first words. These studies considered consonant series in multisyllabic utterances. These results suggested that the entire babbling period may be similar to the period of first words in containing both reduplicated and variegated forms.

Research focussing on consonant/vowel characteristics within and between syllables has been instrumental in confirming that early speech patterns are similar to babbling patterns. There is also proof that these similar consonant-vowel co-occurrences preferred by infants in babbling and first words are seen in several languages. This also applies for syllable shapes (the open syllable CV is considered as the only common syllable type in languages) and for consonants (stops and nasals are frequent in languages) (Maddieson, 1984). However there have been contradictions to these CV occurrence trend as cited by other studies. (Boysson-Bardies, 1993; Oller & Steffans, 1993; 1996; Vihman, 1992). Boysson-Bardies (1993) observed a labial central association in French, Swedish and Yoruba as opposed to English speaking infants where there was a labial front association

According to the studies by Vihman, (1996); Vihman and Velleman, (1989, 2000), Vihman, Velleman and McCune, (1994); Velleman and Vihman, (2002); Vihman & Kunnari, (2006); the child’s ability to approximate adult word targets, shows non-linear development or regression and considerable individual differences. Vihman and Velleman (2000) suggested that the first words, which are relatively accurate and which also closely resemble the repertoire of babbling patterns of the individual child, should be seen as the product of the child’s inherent matching of his/her own production patterns to roughly similar input word forms mediated by the articulatory filter (de Paolis, 2006), resulting in the selection of words to say on the basis of their phonetic accessibility (Ferguson & Farwell, 1975). This articulatory filter 'selectively enhances motoric recall of phonetically accessible words' (Vihman, 1996). Vihman (2005) explained children's emerging consonant production skill on word learning on the basis of a concept called 'vocal motor schemes' (VMS). These are generalized articulatory plans indexed by children's ability to consistently produce a given consonant over a period of time. It has been found that children who master one or more VMS earlier start to learn words earlier, and that these words are largely based on VMS consonants.

The dominant child patterns of the early word production period are seen as responses to challenges posed by adult target words, primarily, the challenge of producing distinct consonants or distinct vowels, or both, in different syllables or different word positions. New words which foray into the child's productive lexicon are not the result of mechanical extension of previously used phonetic structures (Vihman & Velleman, 2000). Instead, individual children must arrive at their own solutions to the mismatch between their phonetic skills and the challenges presented by the native language. Children's use of well-practised vocal patterns to produce words which, in their adult target form, are only broadly similar to the pattern can be conceptualized as child depends on 'word templates'. The patterns which were first based on the child's experience of an implicit match between an existing ('in repertoire') vocal form and closely similar adult targets (i.e. on the operation of an 'articulatory filter') later tend to be applied to word targets which provide no direct phonetic motivation for the pattern.

The major milestone which is a sign of transition to speech is the appearance of protowords. When children transit from the babbling stage to adult like word use, they produce a variety of vocalisations which fall in varying continuum of the utterance being a true word. (Vihman & Miller, 1988). Children frequently use 'invented words' (Locke, 1983) consistently such that they seem to have meaning for the child. These vocalisations used regularly without an evident adult model are called protoword, (Menn, 1978), phonetically consistent forms (Dore et al, 1976), vocables (Ferguson, 1976), sensorimotor morphemes (Carter, 1974) and quasi words (Stoel-Gammon and Cooper, 1984). These sound or sound combinations function as words for the infant even when they are not based on the adult model. This is why they do not qualify as 'true words'. However, they cannot be considered as babbling either because they have some phonetic and semantic consistency (Stoel Gammon & Dunn, 1985). Ferguson (1978) described protowords as 'babbling-like sounds used meaningfully'.

Protowords frequently co-occur with specific context and are often accompany a consistent gesture. These vocal productions have been often considered a link between babbling and adult like speech. Researchers have reported four phonetic forms that are frequently used in protowords: (1) single or repeated vowels (2) syllabic nasals (3) syllabic fricatives (4) single or repeated consonant vowel syllables in which the consonant is a nasal or a stop. (Ferguson, 1978, Halliday, 1975). Ferguson stated that children develop 12 vocables as they transit from babbling to the use of adult based words.

2.4 Literature on development of vowels and consonants

Prior to 1980s, research on vowel acquisition was limited to very few studies. This was because vowels are particularly difficult to transcribe accurately and thus, difficult to characterise. However, presently considerable data is available in this regard. Stoel-Gammon and Herrington (1990) organized the existing data on vowel development into three stages of accuracy of production. The first stage consists of early mastery of [i, u, o, ɑ, ə]. Two features of this early stage are that the corner vowels [i, u, ɑ] are represented and with the exception of [ʌ], mainly tense vowels are produced. The second stage of acquisition includes [æ, ʊ, ɔ, ə], which, combined with the first stage vowels, reflects mastery of the four corner vowels and the entire range of back vowels. Acoustic studies have also been carried out with an attempt to appreciate the development of vowels. A pioneering study by Buhr (1980) aimed at investigating vocal production of an infant from age 16 weeks to 64 weeks. Perceptual and acoustic analyses were performed to identify the sounds that resembled the vowel sounds in English. Formant frequency measurements were made from broad band and narrow band spectrograms. Significant longitudinal trends for individual vowel sounds were not obvious during this period, although formant relationships for some vowels after 38 weeks were consistent with the notion of restructuring of the infant's vocal tract. However, analysis of F1/F2 plots over time revealed the emergence of a well developed vowel triangle, resembling that of older children and adults.

Selby, Robb and Gilbert (2000), in their longitudinal study of normal vowel articulation, collected data from four children at 15, 18, 21, 24 and 36 months of age. Glossable and non glossable production forms were analysed to form an inventory of vowel types. At the 15 months of age, the children produced primarily lax vowels [ʊ, ʌ, æ]. By 18 months of age, tense vowels were evident and corner vowels [i, u, ɑ, æ] were present. At 21 months of age, the children's inventories had doubled in size (eight types) relative to that found during 15 months (4 types). By 24 months of age, the eight cardinal vowels were being produced [i, e, ɛ, æ, ɑ, ɔ, o, u]. By 36 months of age, the children were able to articulate the majority of American English vowels.

Literature on vowel development suggests that the vowels of a language are acquired early, both in production and perception. The acquisition of vowels by typically developing children has always received increasing attention in the past decade. The ambient language has a major influence on acquisition of vowel qualities. Lee, Davis & MacNeilage (2010).et al. (2010) compared vowel patterns of Korean and English-learning infants with the patterns of their ambient languages, and emphasized the particular influence of infant-directed speech. It was suggested that vowels may have apparent ambient language patterns in infant production earlier than consonants owing to their higher amplitude and greater duration.

Analysis of vocalizations by five infants aged 1;1 showed that central and front vowels [ʌ, ə, ɛ, æ] are produced most often in V (monophthongs), VV (diphthongs) and CV (vowels with an initial consonant) syllables (Kent & Bauer, 1985). In addition to these three vowels, [ɑ] is often produced in CV syllables. These authors concluded that central and front vowels are produced more often than back vowels, and low vowels are produced more often than high vowels. A study by Otomo and Stoel-Gammon (1992) described the acquisition of American English /i, ɪ, e, ɛ, æ, a/ vowels by six normally developing children at 1; 10; 2; 2 and 2; 6 years of age. The vowels /i/ and /a/ were mastered early; /ɪ/ and /ɛ/ were the least accurate throughout the study. Variability reduced as the subjects matured. Some context specific vowel substitution patterns were observed as well.

The most extensive information about sounds that can be expected to occur in early phonetic inventories is available on children learning English. An early study by Winitz and Irwin (1973) looked at words, word approximations and `self language' words produced by 93 children between 13 and 18 months of age. Labials, especially [b], were more frequent than consonants produced at other places of articulation. Labials were followed by alveolars in frequency, with [d] being the most frequent sound. Together, labials and alveolars constituted 80% of the total occurrence of consonants. Back consonants were not commonly used by the youngest children, but their use increased slightly in the 15- to 18-month-old groups. Kent & Bauer (1985) also found that bilabial and apical consonants occurred most often in the consonants produced by infants aged 1;1 in various utterance patterns (e.g. CV, VCV and CVCV).

As far as manner of articulation is concerned, Irwin (1947b) showed that frequency of occurrence of [h] and [ʔ] eventually decreased as stops and nasals emerged. Stops, nasals and fricatives dominate in consonants produced by infants aged 1;1 (Kent & Bauer, 1985). Among these, stops represent almost three fourths of the total consonant production in the major syllabic pattern (CV). Prevocalic consonants (in CV) tend to be frontal stops, postvocalic consonants (or consonantal endings) and intervocalic consonants tend to be continuants (fricatives, nasals in VC, and fricatives, glides and liquids in VCV) (Kent & Bauer, 1985). The distribution of consonants in terms of place, manner and voicing suggests that the voiced bilabial and apical stops [b, d] are the most frequent prevocalic consonants in English-learning infants' vocalizations (Kent & Bauer, 1985). The developmental trend for English speaking infants is as follows:

1. Labials and dentals are seen more often than velars
2. Stops and nasals predominate as compared to fricatives, liquids or glides.

Ingram (1981) reported that 15 children (17-26 months) produced stops at three places of articulation, the fricative [h], one nasal and one glide. Stoel-Gammon (1985; 1987) observed children in the same age range and found that at 15 months; only word-initial [b], [d] and [h] were common in their inventories. By age 18 months, three additional consonants, two nasals and a glide, occurred word initially and one, [t], occurred word finally. She summarized the performance of children at 24 months (Stoel-Gammon, 1987, 1994) as including 9-10 different word-initial consonants at three different places of articulation and from four manner categories (stop, nasal, fricative and glide). The children also produced 5-6 different word-final consonants: stops at three places of articulation, a nasal, a fricative and often a liquid.

One characteristic of English inventories before the age of 24 months is the lack of balance between initial and final consonants; there are consistently more different prevocalic consonants than postvocalic. In addition, palatal consonants, final voiced stops and fricatives are typically missing. Dyson (1988) examined the speech of two slightly older groups of children (N=20) on two occasions to determine if they would `fill in the gaps' with these missing consonants between the ages of 24 and 39 months. She found that although the number of word-initial consonants remained relatively constant at 14-15, the number of final consonants increased from 11 to 14 months. In fact, the inequality between positions appeared to be disappearing. Palatals, especially [j], [ʃ], [tʃ], and final fricatives did begin to appear or to increase in frequency, but final voiced stops were still rare even in the oldest children. The only non-English consonants observed with any frequency were [ts] and [ʔ] despite the use of narrow transcription and particular attention to their occurrence. Non-English phonotactic rules were observed, however, especially in the production and creation of consonant cluster combinations (e.g. /ɹɑk/ → [bwɑk]).

Paschall (1983) each reported the consonants observed in the spontaneous speech of 20 children, 16-18 months and 21-24 months of age, respectively. At 18 months of age, nine consonants-stops in two places of articulation, two nasals, both liquids and [s] - made up 82.5% of the consonants produced, whereas at 24 months, the same nine consonants plus the velar stops constituted 84.2% of the total inventory.

Robb and Bleile (1994) examined seven children's consonant productions in a longitudinal study. Data were collected at monthly intervals between the ages of 8 and 25 months. All glossable and non glossable utterances were analysed to determine the number and types of consonants occurring in the children's syllable-initial and syllable-final inventories, and the relative frequency of occurrence of the major manner and place sound classes. During 8-16 months period, it was observed that the syllable initial consonants were mostly voiced consonants. Oral stops occurred most frequently. With regard to place of articulation, syllable initial position comprised of bilabial, alveolars and glottal consonants were present. By 17-25 months of age, there were approximately 10 consonants. Voiced consonants still dominated despite the presence of voiceless consonants. There was a great variety of consonants within oral and nasal consonants. There was a modest increase in the number of fricatives. Velar consonants which were of present earlier became more common. Looking into the syllable final inventories, at 8-16 months of age, there were approximately two consonants. At the syllable final position, most of the consonants were voiceless, voiced consonants were usually nasals. Oral and nasal stops predominated. Presence of fricatives was miniscule. Alveolars and glottals followed by bilabials were the places of articulation during this early age period. At 17-25 months, there approximately 5 consonants present in the syllable final position. Voiceless consonants continued to dominate although voiced consonants became more common. Nasals, oral stops and fricatives dominated. Among the places of articulation, bilabials, alveolars, velars, and glottals were prominent. Table 1 depicts the number of syllable initial and syllable final consonants present in the subjects.

