EMERGING PHONETIC BEHAVIOUR OF HINDI AND MALAYALAM SPEAKING CHILDREN IN THE AGE RANGE OF 4 TO 12 MONTHS: A CROSSLINGUISTIC STUDY

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CERTIFICATE

This is to certify that the thesis entitled **"Emerging Phonetic Behaviour of Hindi and Malayalam speaking children in the age range of 4 to 12 months: A Crosslinguistic study"** submitted by Ms. Reeny Roy for the degree of Doctor of Philosophy (Speech-Language Pathology) to the University of Mysuru, was carried out at the All India Institute of Speech and Hearing, Mysuru.

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DECLARATION

I declare that this thesis entitled **"Emerging Phonetic Behaviour of Hindi and Malayalam speaking children in the age range of 4 to 12 months: A Crosslinguistic study"** which is submitted herewith for the award of the degree of Doctor of Philosophy (Speech-Language Pathology) to the University of Mysuru, Mysuru, is the result of work carried out by me at the All India Institute of Speech and Hearing, Mysuru, under the guidance of Dr. N. Sreedevi, Reader in Speech Sciences, Department of Speech Language Sciences, All India Institute of Speech and Hearing, Mysuru. I further declare that the results of this work have not been previously submitted for any degree.

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Abstract

The emerging phonetic characteristics of infants in the recent years have gained attention. Earlier studies have mainly focused on infants from 6 months onwards considering one or two phonetic behaviours such as vowels, consonants or complex utterances. Hence, the present study aimed to investigate the pre-linguistic phonetic characteristics of typically developing children of Hindi and Malayalam from 4 to 12 months of age. The study also established normative data for the emerging phonetic behaviours in infants of two linguistically diverse languages.

A total of 80 participants with normal development based on parental interview and screening checklists comprised of 40 participants in each of the two languages. The two languages consisted of four age groups 4:0 to ≤ 6:0, >6;0 to ≤ 8:0, >8:0 to ≤ 10:0 and >10:0 to ≤ 12:0 months included 10 participants of 5 boys and 5 girls. The participants were selected from Hindi and Malayalam speaking belts. A language free test- The Language Proficiency scale was administered on the parents to obtain proficiency of their native language.

Audio recordings were carried out and data extracted included types and frequency of vowels, diphthongs, consonants, simple syllable shapes, reduplicated-variegated babbles and early word forms. Analyses was carried out by transcription and data reduction, to consider the type of phoneme produced, calculation of various syllabic behaviours from simple monosyllables to complex syllabic structures, rank ordering them and establishing proto words/ true words. A 60% criteria was employed to indicate the phonetic behavior to be emerging (i.e 6 out of the 10 participants producing the phonetic behavior). The effect on gender, age and the two languages studied (Hindi and Malayalam) in the pre linguistic vocalizations and phonetic behaviour of infants was also analyzed.

No significant difference was observed between gender in the pre linguistic vocalizations and phonetic behaviour of infants in Hindi and Malayalam. Between the four age groups in the pre linguistic vocalizations and phonetic behaviour of infants in both languages it was seen that as age increased there was an increase in production for some of the phonetic behaviours (consonants, simple syllable shapes, complex babbles and early word productions). Vowels and diphthongs decreased with advance in age as more complex patterns emerged. The study also revealed some of the universal nature and native language effects in the two languages studied (Hindi and Malayalam) in the pre linguistic vocalizations and phonetic behaviour of infants. Stops emerged as early as four months and were high in frequency of occurrence in both languages which is similar to other language studies (Robb & Bleile (1994); Davis & MacNeilage (1995) in English; Kerns & Davis (2014) in Dutch, French, Romanian, Tunisian Arabic and Turkish; Shyamala & Basanti (2003) in Hindi and Kannada). In the present study it was also observed that voiced consonants predominated in Hindi infants and unvoiced consonants in Malayalam depicting native language effect.

From the findings of the study, it can be inferred that early emerging phonetic behavior in the two languages reveals similarities and differences in infant vocalizations. The findings obtained is applicable for speech language pathologists in clinical practices of children less than one year and also to predict and indicate infants at risk for communication developmental delays.

Keywords: Infant pre-linguistic vocalizations, emerging phonetic behavior/ babbling, Hindi, Malayalam, universal/ native features of babbling.

Chapter 1

Introduction

The biblical story of Noah's descendents, the ancient people of the earth in their pride decided to build a tower that could reach the heavens. God in His wrath confused the people, making it impossible for them to comprehend one another's speech. This confusion resulted in the tower being un built and the plain was called BABEL, to reflect different languages among the people (Genesis 11:9).

Babel is an inherited English word which is similar to the word babble which resembles speech- like sounds in infancy. In this context, babble presents unintelligible and chaos similar to the main languages, the builders of the tower presented. Babbling in infants provide an identity for reaching a goal for communication. Infant vocal behaviour and its importance have been flowering since mid-1970 during the Victorian period. The ancient scholars assumed that babbling was a precursor to speech. During the mid of 20^{th} century this view was reversed in the minds of scholars that there was no link between infant sounds and first words. However, the last quarter of the 20^{th} century established that babbling is a vital precursor to speech and attributed to the emergent complexity of early vocalizations (Oller, 2000).

Vocalizations in the first few months of infancy are seen as vital indicators of speech and language development. Verbal manifestations during the emergence of early speech pose a crucial marker in language development. To characterize the sounds, parents often imitate with the accents of their native language, adapting the baby sounds to their own mature phonology.

The process by which children learn their first language has fascinated people for centuries. Speech sound acquisition in a child's language refers primarily to the gradual mastery of speech sound form within a given language. During the first few months of an infant's life, the vocalizations produced, show greater divergence from the well formed adult speech. At around six months of age the infant reaches the babbling stage when the child engages in sound play by stringing together sequences of single sounds (Oller, 2000).

Babbling serves as practice for later speech. During babbling, infants are able to produce a variety of sounds that are not present in the native adult language but later sounds are molded in their native language. Irrespective of all cultures, children begin to babble producing long sequences of consonants and vowels. These form the impressive accomplishments in the child's ability to produce speech sounds and the ability to combine these sounds to form words.

1.1 Benchmarks on Phonetic Behaviour

The infant's cries and pre-vocalizations are perhaps the most obvious communicative acts. The study of the speech skills that an infant acquires before his or her first words began to flourish in the late 1970s and early 1980s (Oller, Wieman, Doyle, & Ross, 1976; Oller, 1980 Stark, 1986).

Oller (1980) studied on the phonetic behavior of American infants. She reported that during the phonation stage, between 0-2 months, infants produce quasi-resonant nuclei or quasi vowel sounds which are precursors to fully resonant vowels in the later stages. The gooing stage, between 2-4 months involves vowel sounds as well as sounds produced in the back of the oral cavity. During the expansion stage, 4-6 months infants produce sounds like raspberries, squeals, growls, yells, whisper, isolated vowel sounds and marginal babbles. In the canonical babbling stage, well formed syllables in reduplicated babbling sequences are formed. During the variegated babbling stage, at 10- 12 months, different CV units are produced in sequences.

Following Oller (1980), Stark (1986) also studied the early vocal behavior in American infants and classified early speech development into six stages. Stage I, between birth and 1 ½ months of age is characterized by reflexive vocalizations, vegetative sounds and cry. Stage II, between 1 ½ months and 3 months of age comprises cooing and laughter (pleasure sounds). In stage III, between 4 and 7 months is characterized by growling, squealing, yelling, production of noises and bilabial trills (vocal play stage). Stage IV, between 7 and 12 months, is the reduplicated babbling stage, in which each syllable is produced as similar to the other. In Stage V, between 10-14 months, non reduplicated babbling stage is characterized by the use of different consonant and vowel syllables in series. This stage is also known as the jargon stage, comprising of rich intonation and stress patterns like adult speech. The first words used as symbols or to refer to specific objects or events are produced in stage VI.

As in English, researchers have studied early phonetic behavior in other languages as well. Koopmans- Van Beinum and Van der Stelt (1986) in their study in Dutch infants based their descriptions on phonatory and articulatory movements during one breath unit. Stage I, birth - 1 ½ months is the stage where utterances are produced without any interruptions. In stage II, from +/- 1 ½ months, interruptions in phonation during productions of utterances are present. During stage III, from +/-

2 ½ months, productions of utterances are with one articulatory movement. In stage IV, from +/- 4 ½ months variations in phonation such as growls and squeals are present. During stage V, from +/- 7 months babbled utterances are produced. From stage VI, from +/- 12 months, first words are produced.

Studies by Oller (1980), Stark (1986), and Koopmans-van Beinum and Van der Stelt (1986) show considerable differences in spite of some similarities in onset and quality (content) of the babbling stages. Stages such as cooing and babbling are described in all the three studies. Thus, it seems that all infants go through the same stages roughly at the same ages. These stages and their timing can therefore be used as a starting point for comparing the development of vocalizations of typically developing infants.

1.2 Monolingual studies on phonetic behaviour

Variability in vowel and consonant patterns has been reported in both longitudinal and cross sectional studies as well. Davis and Mac Neilage's (1995) longitudinal study with 6 infants (3 males, 3 females) from monolingual English-speaking homes revealed much individual variability in the use of vowels. According to the tongue height dimension, mid vowels, particularly [^, Y and E], predominated in 3 subjects, while high vowels, particularly [u, Y and I], predominated in the remaining 3 subjects. In relation to tongue advancement, front vowels, particularly [E, Θ and I], predominated in 4 subjects, and the mid vowels [a, ^, ə], predominated in the remaining 2 subjects. The most commonly used vowels in the canonical babbling period were identified as [^, ə, E, ɛ, Y, I and Θ].

Another study by Hua and Dodd (1999) using picture naming and picture description tasks on 129 monolingual Putonghua speaking children, aged 12 to 44 months revealed the emergence of simple vowels during early development. Children acquired nasals before orals and stops before fricatives. The study also revealed that children acquired voiceless consonants such as /p/ and /t/ by 12 months. According to the authors the results are in par with Jacobson's (1941, 1968) law of irreversible solidarity that predicts nasals should be acquired before orals, front consonants before back consonants, and stops before fricatives.

A normative cross-sectional study by Topbas (1997) on 22 monolingual Turkish speaking children aged 12 to 33 months were carried out using the International Phonetic Alphabet of the recorded data. Vowels were not included in the analysis. Consonants such as plosives /b,d,k/ and nasal /m/ were found to be acquired very early before the age of 12 months. Fricatives /ʃ/, affricates /ʧ/ and /ʤ/ and liquid /ḷ/ were mastered after 1.8 years. This study indicated that fricatives are acquired late as compared to other phonemes in Turkish.

Karouson and Lopez-Ornat (2013) utilized parental reports of 1005 Spanish children aged 8 to 30 months to explore pre-speech development OF complex utterances. Parents reported that reduplicated babbling is already present at 8 to 9 months. In contrast, variegated babbling is produced from 8 to 17 months and early word forms are massively present by 12 months.

Rank ordering of multiple syllable structures, Stoel- Gammon (1989) study with ten infants at four month intervals from 6-18 months of age showed the following rank orderings: reduplication, place variegation, and manner variegation at 6-9 and 10-13 months; place variegation, manner variegation and reduplication at

14-17 months. Whereas, Mitchell and Kent (1990) found multi syllables in rank order as reduplication, manner changes, mixed place and manner changes and lastly place changes at 7, 9, and 11 months.

A study on context specificity in Korean babbling infants was carried out by Lee, Davis and MacNeilage (2007) on consonant–vowel association patterns. Coronal consonants were frequently associated with front vowels (coronal–front), labials occurred with back vowels (labial–back) and dorsal consonants preferred front vowels (dorsal–front). This shows the role of naturally occurring input to infants during canonical babbling in the appearance of ambient language-specific patterns. Chen and Kent (2005) observed other CV preferences such as velar central patterns that emerged before first year in infants from Mandarin speaking community and velar back patterns that predominated and emerged after the first year.

Prior to production of words, infants develop syllables, potential components of words (Koopmans-van Beinum & van der Stelt, 1986; Oller, 1980; Stark, Bernstein, & Demorest, 1993). When caregivers identify these babbled syllables, they begin to interact with the infant, treating them as potential words (Papoušek, 1994; Stoel-Gammon, 2011). As word learning begins, caregivers engage infants, recognizing babbled syllables and their potential relation with the ambient language. Some researchers believe that nouns are learned first because the word-object links that underlie them are more easily observable from the world, in contrast to verbs and closed class words (Gillette, Gleitman, Gleitman, & Lederer, 1999; Gleitman, 1990; Gleitman, Cassidy, Nappa, Papafragou, & Trueswell, 2005).

As cited in Gotzke and Goose (2007), during the 7- 9 month period, infants may produce protowords or phonetically consistent forms of vocalizations with consistent structures that do not resemble adult model (Menn & Stoel- Gammon, 2005; Sachs, 2005). These protowords may be recognized as an important step towards first words, as they depict infants to have some degree of voluntary control over the vocal mechanisms and to a certain degree understanding that sound sequences have unique meanings. Infants begin to produce consistent vocal patterns as early as nine months that function as words for the infants (Owens, 2001). It could be inferred that protowords have a somewhat stable sound and syllabic structure and its repeated productions could vary in form as infants are still developing control over their vocal mechanism.

1.3 Crosslinguistic studies on phonetic behaviour

Considering the fact that there were substantial differences among the early phonetic studies across languages, studies emerged on cross linguistic comparisons in this area. Many researchers were in favor of Slobin's (1986) opinion that cross linguistic study is necessary to explore and verify the basis of speech development and the strategies that operate to construct a concrete language. According to Maddieson (1984) on data –driven study of phonological complexity, segment inventories of consonants and vowels in 317 languages were obtained. In spite of the differences across these languages studied, the most typical vowel inventory was [i, e, a, o and u]. Consonants were mainly simple stops and nasals that were frequent in the world's languages.

1.3.1 Vowels

Cross linguistic studies on babbling behavior have shown dissimilarities for early vowel patterns. Oller and Eliers (1982) conducted a cross cultural study of babbling on infants reared in English –Spanish speaking environments in Miami. Vowels belonging to the sound inventory of Spanish were more frequent in the Spanish speaking group while the vowels in English were more frequent in the English speaking group. They found that vowel [æ] in particular had a frequency of 22.4% in English but only 13.5% in Spanish children. This study indicated that phonotactic patterns are necessary for cross linguistic comparisons.

Early phonetic behavior on vowel patterns were also studied using spectral analysis. De Boysson-Bardies et al. (1989) performed spectral analysis using formant measurements for vowels on 10 month old preverbal infants' drawn from four linguistic communities-Arabic, Chinese, English, and French, found that the categories of front-low and mid-central vowels accounted for the vast majority of vowels from all four groups. Acoustic analysis revealed characteristic patterns of vowel production for each group within those limits, however, with more high-front vowels for English, for example, and more low-back vowels for Chinese. The investigators interpreted these differences in vowel production to show that infants begin to position their lips and tongue in a manner specific to the language of their environment even before they produce word-forms modeled on adult speech.

An additional spectral analysis study by De Boysson –Bardies and her colleagues (1989) on vowels in preverbal infants of four different languages were carried out. The four languages were English, French, Swedish, and Japanese. They found that the infants matched vowel patterns of their own ambient language. These reports indicate that there are definite influences of the ambient language on the babbling behavior.

An acoustic study was carried out by Mattock, Rvachew, Alhaidary and Polka (2008) on the emergence of corner vowels [i, a, and u] in infants and the influence of ambient language on babbling. Formants F1-F2 were obtained from 51 Canadian infants (English learning infants [n=24] and French learning infants [n=27]) from 8 to 18 months. The listener judgments confirmed the peripheral expansion of infant vowel space towards diffuse and grave corners with age. A higher proportion of [u] in the English sample was observed throughout the age range suggesting the influence of ambient language at a young age.

A recent spectral study by Benner and Grenon (2011) examines the relationship between vowel quality and laryngeal constriction on Bai and English infants. Five infants (3 females, 2 males) were taken from English speaking families and 2 males and 3 females were taken from Bai (Tibeto-Burman) speaking families. They found Bai infants produced sounds with greater degree of constriction than English infants throughout the phonetic development signifying the ambient language effect.

1.3.2 Diphthongs

Diphthongs do play a vital role in phonological development. Lindau, Norlin and Svantesson (1985) found that diphthongs occur in approximately one-third of the world's languages. Ling (1989) stated that diphthongs frequently occur in children's early words. Studies on diphthongs are majorly reported in the adult population. A few studies have been conducted in the Indian context in children from 12 months onwards and are reported in section 1.4 of this chapter.

1.3.3 Consonants

Ingram (1989) suggested two possible explanations for unpredicted early occurrences of consonants. Ingram suggested that sounds heard most often are first to be acquired. According to “Articulatory learning theory”, the acquisition of /k/ and /h/ in Arabic could be due to most frequent occurrence in the language. Another explanation for the early acquisition might be its auditory saliency (i.e. the ease by which the sound can be perceived).

Complex sounds such as liquids (/l, r/) and consonant clusters are infrequent or are not present (Vihman, Macken, Miller, Simmons, & Miller, 1985). Locke (1983) illustrates the prevalence of consonants in an infant. He found all six stop consonants to be frequent, glides as well as the fricative /s/. The more common sounds with the exception of /h/, were all voiced. The voiced sound was normally present more often.

Consonants were also analyzed from babbling to the production of first words. De Boysson –Bardies and Vihman (1991) investigated consonants using phonetic transcriptions. Infants from four language communities of English, French, Swedish, and Japanese from the babbling stage till the point at which they acquired twenty five words were examined for consonants. Distribution of place and manner in the four languages were analyzed. They found that all the infants produced more labials, dentals among stops than any other types of consonants. However, there were changes seen in the production ability of the growing infant.

In another study by Levitt and Utman (1992) comparisons were done on one French infant and one English learning infant. They found that English learning infants showed higher frequencies of fricatives, affricates and nasals than French; approximants were more frequent in French than in English. Infant consonant inventory moved towards their own ambient language in composition and frequency; both infants showed a close match to the ambient frequencies at 5 months. The French child showed preferences for front low vowels and the English child preferred mid central vowels, consistent with frequency in their ambient language.

Consonant analysis by Kaung (2007) reported that bilabial [m] was the easiest sound to make with the ease of lip formation and was acquired first of the three bilabial stops [p], [b] and [m]. It is one of the most produced bilabial sounds produced by infants (Evans-Morris, 1998; Foster-Cohen, 1999; De-Boysson Bardies, 1999). Sounds [ḍ], [t] was acquired at 11 months as it was the most difficult sound. Glottal [h] was reduced in production as age advanced. Holzman (1997) described that glottal [h] was frequently produced by infants from 4 months onwards probably due to its ease of production which does not require any elaborate movements and as age advanced its production was concealed by the frequency of other consonants such as [b,ḏ,m]. Velar [k] was less frequently produced as it was difficult to produce (Godson, 2004) and also due to the insufficient input from the parents

1.3.4. Syllabic structures

In a typical utterance, consonants and vowels rarely appear in isolation but are produced serially. The combination of consonant-and vowel-like sounds is said to begin during 4 to 6 months. During the later babbling period, open syllables or syllables ending in a vowel are the most frequently occurring syllable shapes (Bauman-Waengler, 2000). Kent and Bauer's (1985) study revealed that V, CV, VCV and CVCV syllable structures accounted for approximately 94% of all the syllables produced at the end of babbling period. They also emphasized that closed syllables were found to be very limited in the repertoire of the infant at this stage of development.

Study by Kern and Davis (2009) on analysis of five additional languages confirmed the prediction for co-occurrence of reduplication and variegation. While both reduplication and variegation occurred, infants preferred to repeat the same syllable within utterances more than variegate or produce different consonants and/or vowels. Zlatic et al.(1997) found that twins in an English- Serbian bilingual input environment showed the same vocalization patterns documented for monolingual children (Kern & Davis, 2009).

1.3.5 Early word forms

Researchers have argued that there is only a noun-bias in noun-friendly languages, like English, and not in verb-friendly languages like Chinese and Korean. In Korean and Chinese, nouns can be dropped from the surface structure, leaving more bare verbs in the input to the child, and relatively fewer nouns, leading children to learn more verbs early on (Tardif, Fletcher, Liang, Zhang, Kaciroti, & Marchman, 2008; Tardif, Shatz, & Naigles, 1997). Benedict (1979) found that when infants appeared to know 10 words, at around 10 months, among those words were nominals, action words, and various social words.

Laakso, Marja-Liisa, Helasvuo, Savinainen-Makkonen and Tuula (2010) studied the patterns of protowords of typically developing Finnish children's interaction with parents. The study revealed that at the age of twelve months, children start to acknowledge or reject parental interpretations. The patterns consisted of acquisition of shared meanings embedded in the sequences of first proto-utterances and their interpretations in the course of daily activities at home. For gaze orientation or pointing gesture, the sequences of proto words varied according to the contexts as interpreted by the parents. They interpreted their findings that Finnish children's early words more often fall into a geminate template, (C)VCCV, with the initial consonant only an optional segment (Savinainen-Makkonen 2000, 2007), whereas in English, first words are usually structured as CVCV (Ingram 1999).

By the end of 10 to 12 months, most infants produce their first words (Owens, 2001 & Sachs, 2005). The first word may be the name of a toy, food or family member (Owens,2001) or may be a greeting, farewell or other social phrase such as peek –a-boo (Menn & Stoel-Gammon,2005). These first words may be used to gain attention. According to Pan (2005), first words tend to b similar for toddlers across cultures. The phase of initial production of words is referred to as "***The First Fifty Word Stage"***. This stage encompasses the time from the first meaningful utterance which is a ***true word*** at approximately one year of age to the time when the child begins to combine two words together at approximately 18-24 months of age. A 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 recognizably related to the adult like word form of a particular language (Owens, 1996).

1.4 Studies in the Indian Context

In the Indian context, a cross sectional study carried out by Shyamala and Basanthi (2003) reported that vowels in Kannada made their appearance during 6-12 months. In Hindi, only four vowels (/i/, /e/, /a/ and /u/) including their longer counterparts were seen. For consonants, the Kannada group had twelve consonants in their phonetic repertoire with higher frequency of stops and nasals. The Hindi group had fifteen consonants with additional sounds /t/, /s/ and /r/. The differences in phonetic repertoire could be observed across these languages.

Similarly, another cross-sectional study by Anjana and Sreedevi (2008) was carried out in Kannada from 6 months to 12 months of age with an age interval of one month. They found that vowel repertoire [I, e, æ, a, u, o] showed variability across age groups. Vowel [i] made more frequent appearances in all the six age groups compared to the other front vowels [e] and [ae]. The central vowel [a] made predominant appearance across all age groups. The back vowels [u] and [o] were lower in their frequency of appearance in all the age groups. The consonantal repertoire in the entire babbling period included 14 consonants /p, b, m, n, t̪ , d̪ ṭ , ḍ , h, k, g, l, j, v /, with stops and nasals exhibiting the highest frequency of occurrence in all the age groups. Results also showed that the voicing feature of consonants was acquired earlier than the unvoiced feature in the youngest group and as infants' transit from babbling stage to the first word stage they begin to produce more unvoiced consonants. Syllable structure CV was the most frequently produced syllable. Reduplicated utterances were high in its frequency of occurrence compared to the variegated utterances produced throughout the babbling period. Among the types of variegated utterances, manner variegation predominated towards the later stages of babbling.