Tfocari-Eecen, Reily and Eadie (2007) analysed over 1700 children and reported that by age 1;0, children had an average of 4.4 consonants in their inventories (median=4, range=0-16) and typically these were /m, d, b, n/. Table 4 depicts the summary of studies of English speaking children's consonant inventories:

Table 4
Consonant inventories of English speaking children

	Robb & Bleile (1994)	**Robb & Bleile (1994)**	**Tofari-Eecen et al (2007)**
Age	**No on syllable initial consonants**	**No on syllable final consonants**	**Total number of consonants**
0;8	5	3	-
0;9	5	2	-
0;10	6	4	-
0;11	4	2	-
1;0	5	2	4.4
1;1	6	2	-
1;2	10	2	-
1;3	6	2	-
1;4	6	2	-
1;5	9	3	-
1;6	6	3	-
1;7	11	6	-
1;8	10	5	-
1;9	9	4	-
1;10	11	3	-
1;11	12	5	-
2;0	10	4	-
2;1	15	11	-

As per Table 4, at 8 months of age, the children produced 5 syllable-initial consonants (typically /d, t, k, m, / and 3 syllable-final consonants (typically /t, m, h/). By age 2; 1, children could produce 15 syllable-initial consonants and 11 syllable-final consonants.

Phoneme classes and syllable structures: Research governing the developmental aspects of phoneme classes and syllable structures generally fall into two types of analyses: independent and relational analyses.

Relational Analyses: Several studies have compared child production of words to adult target using phonological process analysis. This kind of analysis is called relational analysis. A study by McIntosh and Dodd (2008) on 62 two year old children showed that, in their phonetic repertoire, some fricatives, all affricates and /r/ were missing. They also exhibited cluster reduction, final consonant deletion, stopping, fronting, weak syllable deletion, gliding and deaffrication.

Independent Analyses

An independent analysis takes into account, only the client's productions; they are not compared to the adult norm model. Some researchers who have investigated syllable and word shapes reported that the first structures to emerge are CV and reduplicated CVCV, followed by CVC. Next consonant clusters and unreduplicated multisyllables emerge, with the first bisyllables being a combination of monosyllables already used, such as CVCV and CVCVC (Pollock, 1988). By the age of 2 years, children begin to use VC word structures.

In a study by Stoel Gammon (1987) all 33 of the 2-year-old subjects used CV structures in their spontaneous speech, 97% used CVC, 79% used CVCV and 67% used CVCVC. In addition to that, more than half of the two year olds produced consonant clusters (58% of the children used consonantal clusters in the initial position, 30% in the medial position and 48% in the final position). In a longitudinal study of these same children (followed from 15-24 months of age) Stoel Gammon (1985) investigated their phonetic repertoires and found that:

- Stops, nasals and glides occurred earlier than fricatives and liquids
- Anterior sounds preceded posterior sounds.
- Early inventories in initial position were composed primarily of voiced anterior stops, nasals, and glides; by 24 months, voiceless stops, velars, and a few fricatives were also included. In final position, inventories consisted primarily of voiceless stops and alveolar consonants.
- /t/ and /r/ occurred first in final position.

In a review investigating phonology in 2 year olds by McLeod and Bleile (2003), the phonemes missing usually include /ŋ , v, z, ʃ, ʒ θ tʃ, ð , r, l/. The error patterns noted as characteristic of 2-year-old phonology were: cluster reduction, fronting of velars and fricatives, stopping of fricatives and affricates, gliding, context sensitive voicing and final consonant deletion. Quite complex syllable structures and polysyllabic words are reported by a number of researchers (e.g., CCVCCC in monosyllables and CCVC in polysyllables, Watson & Skukanec, 1997). Around 30% of clusters are produced although they may not be accurate (e.g., [fwi] three). Vowels are reported to be rarely in error.

Word shapes and consonant cluster usage was investigated by Dyson (1988) in a quasi-longitudinal study. There was no consistent pattern in the emergence of consonantal clusters because different subjects used different clusters, however, all children used at least 4 different clusters with /fw/ being the most frequently occurring clusters. The following were the developments reported in the study on 2 to 3 year olds

- Word initial and word-final inventories become more balanced in the number of segments used

- Voiced stops emerge word finally
- The word final fricative /s/ is used; and /v/, /z/, and /sh/ begin to emerge
- Voiceless fricatives begin to appear in both word positions
- A broad variety of consonant clusters appears word initially and word finally
- Most words are monosyllables, but two syllabic words of various types make up more than 10% of the samples.

Watson and Skukanec (1997) profiled changes in the phonological skills of 12 children between the ages of 24 months and 36 months. Conversational samples obtained from the subjects at 3-month intervals were analysed for phonetic content, prevalent error patterns, syllable shapes and consonants clusters produced. Analysis of word initial phonetic inventories revealed, at the age of 2;0 years stops and nasals were primarily produced in addition to the fricatives /s/ and /h/ and glides /w/ and /j/. At the age of 2;3, most subjects began to produce the fricative /f/ and liquid /l/ in the initial position of words. The palatal /tʃ/ emerged at 2;6 years. By the age 3;0 years, the word initial inventories increased with the addition of the fricative /ð/ and the liquid /r/. Word-final phonetic inventories revealed the presence of voiceless stops, nasals, /m/ and /n/ and fricatives /s/ and /z/ at the age of 2;0 years. Most subjects were able to produce the plosive /g/ and liquid /l/ word-finally at age 2;6. Velar nasal /ɱ/ emerged at 2; 9. Consonant clusters emerged at the age of 2;6 years. CV, VC, CVC, CCVC, CVCC, CVCV, VCV and CC(C)VCC were the eight syllable shapes that were present in the children. A salient observation was that the production of CV gradually decreased as the children matured. Reductions in the use of CVCV and VCV were also observed though not significant. As the subjects aged, frequency of occurrence of CVC, CCVC and CVCC words increased.

2.5 Children's first fifty words

Children's pronunciations in the first 50 word stage are influenced by their physiology, native language and child specific factors (Vihman, 1992).There is a lot of individual and phonetic variability observed during this phase (Grunwell, 1981). First words typically consist of one or two syllable shapes: CV, VC, CVCV. Consonants produced at the front of the mouth predominate, for e.g., /p. b, t, d, m, n/ (Robb & Bleile, 1994). Final consonants are usually omitted of followed by a vowel. Young children also produce a limited inventory of vowels. Donegan (2002) reported that children prefer low, non-rounded vowels during their first year and produce height differences in vowels before they produced front and back vowels.

First word is usually defined as an entity of relatively stable form that is produced consistently by the child in a particular context and is recognisably related to the adult like word form of a particular language (Owens, 1996). During this early stage of true word production, children typically use single syllables or fully or partially reduplicated words. Closed syllables occur but are less common. This pattern of syllable shapes was also observed in later stages of babbling. Speech sound production is mainly predominated by stops, nasals and/or glides. Fricatives occur much less frequently. Thus as described, from this data one can infer that the phonetic repertoire and syllable structure of true words overlap with that of the late babbling period.

The fifty word stage begins at approximately 18-24 months of age. This phase includes the time frame that begins with the first meaningful utterance till the production of two words together. It is supposed that the phonological development is heavily influenced by the individual words which the child learns. Studies have revealed that children learn words that contain a particular set of sounds and not by learning sounds which are used to make up words. Ingram (1976) called this a presystematic stage in which contrastive words rather than contrastive phones are learnt. This presystematic stage is somewhat similar to Cruttenden's (1981) item learning and system learning stages of early phonologic development. In item learning, the child acquires words as whole words. Later, during the system learning stage, child acquires phonotactic rules of the ambient language to produce meaningful words. The early portion of the item learning stage is known as the holophrastic word, the span of time during which the child uses one word to convey an entire concept. Also, the link between the object, its meaning and the discrete sound segments used to represent the object is not firmly established. According to Piaget (1952), the child is still in the sensorimotor period during this phase and has not yet acquired imitative ability or object permanence. Sounds and meanings constantly change.

2.6 Cross linguistic studies on early phonetic inventory

Inventory descriptions for children acquiring languages other than English are not numerous, but they have increased in number in recent years (Locke, 1983; Ingram, 1989; Vihman, 1996). Some reports have emphasized language universals, whereas others have emphasized individual or language-specific differences. Nevertheless, very few descriptions of Chinese, Arabic-speaking children at this early level could be found. One such study by Amayreh and Dyson (2000) dealt with studying characteristics of phonetic inventories of 13 Arabic-speaking children between the ages of 14-24 months. The samples were analysed to determine the consonant inventories of these children in four word positions (Syllable Initial Word Initial (SIWI), Syllable Initial Within Word (SIWW), Syllable Final Within Word (SFWW) and Syllable Final Word Final (SFWF), as well as the frequencies of occurrence and rank order of consonants, consonants that were `preferred' by some children, and the frequency of occurrence of vowels in the samples. In order to mark the phoneme in the inventory in any of the four positions, the authors believed that a consonant had to be used in at least two lexical items in that position. 100 meaningful and non meaningful utterances of each child were considered in order to study the above mentioned parameters. Results revealed that unlike in English where three stops at two places of articulation [b], [d], [t], the bilabial nasal [m], one glide [w] and the glottal fricative [h] were predominant in word initial consonant inventory, children in this study used /l/ and /j/ commonly. On the other hand, /k/ was common in all the studies of English, but not in the phonetic inventories of Arabic. This difference was attributed to the effect of the ambient language on the phonetic inventories of the young children. Thus in SIWI, [ʔ] was the most frequently occurring consonant, followed by [t], [d], and [b]. [k] was the least frequent. In SFWW, [ʔ] was still the most frequent followed by [t], [h] and [b]. [ʧ], [ʤ] and [ŋ] were the least common. In SIWW, the first rank for commonly occurring consonant went to [d], followed by [l], [t] and [ʔ] [. The last rank went to [q]. In SFWF position, most commonly occurring consonant was [t], followed by [j], [ʔ], [ħ]. The least common was [ð] [β] and [ʒ]. Only [t] and [ʔ] were the most preferred consonants by children. Among the vowels, short vowels were more frequent than their long counterparts. Over 50% of the occurrences were made up of the long and short vowels [a:] and [a].

Hua and Dodd (2000) investigated phonological acquisition of 129 monolingual Putonghua speaking children, aged 1;6 years to 4;0 years. Putonghua (Modern Standard Chinese) syllables have four possible elements: tone, syllable-initial consonant, vowel, and syllable-final consonant. Samples analysed revealed that Putonghua-speaking children acquired these elements in the following order:

tones were acquired first; then syllable-final consonants and vowels; and syllable-initial consonants were acquired last. Phonetic acquisition of the 21 syllable-initial consonants was complete by 3; 6 for 75% of children. By 4; 6 the children were using the syllable-initial consonants correctly on two thirds of occasions (with the exception of four affricates). Simple vowels appeared early in development, by 1.6-2.0 years of age. However, triphthongs and diphthongs were prone to systematic errors. Tone errors were infrequent. Children acquired nasals before orals, and stops before fricatives. However, front consonants (/p/, /p^h/, /m/ and /f/) were acquired at about the same stage as back consonants (/k/, /k^h/, /x/ and /ŋ/. The three alveolo-palatal sounds, which are very rare in the world major languages, were acquired relatively early (75% of children by 2;6). The last 10 phonemes to be acquired in Putonghua include all three retroflex sounds, six affricates and both liquids.

Kern and Davis (2000) compared the developmental trajectory of speech production capacities in 20 typically developing monolingual children acquiring French, Romanian, Dutch and Tunisian Arabic respectively from the babbling period to the emergence of early grammar. They aimed at investigating the universal features and ambient language effects exhibited by the children. The authors prepared a uniform analysis profile on large corpora for each language and put forth certain predictions regarding common vocalisation tendencies which were confirmed. Stop and nasal manner of articulation and coronal and labial place of articulation occurred with a strong preference for vowels in the lower left vowel space. Common patterns of co-occurrences (labial consonants with central vowels, coronal consonants with front vowel and dorsal consonants with back vowels) were seen in all the languages except Dutch.

Texeira and Davis (2002) compared sound patterns in the speech of two Brazilian-Portuguese (followed from acquisition of first words through 36 months of age) speaking children with early production patterns in English-learning children. Analysis was done in two time period, 0;12 years- 0;23 years (equivalent to the first-word and early two-word periods) and 0;24–0;36 (as the sound system expanded in complexity). On the whole, it was observed that coronal was the most strongly represented place (52%), followed by labial (27%). The least frequently occurring consonant place was dorsal. These developmental patterns were quite stable throughout the two age periods studied for both these children. With respect to various manners of articulation, oral plosives represent 46% of all consonant occurrences in the entire corpus. Fricatives (16%), nasal plosives (14%) and glides (13%) were also relatively frequent. Liquids occurred sparingly. With regard to vowel development, central vowels predominated for both children across stages (42%), followed by front vowels (35%) and back vowels (23%). CV syllable type was the most preferred syllable type. Bisyllables were the most preferred word shape, followed by monosyllables and polysyllables.

2.7 Variables influencing speech sound development

A number of individual and social factors affect speech sound development, some of them being gender, socio-economic status (SES), sibling status, intelligence, personality, cognitive style and parenting (Wells, 1985). Girls are generally thought to perform better than boys in verbal and linguistic functions (McCormack and Knighton, 1996). A study by McCormack and Knighton (1996) revealed that 2.5-year-old girls had more accurate phonological output than boys. Hyde and Linn (1988), after conducting a meta-analysis of over 170 studies, reported that they found that gender accounted for approximately only 1% of the variance in language acquisition. The only exception was in the area of speech production, where females were observed to perform better than males. Moore (1967) studied the language development of children during their first 8 years where measures of intelligence and linguistic development were taken longitudinally. A higher speech quotient of the girls was reported at the age of 18 months

Interaction between gender and age in speech and language development has also been found, although studies disagree on when gender-related differences begin. Wellman et al. (1931) observed that 3- and 4-year-old girls achieved statistically significant better consonant accuracy scores than boys of the same age yet no significant difference between 5- and 6-year-old girls and boys. However, Poole (1934) argued that boys and girls developed their phonological skills at the same rate from 2;6 to 5;6 years. After 5;6, girls showed a more rapid growth than boys and therefore completed the acquisition 1 year earlier than boys. In a more recent study, Smit et al. (1990) found that although girls appeared to acquire sounds at somewhat earlier ages than boys, this effect reached statistical significance only in the 4;0, 4;6 and 6;0 year age groups, and not in every preschool age group.

2.8 Acquisition of consonant clusters

Information about normally developing 2- to 3-year olds' consonant clusters mainly comes from independent analyses, where children's consonant clusters are described without reference to adult targets (e.g., Dyson, 1988; Stoel-Gammon, 1987.) A study by McLeod, van Doorn and Reed (2001) reviewed ten trends through which children acquire clusters. They are as follows:

1. Children aged 2 years can produce consonant clusters but they may not be necessarily of the same form as their native language

2. Words that have clusters in the final position are acquired first as compared to those in word initial position. Children's production of word final consonant clusters is increased by the emergence of grammatical morphemes (e.g., plurals and past tense) and consequently the creation of morphophonological consonant clusters (e.g., [-ts] as in *cats.*
3. Two-element consonant clusters are generally produced and mastered earlier than three-element clusters (Smit et al., 1990; Templin, 1957). This phenomenon may in part be due to the increased phonotactic complexity of combining three elements.
4. Consonant clusters containing stops (e.g., /pl/, /kw/) are acquired generally before consonant clusters containing fricatives (e.g., /st/, /θr/)
5. Young children typically delete one element of a consonant cluster (cluster reduction). This phenomenon can be explained for the perspectives of markedness and sonority
6. Homonymy occurs in young children's attempts to produce consonant clusters (McLeod, van Doorn, & Reed, 1998). Homonymy frequently occurs as a result of cluster reduction (e.g., [bɛd] is produced for both *bread* and *bed*); however, homonyms can also occur as a result of cluster creation . For e.g., [snaɪl] is produced for both *snail* and *nail.* (McLeod et al., 1998).
7. There are a number of other non-adult realizations of consonant clusters apart from cluster reduction such as epenthesis and coalescence. Metathesis is infrequent
8. The acquisition of consonant clusters is gradual, and there is a typical developmental sequence. It is not an all-or-nothing process. For word-initial clusters, children may initially delete a member of a consonant cluster (one

element realization), then preserve the members but produce one in a non-adult manner (two element realization), and finally produce the consonant cluster correctly (correct realization) (Greenlee, 1974).

9. There is an interrelationship between cluster reduction, cluster simplification, and correct productions of consonant clusters. Initially most children exhibit cluster reduction. Gradually frequency of cluster reduction decreases and occurrence of cluster simplification increases. Simultaneously, the occurrence of correct production increases, until eventually production is mastered.

2.9 Research on early speech acquisition in Indian context

There is a paucity of data on early phonetic repertoire in the Indian context. However, some studies have been attempted in Hindi, Kannada and Malayalam languages. Shyamala and Basanti's (2003) report on the developmental milestones of language acquisition in Hindi and Kannada showed that the cardinal vowels /i/, /e/, /a/, /u/ and /o/ first appeared by 6-12 months of age in Kannada. Among the consonants, stops and nasals had higher frequency of occurrence. Glides and glottal fricatives were among the less frequently occurring consonants. In Hindi, only 4 vowels, /i/, /e/, /a/, and /u/ including their longer counterparts were seen.

Rupela and Manjula (2006) investigated the phonetic development in 30 Kannada speaking children in the age range of 0-5 years. The speech samples consisted of imitated as well as spontaneous speech, which were collected through interaction with the family members and the investigator. For the purpose of phonotactic analysis, a part of the speech samples, i.e., at least 100 utterances per child were transcribed using broad transcription. The samples of young children, i.e., those from 0 to 18 months of age were analysed for their vocalisation and imitated utterances. Results revealed that CV syllable was the most predominant of the syllable shapes as compared to VC and CVC. CVC syllables appeared to occur at 12 months of age and increased in frequency by 54-60 months. Medial geminated clusters were the first to be acquired and they were the only clusters present in the age range of 12-18 years, occurring frequently and gradually decreasing in frequency at 54 months. Medial non geminated clusters appeared at 18-24 months of age and became more frequent by 30-36 months, remaining stable till 48 moths and becoming predominant by 48-60 months. Bisyllabic words appeared at 6-12 months, becoming predominant by 18 months and then gradually declined in frequency of occurrence at 48 months. The authors opined that the increase in the occurrence of multisyllabic words by this age probably contributed to this decline. Monosyllabic words appeared at 24-30 months but were rare compared to other syllabic types. Moreover, two percent of these words in the age ranges of 24-36 months and around 3% between 48-60 months were English. Both tri and multisyllabic words occurred occasionally at 18-24 months of age and their percentage steadily increased till 54-60 months. Trisyllabic words were more frequently occurring as compared to multisyllabic words. Words consisting of 5-6 syllables appeared first at 36-42 months.

As regards to the phonetic repertoire in babbling, Anjana (2008) established a quantitative and qualitative database on babbling in Kannada in the age range of 6 -12 months. The vowel repertoire consisted of /i, e, æ, a, u, o/ and the consonantal inventory in the entire babbling period compromised of 14 consonants /p ,b, m ,n, θ, ð, ʈ, ɖ, h, k, g, l, j, v/ amongst which stops and nasals exhibited the highest frequency of occurrence in all the age groups. The syllable shapes found were V, CV, CVC, VC and VCV and the mean occurrence of multisyllabic words increased with age.

Irfana (2012) and Alphonsa (2012) conducted cross sectional studies to investigate the phonetic repertoire and syllable structure in eight Malayalam speaking toddlers each with the former focussing on 12-16 months and the latter on 18-24 months age band. In both studies, the eight participants were divided into two age groups of 3 month intervals. Results of both the studies revealed that /a/ was the most predominant vowel across all the age groups. Diphthong /au/ was common in 12-15 age range while in the older children, /ai/ was more frequent. A wide variety of consonants such as stops, nasals, glides, laterals and trills emerged in the phonetic repertoire of the youngest group (12-15 months). Fricatives were abundant in the older children, i.e., in the 21-24 month age group while they were minimal in 12-18 month age range. With respect to syllable shapes, open syllable shapes were common in both younger and older children. Closed syllable shapes began to appear in the 21-24 old children. Geminate clusters were seen in all the age groups but were predominant in the 21-24 month age group. In all the age groups, vowel /a/ preferentially occurred with bilabials /b, m/ thus correlating with the first hypothesis of Davis and MacNeilage's frame content theory. Protowords surfaced from 12-15 months and increased in complexity as children matured. During 21-24 months, protowords gradually paved way for true words.

Literature regarding early phonological development has been relatively restricted to English and other non Indian languages especially Chinese and Arabic. Hence, there is a need to understand the same in Indian languages, especially the phonetic abilities of children in the second year of life as it is during this period that there are proliferating changes in phonological development of young children. Hence the present study intends to broaden our understanding of the early course of phonological ability in 18-24 months of age in native Kannada speaking children.

CHAPTER 3

METHOD

Participants

Twelve typically developing children in the age range of 18-24 months were recruited for the study. All children were monolingual in Kannada. The children were divided into two groups with an age interval of 3 months that is, 18-21months and 21-24 months. Each group included 6 toddlers including 3 boys and 3 girls. The children were identified from immunization centres, neighbouring homes, hospitals and paediatric clinics in Mysore city of Karnataka. Speech samples were collected only after obtaining consent from their parents.

Parental interviews and a brief case history ensured that the children were acquiring Kannada as their first language. A history of medical, speech, language, hearing, cognitive or any other motor difficulties was also ruled out on the basis of the parental interview and after administering a High Risk Register checklist developed by the Dept. of POCD, AIISH, Mysore. Moreover, it will be ensured that the selected children belonged to middle socio economic status by administering the National Institute of Mental Health Socioeconomic status Scale (Venkatesan, 2011). According to Smith (1973) children from a lower socio-economic status would have more articulation and language deficits compared to families with a higher socio-economic status. She also attributed that children from families of a higher socio-economic status have increased speech and language input and higher demands of verbal output. Hence, to control these differences; the middle income families will be selected.

Data recording Procedure: Each child was recorded in a quiet environment preferably at their homes in the presence of the mother/caretaker. Video recordings of each child were obtained individually using a high quality digital video recorder (Sony Full HD 1080 Handycam). The children's utterances were either spontaneous or elicited. The situations during recording were either free play with the parents, elicited speech while playing with toys, or while viewing picture books. Speech stimulation strategies such as modelling, imitation, semantic and contextual prompting etc were employed. Contextual information and related adult utterances were used as cues to the intended words by the children. In cases where sessions yielded fewer than 70 utterances, additional recordings within a couple of days of the session of interest were aggregated to yield 70 utterances.

Data Analysis: The recorded data was subjected to editing to eliminate parent's speech and non-vegetative vocalizations (such as cries, burps and coughs etc) of the child. The child's speech like utterances was retained for transcription and analysis. A minimum of 70 utterances was transcribed using broad and narrow IPA. Any vocalizations that are not fully comprehended after three listening attempts were excluded from transcription. The responses of each subject were analyzed sound by sound to identify the various vowels, consonants and their combinations. Results are discussed based on the objectives of the study. Scores obtained were subjected to appropriate statistical analysis.

Inter and Intra judge reliability

To examine inter judge reliability and intra judge reliability, 10% of the sample of each subject was randomly selected and transcribed and analyzed by three experienced speech language pathologists including the researcher. A point to point method was used which yielded a reliability index of 92% for intra judge reliability and 87% for inter judge reliability.

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Following formulae (Velleman, 1998) were used to quantify the vowels, singleton consonants and consonant clusters in the samples based on the phonological analysis of the sample.

$$\%\text{ of Vowels/Consonants/Consonant clusters} = \frac{\text{No. of occurrences of Vowels/ Singleton Consonants/Consonant Clusters}}{\text{Total no. of phonemes}} \times 100$$

a. Among the vowels, the percentage of occurrence was obtained for front, central and back vowels separately.

   E.g., $\%\text{ of Vowel /a/} = \frac{\text{No of occurrences of vowel /a/}}{\text{Total no of vowels}} \times 100$

b. Likewise, percentage of use of a vowel in initial, medial and final positions was calculated and comparison was done within and across groups

   E.g., $\%\text{ of /a/ in initial position} = \frac{\text{No of occurrences of /a/ in initial position}}{\text{Total occurrences of /a/}} \times 100$

c. Similarly percentage of occurrence was calculated for different singleton consonants based on manner of articulation, place and voicing features. Singleton phones occurring in a given position in at least two different words/occasions were included in the child's inventory for that position (Oller et al. 1985).

d. Positional variations in the use of consonants were calculated and the data was compared across age groups.

e. Analysis was also carried out with regard to preferential occurrence of combinations of consonants and vowels

f. Consonant clusters were further quantified based on geminate clusters and non-geminate clusters if present.

g. Percentage of occurrence of various syllable structures was calculated using the following formula (as given by Velleman, 1998). In order to consider a particular syllable shape as present, only those syllable shapes produced at least two times by an individual child and by a minimum of three out of six participants in each age group were included in the analysis.

$$\% \text{ of CV/CVC/VC etc syllables} = \frac{\text{No. of CV/CVC/VC etc syllables} \times 100}{\text{Total No. of syllables}}$$

h. Multisyllabic utterances of the child were verified with the mother or care taker to establish the existence and frequency of occurrence of proto words/ true words/ holophrastic words for each age group separately. The criteria for identifying true words based on context will be as follows: (Vihman & Mc Cune, 1994).

    1) Determinative context- at least one use that occurs in a context which strongly suggests a word.

    2) Maternal identification- the mother identifies at least one instance of the form of the word which either involves acknowledging or rejecting the word choice.

    3) Multiple use- the child uses the target form/word more than once.

    4) Multiple episodes- more than one episode of use.

Descriptive Statistics was used for the computation of mean and standard deviations of all measurements for each age group separately. For statistical comparisons across age and gender, the non parametric Mann-Whitney test was used (vertical comparison). For comparisons within age group, Friedman and Wilcoxson Rank Sum test were used (Horizontal comparison).