Crossectional studies were conducted by Irfana (2012) and Alphonsa (2012) on the phonetic repertoire of eight Malayalam speaking toddlers with the former focusing on 12 to 16 months and the latter on 18 to 24 months. Results of both the studies on diphthongs /au/ and /ai/ were frequent in their phonetic repertoire. Similar findings were reported by Sushma (2013) and Shishra (2013) indicating the presence of /ai/ and /au/ in twelve Kannada speaking toddlers of age 1 to 1.6 years with /ai/ being more frequent.

A longitudinal study by Sreedevi and Jyoti (2013) was conducted in Kannada. They observed seven vowels [I, e, æ, a, u, o, ɔ] which were highly variable in frequency across the nine participants. Vowel data showed that the appearance of low vowels dominated from 3 - 12 months which were followed by mid vowels. There were eleven consonants in the entire corpus of the nine participants. According to the place of articulation, bilabials, dentals and glottals were predominant. Manner features such as stops, nasals and glides were mainly observed. Reduplicated utterances predominated over variegated utterances and manner variegation was present towards the first year.

In the Indian scenario, there are relatively few studies on the emergence of syllable shapes. A study of phonotactic development in Kannada by Rupela and Manjula (2006) with 30 Kannada speaking children in the age range of 0-5 years, divided into 9 age groups with 6 months interval revealed certain patterns of syllables. The various syllable shapes found in the samples analyzed were V, C, CV, VC, and CVC. CV syllables gradually increased in frequency of occurrence between 0-18 months. VC syllables were found to occur occasionally at 12 months and gradually increased in frequency by 54-69 months. CVC syllables were reported to occur at 12 months, increasing in frequency by 54-60 months.

A study on early word forms in Kannada learning children by Shishira, Sushma and Sreedevi (2014) reported holophrastic and protowords productions were found in all the participants of the younger age group of 12 to 18 months, with their frequency declining in the older age group of 18 to 24 months. True word productions showed the opposite trend of that of holophrastic and protowords, with their frequency being greater in the older age group compared to the younger age group. This finding signaled progressions in expressive vocabulary growth with advancing age.

1.4.1 Frequency of occurrence of phonemes in adults

Studies on frequency of occurrence of phonemes in adult conversations in the Indian context are recorded, Ramkrishna, Nair, Chiplunkar, Atal, Ramchandran, & Subramanian, (1963) studied the relative frequencies of various speech sounds in some of the Indian languages in adult speakers. A sample of 20,000 speech sounds was analyzed in seven languages namely English, Hindi, Malayalam, Marathi, Tamil, Telugu and Kannada. The percentage frequency was thus obtained for each speech sound. Hindi had a high percentage frequency for consonant /k/ followed by dental /t̠/. Dental /t̠/ had the highest percentage frequency in Malayalam. Occurrence of voiceless sounds was more than their voiced counterparts in all the languages.

Similarly, Sreedevi and Irfana (2013) conducted a study on the frequency of phonemes in adult Malayalam speakers. Fluent adult native speakers of Malayalam in the age range of 30 to 55 years were taken for the study. A total of 101 participants out of which 47 were males and 54 were females, participated in the study. The results revealed a predominance of vowel [e] and consonant /k/ in conversation samples. These studies however are related to the frequency of phonemes in the infants' late linguistic period of acquisition of the adult ambient language.

Research on diphthongs are reported in some adults spoken languages (Kumari, 1972 & Punnose in Malayalam , 2010; Watson, 2007 in Liverpool English; Kerswill, Torgesen & Fox,2006 in British Carribbean English; Leimgruber, 2009 in Singapore English). The occurrence of closing type of diphthongs was majorly reported. The presence of closing dipthongs in many of the languages has indicated its universal nature.

1.5 Babbling as a predictor and indicator for language development

Recent research focusing on infant speech development, has repeatedly documented that babbling is not a random behavior, all possible sounds are not produced during the babbling stage, and the transition between the babbling and the first words is not abrupt but continuous (Bauman-Waengler, 2000). Researchers have supported the fact that babbling is a predictor of language complexity as well as an indicator of language delay. Some studies have indicated a correlation between complexity and amount of babbling with later language proficiency (Camp, Burgess, Morgan, & Zerbe, 1987; Stoel- Gammon, 1989; Whitehurst, Smith, Fischel, Arnold, & Lonigan, 1991; Thal, OroZ, & McCaw, 1995; Mirak & Rescorla, 1998).

Reduced/delayed babbling or an abnormal vocalization development might be related to an abnormal spoken language development. Jensen, Boggild-Andersen, Schmidt, Ankerhus and Hansen (1988) studied the development of infants who were at risk for a developmental delay (low birth weight, low Apgar score, neonatal cerebral symptoms) and compared them to infants not at risk. The infants at risk produced significantly fewer consonant-like segments and less reduplicated babbling than the children not at risk. A larger proportion of the children at risk also scored below age level on a language test. Hence, Oller, Eilers, Neal and Cobo-

Lewis (1998) argue that a late babbling onset might possibly function as an early marker of abnormal development. Westermann and Miranda (2004) support these findings by indicating there is growing evidence that the pre-linguistic stage significantly influences the development of phonology.

Canonical babbling onset has also been studied extensively in a number of populations of infants who had disorders of communication. Oller et al. (1985) has documented that the canonical babbling of children with severe to profound hearing losses differs significantly from that of normal hearing children, the variety of phonemes used is reduced and the volume of babbling is reduced. These studies clearly indicate a connection between vocalizations, babbling in particular, and later language development.

Hence, the literature on early phonetic repertoire or babbling has shown the similarities and differences in the vocal behavior across various languages of the world. It is also recognized that the complexity of vocal utterances increase towards the later babbling stages. Most studies reveal that babbling has universal features and native language features as well. Research on babbling, reported in Indian languages are limited and have not been explored cross linguistically in detail.

1.6 Need for the study

In the recent years, speech language pathologists need to evaluate the vocal acquisition of increasing numbers of children even less than one year of age. A major difficulty in carrying out these assessments is the lack of norms for typically developing children in this pre linguistic stage. In the present scenario the challenges of providing services to a linguistic and cultural diverse population like India is manifold by the increased awareness and education of \parents as they are sensitive to even the child's early speech development. Studies on infant vocalizations report that early laryngeal vocalizations such as vegetative and reflexive sounds are differentiated from "speech like" vocalizations after the first trimester in life. Findings also suggest that infants gain increasing control over speech mechanism resulting in increased vocal play from 3-4 months onwards which continues beyond the first year of life. Investigating the phonetic behavior as early as 4 months would present the emerging patterns of vowels and consonants providing an insight to the phonetic and phonotactic patterns in the developing phonological system. Hence the present study intends to study the vocal behavior of infants from 4 – 12 months of age which is a significant phase of the pre-linguistic period.

Research findings have indicated that pre-linguistic vocalizations to a large extent depend on the native language as every language has its own phonotactic patterns. A number of cross linguistic studies have looked at the sound repertoire and syllable shapes used by infants in the babbling stage in several non Indian languages. Studies in this direction have been limited in the Indian context. Hence the present study is planned to explore the similarities and differences in the babbling characteristics of two major Indian languages, Hindi and Malayalam, using a cross-sectional design. These represent two linguistically diverse language families of India with specific phonotactic rules and differences in language structure. Therefore, the research question addressed is to investigate the early phonetic characteristics of infants with a native language background of two language families i.e Indo- Aryan and Dravidian; Hindi and Malayalam respectively from 4 to 12 months of age using a cross-sectional study.

1.7 Research Design

Developmental/ Normative research was employed by the researcher to sample the early linguistic vocalizations and phonetic repertoire in infants in both the languages, Hindi and Malayalam. The advantage of this type of normative research is to observe the distribution of the dependent variables across and within the age groups in typically developing children. The present study intended to measure the features of the sample representing the normal population, in a cross-sectional design. The design demands the use of purposive random sampling and the willingness of families of infants to participate in the study.

The data obtained was both qualitative and quantitative in nature. Hence, statistical methods were used to extract and interpret the findings. Qualitative analysis was utilized in determining the speech sound inventory, and syllable structures. On the other hand, quantitative analysis was used to determine the frequency of production of specific speech sounds and syllable structures. In addition, a quantitative measure was also used for within and across group comparisons in both languages.

1.8 Aim of the study

The aim of the study is to investigate the pre-linguistic phonetic characteristics of typically developing children of Hindi and Malayalam from 4 to 12 months of age.

1.9 Objectives of the study

Early linguistic vocalizations and phonetic repertoire in infants between the ages 4:0 to ≤ 6:0, >6;0 to ≤ 8:0, >8:0 to ≤ 10:0 and >10:0 to ≤ 12:0 months in Hindi[1] and Malayalam[2] languages were studied. The main objectives of the study were

1. To compare the pre-linguistic vocalizations and phonetic repertoire across gender within the languages Hindi and Malayalam.
2. To compare the pre-linguistic vocalizations and phonetic repertoire across age within the languages Hindi and Malayalam.
3. To compare the pre-linguistic vocalizations and phonetic repertoire of infants between the two languages studied (Hindi and Malayalam).

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[1] India is a multilingual country having four distinct linguistic communities. These families include Indo Aryan, Dravidian, Tibeto-Burman and Austro-Asiatic. Hindi belongs to the Indo Aryan family of languages which is a sub group of the Indo European language. According to 2011 census, Hindi is spoken natively by 422,048,642 speakers which is the largest number of speakers of any languages in India. There are ten vowels / i , i: , e: , æ:, ə, a:,u,u:,o: ,ɔ:/ in Hindi. The front vowels include / i , i: , e: , æ:/,central vowels /ə, a:/ and the back vowels are /u, u:, o: ,ɔ:/. There are twenty one stop consonants in Hindi. Nasals include /m, m', m and n/. There is only one lateral /l /. Trills include /r, R, Rh /. Fricatives include /f, ṣ, s, z, h/ and semi vowels /v, ɹ/ in the adult language.
Hindi is a SOV language.

[2] Malayalam belongs to the Dravidian family of four major languages with a rich literacy tradition. According to 2011 census, Malayalam is spoken by 33,066,392 people, primarily in the state of Kerala. Malayalam language consists of eleven vowels. The front vowels are /i, i:, e, e:/. The short vowels are /I and e/ and the long vowels include /i: and e:/. The central vowels are /ə, a and a: / and the back vowels /ɔ and ɔ:/There are sixteen stops present in Malayalam. Nasals include /m, ṃ m, n, n, N, n,ɳ/. Three laterals are /l, L, ḽ/. Trills are /r/ and /ṛ/. Fricatives include /s, ṣ, ṣ, ʃ, h/ and semi vowels /v and ɹ/.

The consonant inventory consists of thirty-eight phonemes. A wide range of retroflex and nasal articulations characterize the Malayalam consonant system. Concerning the vowel system, length is contrastive and four diphthongs or vowel clusters occur. The syllable structure of Malayalam is given by the following (items in parentheses are optional): (C)(C)(C)V(C). Malayalam is also a SOV language. **http://www.lmp.ucla.edu**

1.10 Hypotheses

1. There is no significant difference between gender in the pre linguistic vocalizations and phonetic behaviour of infants in Hindi and Malayalam.
2. There is no significant difference between the four age groups in the pre linguistic vocalizations and phonetic behaviour of infants in both languages.
3. There is no significant difference between the two languages studied (Hindi and Malayalam) in the pre linguistic vocalizations and phonetic behaviour of infants.

Chapter 2
Review of Literature

The process by which children learn their first language has fascinated people for centuries. Speech sound acquisition in a child's language and refers primarily to the gradual mastery of speech sound form within a given language. During the first few months of an infant's life, the vocalizations produced, show greater divergence from the well formed adult speech. Newborns make simple cooing vocalizations which may be precisely coordinated with similar sounds made by an adult imitating sensitively (Malloch, 1999). At around six months of age the infant reaches the babbling stage when the child engages in sound play by stringing together sequences of single sounds.

Babbling serves as practice for later speech. During babbling, infants are able to produce a variety of sounds that are not present in the native adult language but later sounds are molded in their native language. Irrespective of all cultures, children begin to babble producing long sequences of consonants and vowels. These form the impressive accomplishments in the child's ability to produce speech sounds and the ability to combine those sounds to form words.

Much of the literature on early vocalizations is on languages like English, Spanish, French, and Cantonese etc. Development of vocal acquisition studies are mainly based on young children above two years. As language based influences are present even in early vocalizations, there is a need to study the emergence of vocal acquisition in Indian languages also. India is a multi lingual country with four distinct language families- Indo European, Dravidian, Tibeto- Burman and Austro-

Asiatic. Hence, there is a need to study the cross linguistic phonological aspects during the early vocal acquisition in two diverse languages of India.

The review of literature is organized and presented as follows

1.0 Determinants of early phonetic vocalizations

1.1 Subsystems in infant vocal productions.

1.2 Perceptual input for vocal productions.

2.0 Development of early phonetic characteristics in typically developing infants

2.1 Studies on babbling in the Indian Context

2.2 Studies on frequency of phonemes in adults

3.0 Longitudinal and cross sectional methods

4.0 Cross linguistic investigation and the influence of native language.

5.0 Vowels and Diphthongs as a function of age

6.0 Consonants as a function of age

7.0 Syllable structure as a function of age

8.0 Common trends in babbling

8.1 Early native language effects in babbling

8.2 The transition period: from babbling to meaningful speech

8.3 Babbling as a predictor of early language complexity

8.4 Late babbling a predictor of language delay

8.5 Phonetic features in other languages.

2.1.0 Determinants of early phonetic vocalizations

The early determinants of vocalizations are the respiratory system, phonatory system and the articulatory system. Normal subsystems in a human infant would suggest normal production system. The second locus of language learning would be the perceptual input from the environment. The differences in the quantity and form of input by social interactive partners have led to a large variability in timing as observed in typically developing children's language acquisition (Gathercole & Hoff, 2007). Other examples of determinants are cognition, internal feedback, parent-infant interaction, speech and language input and auditory speech and language processing. Some studies focus on the impact of the motor development, such as anatomy and neurology, on vocalization development (MacNeilage & Davis, 2001), while others focus on the influence of hearing (Locke & Pearson, 1990; Oller, 1980, 2000).

2.1.1 Sub systems in infant production

2.1.1.1 Development of anatomy and physiology of speech organs

The development of the structures for speech and its movements in infants differ from an adult as shown in Fig. 2.1. The differences include:

(1) High placement of the larynx, resulting in shorter vocal tract

(2) Shorter pharyngeal cavity which leaves little space for the posterior portion of the tongue to maneuver

(3) A larger tongue in relation to the size of the oral cavity resulting in lesser distinct movements of the tongue blade

(4) A gradual bend rather than a right-angle in the oropharyngeal channel and a close approximation of the velopharynx and epiglottis, allowing for little oral exhalation without mouth opening (Stark,1980; Kent,1981).

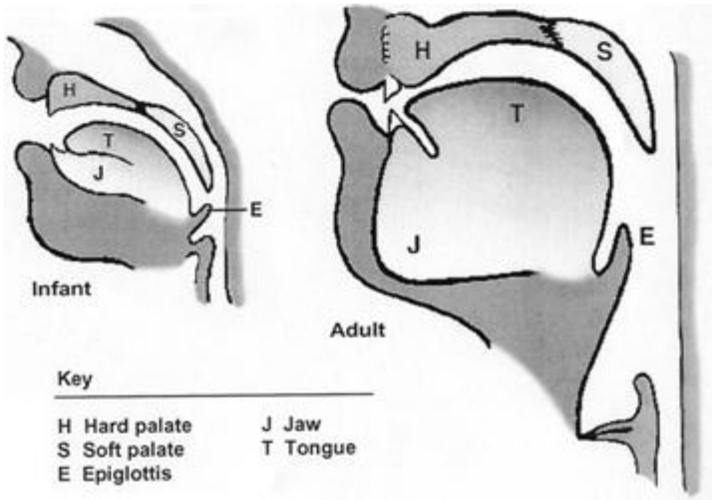

Figure 2.1 Vocal apparatus of an infant compared with that of an adult.
(From: Christina J C. 2004. *Development of vocalizations in deaf and normally hearing infants*. Utrecht: The Netherlands.)

The anatomical differences itself mark the infants vocal productions. For example, the size and placement of the tongue in relation to the oral cavity causes limited production of vowels. Bowman (1971) suggests that there is an orderly development of neuromusculature of the tongue during infancy development. A similar situation exists for the neuromuscular control of the lips such as /u/, which cannot be produced without the necessary neuromuscular control to protrude and round the lips. While there is still evidence of sucking behavior (Whitaker, 1973) which is not still very clear to what extent the activity is under voluntary control. The neuromuscular control infants may indicate the restructuring of the vocal tract during the course of development. For the occurrence of vowels /i/, /ɛ/, /e/, the observations suggest that they are soley by the manipulation of jaw position, hence requiring the development of jaw musculature (Linblom & Sundberg, 1969). The close relationship of the laryngeal and velopharyngeal cavities leads to increase nasal breathing and nasal vocalizations. The airstream moves more through the oral cavity than the nasal cavity when the infant is around two-three months. This is because of the active use of the muscles of the velum. The airstream between the articulators of the velum and tongue vibrate producing back trills or fricative like sounds during the cooing or gooing stage. By the age of three months, the rib cage has restructured more like the adult configuration (Langlois, Baker & Wilder, 1980). During this age, infants can produce a higher subglottal pressure and have a better control of duration and F0 of their utterances. At around four to six months, the mandible grows downwards giving space for the tongue to move, the air passes through the oral cavity causing the velum and the tongue to vibrate. According to Nishimura, Mikami, Suzuki and Matsuzawa (2003) during the same age period the larynx descends and contributes to increase in the processes of phonation and articulation for vocalizations. The jaw moves freely up and down at around seven months. This rhythmic up and down movement of the jaw normally during voicing results in reduplicated or canonical babbling. The Frame – Content hypothesis proposes that the tongue does not move independently from the jaw within the syllables but remains in the same position for the consonant closure and the open or vowel portions of rhythmic cycles. Within syllable consonant -vowel characteristics are based on these rhythmic jaw close open close cycles without independent movement of articulators independent of the jaw (Mac Neilage & Davis, 1990; 2000).

Babbling and words are goal directed behaviors that require respiratory drive for phonation. Studies have reported on tidal breathing and speech related breathing that emerged concurrently in infants (Boliek, Hixon, Watson, & Morgan, 1996; 1997; Connaghan, Moore, & Higashakawa, 2004). The voluntary sounds produced by infants are precursors to speech and breathing related to such utterances are designated as speech related. Only a few studies have reported the use of kinematic measures in infants.

Studies have shown that speech with increased respiratory drive and vocal intensities is associated with faster articulatory speeds (Huber & Chandrasekaran, 2006; Tasko & McClean, 2004). Ignatius, Jordan and David (2009) conducted a longitudinal study on the development of orofacial movements during early stages of communication development from 9 to 21 months. They identified differences in kinematic orofacial behaviours. The findings of the jaw and lower lip closing speeds during silent spontaneous orofacial movements were significantly slower than those producing words. These findings were similar to investigations by Moore, Caulfield, and Green, (2001) in which the patterns of coupling during rest and speech breathing in toddlers are fundamentally different for rib cage and abdomen movements and similar for rib cage volumes and volume excursions (Boliek, Hixon, Watson, & Morgan, 1996). Parham, Buder, Oller and Boliek (2011) also did not detect statistically reliable differences in breathing between unarticulated syllables and canonical syllables. The findings suggest the reason may be due to in extensive data or to the requirement of delicate procedures to detect them. If respiratory kinematic behaviours are more speech like for canonical syllables, then this may be due to global reorganization of speech mechanism with the onset of canonical babbling. Hence, if breath support for babbling is indistinct from the unarticulated syllables, then this would suggest development of speech like articulation proceeds without requiring respiratory behavior during canonical babbling.

Four month old infants produce vowel sounds as they hear, illustrating an early vocal imitation (Khul & Meltzoff, 1982, 1996). At about 7 months, infants begin canonincal babbling (Davis & MacNeilage, 1995; Oller 2000); their mandibles open and close rhythmically, while their vocal folds vibrate. In infants, during canonical babbling, the only active articulator is the lower jaw. Later on, development of babbling onset to appearance of first words and until a completely mature control of the vocal tract involves a control of sequences of mandibular ossicilations (Green, Moore, & Reiley, 2000), of the movements of the articulators carried by the cycle independently one of each other (Green, Moore, Higashikawa & Steve,2000; Munhall & Jones,1998), and of the full shape of vocal tract (Sussman, Duder, Dalston and Cacciatore, 1999), to master sounds and sequential patterns of the ambient language (Abry, Cathiard, Vilain, Laboissiere, & Schwartz, to appear; Nittrouer,1993).

2.1.2 Perceptual Input for vocal production

2.1.2.1 Development of auditory speech and language processing

During the first years of life, infants prefer and recognize their native language especially with respect to prosody. The perceptual development of prosody influences infant production during the early months of life. Though studies (Jusczyk, Friederici, Wessels, Svenkerud & Jusczyk, 1993) indicate that language specific influences appears around 9 to10 months for consonants and 6 months for vowels. Infants do prefer native over non-native phonotactic sequences by 11 months. The exact age at which this effect starts is not known, but it can be assumed that it occurs during the early months of life.

Study by Whalen, Levitt and Wang (1991) found differences in intonation patterns of French and English learning infants between 6 and 12 months. The French infants had an equal percentage of rising and falling intonation patterns whereas the English infants had falling patterns. This can be attributed that auditory speech and language processing occurs during the first years of life. Mampe, Friederici, Christophe and Wermke (2009) suggested that infants show language specific patterns. Prosodic patterns were compared between 30 newborns (born to French monolingual families) and 30 newborns (born to German monolingual families). The newborns were 3.45 day age on an average. The French infants had an increase in the rising melodies and the German infants had falling contours. Hence, development of prosodic perception occurs as early as prenatally in their respective native language environments. The infants' vocalizations of cooing/gooing which occur during the first few months can be related to auditory speech and language processing. .

Preference for the native language was also measured with head-turning experiments at a somewhat later age: at six and nine months of age (for prosody) and at nine months of age (for segmental information) (Jusczyk et al., 1993). For instance, in case of Norwegian and English, languages with a different prosody, infants preferred their native language at six months of age, even if the segmental information was distorted (Jusczyk et al., 1993). The sensitivity for prosody in the first months of age was also shown by the experiment of Jusczyk (1998) in which four and a half months old English infant preferred prosodic complete sentences above sentences with a distorted prosody. Hence, the perceptual development with respect to prosody influences the production of vocalizations already within the first months of life.

2.1.2.2 Parent-infant interaction and spoken language input

The fundamental factor in early speech and language development is the language input and the interaction of parents with their infants. Interaction in the early years of life of an infant is important. The quality and quantity of parent-infant interaction and its influence on speech and language development has been studied (Huttenlocher, Haight, Bryk, Seltzer & Lyons, 1991). It was also found that syllabic utterances were elicited by 3 month old infants due to parent interaction (Bloom, 1988; 1998). Sandner (1981) found imitation of the duration and pitch of maternal utterances in a three-month-old infant. Therefore it can be assumed that vocalizations can be produced somewhat more intentionally and is elicited through parent-infant interaction. These patterns obtained during babbling could provide a retrospective view into Khul's native language magnetic model (Khul & Meltzoff, 1996). Khul's theory suggests that native language skills improve towards the end of the first years of life showing continuity between early phonetic measures and later language skills. Environmental and social factors like age of the mother, education of the parents, socio-economic status may influence parent infant interaction and thus indirectly affect speech and language development. Lower socio-economic status and poor education have affected speech and language development negatively (Smith & Swank 2000).

In a series of experiments (De Boysson-Bardies& Vihman, 1991) the effect of environmental languages have been studied. Though it was found that adult spoken language varies in frequency in the types of sounds, it can be assumed that prosodic information of the environmental languages becomes apparent during the cooing stage and segmental features appear during the babbling stage.