CHAPTER 4

RESULTS

The aim of the present study was to establish qualitative and quantitative data on the phonetic inventories and syllable structures in typically developing Kannada speaking children in the age range of 18-24 months and had the following objectives:

- To establish the phonetic inventory, comprising of frequency of occurrence of phonemes including vowels with respect to tongue height and advancement, consonants with reference to place, manner of articulation and voicing and consonant clusters based on geminate and non geminate clusters
- To compare the phonetic inventories and syllable structures across the age groups of 18-21 months and 21-24 months
- To obtain the positional differences in the occurrence of vowels and consonants
- To obtain the preferential occurrences of consonants with vowels, their frequency of occurrence, types of syllable structures and word shapes.
- To compare the data obtained from the presents study with reported studies in English and other Indian languages

Data of the present study consisted of video recorded samples of 12 toddlers in the age range of 18-24 months having Mysore Kannada as their native language. The subjects were subdivided into two groups with an age interval of 3 months i.e., 18-21 months and 21-24 months respectively, with both groups comprising of 6 subjects each with equal number of males and females. The recorded data was transcribed phonetically using the International Phonetic Alphabet, 2005. In order to consider a particular phoneme as present, a criterion was adopted. That is, only those sounds that were occurring for more than three times were considered as occurring in the respective child's inventory. The data was then analysed with regard to the objectives of the study. Overall analysis revealed that a corpus of 4128 phonemes was produced by the 12 subjects. Out of the 4128 phonemes, 28.56% of vowels and 13.92% of consonants were produced by the children of group 1 (18-21 months) and the remaining 31.78% of vowels and 25.72% of consonants were produced by the subjects of group 2 (21-24 months)

The results are enumerated along the following lines:

1. Vowels (with reference to tongue height, tongue advancement and positional differences in the occurrence of vowels)
2. Diphthongs
3. Singleton consonants (with reference to manner, place and voicing and positional differences in their occurrence)
4. Syllable structure
5. True word shapes
6. Geminate and non geminate clusters
7. Protowords and holophrastic words
8. Preferential occurrence of consonants with vowels within syllables

4.1 Vowels

The 9 vowels present in the phonetic repertoire of the twelve subjects were [a, a:, i, i:, u, æ, e, ɔ and o]. The singleton vowels occurring in different syllables and multisyllabic utterances were transcribed and analyzed for each participant in both groups from the entire corpus of 4128 phonemes; the vowels in the entire corpus were categorized based on the following dimensions:

a) Vowels classified according to tongue height- high [i, i:, u] and mid [e, e:, æ, ɔ and o] and low [a, a:]

b) Vowels classified according to tongue advancement- front [i, i:, e, e:, æ], central [a, a:] and back [u, o and ɔ]

The frequency of occurrence of a particular vowel in each participant was converted into percentage with respect to the total number of vowels in each child's corpus. Further, the mean and standard deviation were obtained from these percentages for each age group. Fig 1 represents the mean percentage of occurrence of vowels in both the age groups. Mean percentage values and standard deviations of the vowels for both groups are presented in Table 5.

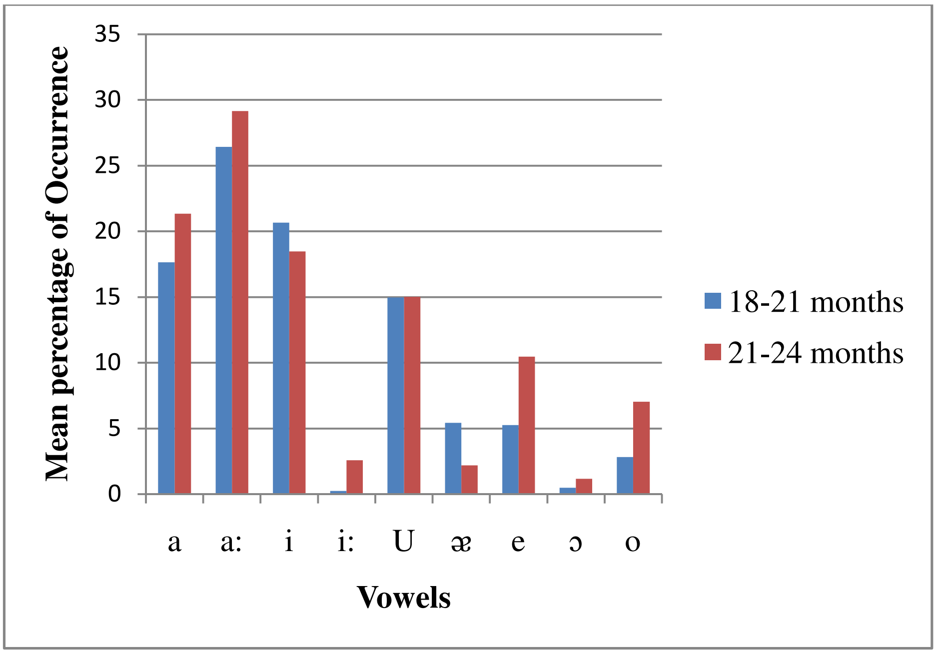

Figure 1, *Mean percentage of occurrence of vowel*

Table 5
Mean percentage of occurrence of vowels

	Group 1 (18-21 months)	**Group 2 (21-24 months)**
[a]	17.64 (3.68)	21.35 (9.51)
[a:]	26.44 (9.39)	29.16 (8.5)
[i]	20.67 (10.3)	18.48 (2.4)
[i:]	0.25 (0.6)	2.57 (2.21
[u]	14.97 (4.20)	15.01 (7.09)
[æ]	5.42 (3.0)	2.18 (2.0)
[e]	5.26 (3.6)	10.47 (5.04)
[ɔ]	0.49 (1.04)	1.16 (0.09)
[o]	2.83 (1.91)	7.03(2.31)

As per Table 5 and Fig 1, in both the groups, the low central vowel [a:] showed the highest frequency of occurrence. In group 1, the presence of the long vowel [i:] and [ɔ] was negligible. Similarly in group 2, the mid back [ɔ] occurred sparingly. While all the vowels increased in frequency with age, the high front [i] and mid front [æ] were the only vowels which reduced relatively in the older group. Also from Table 1 it can be inferred that both younger and older groups are inclined to use central vowels maximally, followed by front and then back vowels. The rank order of vowels in both groups is displayed in Table 6.

Table 6

Rank order of vowels in both age groups

Age in months	Rank order (in descending order)
18-21 months	[a:] >[i]> [a] > [u] >[æ] > [e] > [o] > [ɔ]> [i:]
21-24 months	[a:]>[a]> [i]>[u]> [e] > [o] > [i:] >[æ] >[ɔ]

4.1.1 Vowel classification according to tongue height

With regard to the tongue height feature of vowels, by and large, the low vowels [a:] and [a] had the highest frequency of occurrence in both the groups. Among the high vowels, [i] and [u] had the highest frequency of occurrence in both the groups. The longer vowel [i:] was negligible in the younger group but was slightly higher in the older group. As far as mid vowels are concerned, in Group 1, [æ] was the most prominent mid vowel, followed by [e], [o] and [ɔ]. However in Group 2, [e] was the most often used mid vowel, followed by [o], [æ] and [ɔ]. Both the groups exhibited the tendency to use low vowels to the maximum, followed by the high vowels. Mid vowels were the least preferred by both the groups. While comparing both the groups, except for the high front [i] and mid front [æ], all the other vowels relatively increased in frequency in the older subjects.

4.1.2 Vowel classification according to tongue advancement

From the perspective of tongue advancement, the central vowel [a:] was the most commonly occurring vowel. On the whole, the central vowels [a:] and [a] occupied a major share in the vowel repertoire in both Group 1 (18-21 months) and 2 (21-24 months). Among the front vowels, [i] was the most recurrent vowel in both the groups. While in Group 1, the front vowel [i] was followed by [æ] and [e], in Group

2, [i] was followed by [e] and [i:] and [æ] declined in frequency compared to the younger group. While taking into account the back vowels, [u] is the most evidently occurring vowel in both the groups. [u] was followed by [o] and [ɔ] in both the age groups. One can note that both the groups were predisposed to use central vowels maximally, followed by the front and the back vowel

4.1.3 Comparison of vowels across age

Mann-Whitney U test was run to test the significant difference in the occurrence of high front, high back, mid front, mid-back and low central vowels with age as a factor. The results revealed that none of the vowels showed any significant effect of age.

4.1.4 Comparison of vowels across gender

A comparison of the frequency of occurrence of vowels across gender was carried out to discern any differences in the phonetic development across gender. Mann-Whitney U test was administered to determine the significant difference for vowels with gender as a factor. Among the vowels seen, only the high front [i:] ($/Z/=0.481$, $p<0.05$) showed a significant gender difference which was higher in female subjects.

4.1.5 Positional differences in the usage of vowels

The utterances produced by the participants were analysed to determine the mean percentage of occurrence of vowels for each subject in both groups in each of the three positions: initial, medial and final. The distribution of vowels in initial, medial and final positions is depicted in Table 7.

From Table 7 it can be observed that, the low central vowel [a] occurs maximally in the initial position in Group 1 and in medial position in Group 2. Its longer counterpart [a:] occurs maximally in the final positions in both Group 1 (18-21 months) and Group 2 (21-24 months). The high front vowel [i] occurred more frequently in the final position in both younger and the older groups. Its longer counterpart [i:] was used more often in the initial position in the younger group and in medial position in the older group. The high back vowel [u] appeared more often in the final position in both the younger and the older groups. Mid front vowel [e] was prominently present in the final position in Group1 whereas in Group 2 it was used with almost equal frequency in medial and final positions. The mid back vowel [o] was prominent in the medial position in both the groups. The other mid back vowel [æ] was distributed almost evenly in the initial and medial positions and reduced in the final position in both groups. Another mid back vowel [ɔ] occurred in medial and final positions in Group 1 and only in the medial position in Group 2.

Table 7

Positional difference of vowels in percentage in both age groups

Vowels	Positions	Group 1 (in %) 18-21 months	Group 2 (in %) 21-24 months
[a]	I	54.875	42.18
	M	29.42	50.58
	F	14.01	6.37
[a:]	I	22.73	24.50
	M	29.39	29.78
	F	42.80	42.79
[i]	I	11.89	10.74
	M	28.32	36.43
	F	58.48	41.62
[i:]	I	50.00	19.43
	M	16.67	38.88
	F	16.67	8.33
[u]	I	13.57	1.85
	M	14.87	24.37
	F	71.48	57.03
[æ]	I	31.00	16.67
	M	32.03	19.44
	F	20.27	13.89
[e]	I	12.28	10.05
	M	36.4	43.56
	F	51.26	46.36
[ɔ]	I	-	-
	M	16.67	33.33
	F	16.67	-
[o]	I	19.04	6.25
	M	46.17	51.49
	F	34.74	42.25

I-Initial position, M-Medial position, F-Final position

- not present

4.1.6 Comparison of positional differences of vowels across age and gender

Appropriate statistical analysis was carried out to test whether there was any significant difference in the occurrence of vowels in initial, medial and final positions with age and gender as factors. Results indicated that the high back vowel [u] in the initial position ($/Z/=2.137$, $p<0.05$) showed a significant age difference which was higher in younger subjects. Likewise, a significant gender effect also was seen for [æ] and [o] in the medial position. Both the vowels were higher in the female subjects.

4.1.7 Comparison of positional differences of vowels within age

Appropriate statistical tools were used to examine significant difference in the occurrence of vowels in both age groups. In Group 1 (18-21 months), it was observed that the low central [a] occurred significantly higher in the medial position as compared to initial ($/Z/=2.207$, $p<0.05$) and final positions ($/Z/=2.207$, $p<0.05$). However the high-front [i] occurred significantly higher in the final position as compared to initial ($/Z/= 1.992$; $p<0.05$) and medial position ($/Z/=2.201$; $p<0.05$). Likewise, high-back /u/ occurred significantly higher in the final position as compared to initial ($/Z/= 2.203$, $p<0.05$) and medial position ($/Z/=2.203$, $p<0.05$). In Group 2 (21-24 months), the low central [a] occurred significantly in higher position as compared to initial ($/Z/=2.203$; $p <0.05$) and medial position. ($/Z/=2.203$; $p<0.05$.). Also, the high-front /i/ occurred significantly higher in the final position as compared to medial ($/Z/=1.992$, $p< 0.05$) and initial positions ($/Z/=2.201$, $p< 0.05$). Likewise, the high-back /u/ was significantly higher in final position as compared to medial ($/Z/=2.201$, $p<0.05$) and final positions ($/Z/= 2,201$; $p< 0.05$). Thus, only the corner vowels [i], [a] and [u] showed a significant difference in within group comparison. Moreover, the vowels showed a similar pattern of usage in both groups.

4.2 DIPHTHONGS

/ai/ and /au/ were the two diphthongs produced by the participants in the study. Five subjects in Group 1 (18-21 months) and all subjects in Group 2 (21-24 months) produced diphthongs. The mean percentage of occurrence of the two diphthongs in Group 1 and Group 2 are displayed in Table 8 and Fig 2.

Table 8
Mean percentage of occurrence of diphthongs

Age Groups	[ai]	[au]
18-21 months	46.62	13.29
21-24 months	73.33	26.66

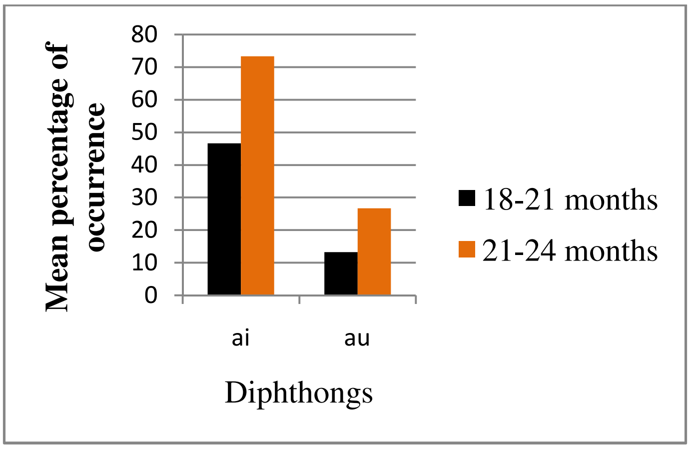

Figure 2, *Mean percentage of occurrence of diphthongs*

As is evident from Table 8 and Fig 2, in both groups of children, /ai/ was the most commonly occurring diphthong. However, the frequency of occurrence of /ai/ and /au/ increased in the older children.

4.2.1 Comparison of diphthongs across age and gender

To examine significant effect of age and gender on the production of diphthongs, /ai/ and /au/ were taken as dependent variables and age and gender were considered as independent variables. On statistical analysis, the results revealed no significant effect of age and gender for diphthongs at 0.05 level of significance.

4.3 SINGLETON CONSONANTS

Totally, the 20 consonants found in the entire corpus of the twelve subjects were [p, b, m, t̪, d̪, n, ṭ, ḍ, ṇ, tʃ, dʒ, j, k, g, h, s, ʃ, v, h, l, r]. On the basis of transcription details, the consonants produced were analyzed and categorized into manner, place and voicing dimensions. The frequency of occurrence of the consonant types for all the subjects was computed. Consonants will be discussed with reference to manner and place of articulation and voicing feature.

4.3.1 Manner of Articulation

The following were the various manners of articulations found in the participants:

- Stops: [p, b, t̪, d̪, ṭ, ḍ, k, g]
- Nasals: [m, n, ṇ]
- Fricatives: [s, ʃ, h]
- Affricates: [tʃ, dʒ]
- Trills: [r]
- Glides [j, v]
- Laterals [l]

The total number of syllable initial, syllable-medial and syllable final consonants were taken into consideration to determine the frequency of occurrence of the various manners of articulation. The mean percentage of occurrence of various manners of articulation seen in the age range of 18-24 months is presented in Table 9 and Fig 3.

Table 9
Mean percentage of occurrence and standard deviations (SD) of various manners of articulation

	Group 1 18-21 months	**Group 2 21-24 months**
Stops	59.32(9.1)	59.55(9.51)
Nasals	20.61(5.2)	21.78(3.47)
Fricatives	3.56(2.1)	0.6(0.2)
Affricates	2.66(2.12)	3.23(2.8)
Trills	1.3(2.1)	1.5(1.6)
Glides	6.5(4.58)	5.93(2.41)
Laterals	5.52(4.12)	6.50(4.21)

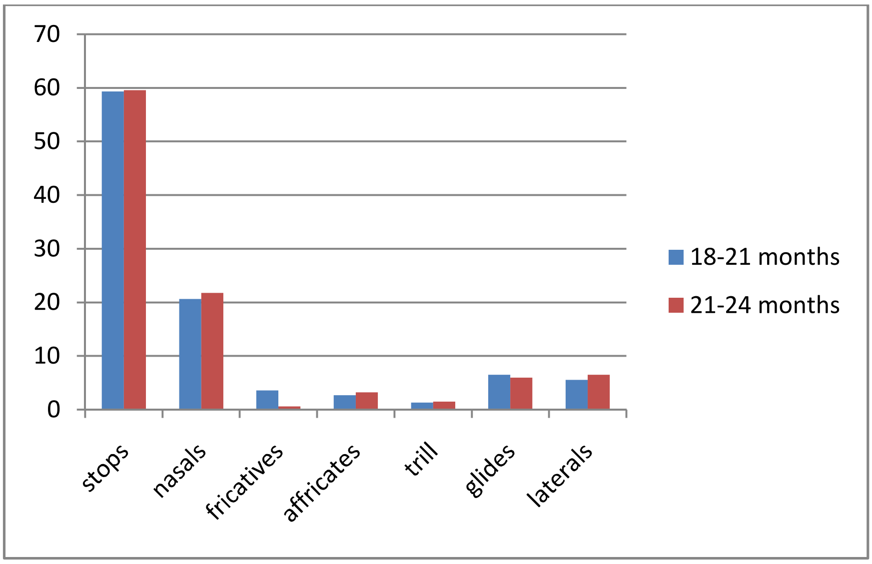

Figure 3, *Mean percentage of various manners of articulation*

As observed, stops occurred with the highest frequency compared to any other manners of articulation in both younger and older groups. Nasals and glides also demonstrated a relatively higher frequency of occurrence compared to other manners of articulation. Occurrence of trills was negligible in both the groups with a marginally higher occurrence in the older group. Stops, nasals and affricates increased in frequency in the older children. The frequency of fricatives [s] and [ʃ] and glides [j, v] was higher in the younger age group than in the older age group. Table 10 shows the rank order of the various manners of articulation in both Group 1 and Group 2.

Table 10
Rank order of consonants: Manner of articulation in both age groups

Age in months	Rank order (in descending order)
18-21	Stops > nasals > glides >laterals > fricatives > affricates >trills
21-24	Stops > nasals >laterals >glides > affricates > trills > fricatives

The rank order of manner of articulation in Group 1 and 2 reveals that stops followed by nasals were the most frequently used class of consonants. Rest of the manners is not exactly similar in both the groups.

4.3.2 Comparison of manner of articulation across age and gender

The frequency of consonants with reference to various manners of articulation was compared between the two groups to determine the effect of age and gender. The statistical results showed no significant effect of age and gender on manner of articulation.

4.3.3 Place of Articulation

The consonants observed in the toddlers' samples according to places of articulation are as given below:

- Bilabials: [p, b, m]
- Dentals: [t̪, d̪, n]
- Labio-dental [v]

- Alveolars [s, l, r]
- Retroflex [ṭ, ḍ, ṇ]
- Palatals [j, tʃ, dʒ, ʃ]
- Velars [k, g]
- Glottal [h]

Out of the phonetically transcribed corpus of 4,128 phonemes, the consonants present were grouped into various places of articulation as per the listed classification. The mean percentage of occurrence and standard deviations were estimated and are shown in Table 11 and Fig 4.

Table 11
Mean percentage and Standard deviation of occurrence of various places of articulation

	Group 1 **18-21 months**	**Group 2** **21-24 months**
Bilabials	35.92 (10.17)	25.50 (6.47)
Dentals	19.8 (6.99)	23.32 (7.94)
Alveolars	10.55 (7.94)	9.80 (6.69)
Labiodental	1.69 (1.91)	2.31 (2.14)
Palatals	13.91 (6.49)	11.63 (5.86)
Retroflex	11.89 (5.99)	9.6 (6.15)
Glottals	-	4.78 (6.69)
Velars	6.12 (5.21)	15.65 (6.80)

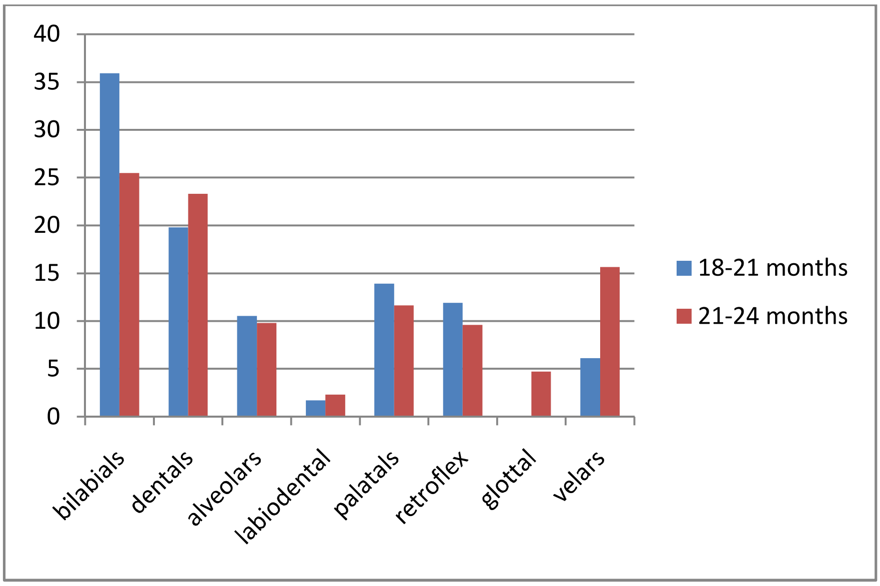

Figure 4, *Mean percentage and Standard deviation of occurrence of various places of articulation*

Overall, bilabials are the most strongly represented place of articulation (35.92% in Group 1 and 25.5 % in Group 2) and the labiodental /v/ was the least represented in the two groups (1.69% in Group 1 and 2.39% in Group 2). It is to be noted that glottal /h/ was altogether absent in the younger age group and was present only in the older group. It can also be observed that the frequency of bilabials, alveolars, palatals and retroflexes increased in the younger age group as opposed to the older group. Dentals, velars and glottals showed a considerable rise in frequency as age increased. Thus the following rank order can be established as shown in Table 12.

Table 12
Rank order of consonants: Place of articulation in both age groups

Age (in months)	**Rank order (in descending order)**
18-21	Bilabials >dentals > palatals > retroflexes > alveolars > velars > labiodentals
21-24	Bilabials > dentals > velars > palatals > alveolars > retroflexes > glottal > labiodentals

Thus it can be summarised that bilabials followed by dentals were strongly represented in both age groups. Palatals, retroflexes and alveolars occurred quite frequently in Group 1 (18-21 months). Velars and labiodentals occurred sparingly. In Group 2 (21-24 months), velars increased considerably occupying the third position in the rank order. Velars were followed by palatals, alveolars, retroflexes and glottals. Labiodentals occurred scarcely.

4.3.4 Comparison of place of articulation across age

Appropriate statistical analysis was carried out to determine if significant differences existed in the frequency of occurrence of these consonants types across age groups. Results depicted that velars showed significant effect of age ($/Z/=2.379$, $p<0.05$). Velars were higher in the older subjects compared to the younger subjects

4.3.5 Comparison of place of articulation across gender

Appropriate statistical tool was employed to verify if any significant differences existed in the frequency of occurrences of various places of articulation with gender as the independent variable. Results revealed that, dentals ($/Z/=0.801$, $p<0.05$) and palatals ($/Z/=0.0.641$, $p<0.05$) showed significant difference in the incidence of occurrence and they were higher in female subjects.

4.3.6 Positional differences in the occurrence of consonants

The utterances transcribed were analysed to determine the mean percentage of occurrence of consonants for each subject in both groups in each of the three positions: initial, medial and final. The distribution of the consonants in these 3 positions is given in Table 13.

Table 13

Positional differences of consonants in percentage in both age groups

Consonants	Positions	Group 1 18-21 months	Group 2 21-24 months
Bilabials	I	55.02	58.33
	M	41.145	40.83
	F	4.22	3.12
Dentals	I	34.41	22.83
	M	63.35	66.14
	F	7.97	10.77
Alveolars	I	3.92	8.99
	M	78.79	61.91
	F	0.59	0.45
Labiodentals	I	27.78	34.12
	M	22.22	32.51
	F	0	0
Palatals	I	27.56	26.88
	M	57.51	69.36
	F	17.43	3.23
Retroflex	I	28.03	12.84
	M	55.95	69.08
	F	18.93	1.32
Glottals	I	-	64.88
	M	-	11.00
	F	-	-
Velars	I	23.33	45.06
	M	35.83	51.32
	F	4.12	3.28

- Not present (I-Initial; M-medial; F-Final)

As is evident from Table 13, bilabials occurred most predominantly in the initial position in both the groups. Dentals, alveolars, retroflexes, velars and palatals were more predominant in the intervocalic or the medial position in both younger and older age groups. Labiodentals were distributed in the initial and medial positions but showed more preference in the initial position in both Group 1 and Group 2.

4.3.7 Comparison of positional differences of consonants across age and gender

Statistical analysis was carried out to determine the significant differences across the initial, medial and final positions for consonant usage across age and gender. Results revealed that there was no significant difference for consonantal positions across age and gender at 0.05 level of significance.