2.1.2.3 Cognition

Mc Cathren, Yoder and Waren (1999) studied vocalizations and early word productions in older mentally challenged infants from 17 to 34 months old. The results showed that children with cognitive delay produced fewer utterances, 39.5 on an average during 10 minutes compared to normal developing infants. This study did comprise of a control group with normal children, thus exact comparisons were not made. However, the results did show cognition had an effect on vocalization development.

In studies on the onset of babbling and cognitive development in infants with Down syndrome and normal developing infants between 3 to 21 months respectively and 3 and 15 months by Smith and Oller (1981), it was concluded that the level of cognitive development had no effect on place of articulation of consonants since both the groups produced the same place of articulation during the same period. Whereas, in another study by Steffens, Oller, Lynch, Levine, Basinger and Umbel (1992) on children with Down syndrome, babbling started two months later. There was significant correlation on the age of onset of babbling with the test of social and communicative behaviours at 27 months of age. It can be concluded that cognition probably affects the age at which babbling starts.

Studies on cognition in Down syndrome may not be the best population to study since there might be associated neurological disorders as well as the anatomical changes in the speech organs (relatively large tongue) on the onset of babbling. Much of the studies do not contain the younger group of infants, as cognitive tests are difficult to perform and are not reliable within the first years of life. Cognition might have an influence on vocalizations from the cooing or one articulatory movement onwards but the exact age is unclear.

2.1.2.4 Internal feedback

The capability of the child to control his/her speech and language productions through auditory, tactile, kinesthetic and proprioceptive feedback is a system developed which is known as the internal feedback. Studies on tracheostomitized infants revealed poor phonological development in later stages of life. Kamen and Watson (1991) found that children who were tracheostomitized before twelve months of age, even after a year of decannulation produced vowels with restricted vowel space. Kertoy, Guest, Quart, and Lieh-Lai (1999) also found of the six infants who had undergone tracheostomy before the age of eight months, five infants had phonological delays such as strident deletion, deviance in vowel formants and cluster reductions, even after speech training. These studies suggest that though the children had normal hearing, normal speech input there was lack of internal feedback for spoken language. Vocalizations are important for internal feedback in infants' speech production (Fry, 1966). However, it is still unclear what influence the internal feedback has on infant vocalization and at what age is internal feedback influences vocalization development. It may be assumed that it may begin as early as the cooing or one articulatory movement stage. Several factors may contribute to the perceptual input for the development of infant vocalizations. However, the exact age is unclear but the influences of these factors may begin as early as two months, the cooing, gooing or one movement articulatory stage.

2.2.0 Development of early phonetic characteristics in typically developing infants

The infant's cries and pre-vocalizations are perhaps the most obvious communicative acts. The study of the speech skills that an infant acquires before his or her first words began to flourish in the late 1970s and early 1980s (Oller, Wieman, Doyle, & Ross, 1976; Stark, 1978; 1980). Children begin to vocalize and verbalize at different ages and at different rates to learn their native language, a highly complex and abstract symbol system, without conscious instruction from the parents or caretakers. Locke (1983) compared published reports of developmental phonological patterns from a range of languages and concluded that children do display many similar sound patterns and noted language specific differences.

Stages in the process of normal speech development in the first years of life have been documented by Oller (1980), Stark (1986), Mowrer (1980), Roug, Landberg and Lundberg (1989) and Koopmans-van Beinum and Van der Stelt (1986, 1998). Few of them referred in literature are as follows

Oller (1980) also studied on American infants. The phonation stages, between 0-2 months, infants produce quasi-resonant nuclei or quasi vowel sounds which are precursors to fully resonant vowels in the later stages. The gooing stage, between 2-4 months involves vowel sounds as well as sounds produced in the back of the oral cavity. During the expansion stage, 4-6 months infants produce sounds like raspberries, squeals, growls, yells, whisper, isolated vowel sounds and marginal babbles. In the canonical babbling stage, well formed syllables in reduplicated babbling sequences are formed. During the variegated babbling stage, 10- 12 months, different CV units are produced together.

Stark (1986) in her study on American infants classified early speech development into six stages. Stage I, between birth and 1 ½ months of age is characterized by reflexive vocalizations, vegetative sounds and cry. Stage II, between 1 ½ months and 3 months of age comprises cooing and laughter (pleasure sounds). In stage III, between 4 and 7 months is characterized by growling, squealing, yelling, production of noises and bilabial trills (vocal play stage). Stage IV, between 7 and 12 months, is the reduplicated babbling stage, in which each syllable is produced as similar to the other. In Stage V, between 10-14 months, non reduplicated babbling stage is characterized by the use of different consonant and vowel syllables in series. This stage is also known as the jargon stage, comprising of rich intonation and stress patterns like adult speech. The first words used as symbols or to refer to specific objects or events are produced in stage VI.

Koopmans- Van Beinum and Van der Stelt (1986) in their study in Dutch infants based their descriptions on phonatory and articulatory movements during one breath unit. Stage I, birth - 1 ½ months is the stage where utterances are produced without any interruptions. In stage II, from +/- 1 ½ months, interruptions in phonation during productions of utterances are present. During stage III, from +/- 2 ½ months, productions of utterances are with one articulatory movement. In stage IV, from +/- 4 ½ months variations in phonation such as growls and squeals are present. During stage V, from +/- 7 months babbled utterances are produced. From stage VI, from +/- 12 months, first words are produced.

Table 2.1 represents the stages in speech development according to the above three authors: Stark (1986), Oller (1980), and Koopmans-van Beinum and Van der Stelt (1986). These three studies show considerable similarities in spite of some differences in onset and quality (content) of the stages. Stages such as cooing and babbling are described in all the three studies. Thus, it seems that all infants go through the same stages roughly at the same ages. These stages and their timing can therefore be used as a starting point for comparing the development of vocalizations of typically developing infants.

Table 2.1
Stages in speech development

Stark (1986) (English)	**Oller (1980) (English)**	**Koopmans-van Beinum and Van der Stelt (1986) (Dutch)**
Reflexive (0- 1 ½ months)	Phonation (0-2 months)	Uninterrupted phonation (0-1 ½ months) Interrupted phonation (1 ½ - 2 ½ months)
Cooing (1 ½ – 3 months)	Gooing (2-4 months)	One articulatory movement (2 ½ - 4 ½ months)
Vocal play (4 – 7 months)	Expansion (4-6 months)	Variegated phonation (4 ½ - 6 months)
Reduplicated babbling (7-10 months)	Canonical babbling (7-10 months)	Babbling (7 – 12 months)
Nonreduplicated babbling (10-14 months)	Variegated babbling (10-12 months)	
First words	First words	First words

2.2.1 Studies on Babbling in the Indian Context

In the past, there have been numerous studies on the speech sound acquisition during the pre-linguistic period in the western context. In the Indian context such findings are relatively limited. However, there are some studies on phonetic inventories of infants carried out in some of the Indian languages.

A study by Shyamala and Basanthi (2003) in Hindi and Kannada on the developmental milestones of language acquisition revealed that vowels in Kannada made their appearance during 6-12months. Long vowels /i/, /e/ and /o/ were not present in all the subjects. In Hindi, only four vowels (/i/, /e/, /a/ and /u/) including their longer counterparts were seen. The Hindi group had a repertoire of fifteen consonants with additional sounds /t/, /s/ and /r/. The Kannada group had twelve consonants with higher frequency of stops and nasals. Glides and glottal fricatives were less frequently occurring.

Rupela and Manjula (2006) studied the phonotactic 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 natural interaction with 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 method of International Phonetic Alphabet (IPA). The samples of young children i.e. those from 0 to 18 months were analyzed for their vocalization and imitated utterances. Results showed that CV syllables were the most commonly occurring syllable shapes compared to VC and CVC. CVC syllables were reported to occur at 12 months and increasing in frequency by 54-60 months. Disyllabic words appeared at 6-12 months, becoming predominant by 18 months.

Anjana and Sreedevi (2008) conducted a cross sectional study on babbling in Kannada in the age range of 6-12 months with 30 infants under 6 groups. The vowel repertoire consisted of /i, e, æ, a, u, o/. Among the high vowel the frequency of occurrence of [i] was higher across age groups compared to [u]. Vowel [a] was higher than [ae] among the low vowels. Mid vowels made fewer appearances across all age groups. Vowel [i] made more frequent appearances in all the six age groups compared to the other front vowels [e] and [ae]. The central vowel [a] made predominant appearance and the back vowels [u] and [o] were lower in their frequency of appearance in all the age groups. The developmental trend in the occurrence of certain vowels is evident in these studies like high occurrence of [e] in 6-7 months age range and it declined at 11-12 month though not linearly. The consonantal repertoire in the entire babbling period included 14 consonants /p, b, m, n, t̪ , d̪ ṭ , ḍ , h, k, g, l, j, v /, with stops and nasals exhibiting the highest frequency of occurrence in all the age groups. Continuants emerged at 9-10 months, lateral and glottal fricatives had the least occurrence compared to other consonants in all age groups. Bilabials were most predominantly occurring consonant types across all the age groups. Glottal /h/ was higher in the youngest group of 6 – 7 months. Glottals were rarely found between 7-12 months. Results showed that the voicing feature of consonants was acquired earlier than the unvoiced feature and as infants' transit from babbling stage to the first word stage; they begin to produce more unvoiced consonants. The syllable shapes found were V, CV, CVC, VC and VCV and the mean occurrence of multisyllabic words increased with age. For multisyllables, they explored the phonetic variation with increase in age. They found the phonetically non-varied multisyllable babbles were predominant from the age of 6 -9 months. The phonetically varied multisyllable babbles made their first appearance at 8-9 months. It was found in this age group, only two infants demonstrated variegated babbling, which was characterized by place variations such as [badaba]. The occurrence of variegated babbling increased in the 9-10 month group. In the 10-11 month group, place variations occurred more frequently. A combination of place and manner variations occurred more frequently than place or manner variations alone in 11-12 month age group.

The Indian studies, focused on developmental aspects of speech and language and have included children between the ages 0-5 years. These studies have not accounted for the frequency of occurrence of vowels and consonants in the phonetic repertoire. Only one Dravidian language, Kannada has been studied in some detail which showed several findings of interest (Sreedevi & Jyothi, 2012) in Kannada infants as early as 3 months to 1 year, wherein reduplicated and variegated babbling continued to dominate towards the later stages of babbling. The reduplicated babbling exceeded variegated babbling in all infants. The variegated babbling began at 8 – 9 months and gradually increased with age. The most common variegation observed was place changes, followed by manner changes and a combination of place-manner variations.

The findings of their study revealed more open syllables than closed syllables on CV combinations. The VC syllables occurred occasionally between 6 to 11 months and did not make its appearance at 11 to 12 months. The VCV syllables made a predominant appearance between 8 to 12 months. This finding was in general agreement with the structure of the native language.

2.2.2 Frequency of occurrence of phonemes in adults

Studies on frequency of occurrence of phonemes in adult conversations in the Indian context are recorded, Ramkrishna, Nair, Chiplunkar, Atal, Ramchandran, & Subramanian, (1963) studied the relative frequencies of various speech sounds in some of the Indian languages in adult speakers. A sample of 20,000 speech sounds was analyzed in seven languages namely English, Hindi, Malayalam, Marathi, Tamil, Telugu and Kannada. The percentage frequency was thus obtained for each speech sound. Hindi had a high percentage frequency for consonant /k/ followed by dental /t̪/. Dental /t̪/ had the highest percentage frequency in Malayalam. Occurrence of voiceless sounds was more than their voiced counterparts in all the languages.

Similarly, Sreedevi and Irfana (2013) conducted a study on the frequency of phonemes in adult Malayalam speakers. Fluent adult native speakers of Malayalam in the age range of 30 to 55 years were taken for the study. A total of 101 participants out of which 47 were males and 54 were females, participated in the study. The results revealed a predominance of vowel [e] and consonant /k/ in conversation samples. These studies however are related to the frequency of phonemes in the infants' late linguistic period of acquisition of the adult ambient language.

Research on diphthongs are reported in some adults spoken languages (Kumari, 1972 & Punnosse in Malayalam , 2010; Watson, 2007 in Liverpool English; Kerswill, Torgesen & Fox,2006 in British Carribbean English; Leimgruber, 2009 in Singapore English). The occurrence of closing type of diphthongs was majorly reported.

2.3.0 Longitudinal and Cross sectional methods

2.3.1 Longitudinal studies

In a longitudinal investigation, data samples are collected at regular intervals ranging from daily observations, weekly, bi-weekly, semiannually or annual sessions. It provides the researcher the information on the patterns of development of the phonological system. A longitudinal study is time consuming and the researcher may face attrition of the participants over a period of time. There are research studies that have investigated infant babbling using longitudinal methods. Stoel- Gammon (1985) presented a longitudinal investigation that not only utilized spontaneous speech but also looked at a sizable number of children. Thirty four children between 15 and 24 months of age participated in this study. The investigation was constructed to look at meaningful speech only; therefore, the subjects were grouped according to the age when they actually began to say at least ten identifiable words within a recording session. This resulted in three groups of children: Group A children, who had ten words at 15 months; Group B, who had ten words at 18 months; and Group C, who had ten words at 21 months. The resulting data provide information about early consonant development and can be summarized as follows:

1. A larger inventory of sounds was found in the word initial than in the word final position.

2. Word initial inventories contained voiced stops prior to voiceless ones; the reverse was true for word final productions.

3. The following phones appeared in at least 50 percent of all the subjects by 24 months of age: /h, w, b, t, d, m, n, k, g, f and s/ - word initially, /p, t, k, n, r and s/ - word finally

4. The liquid /r/ nearly always appeared first in a word final position.

5. If the mean percentage of norm consonant productions was calculated, 70 percent accuracy was achieved. Because there is obviously a large difference between the inventory produced by 2 years old and that produced by

adults, the author states that this accuracy level suggests that children are primarily attempting words that contain sounds within their articulatory abilities.

6. The order of appearance of initial and final phones was relatively constant across the three groups of children tested. Individual differences in the appearance of phones related to the classes of fricatives or affricatives and liquids.

Although individual variability was observed in this investigation, the ability to follow the children in a longitudinal manner from the same point regardless of their age seemed to reduce the extreme variability noted in other cross sectional research. Although this study did not contain a large number of subjects, it certainly suggests some clinical implication. Ferguson, Robb and Bleile (1994) conducted a comprehensive longitudinal study of the consonant inventories of seven children aged 8 to 25 months. They were able to present valuable individualized data on the sequence of development over time. Similarly, Selby, Robb, and Gilbert (2000) studied the development of vowels in five children aged 15, 18, 21, 24, and 36 months of age.

2.3.2 Cross sectional studies

The cross sectional method provides the information on the data obtained at a given point of time. The data can be utilized as norms obtained at that given age. A vast number of participants can be included and individual profiling may not be required.

Jeng (1979) attempted to test the applicability of Jakobson's laws of irreversible solidarity in the acquisition of Mandarin phonology. Two boys aged 0;2-1;8 and 1;3- 2;7, who were acquiring Mandarin in Taiwan, provided the speech data for his study. Jeng found that the acquisition of suprasegmental features preceded that of segmental features. The consonants that were acquired earliest were /p, t, k/ followed by nasals, aspirated stops, fricatives except /f/, and approximant /r/; /f/ was the last sound to appear. The four vowels /a, au, i, e/ occurred earliest, while /u, y, o/ appeared later.

2.4.0 Cross linguistic investigation and the influence of native language

Many researchers were in favour of Slobin's (1986) opinion that cross linguistic study is necessary to explore and verify the basis of speech development and the strategies that operate to construct a concrete language. According to Maddieson (1984) on data –driven study of phonological complexity, segment inventories of consonants and vowels in 317 languages were obtained. The most typical vowel inventory was [i, e, a, o and u]. Consonants were mainly simple stops and nasals that were frequent in the world's languages.

Boysson-Bardies (1993) studied 5 groups of 10-12 month old infants, from four different language communities. She found CV patterns were influenced by the target language. For French, Swedish and Yoruba infants', labial central vowel association for initial syllables were found. Association between dentals and front vowels were observed in English, Swedish and French; between central vowels and dentals in Yoruba. American infants showed associations between labials and front vowels. According to Boysson –Bardies, though these infants differed in pattern productions, these patterns were an influence of the ambient language.

Mattock, Rvachew, Alhaidary and Polka (2008) studied the emergence of corner vowels [i, a, and u] in infant vowel spaces and the influence of ambient language on babbling. Formants F1-F2 were obtained from 51 Canadian infants (English learning infants [n=24] and French learning infants [n=27]) from 8 to 18months. The listener judgments confirmed the peripheral expansion of infant vowel space towards diffuse and grave corners with age. A higher proportion of [u] in the English sample was observed throughout the age range suggesting the influence of ambient language at a young age.

To ascertain the changes that happen in infant perceptual ability, Werker and Tees (1984) examined the discrimination ability of English acquiring infants at 6-8 months, 8-10 months and 10 – 12 months in Hindi and Nthlakapmx (or Salish, a language of the native Indians in Canada). Adults were tested again and their discriminative ability of non native segments was confirmed whereas infants could discriminate the non native distinctions with 95% accuracy at 6-8 months; 60-70 % at 8-10 months and 20% at 10 – 12 months. It can be concluded that as the effect of native language increases with age there is gradual decline in the discriminative ability. Infants around 8-10 months begin to attune to native speech sounds and non native phonetic differences declines with age (Best & McRoberts, 2003; Mattock & Burnham, 2006).

Few studies have failed to document the decline in infants' ability to distinguish non native contrasts. Best and colleagues (1988) evidenced that 6 and 14 month old English acquiring infants did not show any decline for Zulu clicks and were discriminated even by adult English speakers. In an another study by Polka and Bohn (1996) tested 6-8 and 10 – 12 months old English and German acquiring infants as well as adults on English and German vowels and found that both infants and adults of the two languages could differentiate the non native vowels well.

Polka and her co-workers (2001) examined the English [d]-[ð] contrasts in the perceptual performance of English and French acquiring infants. The two language groups did not differ in 6-8 months or 10 – 12 months of age. This undermines the view that the discriminative ability for native sounds is facilitated through exposure and non native without exposure.

Patricia and Joanna (2006) compared the features of consonantality, consonantal repertoire, and consonant combinations across three different groups of infants: Italian-hearing, English-hearing, and Japanese-hearing. Six Italian-Canadian infants who heard mostly Italian from their mothers (more than 75%) were selected. Six Italian-Canadian infants who heard mostly English from their mothers (more than 70%) were selected. These infants had been visited twice between 9 and 10 months. Six Japanese infants were selected who had two sessions at the same ages as the Italian-Canadian infants. In all groups there were 3 males and 3 females. All infant vocalized utterances were transcribed into phonetics, utterances being separated by more than 2 sec. Consonantality was defined as the total number of consonants across utterances, while consonant combinations were the number of utterances containing more than one consonant. Both of these variables were divided by the total number of utterances to control for infant differences in rate of babbling or in recording time. Consonantal repertoire was the number of consonants used more than once. ANOVA was used to compare the three groups on the consonantal features. The Japanese infants had a larger consonantal repertoire than English-hearing infants. The results indicated that these cultural groups are quite similar in their use of consonants in babbling between 9 and 10 months. Japanese-hearing had a greater variety of consonants in their babbling but was not more consonantal or more complex. This may be because Japanese has a larger repertoire and is a CV language. The initial consonants in a syllable are more salient.

2.5.0 Vowels and Diphthongs as a function of age

Vowels are among the first 'quasiresonant' sounds to be produced by an infant (Trevarthen, 1999; Locke, 1993). Jackobson (1968) found that the first vowel to develop is /a/ followed by /i/ or /u/. He has been criticized in some instances for his prescriptiveness, as there is too much variation in terms of languages, individual variation between children, as well as variability within a child's speech, at any age level to form conclusions regarding universal order of phonological development. However, numerous authors, including Hoffman, Schuckers and Daniloff (1989) and Crary (1993) are in agreement with the elements of Jackobson's theories. There is agreement that vowels are the first sounds to develop, especially front vowels, followed by nasals, then glides, then stops, then fricatives and lastly affricates.

Studies in majority of the languages on vowel development address that vowels are acquired earlier than consonants (Templin, 1957). During the first year, infant vowel production shows little change. Adult transcribers typically perceive the primitive vowels as mid-front or central. However, in many studies, identification of vowels by the researcher has been auditory, and in some studies, the listeners who identified the vowels seemed to be using information other than vowel formant heights for identification, since some vowels that were distinguished by ear remained indistinguishable on the formant charts. One must conclude that, despite the difficulties involved in learning to transcribe vowels (especially children's vowels), the auditory identification of vowels is an irreplaceable tool in the analysis of vowel substitutions and development.

The emergence of a well developed vowel triangle resembling that of older children and adults were carried out in many studies using the F1/F2 plots over a period of time. A single case study was carried out by Buhr (1980). He analyzed recordings of vocal production of an infant aged 16–64 weeks. The recordings were subjected to perceptual and acoustic analysis. Sounds resembling the vowel sounds of English were identified, and formant frequency measurements were made from spectrograms. Significant longitudinal trends for individual vowel sounds were not apparent 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.

Lieberman (1980) reported inter-transcriber reliability of 73% for the vowels produced by children aged about 3 to 14 months. He reported frequencies only for the vowels identified as belonging to the English repertoire. Lieberman used spectrographic analysis for a single child as a supplement to phonetic transcription and reported little change in average formant frequency values over the period investigated. However, the various vowels transcribed for four months showed considerable overlap in formant frequencies. A month later, spectrographic analysis yielded identification of a rudimentary vowel triangle. The gradual differentiation in the acoustic vowel space could be seen to continue until age 3. The vowels most often perceived during the entire period were lax [E, I, Θ, ^, u] and were already present at the earliest session. Vowel [e] was heard most frequently (33 % of all the vowels transcribed), and the remaining lax vowels each accounted for 11% -17% of the data. The remaining (tense) vowels each accounted for no more than 5%, with the back-rounded [o] and [u] least frequent (1% each). A similar study by Kent and Murray (1982) investigated the acoustic features of vocalic utterances of seven infants at each age at 3, 6, and 9 months. The range of F1 and F2 frequencies increased somewhat across each age interval, but the majority of the vowels used by the 9-month-old infants showed roughly the same formant pattern as did the vowels of the younger subjects.

Oller and Eliers (1982) conducted a cross cultural study of babbling from infants reared in English –Spanish speaking environments in Miami. Vowels belonging to the sound inventory of Spanish were more frequent in the Spanish speaking group while the vowels in English were more frequent in the English speaking group. They found that vowel [æ] in particular had a frequency of 22.4% in English but only 13.5% in Spanish children. However, according to Oller and Eliers due to inter subject variability there was no statistical difference among the sound inventories in both the groups. This indicated that phonotactic patterns are necessary for cross linguistic comparisons.

De Boysson-Bardies et al. (1989) performed spectral analysis using formant measurements for vowels on 10 month old preverbal infants' drawn from four linguistic communities-Arabic, Chinese, English, and French, found that the categories of front-low and mid-central vowels accounted for the vast majority of vowels from all four groups. Acoustic analysis revealed characteristic patterns of vowel production for each group within those limits, however, with more high-front vowels for English, for example, and more low-back vowels for Chinese. The investigators interpreted these differences in vowel production to show that infants begin to position their lips and tongue in a manner specific to the language of their environment even before they produce word-forms modeled on adult speech.

Another spectral analysis study by De Boysson –Bardies and her colleagues (1989) on vowels in preverbal infants of four different languages were carried out.