4.3.8 Voicing dimension

In the phonetically transcribed corpus of 4,128 phonemes, the voiced consonants present were [b, m, ḍ, n, v, l, r, ʤ, ṇ and g] and the unvoiced consonants were [p, t̪, d̪, s, ṭ, tʃ, ʃ, k, ʧ and h]. The frequency of occurrence of voiced and unvoiced consonants was computed and comparison across age and gender was made. In the younger group, 70.53% of the total consonants produced were voiced and 29.26% was voiceless. Correspondingly, in the older age group, 69.81% of the total consonants were voiced and 30.15% was voiceless. Thus, in both the groups, the production of voiced consonants largely exceeded that of the unvoiced consonants. Table 14 and Fig 5 depict the distribution of voiced and unvoiced consonants in the two age groups.

Table 14
Mean percentage of occurrence of voiced and unvoiced consonants

Age groups (in months)	Voiceless Mean	Voiced Mean
18-21	29.26	70.53
21-24	30.15	69.81

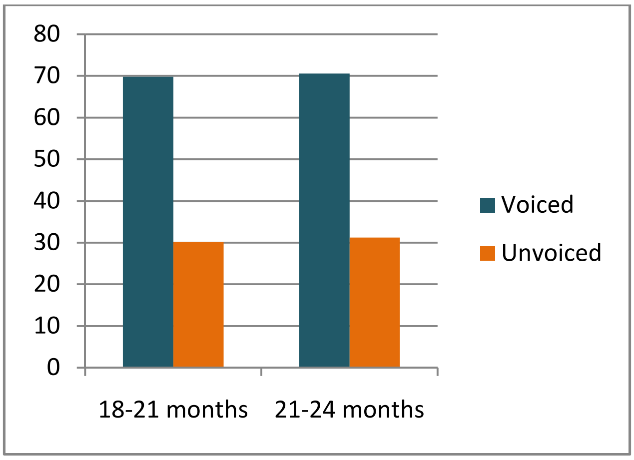

Figure 5, *Mean percentage of occurrence of voiced and unvoiced consonants*

4.3.9 Comparison of voiced and unvoiced consonants across age and gender

Mann Whitney U test was administered to determine the significant differences in the production of voiced and unvoiced consonants across age and gender. Results revealed that there was no significant difference in the voicing dimension across age and gender at 0.05 level of significance.

4.4 SYLLABLE SHAPES

An assortment of syllable shapes including both words and non words were found in the inventory of the twelve subjects with wide inter subject variability. The mean percentage of occurrence of the significantly occurring syllable shapes was determined for all the 12 subjects in both the age groups. Only those syllable shapes produced at least three times by an individual child and by a minimum of three out of six participants in each age group were included in the analysis. The mean percentage of occurrence of various syllable shapes is represented in Table 15 and Fig 6.

Table 15

Mean percentage of occurrence and standard deviations of various syllable shapes

Syllable Shapes	**Group 1 (18-21 months)**	**Group 2 (21-24 months)**
CV	20.89 (12.24)	13.42 (10.67)
VC	3.46 (3.41)	-
CVV	5.11 (3.57)	2.21 (2.94)
CVC	5.56 (5.28)	7.57 (5.87)
VCV	17.31 (7.84)	5.79 (6.30)
VCVC	-	2.22 (3.18)
VCCV	10.72 (5.64)	17.33 (5.20)
CVCV	26.55 (14.32)	27.71 (4.99)
CVCVC	-	1.48 (1.75)
VCVCV	2.58 (2.78)	2.99 (2.25)
CVCVCV	-	4.13 (4.21)
CVCCVCV	-	2.43 (2.43)
CVCVCCV	-	1.06 (1.33)
CVCVCVCV	-	2.25 (2.64)

- Not present

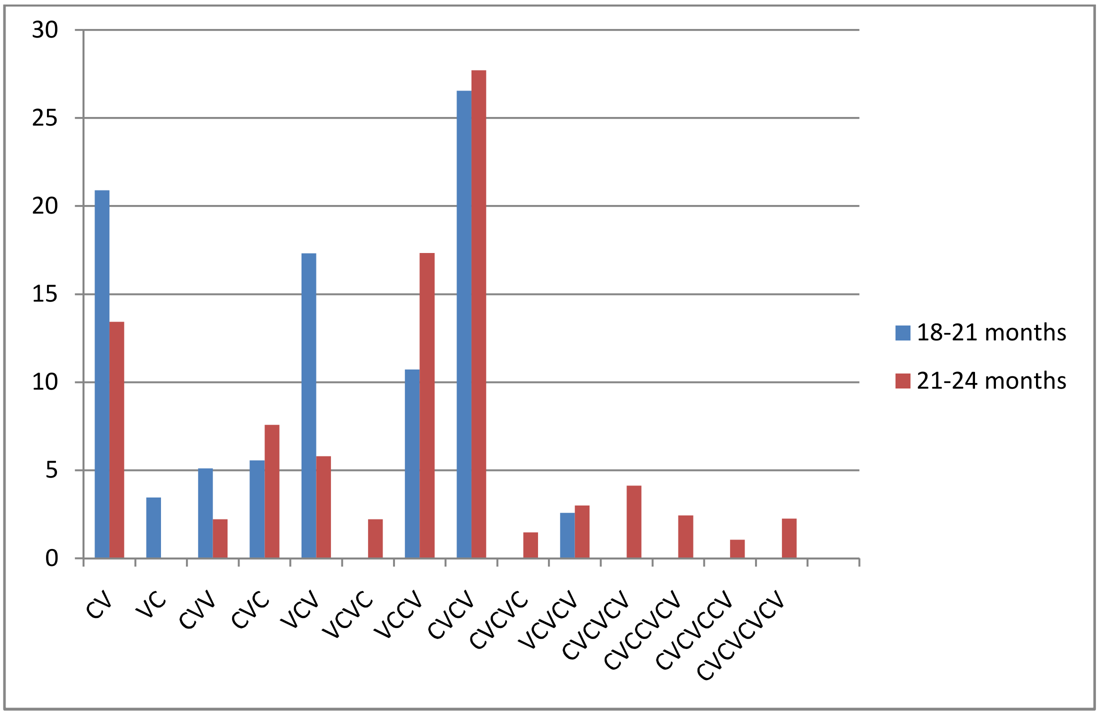

Figure 6, *Mean percentage of occurrence of various syllable shapes.*

There was a wide variability in the production of syllable shapes among the 12 subjects in the two age groups. The syllable shapes that were commonly produced by the two groups were CV, CVV, CVC, VCV, VCCV, CVCV and VCVCV. The preferred syllable type in both Group 1 and Group 2 was the open syllable shape CVCV (26.55% in Group 1 and 27.71% in Group 2). The major syllable types produced by Group 1 (18-21 months) were CV, VC, CVV, CVC, VCV, VCCV, CVCV and VCVCV. It was observed that VC was exclusive to Group 1. The older children produced a varied amount of syllable shapes ranging from open to closed. The syllable types produced by them were CV, CVV, CVC, VCV, VCVC, VCCV, CVCV, CVCVC, CVCVC, VCVCV, VCVCV, CVCVCV, CVCCVCV, CVCVCCV, and CVCVCVCV. The syllable types that were exclusive to Group 2 were VCVC, CVCVC, CVCVCV, CVCCVCV, CVCVCCV, and CVCVCVCV. Thus the frequency of occurrence of multisyllabic occurrences increased in the older age group. A salient observation was that the closed syllable shapes produced were either English loan words or non words.

4.4.1 Comparison of syllable structures across age groups

A comparison of the different syllable structures was carried out to determine whether significant differences existed in the occurrence of the syllable structures across age. Results indicated that only one syllable shape VCV ($/Z/= 2.406$, $p<0.05$) was significantly higher in younger age group among the 7 syllable shapes that were common to both groups.

4.4.2 Comparison of syllable structures across gender

Similar comparison of the various syllable structures was carried out with gender as a factor and results showed no significant difference in the occurrence of any of the syllable types across gender at 0.05 level of significance. However the complex syllable shape CVCVCCV was produced by only female subjects.

4.5 True Word Shapes

Monosyllables, bisyllables and multisyllabic true words were also found in the phonemic repertoire of the participants. The frequency of occurrence of each of these word shapes was determined for each of the 12 participants. All intelligible adult like utterances were considered for the calculation of the percentage of occurrence of true words. The mean and standard deviations of the word shapes in both age groups are presented in Table 16 and Fig 7 depicts the mean percentage of occurrence of word shapes.

Table 16
Mean percentage and standard deviation of occurrence of word shapes

Age Groups	Monosyllabic Words	Bisyllabic Words	Multisyllabic Words
18-21 months	2.33 (1.86)	15.67 (13.48)	0.33 (0.81)
21-24 months	4 (2.61)	19.17(5.49)	2.67(2.11)

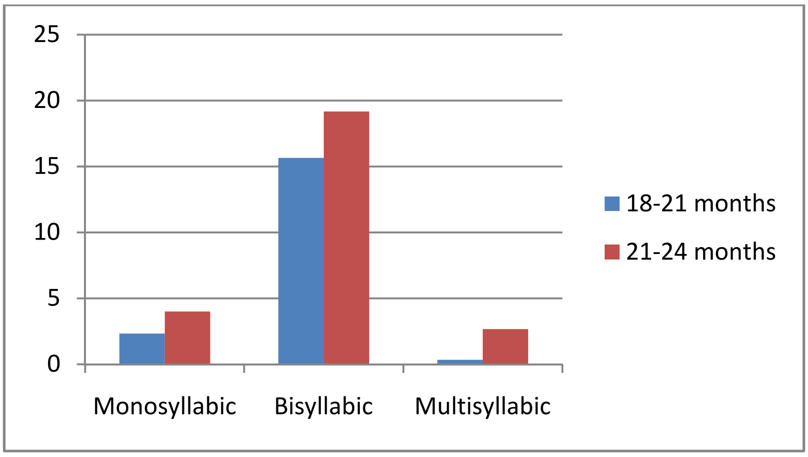

Figure 7, *Mean percentage of occurrence of word shapes*

Overall, bisyllabics were the most strongly represented word shape in both Group 1 and Group 2. All the three word shapes showed an increasing trend in the frequency of occurrence with age. True words produced by Group 1 and Group 2 are provided in the Appendix.

4.5.1 Comparison of word shapes with age

Statistical analysis results showed no significant effect of age on any of the word shape at 0.05 level of significance.

4.5.2 Comparison of word shapes with gender

Statistical comparison across gender showed that production of multisyllabic utterances were significantly (/Z/=1.968, $p<0.05$) higher in female subjects.

4.6 GEMINATE AND NON GEMINATE CLUSTERS

Clusters were produced only in the medial position by the 12 subjects. Onomatopoeic expressions without a CV structure (for e.g., 'drrrr' while playing a car) produced by the children were also considered for cluster analysis. For an individual child in a group, the percentage of medial geminates/non geminate clusters was calculated by dividing the number of medial geminates/non geminates produced by the total number of medial clusters present in his/her inventory and was multiplied by 100. Following this the mean percentage was calculated for each group separately. Table 17 and Fig 8 depict the mean percentage of occurrence of geminate and non geminate clusters in Group 1 (18-21 months) and Group 2 (21-24 months).

Table 17
Mean percentage of occurrence of medial geminates and non geminates

Age Groups	Medial geminates	Medial non geminates
18-21 months	82.60	17.40
21-24 months	78.28	21.72

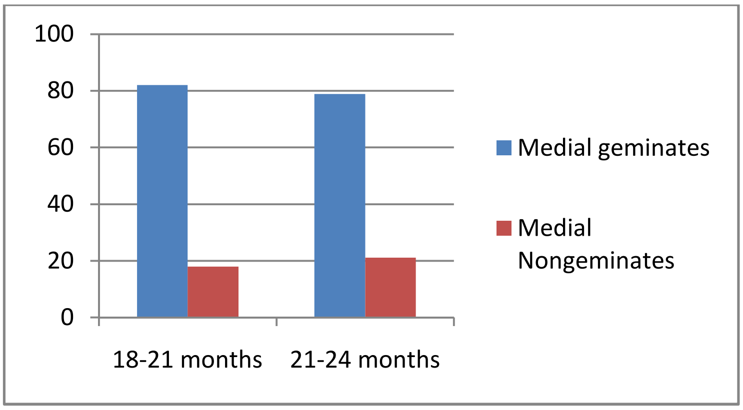

Figure 8, *Mean percentage of occurrence of medial geminates and non geminates*

As observed, medial geminate clusters were higher in production in both the groups compared to medial non geminate clusters. However, the frequency of occurrence of geminate clusters decreased slightly in the older group while non geminate clusters increased. Table 18 represents the occurrence of medial geminates and non geminates in each of the 6 participants of Group 1 (18-21 months) and Group 2 (21-24 months).

Table 18
Types of medial geminates and medial non geminates in each participant

Subjects	**Group 1(18-21 months)**		**Group 2 (21-24 months)**	
	Medial geminates	**Medial non geminates**	**Medial geminates**	**Medial non geminates**
1	ṇṇ, mm, kk, ss,	-	kk. ṭṭ, ll ,ṇṇ, jj, mm, pp, bb	rk, nk, mp,
2	mm, ṭṭ, ll, pp, kk, ṇṇ, nn	-	mm, kk, ll	nd, kr, mb,
3	ll, mm, pp, kk	-	mm, ll, ḍḍ, ṇṇ ,pp, nn, bb, kk	-
4	ll, mm, jj, bb, vv	mḍ, lb,	ṭṭ, kk, ṇṇ, ḍḍ, jj	pr, mb
5	mm	dr , bd̪	mm, ṇṇ ,ll ,kk, ṭṭ, pp, ,	mb, dl
6	mm, kk,	-	mm pp, ṇṇ, ll	mb

- Not produced by the subject

Thus, it can be observed that the younger group produced more medial geminate clusters with fewer productions of medial non geminates. The older group produced a variety of geminates and non geminate clusters.

4.7 PROTOWORDS/ HOLOPHRASTIC WORDS

Children frequently use invented words (Locke, 1983) in a consistent manner thereby demonstrating that they seem to have meaning for the child. These vocalisations used consistently but without a recognisable adult model have been called protowords (Menn, 1978), phonetically consistent forms (Dore, 1976), vocables (Ferguson, 1976) and quasi-words (Stoel-Gammon & Cooper, 1984). Table 19 displays the list of protowords produced by each of the participants in Group 1 (18-21 months) and Group 2 (21-24 months). Each of the protowords listed were 'invented' and were used 'consistently' by the participants in a meaningful context. This was further verified by confirmation with the mother.

Table 19.
Protowords produced by each participant in Group 1 and Group 2

Participants	**Group 1 (18-21 months)**	**Group 2 (21-24 months)**
	Protowords	*Protowords*
1	/ij:a/ (water) ṭɔk (horse)	-
2	ija (water)	-
3	-	æpittu (apple); t̪achi (sleep) ; ɟija (water) d̪ud̪u (milk), ka:ka (crow)
4	/mamam/ (food) /t̪achi/ (sleep)	-
5	ullæ (don't want)	-
6	/mamam/ (food) /ija/ (water)	a:puchi (insect)

- Not present

Holophrastic words are those words where a child uses a single word to represent a complete idea (Cruttenden, 1981). These kinds of words were also observed in a few children. One child in Group 1 produced the utterance /æʃ/ to talk anything about 'ball' such as showing the 'ball', 'catch the ball', 'give the ball' etc. Similarly a participant in Group 2 produced /pa:vu/ to refer to all insects and reptiles and /aṇṇu/ to refer to all fruits. Another child in Group 2 used /ula/ and /uli/ for all forms of negation like (don't want, don't give, won't give etc). The consistency of use of these words was verified with the mother after the recording sessions.

4.8 PREFERENTIAL OCCURRENCE OF CONSONANTS WITH VOWELS WITHIN SYLLABLES

Patterns of co-occurrence of consonants with vowels (CV) were analysed in the data. The mean percentage of such co-occurrences was estimated and is presented in Table 20. Group 1 presented a strong bilabial-central, coronal-central co-occurrence and dorsal-back co-occurrences. Group 2 presented a strong bilabial-central, coronal-front and dorsal-central co-occurrence. The relevance of these findings to Frame Content Theory (Davis & MacNeilage, 1995) will be discussed later.

Table 20
Preferential co-occurrences of consonants and vowels.

	Group 1 18-21 months			**Group 2 21-24 months**		
Phoneme Class	a	i	u	a	i	u
Bilabials	**12.5**	1.83	2.6	**11.00**	2.5	4.67
Coronals	**14.6**	10.33	10.50	15.16	**17.16**	15.00
Velars	2.16	2.16	**10.5**	**5.12**	1.5	2.67

CHAPTER 5

DISCUSSION

The objectives of the present study were to establish qualitative and quantitative information on the phonetic repertoire and syllable structures in typically developing Kannada speaking children in the age range of 18-24 months. The analyses revealed several interesting findings that shed light on the rapid developmental changes in the phonetic inventory of 18-24 month children. The children's utterances took the form of an assortment of vowels, diphthongs, consonants, syllable structures, true word shapes, protowords and holophrastic words. The findings of the current study, in general, are at par with the literature on early phonetic repertoire in children.

It was found that the low central vowel [a:] was the most predominant of all the vowels in both the groups. [a:] was followed by the high front [i] and then the high back [u]. This finding is in par with the existing literature on trends of vowel development in young children. Otomo and Stoel Gammon (1992) described the acquisition of unrounded American English vowels at 22, 26 and 30 months of age and stated that /a/ and /i/ were mastered early compared to the other vowels**.** Donegan (2002) stated that children prefer low, unrounded vowels during their first year and produce height differences in vowels before they produce front-back differences. That is, the optimal front vowel is /i/, the optimal labial vowel is /u/, and the optimal sonorant vowel is the non palatal and non labial /a/ and these are the three vowels that are acquired early and are favoured among the world's languages. Also, a study by Kent & Bauer (1985) revealed that /a/ was often produced in CV syllables. From an anatomical point of view, the greater frequency of occurrence of a/ could be because the musculature of lips, jaw and frontal portion of tongue seem to develop at a faster rate compared to the tongue back (Bosma, 1975). The findings of the study also reveal that both younger and older groups are inclined to use central vowels maximally, followed by front and then back vowels. This developmental trend has been supported by many studies that dealt with analysis of formant patterns (Buhr, 1980). The finding that front vowels are more prominent compared to back vowels is also supported by Selby, Robb and Gilbert (2000), who reported front vowels to be produced more frequently than back vowels from 18 months of age.

In the present study, it was found that mid vowels were used minimally by both groups. This could be because it is suggested that mid vowels are produced in those areas of the oral cavity that are susceptible to subtle articulatory changes and therefore require more precision than the corner vowels (Otomo & Stoel Gammon, 1992).

Results of the present study showed that the mid-front vowel [æ] seemed to occur more often in the younger group than in the older group. This could be because the vowel [æ] was a futile attempt to produce the right vowel which is closer to it in vowel space, (for e.g., substituting [æ] for [a]), or as an onomatopoeic expression (/mæ/ to show how a goat bleats) or due to the production of English loan words. The first two reasons were more prominent in the younger group (18-21 months) and hence the finding. Though Kannada phonotactics does not have a provision for the mid back vowel [ɔ], it was still seen in both the groups. This could be because the vowel [ɔ] was mainly embedded in either English loan words or non words that were produced by the children. Another salient observation was that mid back vowel [o] was negligible in both the groups. This finding is in consonance with a longitudinal study done by Texeira and Davis (2002) on 2 Brazilian Portuguese children followed from age 12 to 36 months, the findings of which showed that [o] occurred with negligible frequency until 36 months of age.

There was no significant effect of age on the frequency of occurrence of vowels across Group 1 (18-21 months) and Group 2 (21-24 months). This could be because vowels such as [a, i, u] are acquired very early. Limited number of subjects in both the groups could also have been an added reason. In the present study a significant gender difference was also noted for the vowel /i:/. This is possibly because girls are generally thought to perform better than boys in verbal and linguistic functions (McCormack & Knighton, 1996).

With regard to the positional differences in the use of vowels, it is to be noted that, in Kannada, most of the vowels including long vowels, occur word finally. This is in consonance with the finding of the present study where vowels like /a:/, /i/ and /e/ occur word-finally. /u/ is preferred more in the final position in both the groups because in spoken Kannada, /u/ is added to most of the consonant final stems (Schiffman, 1979).

In the current study, /ai/ and /au/ were the two diphthongs produced by the participants. As reported in the literature, these are the 2 diphthongs present in Kannada language (Schiffman, 1979). A similar cross sectional study by Alphonsa (2012) reported the presence of diphthongs /ai/ and /au/ in 8 Malayalam speaking toddlers of age 1.6-2 years. An ongoing study by Shishira S. B. (2013) also reported the presence of /ai/ and /au/ in 12 Kannada speaking toddlers of age 1-1.6 years with /ai/ being more frequent. Literature on diphthongs is scanty for comparison.

The findings of the present study for manner, place and voicing features reveal that stops followed by nasals and glides and laterals were the most predominant; bilabials followed by dentals had the highest frequency of occurrence in both groups; voiced consonants largely exceeded unvoiced consonants. All these findings can be supported by copious literature. Kent and Bauer (1985) stated that voiced bilabials apical stops [b, d] are the most frequent prevocalic consonants in English-learning infants' vocalizations. Vihman et al (1986) and Boysson Bardies et al (1992) attributed the increased occurrence of bilabials to their visual salience. Robb and Bleile (1994) reported that the most frequent manners of articulation were stops and the most frequent places of articulation were towards the front of the mouth such as labials and alveolars.

A longitudinal study by Stoel-Gammon (1985) indicated that stops, nasals and glides occurred first. Anterior sounds preceded posterior sounds. Paschall (1983) and Hare (1983), both reported that at 18 months of age, stops, nasals and liquids made up 82.5% of consonants produced. By 24 months of age, the same consonants combined with velar stops constituted. The finding is also in consonance with a cross linguistic study by Kern, Davis, MacNeilage, Kobas and Zink (2011) considering four languages, i.e., Turkish, French, Romanian, Dutch and Tunisian Arabic. Their findings also showed that children produced more stops, nasals and glides than other types of sounds; they tend to use more coronals and labials than dorsal sounds. Amaryeh and Dyson (2000) also reported the emergence of glides in Arabic children of age 14-24 months. In the current study, affricates and trills were less commonly produced. This could be because of the oro-motor complexity involved in their articulation. Affricates are reported to develop after the age 2 years and 2 months.

Until then, most of the affricates are substituted mostly by dental stops (Zhu & Dodd, 2000).

An interesting finding in the present study was the increased presence of fricatives /s/ and /ʃ/ in the younger children as compared to the older children. This finding can by supported by a study by Poole 1934 who reported that sounds /s/ and /z/ appeared in the 5.5 year old group and then disappeared in the later age groups and did not reappear till 7.5 years of age. This phenomenon is referred to as 'reversal' by Wellman**,** 1931 which may reflect a child's inconsistent productions. Therefore, fluctuation in sound inventory is inevitable.

Another salient feature of the younger subjects in the present study is that velars were one among the last class of consonants to be present. The number of velars significantly increased in the older group. Similar finding has been reported earlier also. Dyson and Payden, (1983) state that some children may have difficulty in producing velars and may substitute front sounds such as alveolars and so on. This could explain the increased production of alveolars compared to velars in the younger group. This fronting pattern is reported to disappear by age 3 years. (Grunwell; 1982; Stoel Gammon & Dunn, 1985). Gender difference for palatals and dentals was observed in the present study. This could be because of the superior performance of girls in verbal and linguistic performance (McCormack & Knighton, 1996)

In the present study, with respect to positional variations in the use of consonants, it was found that both age groups produced bilabials more frequently in the initial position. Similar finding was reported by Robb and Bleile (1994) where children right from 8 months to 25 months of age produced bilabials, alveolars and glottals predominantly in the initial position. Both younger and older subjects in the present study produced velars in the medial position rather than in the initial position.

Velars in the final position were negligible. A study by Dyson (1986) focussing on the development of velar consonants in 2 year olds reported that velars developed earlier in the final position rather than in the initial position. However in spoken Kannada, the tendency to produce closed word shapes is minimal and most of the words take the form of an open syllable. Even in case of borrowed words, a vowel is added at the word ending often. Hence, velars were present predominantly in the medial position, in the present study. In the present study, labiodental /v/ and palatals [tʃ, dʒ] occurred more prominently in the word-initial position and medial position respectively. These findings are similar to reports of Stoel Gammon (2002) where children from 21-24 months produced labiodentals in the initial position and palatals in the medial position.

In the present study, it was also found that consonants in the final positions were reduced as compared to their use in initial and medial positions. This correlated with the findings of a longitudinal study carried out by Watson and Skukanec (1997) who reported fewer consonants in the word final position at 2 years of age. Generally speaking, the tendency of the subjects to produce consonants like dentals, alveolars, palatals, velars and retroflex reflects the nature of the ambient language. Moreover, in Kannada language, word shapes often end with a vowel in the final position as opposed to consonants.

In the present study, voiced consonants were higher in frequency in both Group 1 (18-21 months) and Group 2 (21-24 months) though voiceless consonants occurred more commonly in the older group as compared to the younger group. Similar finding has been reported in a longitudinal study by Robb and Bleile (1994) which indicates that from 8^{th} month through 16^{th} month, there were increased productions of voiced consonants as compared to unvoiced. From 17^{th} month to 25^{th}

month of age, voiced phonemes still predominated. However, the frequency of voiceless also increased though not significantly, much similar to the finding of the present study.