The four languages were English, French, Swedish, and Japanese. They found that the infants matched vowel patterns of their own ambient language.

To determine the vowel-like sounds used most often by children at the end of variegated babbling stage, Bauman-Waengler (2000) compared Irwin's (1957) data with a study conducted by Kent and Bauer (1985). Some differences and similarities were noted in the data. The rank order of the six most prevalent vowels according to Irwin's study were /e/, / I /, /^/, /Y/, / A/, /u/ Kent and Bauer reported a different rank order: /^/, /E/, / Θ /, /A/, /Y/. Although the rank order varied slightly, at least four sounds remained constant across the two studies as the most prevalent: /E/, /^/, /A/ and /Y/.

Davis and Mac Neilage's (1995) longitudinal study with 6 infants (3 males, 3 females) from monolingual English-speaking homes revealed much individual variability in the use of vowels. The vowel data in the study was analyzed according to tongue height and tongue advancement dimensions. In relation to tongue height, the vowels were grouped into high, mid and low. For tongue advancement, the vowels were categorized as front, mid, and back. According to the tongue height dimension, mid vowels, particularly [^, Y and E], predominated in 3 subjects, while high vowels, particularly [u, Y and I], predominated in the remaining 3 subjects. In relation to tongue advancement, front vowels, particularly [E, Θ and I], predominated in 4 subjects, and the mid vowels [a, ^, ə], predominated in the remaining 2 subjects. Some common trends were identified in this study. The most commonly used vowels in the canonical babbling period were identified as [^, ə, E, U, Y, I and Θ], which were consistent with other studies (Irwin, 1957; Kent & Bauer, 1995).

An exploratory study was carried out by Benner and Grenon (2011) to examine the relationship between vowel quality and laryngeal constriction on Bai and English infants. Five infants (3 females, 2 males) were taken from English speaking families and 2 males and 3 females were taken from Bai (Tibeto-Burman) speaking families. Vowels included in the study were front vowels [i], [I], [Ɛ]and[e] and Neutral vowels included[ə], [ɜ], [ɘ] and [ɐ]. Open vowels included were [a], [ɑ], and [æ]. Data was organized into four age groups: 0-3 months, 4-6 months, 7-9 months and 10-12 months. Measures of spectral tilt (H2-H1) were done to provide a reliable indication of glottal tension in relation to the vowel quality. Spectral tilt measures usually decreases with increase in age. They found Bai infants produced sounds with greater degree of constriction than English infants throughout the phonetic development. During the early months, infants are physiologically predisposed to laryngeal constriction especially for a low vowel [a] which is retracted is produced more frequently followed by neutral vowels. Front vowel [i] are unlikely to be produced at all in the first three months. When this vowel emerges infants are likely to produce unconstructed laryngeal constriction. It can be inferred from this study that there is attunement of the laryngeal settings of the ambient language.

In the Indian context, Shymala and Basanthi (2003) revealed that vowels in Kannada made their appearance during 6-12months. Long vowels /i/, /e/ and /o/ were not present in any of the Kannada subjects. In Hindi, only four vowels (/i/, /e/, /a/ and /u/) including their longer counterparts were seen.

A cross-sectional study by Anjana and Sreedevi (2008) found that vowel repertoire [I, e, æ, a, u, o] showed variability across age groups. Among the high vowels, the frequency of occurrence of [i] was higher across age groups compared to [u]. Vowel [a] was higher than [ae] among the low vowels. Mid vowels made fewer appearances across all age groups. Vowel [i[made more frequent appearances in all the six age groups compared to the other front vowels [e] and [ae]. The central vowel [a] made predominant appearance across all age groups. The back vowels [u] and [o] were lower in their frequency of appearance in all the age groups. The developmental trend in the occurrence of certain vowels is evident in these studies like high occurrence of [e] in 6-7 months age range and it declined 11-12 month though not linearly.

A longitudinal study by Sreedevi and Jyoti (2012) revealed seven vowels [I, e, æ, a, u, o, ɔ] which were highly variable in frequency across the nine participants. Vowel data showed that the appearance of low vowels dominated from 3 - 12 months which were followed by mid vowels.

Vowels and diphthongs may provide additional insights to the issue of universal patterns of development. Diphthongs do play a vital role in phonological development. Lindau, Norlin and Svantesson (1985) found that diphthongs occur in approximately one-third of the world's languages. Ling (1989) stated that diphthongs frequently occur in children's early words. Ingram's (1997) hypothesis suggest that diphthongs with least featural complexity (i.e least difference between the two constituent vowels) will be acquired first. It is assumed that children will have to "mark" the difference between the two constituent diphthong vowels in their underlying representation. Therefore, according to generative phonology, it is suggested that children acquire unmarked features before marked ones and the phoneme with the least featural complexity (least marked features) would be acquired first (Ingram,1997)

Davis et al., (1990) suggests the low to mid front and front to central vowel productions as “ pure dynamics”. Tse (1991) found that his subject acquired longer vowels [ɛ, a, i] at an earlier age. of 14 to 36 months for Cantonese. He found maximally contrasted vowels /i/ and /a/ to be acquired first. According to Jacobson’s (1968/1941) prediction front –rounded vowels do not appear before unrounded vowels during the early mastery of vowels. Wong (2001) found that coronal vowels were produced in the earliest age period of 10-15 months, this finding is supported by Bhur’s study (1980) that claimed the musculature of lips, jaw and frontal portion of the tongue to develop at a faster rate compared to the lowering of the larynx and rear portion of the tongue. Height dimensions in vowels are easily attained by mandibular movements at 10-15 months (Matyear, 2007) and for backness Bhur (1980) the rear portion of the oral cavity develops at a slower rate; hence the coronal and dorsal contrasts develop at a later stage of the phonological development at around 24-27months. However, the present study investigates the nature of singleton vowels in the early pre-linguistic period of 4 to 12 months. Levitt and Utman (1992) compared one French and oneEnglish learning infant. The French infant favoured front low vowels and the English infant preferred mid central vowels, consistent with their ambient languages. Khul’s native language magnet (NLM) model encompasses infant vocalizations. It is hypothesized that infants listening to the ambient language store perceptually derived representations of speech sounds they hear which in turn serve as a target for production (Khul & Metzloff,1996). Therefore, it is expected that the phoneme in a child increases when the frequency of occurrence of that phoneme is high with the ambient language. The high front vowels are frequent in English (Bernhardt & Stamberger, 1998), so they are acquired first. By contrary, vowels [u], is the least frequent in Cantonese (Fok, 1979). The late mastery may be attributed to its low frequency of occurrence in the ambient language. The effect of ambient language was also noted in vowel and diphthong development in 40 Cantonese speaking children aged 10 to 27 months (Wong, 2001). The results suggested a hierarchy of vowel feature development with decreasing order of height >backness> roundness. Diphthongs with round and dorsal elements appeared in the later stages.

Westermann and Miranda (2004) support the above findings by indicating there is growing evidence that the pre-linguistic stage significantly influences the later development of phonological skills in children. Hence literature suggests that babbling is a predictor of later language complexity as well as language delay.

Studies on infant vocalizations report that early laryngeal vocalizations such as vegetative and reflexive sounds are differentiated from “speech like” vocalizations after the first trimester in life (Davis & MacNeialge, 1990; Oller,2000). Findings also suggest that infants gain increasing control over speech mechanism resulting in increased vocal play from 3 - 4 months onwards which continues beyond the first year of life. Investigating the phonetic behavior as early as 4 months would present the emerging patterns of vowels and diphthongs providing an insight to the phonetic and phonotactic patterns in the developing phonological system. Hence the present study intends to study the vocal behavior of infants from 4 – 12 months of age which is a significant phase of the pre-linguistic period. Research findings have indicated that pre-linguistic vocalizations to a large extent depend on the native language as every language has its own phonotactic patterns.

2.6.0 Consonants as a function of age

Consonants may be extended like vowels in powerful non-verbal expressions. For example, 'contoid consonants', such as /p/, /f/, /h/, and 'fricative consonants', such as /s/, can be prolonged to act in the same way as vowel sounds (e.g. pssst). They can be used to sooth (e.g. shhhh) and to express complex emotions (e.g. mmm). 'Vocoid consonants' such as / l, r, w, or j/ can also act in the same way (Crystal, 1997). Like vowels, the first consonants that are produced are guided by the constraints of physical development. Stop consonants (/b, p, t, d, g, k/) and nasal consonants (/m, n, ŋ/) are the most common that are produced during babbling across languages (Vihman, 1986; Locke, 1983; Davis & MacNeilage, 1995). During the babbling period, children also tend to produce many coronal and labial consonants. Infants initially have a greater facility with front consonants such as the alveolars [/d, t/], and labials [/m, b, p/] (Locke, 1983) and few dorsals (Stoel-Gammon, 1985). Complex sounds such as liquids (/l, r/) and consonant clusters are infrequent or are not present (Vihman, Macken, Miller, Simmons, & Miller, 1985).

Locke (1983) illustrates the prevalence of consonants in an infant. He found all six stop consonants to be frequent, glides as well as the fricative /s/. The more common sounds with the exception of /h/, were all voiced. The voiced sound was normally present more often. According to Warren's findings (1976), voiceless consonants have increased intra oral breath pressure. The sub-glottic air pressure is lost at the level of vocal folds for voiced consonants; they do not have the capacity to build up air that voiceless sound such as /p, t, k/ necessitate.

Perceptual studies

De Boysson –Bardies and Vihman (1991) investigated consonants using phonetic transcriptions. Infants from four language communities of English, French, Swedish, and Japanese from the babbling stage till the point at which they acquired 25 words were examined for consonants. Distribution of place and manner in the four languages were analyzed. They found all the infants produced more labials, dentals and stops than any other types of consonants. The perceptual ability exhibited by infants as young as newborns make them seem like universal learners by their ability not being restricted to any specific language. However, studies reveal that there are changes seen in the perceptual ability of the growing infant.

Werker and her colleagues (1984) documented the ability of 6-8 month old English acquiring infants to discriminate retroflex verses dental onsets in Hindi. Native adult speakers of Hindi and English were also tested on the same contrasts. The adult native speakers of Hindi could perceive contrasts as belonging to two different phonemic categories, while native speakers of English failed to do so. This study correlated with the investigation by Miyawaki, Strange, Verbrugge, Liberman, Jenkins and Fujimura (1975) on adult Japanese speakers' inability to discriminate the liquid contrasts of /r/ and /l/ present in English phonology and not in Japanese. Hence, there is a clear indication that the infant discriminative ability does not last into adulthood.

Research began in 1970s on studies that focused on whether infants perceive the presence or absence of phonetic features when less than six months old. Moffit (1971) found that 5 month old infants could discriminate differences in place of articulation contrasts of onset stop consonants, for example [ba]/[ga] contrast. Morse

(1972) replicated the study and found that infants could discriminate differences and the findings were valid for 2 month old infants. Contrasts were also perceived by infants in a categorical manner like in adults by the investigation of place of articulation of onset stop consonants (Eimas 1977). Experiments were also conducted on 2 month old infants regarding contrasts in syllable –final positions by Jusczyk (1977) and in medial positions by Jusczyk and Thompson (1978). Their study also supports the earlier findings. It can be known that infants show categorical perception and are born with the capacity to perceive speech in terms of phonemes.

2.7.0 Syllable shapes as a function of age

2.7.1 CV in preferred combinations

Kent (1992) stated that a C-V syllable is the “earliest recognized unit”. The most basic component of speech has been addressed since the beginning is the “Frame”, the consonant- vowel (CV) sequence or syllable. The criteria it adopts is the biochemical lingual inertia which states the tongue tends to stay in the central position that it adopts for rest during and following labial consonants (“ pure frames”), and it tends to stay either in the front (“ fronted frames”) or the back of the mouth (” backed frames”) for other sequences (MacNeilage & Davis, 1990). Research has shown the C-V interactions are present in early phonological development (Stoel-Gammon, 1983; Davis & MacNeialge, 1990; Tyler & Langsdale, 1996). According to MacNeilage and Davis (1990a, 1990b, 1993) proposal of the Frame- Content hypothesis, however, describes the spatio-temporal and biomechanical characteristics of bab- bling and early speech. The term Frame applies to the regularity of mandibular oscillation resulting in listener perception of syllable speech-like output. It is claimed that close and open phases of the cycle often may have no associated neuromuscular activity other than movement of the mandible and consequently may have no subsyllabic organization or Content. In this view, the syllabic Frame thus constitutes the earliest temporal envelope within which segment-specific Content elements develop as the child gains increasing independence of control over speech articulators in speech movement sequences. If Frames initially predominate over Content, then particular co-occurrence patterns in contiguous consonants and vowels, due to mechanical characteristics of jaw movement and relative lack of lingual independence, are predicted.

From the retrospective view of the emergence of syllable shapes, the CV syllable, the favored syllable type of babbling is considered to be the only universal syllable. Much work on CV co articulation has been carried out on European languages like German (Piske, 1997), American English (MacNeilage & Davis, 1990), French, Swedish and English (Boysson-Bardies, 1993). Japanese compared with French, Swedish, Ecuadorian- Quincha, and Brazilian- Portuguese (MacNeilage & Davis, 2000). In similar lines, Chan (2001) studied CV occurrences in early speech development of normal Cantonese speaking children.

For the work on CV co articulation, Piske (1997) conducted a longitudinal data from eight children acquiring German as their Ll. the children were between seven and thirteen months old. The study revealed, one of the subjects clearly preferred coronal and labial articulations. Plosives and nasals were much more often produced than fricatives, approximants or trills. Front vowels, i.e. open and mid-open front vowels, as well as central and centralized vowels clearly dominated over close. Stable consonants were preferably combined with open or mid-open vowels or with central or centralized vowels at later stages were the patterns expanded in such a way that the consonants also occurred together with high vowels or back vowels. These were the preferred cv combinations observed in the study. A variety of studies have tested these intrasyllabic predictions of the frame/content theory made in an original case study of early speech production made in 1990 (Davis &MacNeilage, 1990). In addition, Davis and MacNeilage (1995) studied 6 English-learning infants during babbling. In this study, the three predicted intra-cyclic CV associations, involving stops, nasals, and glides, were confirmed at significant levels in all infants (18 total predictions for 6 infants).

On similar lines, Gildersleeve-Neumann, Davis and MacNeilage (2000) also considered lower frequency consonants (fricatives, liquids, and affricates, often very late to appear in 13 typical speech developments) in four of the infants previously studied in babbling. With minor exceptions, CV co-occurrence patterns similar to the patterns for stops, nasals, and glides were found (i.e. coronal consonants with front vowels and labial consonants with central vowels).

MacNeilage, Davis, Kinney & Matyear, (2000b) also found all three intrasyllabic properties to be largely present in a dictionary analysis of a group of 10 languages (i. e. English, Estonian, French, German, Hebrew, Japanese, New Zealand Maori, Quichua, Spanish and Swahili), suggesting that they are basic to the operation of the speech production system in general and are retained in modern languages, rather than simply being transient aspects of early speech development. Rousset (2003) investigating data on 14 languages available on the ULSID (UCLA Lexical and Syllabic Inventory Database; Maddieson, 1992) database, created incorporate genetic and geographical diversity into language typology study. Their analysis confirmed the three CV co-occurrence predictions in these languages as well.

The effect of lexicon has an effect on CV combination production may be language-based. According to Boysson-Bardies (1993), CV pattern in 10 to 12 month infant production is influenced by the ambient language being studied from 5 different language communities. For French, Swedish, and Yoruba children, the Labial-Central pattern is preferred. In American children, the Labial-Front (LF) vowel combination is preferred. But, in English children, the dental-front vowel combination is preferred. Therefore, the preference of LF in Cantonese-speaking children could be language specific: LF is preferred because words with LF have a greater importance in daily communication.

However, Chan’s (2001) results show that the F/C theory was able to predict the predominant CV patterns in prespeech babbling, but not in babbling concurring with words: "frame dominance" was concluded in prespeech babbling. Only the effect of lexical development with respect to Cantonese on the production of CV patterns of the older children was also evaluated. Older children aged 16-22 months tended to target at CV patterns of words according to predominant CV pattern distribution in Cantonese lexicon, instead of targeting at the predicted patterns of the F/C theory. Kent (1992) has pointed out; this kind of variability is not unexpected at the onset of speech primarily because of immaturity in neuromotor control.

Consonant vowel syllables were found to be more frequent in both French and English (Maneva & Genesee, 2002). Open sylllables were more frequent than closed syllables in French and English. Stop + vowel syllables were more prominent in English than French which had approximant + vowel syllables (Delattre, 1965).

Studies on monolingual infants exposed to different languages indicate that their babbling exhibits features that are language independent for example predominance of stops, predominance of open verses closed syllables (Boysson- Bardies, 1999; Vihman, 1996). Monolingual infants initially produce more open syllables than closed syllables (Boysson- Bardies, 1999), originally because open syllables are easier to produce.

Sequences of Pure frames (labial consonants with central vowels), fronted frames (alveolar consonants with front vowels) and back frames (velar consonants with back vowels), these strong occurrences were reported in longitudinal studies (Davis & MacNeilage, 1994; MacNeilage, Davis & Mateyear, 1997). Labial consonants were replaced by alveolars when followed by front vowels (Stoel-Gammon, 1983). Davis and MacNeilage (1990), in a transcription-based case study of a child between 14 and 20 months old, 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 velar consonants with back vowels. Another 7-12-month-old infant studied during the babbling period (Davis & MacNeilage, 1994) also showed very strong co-occurrence patterns for sequences of front vowels with tongue front consonants and central vowels with labial consonants. This infant produced few velar consonants and back vowels.

On the contrary, Tyler and Langsdale (1996) showed children in 18 to 24 months, association between velars and back vowels was evident, but bilabial-central vowel and alveolar- front vowel associations were not supported. Oller and

Steffans (1993) showed that CV associations were strong for children aged 10-12 months, but weakened by 16 to 24 months. Levelt (1996) proposed phonological approach with children aged 12- 35 months. They showed coronal consonants were associated with coronal vowels, labial consonants with labial vowels and dorsal consonants with dorsal vowels.

In case of children with cleft lip and palate, a study carried out by Stout, Hardin-Jones and Chapman (2011) on 16 nine month old babies and age matched typically developing infants suggested a more of labial back co-occurrence patterns. This pattern was also found in other studies in the babble of babies from English speaking communities (Davis & MacNeilage, 1995; Davis, MacNeialge and Matyear, 2002) and in Romanian speaking infants Kern and Davis (2011). Kern and Davis (2011) reported patterns in French, Romanian and Dutch speaking infants and suggested the ambient language may influence vocal development in babble. Chen and Kent (2005) observed velar central patterns emerge before first year in infants from Mandarin speaking community and velar back patterns were predominant and emerged after the first year. The report by Stout, Hardin-Jones and Chapman (2011) is consistent with the findings by Davis and MacNeilage (1994) demonstrating a lack of velar production in their study of typically developing male infant. In addition, McCaffrey et. al (1999) also reported a lack of velars in the babble of an infant with sensori neural hearing loss.

2.7.2 Other syllable combinations

In a typical utterance, consonants and vowels never appear in isolation but are produced serially. This phenomenon of serial ordering is one of the most distinctive properties of speech production. The combination of consonant-and vowel-like sounds is said to begin during the Exploration Stage at about 4 to 6 months. During the later babbling period, open syllables or syllables ending in a vowel are the most frequently occurring syllable shapes (Bauman-Waengler, 2000). Kent and Bauer's (1985) study revealed syllable shapes that were predominant during the babbling period. They found that V, CV, VCV and CVCV syllable structures accounted for approximately 94% of all the syllables produced at the end of babbling period. They also emphasized that while closed syllables occurred, they were found to be very limited in the repertoire of the infant at this stage of development. Children tend to favor open (CV) as opposed to closed (CVC) syllable types (Kent & Bauer, 1985; Locke, 1983; Oller & Eilers, 1982; Stoel-Gammon, 1985; Vihman, 1992).

Stoel- Gammon's (1989) study on ten infants at for month intervals from 6-18 months of age showed the following rank orderings: reduplication, place variegation, and manner variegation at 6-9 and 10-13months; place variegation, manner variegation and reduplication at 14-17 months. Mitchell and Kent (1990) found manner changes to be more frequent over place changes in babbling of eight infants studied at 7, 9, and 11 months. Frequency of multi syllables in rank order, were reduplication, manner changes, mixed place and manner changes, and place changes.

Robb and Saxman (1990) examined the continuity in development of syllable duration patterns in 7 young children as they progressed from pre-word to multiword periods of vocalization development. Using a combination of lexical and chronological age points, monthly vocalization samples were analyzed for bi-syllable duration and final syllable lengthening. Results revealed no systematic increase or decrease in the duration of bi-syllables produced by children as a group. Lengthening of final syllables was observed across nearly all recording sessions for all children. It is likely that the feature of bi-syllable duration is not discernibly sensitive to changes associated with a developing speech mechanism and environmental input. The results suggested that the regularity in final syllable lengthening is consistent with a continuity theory of development.

2.8.0 Trends in babbling

In infants the first step into the production of syllable like output is the canonical babbling. Canonical babbling is defined as rhythmic alternations between consonant and vowel-like properties, giving a percept of rhythmic speech that simulates adult output without conveying meaning (Davis and MacNeilage, 1995; Oller 2000). Jakobson's (1941/1968) "discontinuity hypothesis" states that a child typically undergoes a period of silence between the end of the babbling period and development of the first real words is no longer accepted as a fact. Recent research focusing on infant speech development, has repeatedly documented that babbling is not a random behavior, all possible sounds are not produced during the babbling stage, and the transition between the babbling and the first words is not abrupt but continuous (Bauman-Waengler, 2000).

Longitudinal investigations of the transition from canonical babbling to speech have shown continuity between phonetic forms in infant pre-linguistic vocalizations and earliest speech forms (Stoel-Gammon & Cooper, 1984; Vihman, Ferguson & Elbers, 1986). This continuity supports the importance of considering canonical babbling as a crucial first step in the young child's journey toward mastery of ambient language phonology.

Patterns in canonical babbling tend to be continuous with vocal patterns in the early language based single word stage. This continuity emphasizes on the importance of considering speech like pre-linguistic babbling as the first step into language complexity. Infants progress through a series of stages of vocal development during the first half year of life, culminating in the appearance of canonical babbling between 4 and 10 months of age, with a median at 6 to 7 months (Oller, 1980; Stark, 1980). Canonical babbling implies either reduplicated or variegated babbling. It is characterized by the production of repetitive, syllable-like output (i.e., [baba] or [daedae]). Oller (1986) noted the following perceptual properties of canonical babbling: (a) at least one fully resonant nucleus (i.e., vowel with an identifiable quality, excluding highly nasalized vowels), (b) one nonglottal margin (consonant other than glottal consonant), (c) duration of syllable and formant transitions that are perceptually consistent with mature syllable production, and (d) normal phonation and pitch range. Normally infants begin canonical babbling with great variability. At about seven months, infants start to make extended sounds that are chopped up rhythmically by oral articulations into syllable-like sequences, opening and closing their jaws, lips and tongue. The range of sounds produced is heard as stop-like and glide-like. Fricatives, affricates and liquids are more rarely heard, and clusters are even rarer. Vowels tend to be low and open, at least in the beginning.

Despite controversies regarding the sequential nature of babbling (Holmgren, Lindblom, Aurelius, Jalling, & Zetterstrom, 1986; Smith et al., 1989;

Mitchell & Kent, 1990), babbling continues to be divided into two stages. The initial portion of babbling known as **reduplicated babbling** (Oller's stage 4, Oller, 1980) progresses from 7 months to 9 months of age. This form of babbling is characterized by the reduplication of similar consonant-vowel (CV) syllable strings. The CV syllable production in this stage are reduplicated resulting in syllable sequences such as [baba], [kaka], and [tata]. The reduplicated or repeated syllables account for half or more of all vocal patterns in babbling and more than half of the early word forms (Davis et al, 2000). A variation in the vowel sounds may occur from syllable to syllable; however the consonant tends to remain constant (e.g., [mamu]). The phonetic repertoire at this stage, although limited, may consist of stops, nasals, glides, and the lax vowels /e/, /□/, /^/. Stops present the sharpest possible contrast with vowels and provide the most prominent break in the acoustic stream of speech sounds. On the other hand, stop production is also relatively undemanding: Syllables such as [ba], [da], and [na] may be articulated through mandibular action alone (Kent, 1992). It is likely that this production milestone represents an advance in: (a) Motoric control, which is maturational, or tied to natural physiological development in the first year; (b) the experience-based integration of visual and auditory perception of adult sequences of open-closed mouth and voice-silence alternation, and (c) the expression of the percept of adult vocalization through global imitation. That is, children see as well as hear stop consonants in adult speech, produce such sounds themselves, and engage in repetitive vocal production or sound play, re-creating their impression of adult speech.

Non-reduplicated or **variegated babbling** (Oller's stage 5, Oller, 1980) is marked as the second portion of babbling, which begins at approximately 9-10 months of age and progresses to about the first year. This form of babbling is characterized by continual use of adult-like syllables supplemented by the increasingly varied consonants and vowels within a single vocalization. The CV syllable sequences continue, but the infant combines a variety of CV sequences resulting in productions like [madaga], [putika], and [tikadi]. The infant's vowel and consonant repertoire increases significantly at this point. In variegated babbling, more manner changes occur than place changes for consonants (Davis & MacNeilage, 1990; Davis & MacNeilage, 1995) and more height than front-back changes for vowels have been shown during babbling and first words (Bickley, 1983; Davis & MacNeilage, 1995, Davis et al, 2002). The preference for manner changes for consonants and height changes for vowels is consistent with the Frame Content hypothesis (MacNeilage & Davis, 1990). The Frame Content hypothesis proposes that the tongue does not move independently from the jaw within syllables, but remains in the same position for the consonant closure and the open or vowel portions of rhythmic cycles. Within syllable consonant vowel characteristics are based on these rhythmic jaw close open close cycles without independent movement of articulators independent of the jaw. Reduplicated and variegated babbling has frequently been included in a single stage of development called canonical babbling because of the difficulty that often arises in distinguishing the two (Smith, Brown-Sweeney & Stoel-Gammon, 1989; Mitchell & Kent, 1990). Early studies of babbling held that reduplicated and variegated babbling was produced by the infant during different stages (Elbers, 1982; Oller, 1986). Recent studies have found that these two types of babbling co-occur from the onset of canonical babbling, although variegated sequences may not become a dominant category in the child's production until some weeks or even months later. Thus, Roug, Landburg and Lundburg (1989) found that variegated utterances were present throughout their study, but increased dramatically towards the end of the first year of life or in the second year.

A form of babbling that frequently overlaps with the early period of meaningful speech is characterized by strings of sounds and syllables produced with a variety of stress and intonational patterns. This form of babbling has been called conversational babble, modulated babble, and jargon (Gleason, 1993). Jargon usually begins once the variegated babbling has been reached, at approximately 10 months of age. The primary difference between variegated babbling and jargon is the infant's increasingly varied and consistent use of intonation, rhythm, and pausing in the latter. Jargon may be thought of as variegated babbling with intonation patterns superimposed on the sound productions.

According to Stoel- Gammon (1989), variegated babbling vocalizations are defined as the pre-linguistic productions that contain two or more different consonant types, disregarding voicing differences. As reported by Hoff (2003), the major milestones of pre-speech vocal development are the productions of canonical syllables (well formed consonant+ vowel combinations), which appear between 6 and 10 months, followed shortly by reduplicated babbling (repetition of syllables). By the canonical babbling stage in the second half of their first year, young children have already shown evidence of recognizing precise ambient language regularities available from input (Saffran et.al, 1996; Werker & Curtin, 2005).

Stoel-Gammon and Cooper (1984) studied 10 infants at four month intervals from 6-18 months of age. They analyzed consonant place changes as indices of variegation in multisyllables. A post-hoc analysis showed the following rank orderings: reduplication, place variegation, and manner variegation at 6-9 and 10-13 months; place variegation, manner variegation, and reduplication at 14-17 months. Their results show that the number of reduplicated babbles actually rises slightly until the age range 10-13 months when it begins to fall, finally dropping below the rate of variegated babbling at about 14 months of age. In contrast, the rate of production of variegated babbles falls slightly until 10-13 months of age, when it then starts to rise. By 14-17 months of age, the rate of production of variegated babbles is larger than the rate of reduplicated babble production, but at no time (before 17 months) does the production of reduplicated babbles cease. Similar results were obtained by Mitchell and Kent (1990). They found manner changes to predominate over place changes in babbling of eight infants studied at 7, 9, and 11 months. Frequency of multi syllables in rank order, were reduplication, manner changes, mixed place and manner changes, and place changes. These studies considered consonant series in multisyllabic utterances. These results suggest that the entire babbling period may be similar to the period of first words in containing both reduplicated and variegated forms.

Contrary to Jacobson's assertion (1941) of no continuity between babbling and first words, investigations have shown canonical babbling to early speech forms have continuity (Locke, 1983; Oller & Steffans, 1993; Vihman., 185, 1986). This supports the continuity of babbling to the child's first words of the ambient language. A comparison of the children's output patterns in diverse language environments that provide diverse ambient language learning targets is needed. This type of analysis enables the establishment of potentially universal patterns in canonical babbling based on characteristics of the production subsystems common to young children across language environments. It also highlights the timing and precise nature of early perceptually based learning from social interactions with adult speakers in an ambient language community.

Vocalization patterns across syllables are also considered in the emergence of vocal complexity. In languages, most words contain varied consonants and vowels across syllables; phonological reduplication, or repetition of the same syllable, is infrequent (Maddieson, 1984). In variegated forms, infants change vowels and/ or consonants in two successive syllables. Several studies have shown the concurrent use of both reduplicated and variegated babbling (Mitchell& Kent, 1990; Smith et al., 1989). There are studies that have also shown the proportions of variegated utterances increase while reduplicated utterances concomitantly decrease across the course of development (Davis &MacNeilage, 1995; Mitchell & Kent, 1990; Robb, Bauer, & Tyler, 1994; Roug, Landburg, & Lundburg, 1989; Smith, Brown-Sweeney, & Stoel-Gammon, 1989). Intersyllabic patterns following the Frame- content hypothesis (MacNeilage & Davis, 1990) proposes that changes in the amplitude (i.e., the vertical dimension) of the mandibular cycle should guide the types of consonant and vowel changes rather than changes in anterior-posterior tongue position (i.e., the horizontal dimension) have not been considered in this study although an attempt was considered to review the patterns present in other findings.

Davis and MacNeilage (1995) conducted a longitudinal babbling study of 6 typically developing hearing infants from approximately 7 to 12 months. Vowel changes across syllables typically involved vowel height (84%) and consonant manner (61%), confirming variegation predictions. Researchers have studied intersyllabic sequences in early words as well (Davis et al., 2002; Kent & Bauer, 1985; Shibamoto & Olmsted, 1978). Shibamoto and Olmsted (1978) examined consonant patterns in 4 infants from the onset of first words till the 50 word productons. Infants reduplicated consonant place (44%), particularly for labial (43%) or coronal (48%) types. Consonant manner and vowel patterns were not analyzed.

Kent and Bauer (1985) studied intersyllabic patterns in CVCV utterances in first words and concurrent babbling in five 13-month-old infants. One-third of productions involved total syllable reduplication. Consonant reduplication (60%) occurred more than variegation, primarily involving repetition of labial (65%) or coronal (20%) place. Vowel variegation (56%) occurred more frequently than vowel reduplication. Specific intersyllabic patterns for consonant manner, vowel height or front-back were not reported. Davis et al. (2002) also found concurrent use of reduplication (58%) and variegation (42%) in CVC and CVCV utterances in first words. Their 10 infants produced 75% consonant reduplication, primarily involving labial (58%) and coronal (31%) place or stop (73%) and nasal (26%) manner. Consonant place variegations most frequently occurred consistent with Shibamoto and Olmsted's (1978) findings. Detailed relationships of manner variegation and total consonant variegation (change in both place and manner characteristics) were not included. In variegated babbling, more manner than place changes for consonants (Davis& MacNeilage, 1995, Davis, MacNeilage, Matyear & Powell, 2002) is reported.

Analysis of Kern and Davis (2009) of five additional languages confirmed the prediction for co-occurrence of reduplication and variegation. While both reduplication and variegation occurred, infants preferred to repeat the same syllable within utterances more than variegate or produce different consonants and/or vowels. Zlatic, MacNeilage, Matyear and Davis (1997) found that twins in an English- Serbian bilingual input environment showed the same vocalization patterns documented for monolingual children (Kern & Davis, 2009).

2.8.1 Prosodic patterns in babbling

Pre-linguistic babbling often seems remarkably speech-like, not because it has recognizable words but because it seems to have adult-like prosody. The prosodic correlates of stress in babbling were investigated by Davis, MacNeilage, Matyear, and Powell (2000). They compared disyllabic sequences from five infants and five adults in terms of the use of frequency, intensity, and duration to mark stress. Significantly larger values for the three acoustic variables were observed on stressed than on unstressed syllables independent of syllable position for both groups. Adults showed the correlates of utterance final syllables-lower fundamental frequency, lower intensity, and longer duration; infants showed only decrease in intensity. Ratios for stressed to unstressed syllables and participation of the three variables in stress production in individual disyllables were highly similar in both groups. No bias toward the English lexical trochaic stress pattern was observed. It can be concluded that infants in English environments produce adult-like stress patterns before they produce lexical items, which specify stress. Acoustic and perceptual analyses are used to explore stress marking by pre-linguistic infants in an English language environment. Results showed that infants employ the three acoustic correlates of stress in individual syllables in a manner largely similar to that of adult speakers, although they do not show second-syllable declination effects or an English language trochaic stress bias.

The results of the study by Ducey, Abry and Vilain (2006) showed that between 6 and 9 months, there are very few CVCV (between 1% and 10%) verses other productions in babbling. At 10 months, the proportions increase dramatically to reach a peak of 40 % of the babbling productions at 11 months. At the age of 13 and 14 months the figures decrease and there is less CVCV than other patterns in the production of the child.

The very strong persistence of these patterns in languages as well as their presence at the onset of speech-like vocalizations in infants indicate that they reflect fundamental properties of the speech production system. MacNeilage, Davis, Kinney and Matyear (2000) analyzed dictionary data for the three predicted CV co-occurrence in ten languages: English, Estonian, French, German, Hebrew, Japanese, New Zealand Maori, Ecuadorian Quichua, Spanish and Swahili using chi square analysis. Observed frequencies exceeded expected frequencies for labial-central pairs in 7 languages, for coronal-front pairs in 7 languages, and for dorsal-back pairs in 8 languages. Mean values across the ten languages were labial-central, 1.10, coronal-front 1.18; and dorsal-back, 1.27. Japanese was the only language that did not show an overall average above 1.0 for the three categories combined. Rousset (2004) examined 14 languages from the ULSID database (Maddieson, 1984). The languages were Afar, Finnish, French, Kannada, Kanouri, Kwakw'ala, Navaho, Ngizm, Nyah Kur, Quechua, Sora, Swedish, Wa,Yup'ik, and !Xoo. In CV forms, very few exceptions to the predicted CV co-occurrences were found. The labial-central trend was not found in Navaho, Thai, and Xoo and the coronal front co-occurrences were not found in Kwakw’ala.

There are no reported cross-linguistic studies focusing on the early vocal acquisition of the phonetic repertoire. The CV syllable, the most syllable type of babbling is considered to be universal syllable type in languages.

2.8.2 Early native language effects in babbling

Infants exhibit abilities to learn rapidly from language input regularities as early as 8- 10 months (Saffran, Aslin, & Newport, 1996). Similar findings have been observed by Indian researchers (Anjana & Sreedevi,2008; Irfana,2012; Shishira, 2013) During the late babbling or the first word periods, it has been proposed that learning from ambient language input may influence and shape vocalizations. Influences of ambient language have been examined in utterances and syllable structures (De Boysson- Bardies, 1993; Kopkalli-Yavuz & Topbas, 2000), vowel and consonant repertoires (De Boysson-Bardies, Halle, Sagart & Durand, 1986 & 1989) as well as CV co-occurrence preferences.

Research on early appearance of ambient language regularities have focused on the adult capacities for perception of differences in children from different language environments. De Boysson-Bardies, Sagart ,Halle and Durand (1989) conducted a perceptual study on native adults of French, Cantonese and Arabic infants. The participants were presented with sequences of early babbling and were asked to identify babbling of French infants. Results indicated that the adults were able to identify 70% of the tokens; suggesting babbling in the pre-linguistic period may exhibit perceptually apparent ambient language characteristics. Adults were able to accurately identify language difference in 6 and 8 month old infants, but not in 10 month olds. According to De Boysson-Bardies et al., (1989) this may be due to the stimuli of the 10 month olds that showed “less consistency” in the intonation contours and also suggested that the role of prosodic cues of adults to judge language background may be less accurate.

Supports for early ambient language learning have also been provided targeting acoustic and phonetic properties of infants’ babbling output. De Boysson-Bardies et al. (1989) compared vocalizations of French, English, Cantonese and Algerian 10 month olds. They proposed that mean distribution of the vowel acoustics (mean F1 and F2) were significantly different for each of the four language groups. De Boysson-Bardies, Sagart and Durand (1989) also found significant differences in the distribution of consonants in English, French, Swedish and Cantonese languages. The differences were seen in place and manner of articulation across the languages. Stop consonants represented the largest proportion for all the infants. It was found that from 10 months, French infants produced fewer stops than American and Swedish infants.

However, in another study by Levitt and Utman (1992) comparisons were done on one French infant and one English learning infant. They found that English learning infants showed higher frequencies of fricatives, affricates and nasals than French; approximants were more frequent in French than in English. Infant consonant inventory moved towards their own ambient language in composition and frequency; both infants showed a close match to the ambient frequencies at 5 months. The French child showed preferences for front low vowels and the English child preferred mid central vowels, consistent with frequency in their ambient language. The study reported on a very small sample data, complicating in the generalization of the results on the timing of early ambient language learning.

2.8.3 The transition period: from babbling to meaningful speech

The transition period is best defined by certain developmental events. It begins with the onset of comprehension of the adult language, and it closes when usage of words begin to dominate babble. The age range in which these developments occur is extremely variable. Some normally developing children fail to produce many recognizable words before the age of 2, although they will show evidence of good language comprehension long before this time.

For many, and perhaps most children, the transition to speech will occur during the period from about 9 to 18 months. The transition from babbling to meaningful speech is a very important milestone in the development of articulation and phonological skills. The child moves from pre-linguistic to linguistic phonological development. This transition phase accounts for two perspectives, one a continuity phase and the other a discontinuity phase as cited in Kamhi (1986). The continuity phase as proposed by Bates and her colleagues (Bates 1976, Snyder, Bates & Bretherton 1981) suggests no clear demarcation between prelexical forms and true words. Prelexical forms become phonetically consistent, semantically coherent and symbolically autonomous; they become more like true words. Whereas in support of the discontinuity hypothesis, Dore (1976) and McShane (1979) argue that the true words are separated by the prelexical forms by the acquisition of symbolic properties of language. However, there is an overlap of a few weeks to several months in the use of babbled and meaningful productions (Stoel- Gammon &

Dunn, 1985). Combinations of babbling and meaningful speech in a single utterance are also produced by typically developing children (Branigan, 1977).

Prior to production of words, infants develop syllables, potential components of words (Koopmans-van Beinum & van der Stelt, 1986; Oller, 1980; Stark, Bernstein, & Demorest, 1993). When caregivers identify these babbled syllables, they begin to interact with the infant, treating them as potential words (Papoušek & Papoušek, 1992; Stoel-Gammon, 2011). As word learning begins, caregivers engage infants, recognizing babbled syllables and their potential relation with the ambient language.

A child's first meaningful productions have been labeled proto words (Menn, 1983). Protowords are also known as vocables (Ferguson, 1979), phonetically consistent forms (Dore, Franklin, Miller, & Ramer, 1976), invented words (Locke, 1983), sensori-motor phonemes (Carter, 1979) and quasi-words (Stoel-Gammon & Cooper, 1984) are vocalizations absent of a recognizable adult model that are consistently produced by the infant. These sounds or sound combinations function as words for the infant, even though they are not based on the adult model. Because they are not based on the adult words, these vocalizations do not quantify as "true words". However, they cannot be considered babbling either because they have some phonetic consistency (Stoel-Gammon & Dunn, 1985). Ferguson (1979) described proto words as "babbling-like sounds used meaningfully". Protowords are frequently tied to a specific context and are often accompanied by a consistent gesture. These vocal productions have frequently been considered the link between babbling and adult-like speech. Researchers have reported four phonetic forms that are frequently used in protowords: (1) single or repeated consonant vowels, (2) syllabic nasals, (3) syllabic fricatives, and (4) single or repeated consonant vowel syllables in which the consonant is a nasal or a stop (Ferguson, 1979 Halliday, 1975; Lewis, 1951).

At the end of the first year, vocalizations begin to be affected by the phonetic make-up of the specific language of the child's environment. They begin to produce intended words which are almost of an intended adult word. Several reports on childs production during this period are documented. Carter (1979) observed the transition of protowords to true words in a single subject. The subjects productions were termed as "sensori-motormorphemes". She reported between the age range of 1 year 1 month, and 1 year 2 months, the subject produced vocalizations that differed from babbling, it also had some phonetic consistency and were frequently accompanied by a gesture.

Ferguson (1979) stated that children develop about 12 vocables as they undergo transition from babbling to the use of adult-based words, which was contradicted by Stoel- Gammon and Cooper's study (1984). Their study with 3 subjects showed greater variations among children. Stoel – Gammon and Cooper found that 1 subject used 13 vocables during the acquisition of 50 conventional words, while the other 2 subjects used only one vocable each during the same period. Elbers and Ton (1985) recorded play-pen monologues of a one year old Dutch boy for 20-30 minutes each day, for a period of 6 weeks. The mother kept a diary and noted the occurrence of new words. During the study, the infant acquired 4 new words, and it was found that prior to babbling, the infant was "prepared for" the selection and production of these true words.

Stoel-Gammon and Cooper (1984) studied 3 infant productions in English, from late babbling to the acquisition of the first 50 words. The goal of the study was to determine the relationship between word acquisition and phonological development. In their study, they distinguished between babbling, acquisition of adult words and creation of child based “quasi-words”. They found that the vocalizations produced by infants were not the same phonemes in English and therefore concluded that would not appear in real words. They also concluded that the infants use a limited number of “patterns” in the first words.

Locke (1983) noted that a number of researchers have reported that there is a tendency for words for “father” to appear earlier than words for “mother”. Such gender differences are common across cultures. In English, ‘dada’ is produced much earlier before than ‘mama’. Many infants referred ‘papa’ as ‘baba’ because they might have, in fact, perceived [b] and [d] as voiceless, unaspirated stops. It was also noted that infants were more likely to say a bilabial or an alveolar stop than a bilabial nasal. The infants had a 10% preference for producing bilabial nasals.

Conklin (2010) recognized protowords and divided them into three categories: firstly, the phonetically consistent form has a standard sound pattern, but is not referentially stable, nor based on adult language. Secondly, the pre-word is phonetically consistent and referentially stable, yet not based on adult language. It is accurate in its categorisation, according to adult model, yet the child has found an individual way of communicating meaning. Finally, the sensorimotor morpheme is phonetically and referentially stable, and it is based on adult language, but cannot be communicated without the use of a supporting gesture, and is sometimes part of routine.

Laakso, Maria-Liisa, Helasvuo, Savinainen-Makkonen and Tuula (2010) studied the patterns of protowords in the interaction with parents. The study revealed that at the age of 12 months children start to acknowledge or reject parental interpretations. The patterns consisted of acquisition of shared meanings embedded in the sequences of first proto-utterances and their interpretations in the course of daily activities at home. For gaze orientation or pointing gesture, the sequences of proto words varied according to the contexts as interpreted by the parents.

As cited in Gotzke and Goose (2007), during the 7- 9 month period, infants may produce protowords or phonetically consistent forms of vocalizations with consistent structures that do not resemble adult model (Menn & Stoel- Gammon, 2005; Sachs, 2005). These protowords may be recognized as an important step towards first words, as they depict infants to have some degree of voluntary control over the vocal mechanisms and to a certain degree understanding that sound sequences have unique meanings. Infants begin to produce consistent vocal patterns as early as nine months that function as words for the infants (Owens, 2001). It could be inferred that protowords have a somewhat stable sound and syllabic structure and its repeated productions could vary in form as infants are still developing control over their vocal mechanism.

By the end of 10 to 12 months, most infants produce their first words (Owens, 2001 & Sachs, 2005). The first word may be the name of a toy, food or family member (Owens,2001) or may be a greeting, farewell or other social phrase such as peek –a-boo (Menn & Stoel-Gammon,2005). These first words may be used to gain attention. According to Pan (2005), first words tend to be similar for toddlers across cultures. The phase of initial production of words is referred to as “***The First***

Fifty Word Stage". This stage encompasses the time from the first meaningful utterance which is a ***true word*** at approximately one year of age to the time when the child begins to combine two words together at approximately 18-24 months of age. A 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 recognizably related to the adult like word form of a particular language (Owens, 1996). Vihman and Mc Cune (1994) have put forth certain criteria or the identification of true words, which was considered in the present study. 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 and 4) Multiple episodes- more than one episode of use.

Ingram (1978) refers to the **First Fifty Word Stage** as a ***PreSystematic Stage*** in which contrastive words rather than contrastive sounds are acquired. In course of phonological development where the child uses a single word to indicate a complete idea is referred to as the ***Holophrastic period*** (Cruttenden, 1981). During this phase, the child uses one word to indicate a whole or a complete idea. The link between the object, its meaning, and the discrete sound segments are not firmly established. Psycholinguist Braine (1963, 1971) noticed that these single words gradually embodied the communicative functions of entire phrases: e.g. the child's word *dada* could mean 'Where is daddy?' 'I want daddy,' etc. according to specific contexts. He called them ***holophrastic***, or one-word, utterances. In situations of typical nurture and development, ***holophrases*** reveal a vast amount of neuro-physiological and conceptual development in the child by the end of the first year of life. Holophrastic words suggest a child's intention more than expression in the developing environment.

Ferguson and Farwell (1975) stated that variability in children's own pronunciation of words reveal incomplete knowledge on the part of the child indicating the immature status of child's linguistic and neuromotor capabilities in his/her formative years. The difference in canonical babbling in pre-term and full term infants was carried out by Lehithalmes, Heikkinen, Olsen and Yliherva (2012). The study revealed the extremely low birth weight infants failed to produce more different kinds of canonical syllable types and remained in the babbling phase longer than reaching the first meaningful words compared to the full term infants.