With regard to syllable structures, younger group tended to produce predominantly open syllable shapes like CV, CVV, CVCV and VCV while older children produced more complex varieties like VCVC, CVCVC etc. Syllable shapes like CV, CVV and VCV declined with age. The findings correlated with that of Watson and Skukanec (1997) who also observed a reduction in the CV and VCV shapes over the course of their longitudinal investigation. It is also reported in the literature that CV and CVCV were the earliest phonotactic structures to emerge (Grunwell, 1982; Dyson, 1988). In Kannada, the syllable shape CV occurred commonly at 12 months of age (Rupela & Manjula, 2006). In the present study, it was interesting to note that VC occurred only in the younger subjects. Also, the syllable shape VCV was significantly higher in the younger children which reflect their oro-motor immaturity in the early linguistic period. It could have been lower in the older participants because they had moved on to produce more complex syllable and word shapes. Another salient feature was that both the younger and older groups produced only a limited variety of closed syllable shapes, namely, VC and VCVC-CVCVC respectively. These syllable shapes were either English loan words or non words. This reflects the effects of the ambient language on acquisition of phonological skills.

Findings pertaining to the occurrence of word shapes were also in agreement with available research reports; i.e., the frequent occurrence of bisyllabic words with occasional occurrence of multisyllabic words in the second year of life. These findings are in accord with Rupela and Manjula's (2006) study, wherein bisyllabic words began to emerge at 6-12 month; becoming predominant by 18 months. A varied amount of syllable shapes was produced by the subjects in the present study. This is because the speech of two year olds is said to be highly variable, dynamic and inconsistent (Grunwell, 1982; Vogel Sosa & Stoel Gammon, 2006). It also been cited in the literature that, in an attempt to approximate adult word targets, young children often show non-linear development or regression and considerable individual differences (Vihman, 1996; Vihman & Velleman, 1989, 2000; Vihman, Velleman & McCune, 1994; Velleman & Vihman, 2002; Vihman & Kunnari, 2006; Vihman & Croft, 2007). Ferguson and Farwell (1975) stated that variability in children's own pronunciation of words reveal incomplete knowledge on the part of the child. This difference in the control of speech sound productions may reflect the immature status of child's linguistic and neuromotor capabilities in his/her formative years.

In the present study, all the word shapes increased in frequency in the older participants. Vihman (2005) explained children's emerging word learning skills and accurate consonant production skill on word learning occurs on the basis of 'vocal motor schemes' (VMS). These are generalized articulatory plans indexed by children's ability to consistently produce a given consonant over a period of time. Thus as children grow, they were able to efficiently carry out the vocal motor schemes thereby exhibiting increased word and consonant production skills.

A salient feature was the use of the complex syllable shapes such as CVCVCCV and multisyllabic word forms only by female subjects. Similar finding about the superior performance of females have been reported in literature. This is possibly because girls are generally thought to perform better than boys in verbal and linguistic functions (McCormack & Knighton, 1996).

In the present study, clusters were produced only in the medial position by the participants. This is because in native Kannada, the use of clusters word-initially or word finally is uncommon. However, due to the influx of borrowed words, clusters now occur in the initial position as well. Similar findings have been described by Rupela and Manjula (2006). In their study, medial geminated clusters were the first to be acquired and they were the only clusters present in the age range of 12-18 months, occurring frequently and gradually decreasing in frequency at 54 months. Several reasons have been proposed to explain the emergence of clusters in the second year of life. Ingram (1991) suggests that the “word spurt” may be linked to a significant development in children’s phonological analysis of the receptive vocabulary in terms of phonotactics. Consonant clusters represent an important departure in phonotactics from the earlier word shapes of CV, VC, or CVCV. The ability to produce consonant clusters may also be related to maturation of the children’s motor speech mechanism and continued anatomical development of the oro musculature. The present study also reveals increased use of consonant clusters in older subjects which is in agreement with the reports of a review of normal acquisition of clusters by Mc Leod, van Doorn and Reed (2001). Another salient feature in the current study was that non geminate clusters were embedded either in onomatopoeic expressions or non words.

In the present study, protowords and holophrastic words were used more commonly by the younger participants than the older participants. This could be because the older children began to use more number of true words to refer to various items/ ideas.

In an attempt to correlate the present findings with Frame Content Theory by Davis and Mac Neilage (1995), the current study showed that Group 1 (18-21 months) abided by 1st (pure frame–labials with central vowels) and 3rd hypothesis (dorsals with back vowels) and Group 2 followed 1st and 2nd (front frame–alveolars with front vowels) hypothesis of frame content theory. The partial agreement of the findings with the frame content theory shows that the proposed frames offered explanations during the early linguistic stage, primarily the babbling period. Context-independent segmental components (content) emerge later. This probably indicates that the Frame Content theory cannot be applied to explain early linguistic stages beyond babbling. It also reflects the limitations of its relevance in languages other than English.

Thus in the present study, many findings could be supported by various studies on the early speech in young children. However, some of the observations did not agree with the universal findings and reflected the influence of ambient language. Thus, in order to fully understand the dynamic nature of early acquisition of sound systems, one must relate to both the maturity of the articulatory system and influence of the ambient language.

CHAPTER 6

SUMMARY AND CONCLUSIONS

The acquisition of articulatory and phonological skills that reflect in the production of a child's first words is the result of interaction between complex motor and linguistic processes that begins in infancy and proceeds through the early school years. The logarithmic growth of phonological skills is prominent during the first fifty word stage, wherein the child is rapidly acquiring and producing an assortment of vowels, consonants, different types of syllable shapes, protowords and true words. In the present study, an attempt was made to analyse the phonetic characteristics of typically developing toddlers in the age range of 18-24 months from native Kannada speaking homes.

Data consisted of video recorded samples of twelve toddlers from ages 18-24 months with Mysore Kannada as the native language. The subjects were categorised into two age groups with an inter age interval of 3 months: 18-21 months and 21-24 months. Each group consisted of 6 subjects with equal representation for males and females. The spontaneous speech samples were transcribed using broad IPA. The vowels present in the samples were analysed with respect to tongue height and tongue advancement dimensions and the consonants were analysed with in terms of manner, place and voicing features. Types of syllable structures, word shapes and emergence of cluster patterns were analysed as well.

Percentage occurrence of vowels, consonants and their positional differences syllable structures, word shapes were determined. These phonological parameters were subjected to appropriate statistical analyses to infer the developmental trend across age and gender during the early linguistic period. Protowords, true words and phrases were analysed from the production of each participant. A qualitative analysis was made to determine the preferential occurrence of consonants with vowels (initial CV portion) within syllables. Non parametric tests were used for statistical comparisons.

There were 9 vowels [a, a:, i, i:, u, æ, e, ɔ and o] in the phonetic repertoire of the twelve subjects. The low central vowel [a:] was the most frequently occurring vowel in both groups. The least frequently occurring vowels were [o] and [ɔ]. Two diphthongs [ai] and [au] were also seen in both groups.

Vowels showed wide variability in positional occurrence in the two groups. The most significant finding was the presence of the high back vowel [u] and high front vowel [i] in the final position in both groups. The low central vowel [a] was prominent in the initial position in both groups. rest of the vowels were scattered across the three positions.

The 20 consonants present in the corpora of the 12 subjects were [p, b, m, t, n, ṭ, ḍ, ṇ, tʃ, dʒ, j, k, g, h, s, ʃ, v, h, l, r]. Among these, the glottal [h] was produced only by the older children. Stops, followed by nasals were the most frequently occurring manners of articulation. Glides and laterals also showed a relatively high frequency of occurrence. Occurrence of trills was negligible. In terms of place of articulation, bilabials [p, b, m] were the most predominant consonant type across groups, followed by dentals.

From the perspective of voicing feature, the voiced consonants present were [b, m, ḍ, n, v, l, r, ʤ, ṇ, and g] and the unvoiced consonants were [p, t̪, d̪, s, ṭ, tʃ, ʃ, k, ʧ and h]. In both groups, the percentage of voiced consonants largely exceeded that of the voiceless consonants although voiceless consonants increased in frequency in the older group.

With respect to positional variations in occurrence, bilabials occurred most predominantly in the initial position in both the groups. Dentals, alveolars, retroflexes, velars and palatals were more predominant in the intervocalic or the medial position in both age groups. Presence of consonants in the final position was minimal and they were primarily either borrowed words or onomatopoeic expressions.

An assortment of syllable shapes including both words and non words were found in the inventory of the participants with wide inter-subject variability. CVCV was the most commonly occurring syllable shape in both groups. The younger group primarily produced a variety of basic shapes such as CV, VCV, VCCV, while the older group produced much complex varieties such as VCVC, CVCVC, CVCVCV, CVCCVCV, CVCVCCV, and CVCVCVCV which were seldom seen in the younger subjects.

With regard to word shapes, bisyllabic words were the most frequent in both groups. All the word shapes increased in frequency with increase in age. Multisyllabic patterns were significantly higher in female subjects as compared to males.

Analysis of clusters revealed that clusters were present only in the medial position in both groups. Medial geminate clusters were higher compared to medial non geminate clusters. However, the frequency of occurrence of geminate clusters decreased slightly in the older group while non geminate clusters increased. In both the groups, non geminate clusters were primarily embedded in onomatopoeic expressions or non words. Protowords and holophrastic words occurred with a higher frequency in the younger group as compared to the older group.

An analysis of preferential occurrence of consonants with vowel (CV portion) revealed that Group 1 (18-21 months) presented a strong bilabial-central, coronal-central co-occurrence and dorsal-back co-occurrences while Group 2 presented a strong bilabial-central, coronal-front and dorsal-central co-occurrence.

Future directions

- A longitudinal study will provide greater information on the growth and variability exhibited by children during their second year of life.
- Studies can be conducted on a larger toddler population
- A cross linguistic comparison of the phonetic inventory in young children across major Indian languages can be carried out to discern the similarities and differences in the early phonetic repertoire.

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APPENDIX

True words produced by Group 1

Participants	Group 1(18-21 months)
	True words
1	/aṇṇa/, /amma/, /akka/, /bassu/, /pa:pu/, /kai/
2	/amma/, /baṭṭe/, /na:nu/, /adʒdʒi/, /siṭi/, /illi/, /ma:ma/, /appa/, /miṭai/, /papu/, /id̪u/, /a:ne/, /t̪at̪a/, /a:lu/, /ba:lu/, /bisi/, /ba:ji/, /ad̪u/, /anṭi/, /akka/, /mugu/, /papa/, /baj-baj/, /d̪uḍḍu/, /kæʧ/, /monne/, /illa/, /ka:lu/, /nenne/
3	/jelli/, /id̪u/, /papal/, /amma/, /bal/,/appa/, /ṭaṭal/, /a:ne/, /æpal/, /t̪a/, /bi:m/, /alli/, /ba/
4	/illi/, /amma/, /ajjo/, /a:lu/, /ja:ru/, /alli/, /ba/, /avva/
5	/bai/, /amma/, /jej/
6	/mammi/, /na:nu/, /ba:lu/, /ba:ji/, /uru/, /karu/, /koḍi/, /na:nu/, kalu/, /na/, ,ba/

True words produced by Group 2

Participants	**Group 2 (21-24 months)**
	True words
1	/a:ne/, bekku/, /ni:n/, /barIt̪a:jid̪a:ne/, /aṇṇa/, /tarka:rI/, /ba:t̪u/,/tʃapa:t̪i/, /a:ṭa/, /od̪ut̪a:id̪a:ne/, /kærʌṭṭu/, /mʌne/, /pa:rk/, /va:ʧ/, /hu:va/, /halluʤut̪a:ne/, /a:lu/, /t̪aṭṭe/, /loṭa/, /nagt̪a:ne/, /ba:ʧu/, /æpal/, /bʌrit̪a:ne/, /aʤʤi/, /a:nṭi/, /likit̪/, /amma/, /appa/, siṭi:ge/
2	/guṇḍi/, /amma/, /beku/, /ka:ru/, /bat̪t̪i/, /akka/, /balunu/, /va:ʧ/, /mugu/, /koḷi/, na:ji/, /bekku/, /gombe/, /id̪ond̪u/, /id̪ond̪u/, /illi/, /pa:pu/, /a:gojt̪/, /van/, /ṭu/
3	/amma/, /appa/, /munna/, /ba:lu/, /kai/, /aṇṇa/, /akka/, /ba/ /bukku/, /haṇṇu/, /ka:lu/
4	/kai/, /æpal/, /ba:l/, /bas/, /aṇṇa/, /ʧi:ṭa/, /amma/, /t̪a:ta/, /d̪uḍḍu/, /æpal/, /aṇṇu/, /banana/, /aʤʤi/
5	/band̪e/, /aṇṇa/, /ba:lu/, /ba:lu/, /gombe/, /illi/, /van/, /ṭu/, /sa:nid̪apa/, /akka/, /aʤʤi/, /ʤajamma/, /aṇṇu/, /a:ne/, /ma:ma/, /baṭṭe/, /d̪uḍḍu/, /pennu/
6	/amma/, /karu/, /ka:ge/, /mammi/, /anti/, aṇṇa/, /ba:ro/, /appi/, /na:ji/