In the Indian context, a study conducted by Rupela and Manjula (2006) on 30 Kannada speaking children from the age range of 0 to 5 years revealed bisyllabic words emerging at 6-12 month and was predominant only by 18 months. Irfana (2012) conducted a study on the early phonetic repertoire in typically developing native Malayalam speaking children from 12-18 months. Her study indicated the emergence of protowords in the first age group of 12 to 18 months and the complexity of protowords was higher in 15 to 18 months age group owing to the use of more multisyllabic utterances. Presence of true words emerged only in the 15 to 18 month age group. Shishira (2013) carried out a similar study in native Kannada speaking children from the age range of 12 to 18 months. Holophrastic words were found to be present in all the participants with a mean percentage of frequency of occurrence of 25.8%. Protowords existed in abundance, with the mean percentage of frequency of 41.6%. True word productions exhibited a reverse trend as that of holophrastic and protowords productions. The participants exhibited a mean percentage of 32.6% frequency of occurrence for true words and later showed a gradual increase of truewords in the participants nearing 16-18 months.

Similarly another study in native Kannada speaking children, Shishira, Sushma and Sreedevi (2014) found that protowords, holophrastic productions as well as true words emerged in children during 12 to 24 months, the frequencies of each varying with progressing age. Holophrastic and protowords found copiously in the younger age group (12-18 months), were a reflection of the children's limited vocabulary to accommodate a huge conceptual framework, whereas decrease in their frequency with advancing age (18-24 months), portrayed their linguistic growth and maturity to meet the demanding needs of their conceptual system and progress incisively. Due to paucity of research on emergence of early word forms in children younger than 1 year of age, the present study aims to overcome the limitation by studying the same in Hindi and Malayalam languages.

2.8.4 Babbling as a predictor of early language complexity

Syllables first appear at around three months, Oller (2000) describes this stage they fall into the category of 'marginal babbling'. This is the combination of consonants like sounds with some vowel-like sounds begin to occur. In the period 5-13 months, the proportion of syllable type sequences are V (60%) > CV (19%) > CVCV (8%) >VCV (7%) > VC (2%) > CVC (2%). This refers to the overall proportion of vocoids produced relative to consonants. A cross-linguistic data gathered by Vihman (1996) on favoured syllables sequences are [da] > [ba] > [wa] > [də] >[ha] > [hə]. The main features are that vocoids are generally low-back or central and consonants are front articulated either bilabial or apical or glottal. These patterns are not language specific but reflect the physiological rather than phonological development.

Vocalization emergence during the canonical babbling period results from a complex process involving coordination of multiple subsystems. In particular, neurophysiologic–motor, tactile, proprioceptive, and perceptual factors have been noted as contributing to vocal patterns (Eilers & Oller, 1994; Goffman, Ertmer, & Erdle, 2002; Oller & Eilers, 1988; Stoel-Gammon & Otomo, 1986). Each of these subsystems varies in the extent to which it contributes to the observable properties of vocalization development. Canonical babbling is monumental to parents and specialists because of its assumed relationship to later speech and language development (Chapman, Hardin-Jones, Schulte & Halter, 2001). Some studies have indicated a correlation between complexity and amount of babbling with later language proficiency (Camp, Burgess, Morgan, & Zerbe, 1987; Mirak & Rescorla, 1998; Stoel- Gammon, 1989; Thal, Oroz, & McCaw, 1995; Whitehurst, Smith, Fischel, Arnold, & Lonigan, 1991). The process of vocal development in typically developing infants and toddlers has been characterized as consisting of overlapping stages during which new vocalization types emerge and become common (Vihman, 1996). Advancements to higher levels of vocal development have been interpreted as signs of progress towards meaningful speech and phonological organization (Stoel-Gammon, 1998; Vihman, Ferguson, & Elbert, 1986). A relationship between the number of vocalizations and the later speech and language development has also been found. Kagan (1971) found a relationship between high number of vocalizations and larger vocabulary development at 27 months for girls. Also, Roe (1977) found a positive correlation between the number of vocalizations at three months of age and the amount of talking at three years, as well as the vocabulary development at five years in his study of 14 boys. Camp, Burgess, Morgan and Zerbe (1987) studied 141 normally developing infants and reported a correlation between the number of vocalizations at four to six months of age and word use at one year.

2.8.5 Late babbling a predictor of language delay

Later studies indicate that late canonical babbling might be a predictor of disorders (Oller, Eilers, Neal, & Schwartz, 1999). Oller et al. (2000) evaluated 3,469 infants who were at risk for delays. The researchers discovered that of the infants who demonstrated delayed onset of canonical babbling; fewer than half were diagnosed with a medical problem accounting for the delay. During a follow up study researchers found that infants who were delayed in canonical babbling had smaller vocabularies at 18, 24, and 30 months. Hence they found that late canonical babbling might be an effective predictor of emerging speech and language disorders in general. Westermann and Miranda (2004) support these findings by indicating that there is growing evidence that the pre-linguistic stage influences the development of phonology. Research provides evidence of similarities between babbling and early speech (Nakazima, 1962; Murai, 1963; Cruttenden, 1970; Oller, Wieman, Doyle, & Ross, 1976).

2.8.5.1 Babbling in atypically developing children

In studies on atypically developing children a relationship between number of vocalizations and later speech and language development is found. In the study of McCathren, Yoder and Warren (1999) a clear positive correlation was found between rate of vocalizations at 17-34 months of age and later expressive vocabulary of 58 children with a developmental delay.

If a relationship between vocalization and the later speech and language development exists, it might be the case that an abnormal vocalization development might be related to an abnormal spoken language development. Jensen, Boggild-Andersen, Schmidt, Ankerhus and Hansen (1988) studied the development of infants who were at risk for a developmental delay (low birth weight, low Apgar score, neonatal cerebral symptoms) and compared them to infants not at risk. The infants at risk produced significantly fewer consonant-like segments and less reduplicated babbling than the children not at risk. A larger proportion of the children at risk also scored below age level on a language test. Moreover, Oller, Eilers, Neal and Cobo-Lewis (1998) argued that a late babbling onset might possibly function as an early marker of abnormal development.

In a study by Chapman, Hardin-Jones and Halter (2003) the relationship between vocalizations and later speech and language performance was shown for infants with a cleft lip and palate. It was suggested that the production of stop consonants in vocalizations at 9 months of age was related to phonological development at 21 months.

Canonical babbling onset has also been studied extensively in a number of populations of infants who either had disorders of communication or were deemed to be at risk for such disorders (Smith & Oller, 1981). Oller et al. (1985) has documented that the canonical babbling of children with severe to profound hearing losses differs significantly from that of normal hearing children, the variety of phonemes used is reduced, the volume of babbling is reduced and most importantly, the timing elements between the consonant and the vowel are significantly longer than those of normal hearing children. These studies clearly indicate a connection between vocalizations, babbling in particular, and later language development.

Lehithalmes, Heikkinin, Olsen and Yliherva (2012) investigated the canonical babbling upto first words in 18 pre term infants with extremely low birth weight and 11 full term infants. It was found that the pre term infants failed to produce more different kinds of syllable types and remained in the babbling phase longer compared to the full term infants who reached their first meaningful words.

Wetherby, Yonclas and Bryan (1989) in their findings suggest that deficits in babbling may be a characteristic of autism. They observed 3 young children with autism who displayed both a deficit in syllable production and substantially high proportions of atypical vocalizations than children with Downs syndrome or specific language impairment. Hence, studying the patterns of early vocalizations would help to identify late onset of babbling or atypical babbling which would serve as a valid predictor of subsequent speech sound disorder or delay.

2.9.0. Phonetic features in other languages

It has been proposed that learning from the ambient language influences and shape vocalizations in late babbling periods. Khul's native language magnet (NLM) model encompasses infant vocalizations. It is hypothesized that infants listening to the ambient language store perceptually derived representations of speech sounds they hear which in turn serve as a target for production (Khul & Metzloff, 1996). Therefore, it is expected that the phoneme in a child increases when the frequency of occurrence of that phoneme is high with the ambient language.

Consonants and vowels have been studied extensively in infant production patterns across languages. As observed in English by Davis and MacNeilage (1995) and in across various diverse languages (Locke, 1983; Kerns and Davis (2011), the occurrence of predominant consonants were stops and nasals and in the restricted region of the vowel space were mid and low as well as front and central vowels. These similarities have provided data supporting production system oriented view of early acquisition.

Locke (1983) surveyed three studies of consonant production involving a total of 131 English-learning infants at the age of 11 months to one year. 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. Locke (1983) asserted that preferences found in the English-learning infants tended to be confirmed in infants' babbling in fourteen other language environments.

Except for the frequency of [h], and somewhat higher frequencies for fricatives and liquids, similar patterns were found in a large-scale study of six English-learning infants, including analysis of a total of 15,690 consonants (Davis & MacNeilage, 1995). The median percentages of occurrence for manner of articulation were stops (48%), nasals (14%), glides (11%) and other consonants (18%), consisting primarily of liquids and fricatives. For place of articulation, the median percentages were coronals (47%), labials (26%), dorsals (9%) and other (17%). While Davis and MacNeilage used a larger sample, their results were mainly descriptive.

Although Kern and Davis (2009) employed statistical analyses, most studies of diverse languages have employed descriptive methods to report infant consonant and vowel patterns, often based on very small corpora. In addition, vowel production has been examined largely within Indo-European languages such as English, French and Spanish. It is not certain whether the lower left quadrant vowel space is a universal characteristic in infant vowel production patterning. Moreover, infant patterns have not been compared to ambient language sound patterns consistently. No comparison with ambient language frequencies is available in the large infant databases reported by Kern and Davis (2011) for five Indo-European languages or in the English database analyzed by Davis and MacNeilage (1995). It is difficult to argue conclusively that infant speech patterns are based only on production limitations without comparison with adult input frequencies.

In the most comprehensive cross-language study of babbling available in terms of database size (Kern & Davis, 2011), consonant and vowel frequencies were tabulated for five sets of four children in Dutch, French, Romanian, Tunisian Arabic and Turkish language environments. A total of 57,472 consonants were tabulated. The median percentages for occurrence of manner of articulation were stops (51%), nasals (16%), glides (17%), oral fricatives (8%), glottal fricatives (5%) and others (5%). For place of articulation, the median percentages of occurrence were coronals (50%), labials (23%), dorsals (12%) and glottals (3%).

Levitt, Aydelott and Utman (1992) compared the babbling of one infant reared in an English and one reared in a French environment in weekly 20-minute sessions at ages 0 ; 5, 0 ; 8, 0 ; 11 and 1 ; 2. Both children produced stops most frequently. This pattern was consistent with cross-language tendencies observed in

Locke (1983). However, the absolute frequency of stop productions was different between the two children. The difference in frequency of stop consonants was interpreted as resulting from language-specific feature differences between English and French. The authors suggested that their results provided evidence of both universal and language specific characteristics in babbling. Levitt and Aydelott Utman's data were based on analysis of one infant per language. It may thus not be valid to generalize these case study results or compare them with group data.

MacNeilage and Davis (1990) reviewed studies of vowels in babbling in a total of twenty-three infants in English (Kent & Bauer, 1985; Lieberman, 1980), French (De Boysson-Bardies *et al.*,1989) and Spanish (Oller & Eilers, 1982) language environments. They found a tendency for mid and low as well as front and central vowels to be preferred across languages. This pattern has been designated as a preference for 'lower left quadrant' vowels. The lower left quadrant preference was confirmed in the analysis of a large database of 15,719 vowels produced by six English-learning infants in babbling (Davis & MacNeilage, 1995), of the top three vowels for the 6 subjects, all but one vowel for one subject were mid or low front or central vowels'. In the babbling data on five languages analyzed by Kern and Davis (2011), a total of 69,007 vowels were tabulated. About two-thirds of all vowels occurred in the lower left quadrant. In all five languages, front and central vowels exceeded back vowels, and mid and low vowels exceeded high vowels.

Lee, Davis and MacNeilage (2009) for infant output, compared the babbling samples of six Korean learning infants with the existing English database of Davis and MacNeilage (1995). For ambient language comparisons, consonants and vowels in ten Korean and ten English Infant Directed Speech (IDS) samples were analyzed.

The two infant groups in this study demonstrated similar consonant patterns, but showed different vowel patterns from each other. For consonants, both Korean- and English-learning infant babbling were characterized by a predominance of stop consonants (over 50% for both) and relatively frequent nasal (33% for Korean and 17% for English) manner of articulation. Both groups produced frequent labial (46% for Korean and 33% for English) and coronal (38% for Korean and 42% for English) compared to dorsal and glottal place of consonant articulation, consistent with previous studies of the babbling period (De Boysson-Bardies & Vihman, 1991; Davis & MacNeilage, 1995; Kern & Davis, (2011); Vihman, Ferguson & Elbers (1986); Vihman, Macken, Miller, Simmons & Miller (1985)).

The two infant groups, on average, however, showed different frequencies of nasal, fricative and glide manner of articulation. Korean-learning infants produced more nasals and fewer glides and fricatives than English-learning infants. Compared to previous studies, the percentage of nasal consonants produced by these Korean-learning infants (33%) was consistently higher than in the English-learning infants reported by Locke (1983; 9%), De Boysson-Bardies and Vihman (1991; 16·8%) and Levitt, Aydelott and Utman (1992; less than 10%). In contrast, the percentage of fricative consonants produced by Korean-learning infants (5%) was also consistently lower than the English-learning infants in the Boysson-Bardies and Vihman (11·8%) and Levitt, Aydelott and Utman (30%) data. Inspite of a large database that was analyzed in this study, for major consonant categories, statistical significant difference could not be obtained. This may be due to variations in day to day consonant repertoire in babbling of infants.

For vowels, both Korean- and English-learning infants showed some common vowel patterns. They produced similar frequencies of low-back and high-central vowels even though the frequencies of these vowels were different between English and Korean IDS. The extremely rare production of low-back and high-central vowels in infant babbling in both language environments confirmed previous findings that production of these vowels was low frequency in infant babbling (Davis & MacNeilage, 1995; Roug 1989). Furthermore, English-learning infants produced more low-central than low-back vowels, although English IDS contained less frequent low-central than low-back vowels. This finding was consistent with Oller and Eilers (1982) in that their English-learning infants produced more low-central [a] (8%) than low-back [α] (2·4%) vowels.

For both languages, infant vowel pattens were related to the ambient language IDS. This may be because vowels were more perceptually and motorically available in the input and output capacities of babbling infants. Thus, common production patterns and ambient language influence can be found simultaneously in this early developmental stage of speech like vocal development. The results of this study are consistent with Levitt, Aydelott and Utman (1992), Oller and Eilers (1982) and Kern and Davis (2011) in indicating both language-universal and language-specific patterns in prelinguistic babbling in studies of Indo-European languages.

Chapter 3

Method

3.1 Participants

A total of 80 participants were randomly selected, 40 infants in each of the two languages, Hindi and Malayalam. Participants were considered in 4:0 to ≤ 6:0, >6;0 to ≤ 8:0, >8:0 to ≤ 10:0 and >10:0 to ≤ 12:0 months with an age interval of two months. Each of the four age groups in each language consisted of ten infants including five boys and five girls. Hence, the present study comprised a total of 80 infants. The study was briefed to the parents and a written consent was obtained from them for involving the participation of the infants (Appendix A). The study adhered to the 'Ethical guidelines for bio-behavioral research involving human subjects' set by the All India Institute of Speech and Hearing Ethical Committee and subsequently ethical committee approval was obtained on 09.05.2013.

3.1.1 Inclusion criteria for the participants (common to both languages)

3.1.1.1 Participant selection criteria

Language: The native languages of the participants were either Hindi or Malayalam. Hindi participants were identified from Hindi speaking belt, Delhi, India and Malayalam participants were be identified from Malayalam speaking belt, Kerala, India. In addition few of the participants for both the language groups were recruited from native Hindi and Malayalam speaking families respectively in Karnataka (Mysore & Bangalore). These participants were exposed to their native language only.

3.1.2 Participant Exclusion criteria

- Pre-term infants
- Infants with oral clefts
- Laryngomalacia
- Hearing loss
- Cerebral palsy and
- Other neurological disorders

3.1.3 Screening tests: The infants selected were developing normally according to community standards and reports from parents and physicians regarding the developmental milestones. Skills that included reception and expression, were assessed on a [3]checklist (Swapna, Jayaram, Prema, & Geetha, 2010) obtained through parental interview. The High Risk Register (Prevention Of Communication Disorders, AIISH, 1993) was also administered to rule out the same. The oral peripheral mechanism was examined for normal structural and functional development of the oro-facial structure in the participants to rule out high risk

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[3] ***Checklist to assess different domains in preschool children with communication disorders (0-6 years)***

The checklist was developed as a part of an AIISH Research Fund Project undertaken at All India Institute of Speech and Hearing by Swapna, Jayaram, Prema and Geetha (2010). The checklist was designed for an intervention module for pre-school children with communication disorders. The checklist assess ten different domains namely self help, social, motor, cognitive, sensory, speech and language, play, pre-reading, pre-writing and pre-arithmetic skills respectively. For the present study domains of social, visual, audiotory, speech and language, play, motor and cognition skills were considered. It incorporates the items which the child develops in a hierarchical manner based on the developmental norms of typically developing children. The responses of the child was observed and interviewed and scored (0- not applicable/ absent, 0.5 totally dependent, 1- consistent and independent). If the development of a skill was not age appropriate, the parents/ caregivers would be counseled on further interventions. Hence, the profile provides a quantification of child's functional level and an observational summary of the child's performance.

infants with nasal regurgitation and/or otitis media. Subjects were selected according to the age criteria as shown in Table 3.1 in both languages:

Table 3.1
Grouping of participants according to age criteria

Groups	**Age criteria for infants in months**
Group I	4:0 to ≤ 6:0
Group II	>6;0 to ≤ 8:0
Group III	>8:0 to ≤ 10:0
Group IV	>10:0 to ≤ 12:0

3.1.4 Socio-Economic Status: The selected subjects belonged to middle socio-economic class according to the adapted version of National Institute of Mental Health Socioeconomic Status Scale (Venkatesan, 2011), shown in Appendix B. Smith (1973) reported that children from a lower socio-economic status have more articulatory deficits and language delays compared to families with higher socio-economic status. In addition he reported that children from families of higher socio-economic status have increased speech and language stimulation. Hence, to control these differences, the middle income families were selected.

3.1.5 Education of the parents*:* Minimum education level of both the parents was 10^{th} grade.

3.1.6 Language proficiency of the parents*:* The proficiency of the native/native language of the parents was assessed using a language free test-Language Proficiency Questionnaire: An adaptation of LEAP-Q in the Indian context (Ramya Maitreyee & Goswami, 2009). The rating for the questionnaire was

0- least proficient and 5- perfect native speaker. In the present study, according to the rating scale, the language proficiency of both the parents were "4- good" or "5- perfect/ native" for the languages Hindi and Malayalam.

3.1.7 Assessing the stimulation of the participant*:* Based on the information obtained through case history with the parents/caregivers, it was ensured that the number of hours spent with the child was adequate for good speech. The format used for obtaining the parent – infant interaction is provided in Appendix C.

3.1.8 Family type*:* Infants from both family types either nuclear or joint were enrolled in the study. Also only infants having ≥ 80% monolingual exposure to their native languages of Hindi and Malayalam were included.

3.1.9 Gender: The study included 5 boys and 5 girls in each of the four age groups.

3.2 Procedure

3.2.1 Data collection and Recording Procedure

Audio recordings were carried out by the investigator in a fairly quiet room with minimal distractions at the respective homes of the participants. Vocalization samples were recorded when the child was fed and was in a comfort state. According to Stoel-Gammon (1959) and Winitz (1961), vocalization is defined as the production of vowel-like and consonant-like sounds and sound patterns occurring within a single breath unit.

Audio recording was carried out using a Sony MZ-55 digital voice recorder with an integrated microphone for each participant. Sampling rate of 44,100 Hz was used. The audio recordings were carried out with the recorder held at a distance of 10-15 cms from the infants' vicinity, and it was ensured that the infant was not distracted. Parents were asked to interact naturally with the child. To reflect the infants' typical vocalizations in familiar surroundings, no additional play materials were introduced into the environment. Approximately 45 to 50 utterances were recorded from infants at 4 to 6 months of age. From infants beyond 6 months of age, it was ensured that at least a minimum of 100 utterances were recorded. If any of the participants did not produce the targeted number of vocalizations, the recording was carried out on consecutive days. The researcher had 1 to 2 sittings on an average with each participant. The exact age of the participant at the time of recording and the total corpus of vocalizations has been enlisted in Appendix D. All the recordings were transferred to a computer for segmentation and data analysis using the VLC media player software.

3.2.2 Analysis considered in the study

Based on the transcription, the following analysis were carried out

1) Frequency of vowels and diphthongs and their types

2) Frequency of consonants and their types

3) Frequency of various syllable shapes and their types

4) Frequency of reduplicated and variegated utterances and their types

5) Frequency of holophrastic/protowords/ true words

3.2.3 Data analysis

Data analyses were carried out in the following four stages.

Stage 1- Transcription and data reduction

Stage 2- Quantification of syllable shapes

Stage 3- Establishing proto words/ holophrastic words/ true words.

Stage 1-Transcription and data reduction: Every perceptually distinguishable vocoids (vowel-like) or contoids (consonant-like e.g [m],[b]) vocalization produced by each child was transcribed using broad and narrow International Phonetic Alphabet (2005) (refer Appendix E). The primary investigator (researcher) transcribed all the samples in broad and narrow IPA by listening to the recorded audio samples. If required the same sample was listened to repeatedly. Only speech like productions with an egressive airstream and imitated vocalizations were considered for the transcription. Sounds such as grunts, gurgles, laughs, shrieks, whispers etc. and any vocalizations unlike speech were excluded from the transcription.

Stage 2- Quantification of syllable shapes*:* Based on the criteria adopted, singleton vowels, consonants, various syllable shapes such as CV, VC etc and multisyllabic productions were identified in the infant's babbling sample. Following the quantification of the syllable shapes, the percentages of reduplicated and variegated babbling were calculated. The multisyllabic utterances in which the second CV consists of the same phonemes that are present in the first CV were assigned to the category of reduplication, including a variation in the vowel such as /bababa/, /gagigu/ etc. All other multisyllabic productions that had variations within the vowel and/or consonants were assigned to the category of variegation such as /bapiku/, /kitupa/ etc.

Types of reduplicated babbles such as consonant reduplication[3] and vowel[4] reduplication were less in frequency of occurrence hence were included under the major category of reduplicated babbles. However, in the present study, the variegated babbles were categorized as follows:

i. **Voicing variegation (VgV)-** Vocalizations in which there are changes only in voicing features of consonants irrespective of the vowels E.g /bepa/, /gika/

ii. **Place variegation patterns (PLV)** - Vocalizations in which there are only changes in places of articulation of consonants irrespective of the vowels. E.g nəmɔ/ dagi

iii. **Manner variegation patterns (MV)-** Vocalizations in which there are only changes in manner of articulation of consonants irrespective of the vowels E.g mapapa/ bemabi. Following this, mean percentages of these various phonetic behaviours were calculated using the following formula (Valleman, 1998) as provided in Table 3.2.

[3] Consonant reduplication (CR) - If 2 or more syllables, having same consonants and vowels repeatedly occur; they are characterized as sequences of consonant **reduplicated utterances**. E.g babababababa/ gugugugu also utterances in which 3 or more consonants repeatedly occur with an inaudible vowel segment were also characterized as **consonant reduplication**. E.g mmm/ gggg

[4] Vowel reduplication (VR) - Utterances in which the same vowel segments are replicated without change in vowel features (i.e tongue height/ tongue advancement or rounding) e.g aaaa/uuuu was characterized as **vowel reduplication**.(Oller, 2000).

Table 3.2
Formulae to calculate mean percentage of frequency of occurrence of phonetic behaviours

PHONETIC BEHAVIORS	FORMULAE
Simple syllable shapes	No of V/ VC/CV/CVC etc ---------------------------------- X 100 = % of V/ VC/CV/CVC Total no. of different types of syllables
Reduplicated and variegated babbles	No. of reduplicated/ variegated syllables ---X 100 = % of redup/ variegated babbles Total no. complex vocalizations in the corpus
Types of variegated babbles	No. of VgV/ PLV/MV/ -- X 100= % of VgV/ PLV/MV/ Total no. of variegated babbles

Stage 3- Establishing proto words/ holophrastic words/ true words: The infants' productions from 10 months onwards were evaluated for word status based on Vihman's procedure (Vihman & McCune, 1994). The criteria for identifying true words based on context were as follows:

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.

The criteria for other word types differed. On parental interview, the type and frequency of holophrastic, protowords and true words were established

3.3 Reliability

3.3.1 Inter transcriber reliability

Selection of judges: Three (post graduates) speech language pathologists (practicing SLPs) including the researcher, who were proficient in transcription of speech samples served as judges for determining inter transcriber reliability in both the languages. Initially the SLPs were trained to listen to the samples and transcribe them.

The recorded samples were played to both the judges independently. They were not allowed to discuss about the transcription of the sample before or after the task. The investigator also participated as the third judge for the transcription. In each language consisting of 40 subjects, 10% of each subject sample was considered for inter transcriber reliability. From the samples recorded, 10% of the sample data was transcribed by the three Speech Language Pathologists including the researcher and was verified for inter rater transcriber reliability.

3.3.2 Intra transcriber reliability

In each language 10% of the subject sample was subjected to intra-transcriber reliability. From the samples of these subjects 10% of the data from each subject was transcribed and verified by the researcher for intra transcriber reliability. Inter and intra judge reliability measures using Cronbach's alpha test revealed a reliability index (α) of 0.73 for inter judge and 0.82 for intra judge reliability, suggesting the data to be reliable.

3.4 Statistical analyses

Statistical methods were employed using SPSS (Statistical Package for Social Sciences) version 18.0. The transcribed data was assessed to verify if it followed a normal distribution.

3.4.1 Box plots

Box plots were constructed to trace the outliers across age and language groups. As each participant was an outlier in at least one of the measures, outliers were not removed and were included for data analysis.

3.4.2 Test of normality

Test of normality was administered on the data using Shapiro- Wilk's test. Results of Shapiro-Wilk's test revealed the data to be non-normal distribution in all the four age groups in both languages. This could be because the babbling samples of 80 infants consisted of some types of phonetic behaviors that were scattered (i.e. vocalizations produced with a high frequency of occurrence by some participants and/or some of the vocalization types minimally produced by few participants).

3.4.3 Descriptive statistics

Descriptive statistics was carried out for all the types of phonetic behaviour evaluated. The descriptive statistics of mean, standard deviation, median and inter-quartile range were computed in all four age groups in Hindi and Malayalam. The Mean and Standard deviations are provided in Appendix H. Median and inter-quartile ranges are given in the text. Since the data presented a non-normal distribution and high standard deviations in many of the utterance types, median percent scores are used for descriptions and comparisons. Median scores were converted to percentages since the frequency of phonetic behaviors were different for each participant. Mean ranks are provided for descriptive comparison across groups. To consider a phonetic behavior to be emerging, a 60% criteria was adopted. i,e 6 or more participants out of 10 had to produce the specific phonetic behavior.

3.4.4 Non- parametric tests

As the data displayed a non normal distribution, non parametric statistics were carried out for comparisons of types of phonetic behaviors across gender, age and languages. A flowchart of the statistical analysis carried out in the study is shown in Fig.3.1. Non parametric Mann Whitney U test was applied to examine the significant difference across gender. Kruskal Wallis test was employed for the comparison of phonetic behavior types across age groups, if significant effect was present; Mann Whitney test was employed for pair wise comparison across age groups and languages.

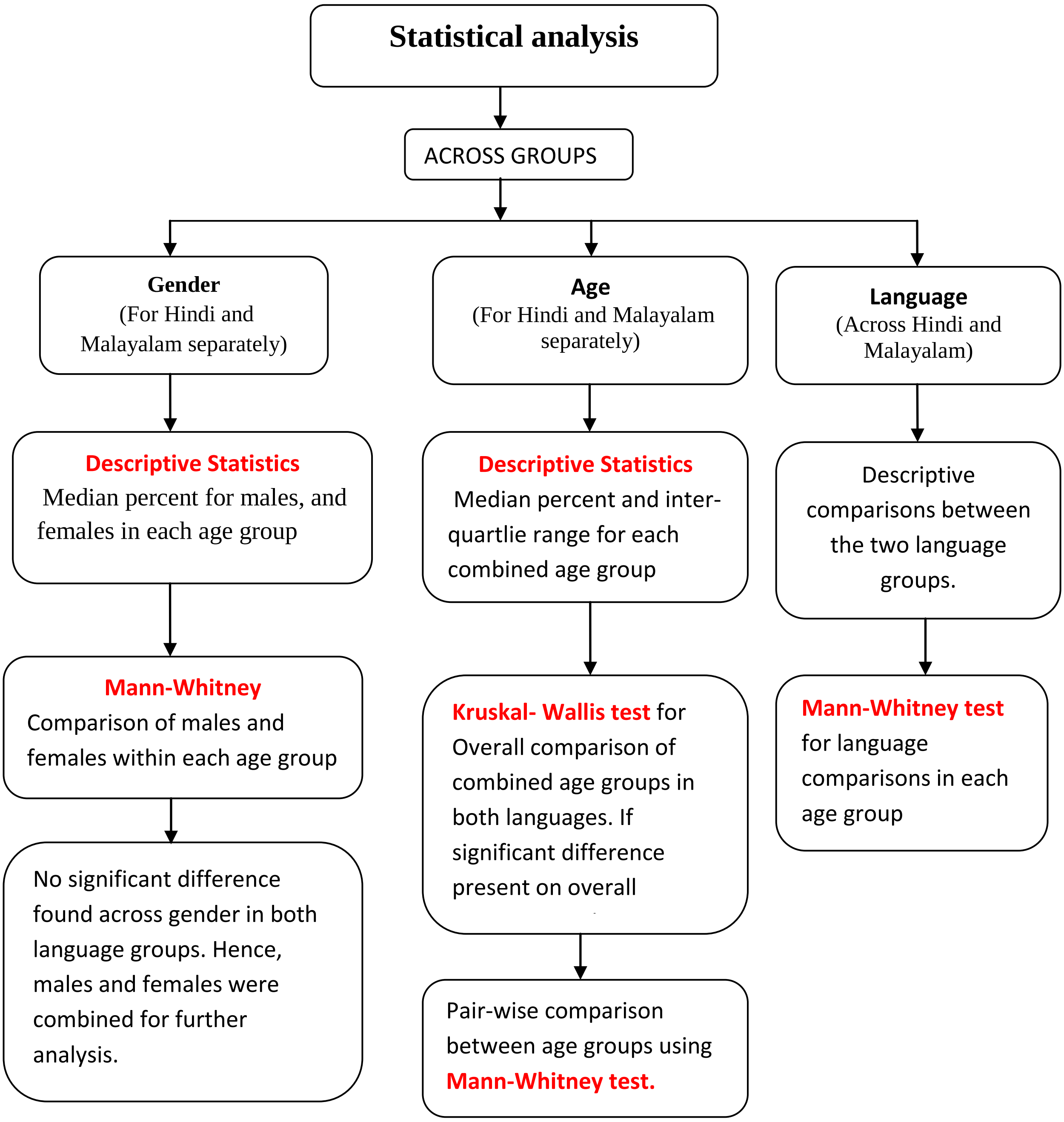

Figure 3.1. Flow chart of the statistical analyses

Chapter 4

Results and Discussion

The aim of the study is to investigate the pre-linguistic phonetic characteristics of typically developing children of Hindi and Malayalam from 4 to 12 months of age.

The main objectives of the study were:

1. To compare the pre-linguistic vocalizations and phonetic repertoire across gender

   within the languages Hindi and Malayalam.
2. To compare the pre- linguistic vocalizations and phonetic repertoire across the four age groups 4:0 to ≤ 6:0, >6;0 to ≤ 8:0, >8:0 to ≤ 10:0 and >10:0 to ≤ 12:0 months within the two languages.
3. To compare the pre-linguistic linguistic vocalizations and phonetic repertoire of infants between the two languages studied (Hindi and Malayalam).

The recorded data of the 80 participants was phonetically transcribed using International Phonetic Alphabet (2005) which yielded a total of 9501 utterances in the entire babbling corpus of the 80 participants. The types of utterances extracted from the infant vocalizations are represented elaborately in the flow chart 4.1.

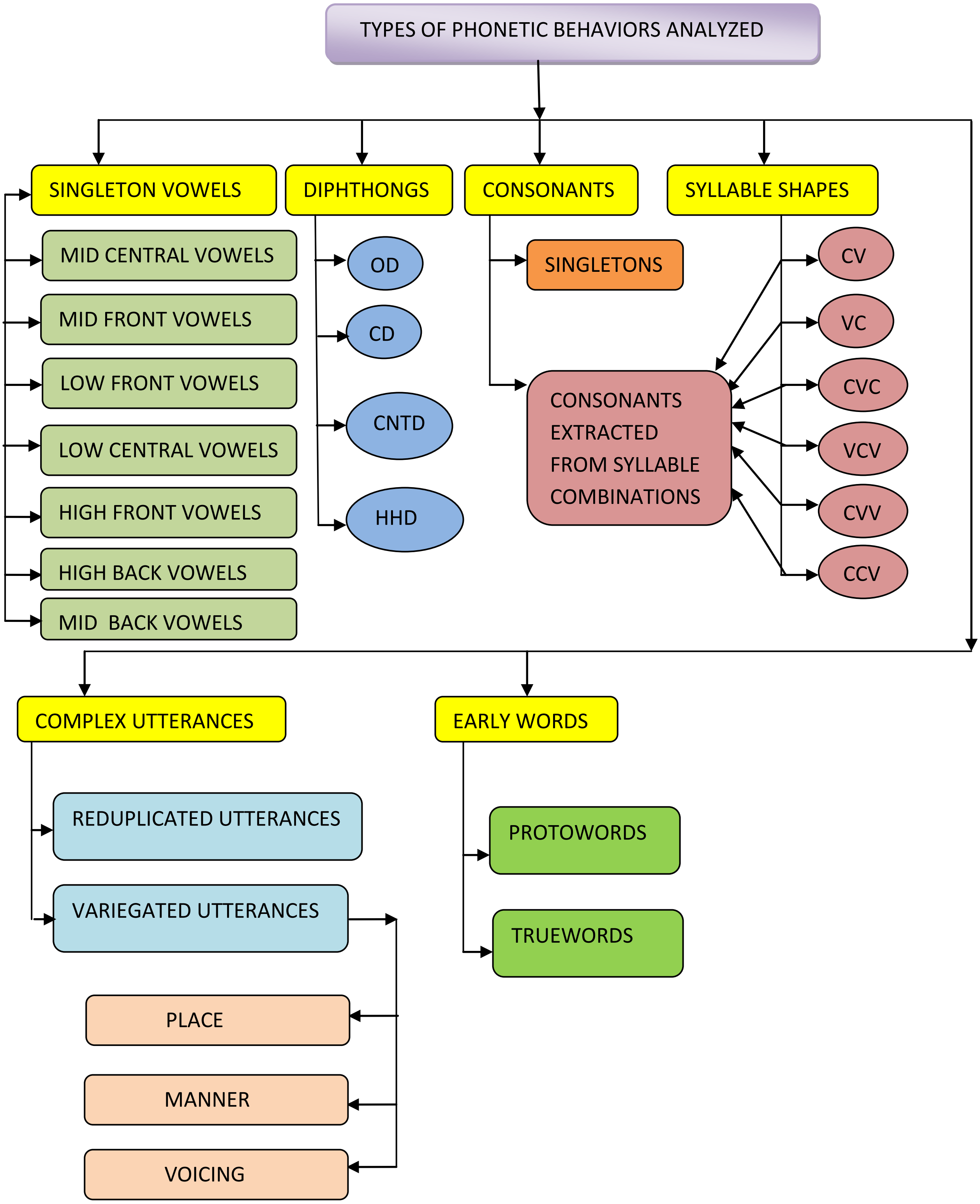

Figure 4.1 Flow chart representation of the types of utterances analyzed in the infant vocalizations of the present study.

Notes: OD- Opening Diphthongs, CD- Closing Diphthongs, CNTD- Central Diphthongs, HHD- Height Harmonic Diphthongs, CV- Consonant – Vowel, VC- Vowel- Consonant, CVC- Consonant-Vowel-Consonant, VCV- Vowel-Consonant-Vowel, CVV- Consonant-Vowel-Vowel, CCV- Consonant-Consonant-Vowel.

The transcribed phonetic repertoire of the infants consisted majorly of the following types of utterances as described in a flowchart:

Vowels analyzed in the study were single utterances and not extracted from simple syllabic forms and other complex utterances. The vowels included front vowels (mid front vowel [e], [e:]; low front vowels [æ], [æ:]; high front vowels [i], [I]), central vowels (mid central vowel [ə], [ə:]; low central vowels [a], [a:]), and back vowels (high back vowels [U], [u], and mid back vowels [ɔ], [ɔ:]). The articulation of diphthongs involves a change in quality from one vowel to another (Ladefoged, 2006). Various kinds of diphthongs such as Opening diphthongs have the second vowel more open than the first i.e. tongue ends lower in the mouth (e.g /uə/, /e:ɔ/). Closing diphthongs have the second vowel more closed than the first i.e. the tongue ends higher in the mouth (e.g /au/ and /ai/). Central diphthongs are with both vowel elements more central in the mouth (e.g /æə/, /əe/). The Height Harmonic Diphthongs have both the vowel elements which are either the open vowels or the close vowels (e.g /əə/, /aa:/) (Jones, 1975). The types of diphthongs produced by Hindi and Malayalam learning infants are displayed in Appendix F.*(http://slbltsu.hull.ac.uk/awe/index.php?title=Different_classifications_of_diphthong)*

Singleton consonants included short and long nasal [m] occurring in isolation. The voiced bilabial nasal [m] occurred with the highest percent median score in the youngest age group of 4 to 6 months in both Hindi and Malayalam. Consonants were also extracted from the syllable shapes CV, VC, CVC, VCV, CVV, and CCV. However consonants were not extracted from complex utterances such as reduplicated and variegated babbles. The number and type of consonant productions varied across the age groups. Further, the voiced and unvoiced cognates increased in their appearance as age advanced. The consonants are discussed with regard to voicing (voiced and unvoiced), manner of articulation (stops, nasals, glides, laterals, trills, fricatives and, affricates) and place of articulation (bilabials, dentals, alveolars, palatals, velars and glottal) dimensions.

Simple syllable shapes: Simple syllable shapes included monosyllabic syllable structures represented as V (Vowels), CV (Consonant-vowel), and VC (Vowel-consonant) and other syllable structures such as CVC (Consonant-vowel-consonant), VVC (Vowel-vowel-consonant) and CVV (Consonant-vowel-vowel) and the modest expansions of the simple CV syllable type such as VCV (Vowel-consonant-vowel). Other syllable shapes CVCV, VCCV and the complex structures such as CVCVCV, CVCVVCCC, VCVVCCV, etc. were not considered in this category.

Reduplicated and Variegated babbles included disyllabic syllables, CVCV and VCCV and the complex syllable structures such as CVCVCV, CVCVVCCC, VCVVCCV, etc. These were analysed for: 1. Frequency of reduplicated and variegated babbles 2. Frequency of types of variegated utterances including place (e.g /nəmɔ/), manner (e.g / mapapa /) and voicing (e.g /bepa / variegations) .

Early word forms included proto words and true words. Protowords and trueword productions observed in both languages are listed in Appendix G. Results are discussed as per the three main objectives of the study

4.1 To compare the pre-linguistic vocalizations and phonetic repertoire across gender within the languages Hindi and Malayalam.

The non parametric Mann-Whitney U test was applied to examine the significant difference across gender of infants in Hindi and Malayalam. The test revealed no significant difference across gender ($p > .05$) in both languages for all the four age groups (Appendix I); hence the scores for boys and girls were combined for further analysis and gender was not considered a variable. Thus, the hypothesis that there is no significant difference between gender in the pre linguistic vocalizations and phonetic behaviour of infants in Hindi and Malayalam is accepted. The various phonetic behaviours produced by the participants are discussed with regard to age and language for the second and third objectives.

4.2 To compare the pre-linguistic vocalizations and phonetic repertoire across age within the languages Hindi and Malayalam.

4.2.1 Vowels

4.2.1.1 Comparison of vowels across age in Hindi participants

A total corpus of 4713 phonetic behaviors in Hindi produced by 40 participants consisted of 1072 singleton vowels. Among these, 269 vowels were produced by Group I (4-6 months), 324 vowels by Group II (6-8 months), 227 vowels by Group III (8-10 months) and 252 vowels by the oldest group of participants of Group IV (10-12 months). It was seen that there were relatively less number of singleton vowels in the older two groups from 8 to 12 months. The vowels are presented in front, central and back dimensions. Singleton vowels such as /i, iː, u, uː,ɔ and ɔː/ were produced by few participants in all the 4 age groups, hence were not included for statistical analysis. However, relatively more productions of these infrequent vowels were seen in the older age groups.

The vowels are described with reference to their tongue height and tongue advancement dimensions. Table 4.1, describes the median (*Mdn*) percent and inter-quartile range (*IQR*) for the combined scores of boys and girls for front, central and back vowels in Hindi.

Table 4.1
Descriptive statistics (Median percent and inter quartile range) of vowels in Hindi

	Hindi							
	Age range (in months)							
Vowels	**4:0 to ≤ 6:0 Group I**		**>6;0 to ≤ 8:0 Group II**		**>8;0 to ≤ 10:0 Group III**		**>10;0 to≤ 12:0 Group IV**	
N= 10	**Mdn**	**IQR**	**Mdn**	**IQR**	**Mdn**	**IQR**	**Mdn**	**IQR**
FRONT VOWELS	30.71	24.63 -55.18	30.38	14.9 - 51.14	45.00	36.46- 61.47	53.21	35.91 - 75.83
CENTRAL VOWELS	70.00	47.55- 75.73	69.62	48.86 -85.03	60.00	44.39- 64.58	53.57	26.38 - 66.64
BACK VOWELS	0.00	0.00-0.51	0.00	0.00-0.42	1.61	0.00-4.76	0.00	0.00-6.79

Front and central vowels emerged (considering 60% criteria for the phonetic behavior as emerging) early as 4 months and continued to be present till 12 months. From Table 4.1, it is seen that there is a linear progression of front vowels and reduction in central vowels with advance in age. Back vowels remained to be the least occurring in all the age groups. The median percent scores are higher for central vowels compared to front vowels in all the 4 age groups in Hindi. This is because among the vocalizations of the eight frequent vowels, the mid central vowel [ə] and its longer counterpart [ə:] exhibited relatively high production across the four age groups. Central vowel [a] also had a linear progression in its production with advance in age, a finding consistent with Oller and Eilers (1982) in English-learning infants and Lee et.al (2010) in Korean-learning infants, who produced an extremely high frequency of central vowels with advance in age. Its longer counterpart [a:] was vocalized by participants in the older group of 8 to 10 months; this may be because infants are physiologically predisposed to laryngeal constriction especially for a low vowel which is retracted and produced more frequently during the babbling period (Benner & Grenon, 2011).

Findings of pre-linguistic production of central and front vowels is in support of reviewed studies in babbling in Kannada (Sreedevi & Jyothi, 2014), English (Kent & Bauer, 1985; Lieberman, 1980, McNeilage & Davis, 1990), French (Boysson-Bardies et al., 1989) and Spanish (Oller & Eilers, 1982) language environments. All these studies found a tendency for front and central vowels to be preferred across languages. This pattern has been designated as a preference for ‘lower left quadrant’ vowels (Bickly, 1983; Bhur, 1980 Kent & Bauer, 1985; Lieberman, 1980; Stoel-Gammon & Harrington, 1990). The lower left quadrant preference was confirmed in the analysis of a large database of 15,719 vowels produced by six English-learning infants in babbling (Davis & MacNeilage, 1995).

Fig. 4.2 depicts the developmental trend for central, front and back vowels in Hindi participants. It could be seen that among the types of vowel dimensions, central vowels were higher than front vowels and emerged as early as 4 months and reduced in production as age advanced and vice-versa for the front vowels. Hence, among the central vowels [ə, ə, a, a:], it was observed that there was a high occurrence of vowel [ə] which can also be related with the acoustic study of vowels by Boysson-Bardies et al., (1989) in the babbling utterances of Arabic, Chinese, English and French infants at age 10 months, reflecting relatively more central vowels for French and Arabic.

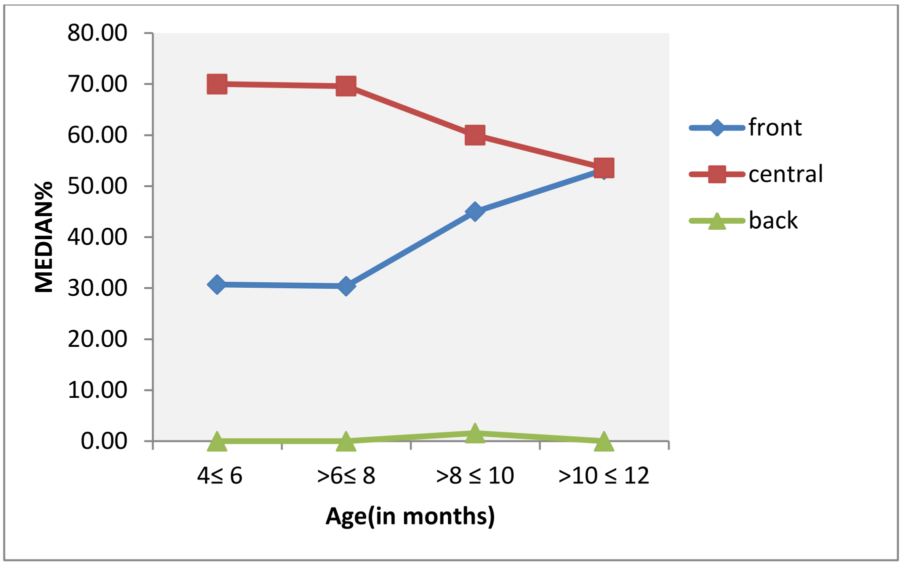

Figure 4.2 Shows central, front and back vowels in Hindi

For a qualitative analysis of the vowels produced by Hindi participants, an attempt was made to superimpose the same on the adult vowel quadrilateral as depicted in Fig. 4.3

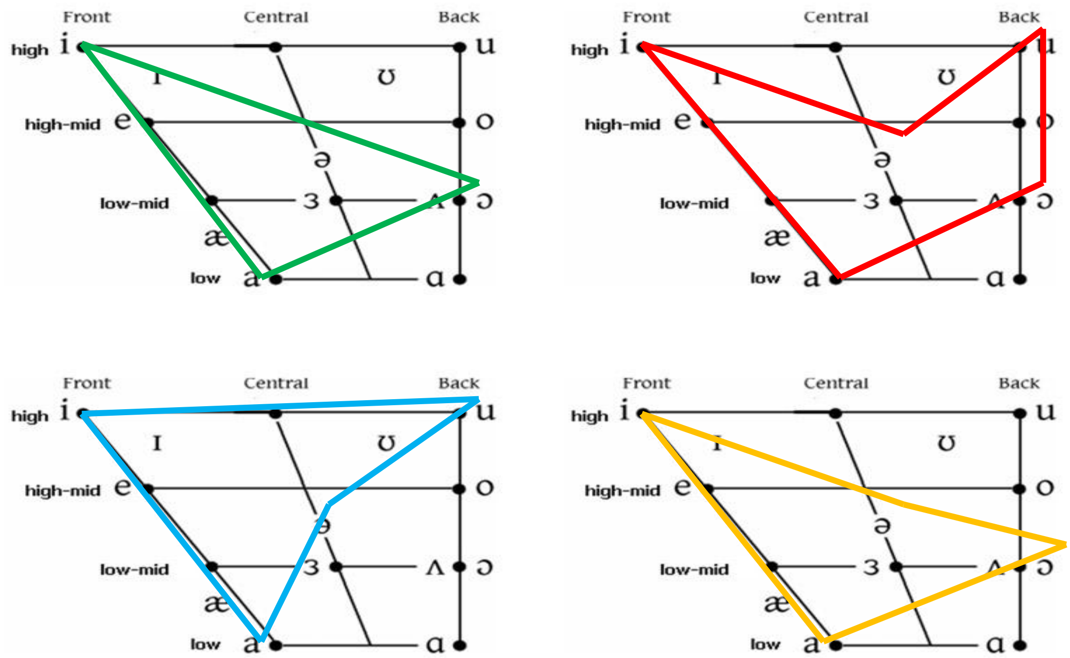

Figure 4.3 Comparison of vowel repertoire of Hindi participants with a vowel quadrilateral

Note: 4 to ≥6 months, ≤6 to ≥8 months, ≤8 to ≥10 months and ≤10 to ≥12months

From Fig. 4.3, it can be observed that, the mid central vowels /ə/, low front vowels /æ/ and mid front vowels /e/ were frequently produced and back vowels /u/, /ɔ/ were the least occurring vowels in all the age groups. This may be because infants show more involuntary mouth openings for this vowel based on visual salience of imitation (Khul & Meltzoff, 1982, 1996) as well as open jaw movements along with co-ordination of the laryngeal air stream (Bowman,2009). It could be observed from Fig 4.3, that participants in Group II (6 to 8 months) show vowel plots that relatively resemble the adult vowel quadrilateral, indicating articulatory development for vowel productions. As observed, the other age groups show vowel productions mainly confined to low and mid in terms of tongue height, and front and central in terms of tongue advancement dimensions. This is in support of the babbling data on five languages (English, Arabic, French, Romanian and Spanish analyzed by Kern and Davis (2014) that depicted mid- front, low-front and mid-central vowels to be exceeding back and high vowels.

Other more complex vowels such as the high front vowels [i]and [i:], high back vowels [u] and [u:] and mid back vowels [ɔ] and [ɔ:] were produced by very few participants in all four age groups. These findings are similar to studies as reported by Lieberman's (1980) spectrographic analysis for children aged about 3 to 14 months in English revealed back-rounded [o] and [u] to be least frequent in production. On crosslinguistic comparisons, Rvachew et al. (2008) reported that their French-learning infants produced a lesser frequency of high front vowels and high back vowels relative to English learning infants. In Kannada learning infants of 4 to 12 months, Sreedevi and Jyothi (2013) reported that /i/, / i:/, /u/, /u:/ and /o:/ were less frequent in production and occurring in less than 50 % of the subjects studied.

Among the relatively infrequent vowels, the occurrence of front vowels [i, i:] were higher compared to back vowels [u, u:] in all the age groups. The present finding draws parallels with studies of Anjana and Sreedevi (2008) in Kannada; Liberman (1980) and Boysson-Bardies et al., (1989) in English, that front vowels were more frequent from 8 months onwards until 12 months compared to back vowels. However, the less frequent back vowels [ɔ] and [ɔ:] also appeared at 4 to 6 months and continued until 10 to 12 months. This similarity across languages can be inferred as the universal nature in babbling.

To determine the overall significant difference in the occurrence of vowels in Hindi, Kruskal -Wallis test was carried out across the four age groups. The test revealed no significant effect of age for front vowels [$\chi2$ (3) = 4.810, p= .186], central vowels [$\chi2$ (3) = 4.225, p= .235] and back vowels [$\chi2$ (3) = 4.748, p= .191]. *Thus, the hypothesis, that there is no significant difference in the phonetic behavior of singleton vowels across age in Hindi is accepted.*

4.2.1.2 Comparison of vowels across age in Malayalam participants

A total corpus of 4788 phonetic behaviors produced by 40 participants comprised of 1378 singleton vowels in the babbling samples of infants aged 4 to 12 months of age. Out of 1378 vowels, Group I (4 to 6 months), Group II (6 to 8 months), Group III (8 to 10 months) and Group IV (10 to 12 months) produced 405, 360, 314 and 299 vowels respectively. Median (*Mdn*) percent scores and inter-quartile ranges (*IQR*) for the combined scores of boys and girls for vowels in Malayalam are presented in Table 4.2. Similar to the Hindi learning infants, the Malayalam group also displayed the same eight frequent types of vowels (mid central vowels [ə], [ə:], mid front vowels [e], [e:] low front vowels [æ], [æ:], and low back vowels [a], [a:]). High front vowels [i], [I], high back vowels [U], [u], and mid back vowels [ɔ], [ɔ:] occurred sparingly in all four age groups and hence were not included for statistical analysis.

Table 4.2
Descriptive statistics (Median percent and inter quartile range) of vowels in Malayalam

Vowels	Malayalam							
	Age range (in months)							
	4:0 to ≤ 6:0 Group I		>6;0 to ≤ 8:0 Group II		>8;0 to ≤ 10:0 Group III		>10;0 to≤ 12:0 Group IV	
N = 10	Mdn	IQR	Mdn	IQR	Mdn	IQR	Mdn	IQR
FRONT VOWELS	72.86	36.91 -84.18	87.86	48.71 - 92.99	74.84	41.67-87.55	77.10	58.57- 88.34
CENTRAL VOWELS	27.14	15.82 -63.09	12.14	7.01 - 51.29	26.32	15.94 - 61.11	22.90	11.66 - 41.43
BACK VOWELS	0.00	0.00- 0.81	0.00	0.00-0.00	1.09	0.00-4.44	0.00	0.00 - 4.17

The vowels produced are described with reference to dimensions of tongue height and tongue advancement. Based on the 60% criteria, it was observed that front vowels emerged from the youngest age group and continued to be present in the 3 older age groups. However, central vowels also showed emergence as early as 4 months but reduced in production with advance in age. The back vowels were produced by less than 60% of the participants in all the 4 age groups. As observed from Table 4.2, the front vowels showed a higher production than central vowels in all the four age groups. This is similar to the findings by Sreedevi and Jyothi (2013) who reported vowel [e] to be predominant in its frequency of occurrence in a longitudinal study of babbling in Kannada learning infants. The predominance of this vowel can be related to the high frequency of occurrence of vowel [e] in adult Malayalam speakers (Sreedevi & Irfana, 2013). Longer counterpart [e:] was relatively high in the older age groups compared to the younger age groups. The predominance of this vowel can be related to other language studies by Lee et.al., (2010) in Korean and French infant learning groups. Both showed relatively high frequencies of vowels in the mid-front dimensions of the vowel space. Lieberman (1980) reported that vowel [e] was heard most frequently of all the vowels transcribed in the phonetic repertoire of English infants of 3 to 14 months. This can also be explained by the investigations of Bardies and her colleagues (1989), who interpreted that infants begin to position their lips and tongue specific to the sound production of their language environment with increase in age.

Similar to [e], front vowel [æ] and its long counterpart [æ:] were high in occurrence in the younger two age groups and subsequently reduced in the older age groups. This is in consonance with the reports of Anjana and Sreedevi (2008) that vowel [æ] gradually diminished with increase in age. Reports of Shyamala and Basanthi (2003) also revealed that vowel [æ] frequently occurred in the samples of younger subjects of 6 months compared to older infants of 12 months in Hindi and Kannada. This finding is also similar to the cross cultural study by Oller and Eliers (1982) on babbling in infants from 6 to 12 months reared in English –Spanish speaking environment and vowel [æ] in particular was predominant in the younger English group than in Spanish children. Hence the strong similarities in vowel vocalization preferences across the different languages suggest a universal basis of babbling in the early linguistic period. These observations suggest that they are probably because of the manipulation for jaw development at early infancy (Lindblom & Sundberg, 1969, Davis & Mc Neilage, 1990).

Central vowels [ə] and [ə:] were high in occurrence in the youngest and oldest age groups respectively. Similar findings have been observed in the Hindi learning infants also, where a high occurrence of vowel [ə] was present in the younger age groups with a reduction in the older age groups. This could suggest that these infants hear and visualize open mouth sounds and respond to early vocal imitation (Khul & MeltZoff, 1982, 1996). It was observed that the production of low central vowel [a] was high in the mid age groups and long low central vowel [a:] were low in production in the 6 to 8 months and the 10 to 12 months groups. The gradual reduction of singleton [a] in the oldest age group also may be because it occurs in combination with other well developed utterances (Green, Moore, & Reiley, 2002).

Fig 4.4 depicts the developmental trend for central and front vowels in Malayalam infants. Overall, it could be seen that front vowels were higher than central vowels and emerged as early as 4 months. From Figure 5, it can be seen that front vowels were the highest in production at 6 to 8 months and relatively reduced in the older age groups and vice versa for the central vowels. Back vowels were the least in occurrence.

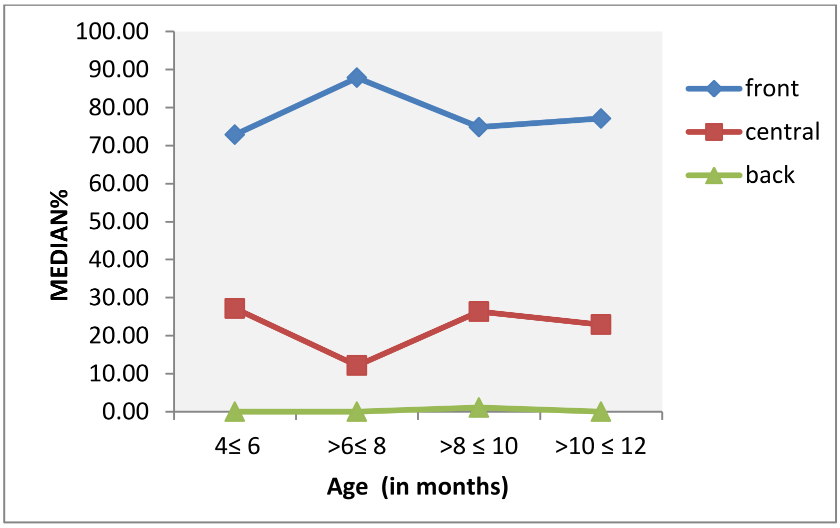

Figure 4.4 Shows central, front and back vowels in Malayalam

Fig. 4.5 shows a representation of the vowels produced by infants of all Malayalam groups from the most to the least occurring singletons. The vowels that emerged during each of the 4 age groups are superimposed on the adult vowel quadrilateral as shown in Fig.4.5

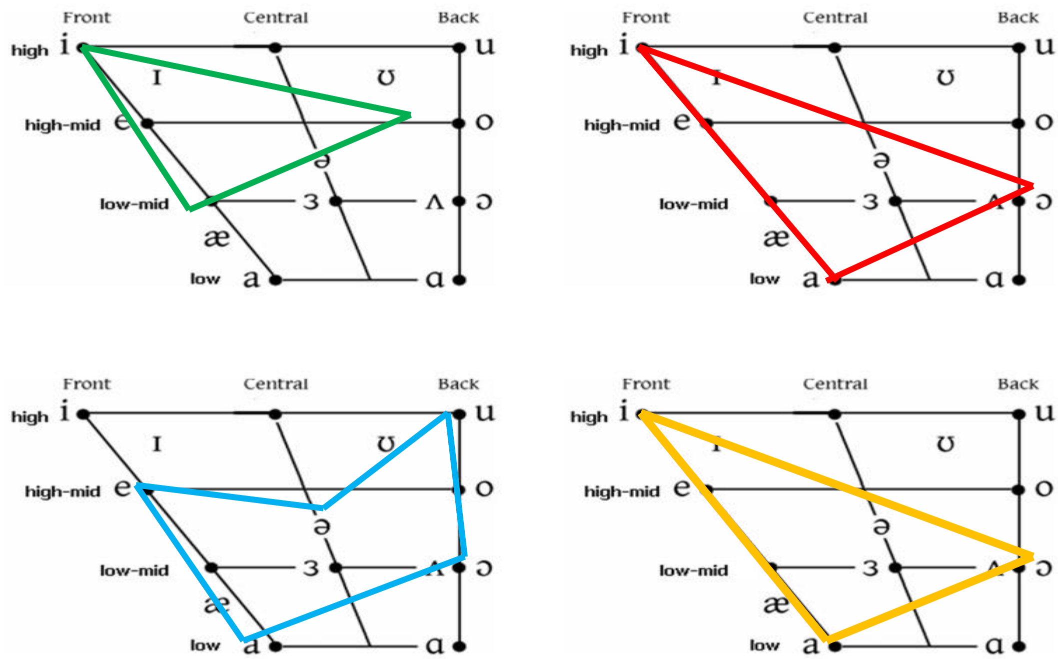

Figure 4.5 Comparison of vowel repertoire of Malayalam participants with vowel quadrilateral

Note: 4 to ≥6 months, ≤6 to ≥8 months, ≤8 to ≥10 months and ≤ 10 to ≥12months

It can be observed from Fig. 4.5, that vowel plots mainly confined to front and central vowels and back vowels were the least in production. As age advanced participants in Group III (8 to 10 months) showed slight resemblance of the adult quadrilateral, indicating exploration of the oral cavity for back sounds. In the present study, high front vowels [i] [i:], high back vowels [u], [u:] and mid back vowels [ɔ] [ɔ:] were the least occurring vowel types that made their appearances from 4 months to 12 months in the Malayalam group. Anjana and Sreedevi (2008); Shyamala and

Basanthi (2003) also found the occurrence of these vowels to be relatively low in Kannada learning infants of 6 to 12 months. In a crosslinguistic study, Rvachew, Alhaidary, Mattock and Polka (2008) reported that French-learning infants produced less frequent high-back vowels than English-learning infants through the age range of 0;8 to 1;6 years, thus, implying the productions of these less frequent vowels as a universal nature in the babbling period.

To examine the significant difference in the occurrence of vowels across all the four age groups in Malayalam, non parametric Kruskal-Wallis test was carried out. The test revealed no significant effect of age for front vowels [$\chi2$ (3) = 2.090, p= .554], central vowels [$\chi2$ (3) = 2.860, p= .414] and back vowels [$\chi2$ (3) = 3.204, p= .361]. *Thus, the hypothesis that there is no significant difference in the phonetic behavior of singleton vowels across age in Malayalam is accepted.*

4.2.2 Diphthongs

4.2.2.1 Comparison of diphthongs across age in Hindi participants

A total of 557 diphthongs were present in the corpus of 4713 phonetic behaviors by the Hindi group. Among these, 173 diphthongs were produced by Group I (4-6 months), 169 by Group II (6-8 months), 125 by Group III (8-10 months) and 90 by the oldest group of participants, Group IV (10-12 months). It was observed that the number of diphthongs decreased as age increased. Median (*Mdn*) percent scores and inter-quartile ranges (*IQR*) for the combined scores of boys and girls for diphthongs and its types in Hindi are presented in Table 4.3.

Table 4.3

Descriptive statistics (Median percent and inter quartile range) of diphthong types in Hindi

Diphthong types	Hindi							
	Age range (in months)							
	4:0 to ≤ 6:0 Group I		>6;0 to ≤ 8:0 Group II		>8;0 to ≤ 10:0 Group III		>10;0 to≤ 12:0 Group IV	
N= 10	Mdn	IQR	Mdn	IQR	Mdn	IQR	Mdn	IQR
OD	0.00	0.00 -25.07	27.44	17.39 -35.95	17.50	6.82 -34.21	25.00	7.50 -35.00
CD	2.00	0.00 -10.77	0.00	0.00 -18.79	2.50	0.00 -10.67	36.67	9.17 -52.50
HHD	54.01	46.78 -66.96	62.28	36.44 -72.83	65.33	53.09 -79.55	28.33	7.50 -55.00
CNTD	20.83	5.36 -38.46	1.64	0.00 -16.32	4.50	0.00 -12.88	3.13	0.00 -11.67

Note: HHD- Height Harmonic Diphthongs, CNTD- Central Diphthongs, CD- Closing Diphthongs, OD-Opening Diphthongs

The diphthongs are described with reference to their jaw opening and closing. All 40 participants produced at least one of the diphthong types. As evident from Table 4.3, the median percent (0.00) indicated minimal or no production of OD and CD diphthong types by majority of the participants in the younger age groups of 4 to 6 and 6 to 8 months respectively. A high standard deviation obtained indicates greater variability in diphthong production in the Hindi group.

Based on the 60% criteria (*to specify the phonetic behavior as emerging*), it is observed that opening diphthongs emerged at 6 to 8 months and continued to be present till 10 to 12 months. Closing diphthongs emerged at 10 to 12 months. Central diphthongs emerged as early as 4 to 6 months and Height Harmonic diphthongs also emerged at 4 months and continued till 10 to 12 months.

Fig. 4.6 depicts diphthong types in all the four age groups. As observed, among the diphthong types in the Hindi learning infants, Height Harmonic Diphthongs (HHD) had the highest percent median score in the first three age groups. It could be hypothesized that the infants in the younger age groups produced

HHDs predominantly owing to ease in the oro motor musculature in production of the two vowels of the same height. Secondly, it may be because the infants imitated prolonged vocal productions of their caretakers which resulted in abundance of HHDs.

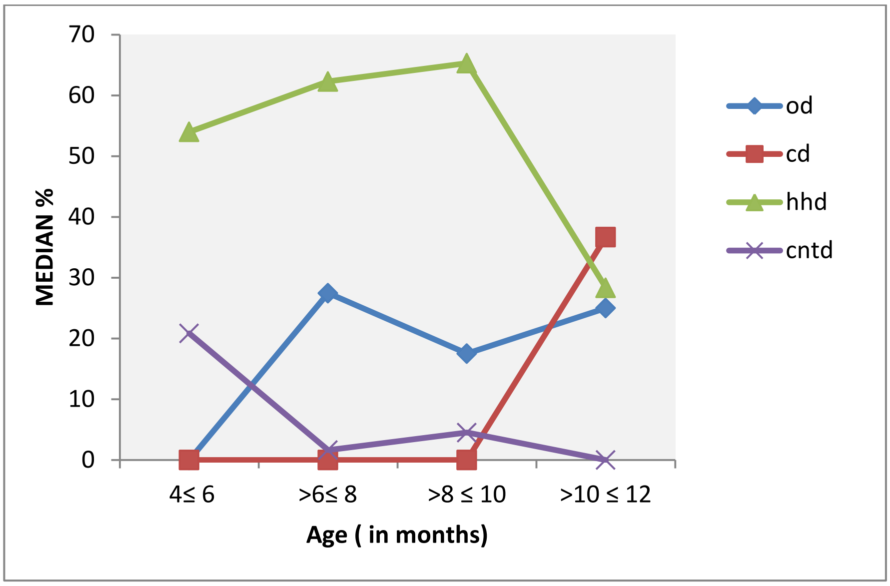

Figure 4.6 Shows diphthong types in Hindi

With regard to the oldest age Group IV (10-12 months), Closing Diphthongs had the highest percent median score (Table 4.3). The finding draws significant parallels from reports of Irfana (2012) and Alphonsa (2012) that /au/ and /ai/ were the most common and frequently produced diphthongs in Malayalam speaking toddlers of age 12-18 and 18-24 months respectively. Similar findings have been observed in studies conducted in the same age range by Shishira (2013) and Sushma (2013) in Kannada learning children.

As observed in Fig. 4.6, the least occurring diphthongs types were Opening Diphthongs in the youngest age group of 4 to 6 months. Closing diphthongs were scarce in the three younger age groups and the highest in the oldest age group. Central Diphthong types of utterances were the least occurring diphthongs in the oldest age group of 10 to 12 months indicating a more complex transition from an open vowel to a close vowel, in other words a clear control over the tongue height. It can also be explained that the rudimentary central vowel [ə] was produced with other developed vowels at this age. A high standard deviation was obtained for the various types of diphthongs in all the age groups.

Kruskal-Wallis test was employed for overall comparison of diphthong types across the age groups in Hindi. The test revealed significant effect of age for closing diphthong types [χ^2 (3) = 9.663, p=.022]. Hence, Mann-Whitney U test was performed to show the significant difference of closing diphthong types across each pair of age groups in Hindi as displayed in Table 4.4.

Table 4.4
Age group comparison of Closing Diphthongs in Hindi

Age pairs (in months)		**|Z|**
4-6 with	6-8	0.041
	8-10	0.202
	10-12	**2.606***
6-8 with	8-10	0.083
	10-12	**2.434***
8-10 with	**10-12**	**2.299***

*****Significant at $p < .05$

On pair-wise comparisons, the oldest age group had a significantly higher production of closing diphthongs compared to the 3 younger age Groups I, II and III as shown in Table 4.4. From data on vowels in the present study, it was seen that the closed vowels /i/ and /u/ were more towards the later stages of babbling. The combination of the rudimentary vowels with these high vowels resulted in a spurt of

CDs. This is in consonance with the reports of Shyamala and Basanthi (2003) in Hindi and Sreedevi and Jyothi (2013) in Kannada, that Closing diphthongs such as /ai/ and /au/ were higher in occurrence in infants towards the latter part of the pre-linguistic period. Secondly, the occurrence of closing diphthongs are universally present in the adult spoken languages and can be related to the studies by Kumari (1972) and Punnosse (2010) in Malayalam, Watson (2007) in Liverpool English, Kerswill, Torgesen and Fox(2006) in British Caribbean English; Leimgruber (2009) in Singapore English. This is because closing diphthongs in adult speakers generally, are produced when the tongue rises and closes the space between the tongue and the roof of the mouth (Collins & Mees, 2006).The results of the present study support the claims of Boysson-Bardies et al., (1989); Locke (1983) and Lindblom (1984) that infant productions can be influenced by the characteristics of the linguistic environment as there is a close similarity in productions between infants and adults.

No significant effect of age was present for opening diphthongs [χ^2 (3) = 5.049, p= .168], height harmonic diphthongs [χ^2 (3) = 5.862, p= .119] and central diphthongs [χ^2 (3) = 6.304, p= .098]. As closing diphthongs had significant effect on age, *the hypothesis that there is no significant difference in the phonetic behavior of diphthongs across age in Hindi is rejected.*

4.2.2.2 Comparison of diphthongs across age in Malayalam participants

The current section highlights diphthong types in Malayalam participants. Among the 4788 phonetic beaviours produced, there were 465 diphthongs. A total of 133 diphthongs were produced by Group I (4-6 months), 141 by Group II (6-8 months), 106 by Group III (8-10 months) and 85 diphthongs by the oldest group of participants, Group IV (10-12 months). It was seen that the number of diphthongs decreased in the two older age groups. Median (*Mdn*) percent scores and inter-quartile ranges (*IQR*) for the combined scores of boys and girls for diphthongs and its types in Malayalam are presented in Table 4.5.

Similar to the Hindi group, all 40 participants of Malayalam produced at least one of the diphthong types and hence were considered for further analysis. The median percent (0.00) indicated minimal or no production of CD types by majority of the participants in the first three age groups of 4 to 6, 6 to 8 and 8 to 10 months. A high standard deviation is obtained for the same indicating the distribution of data to be non normal in the Malayalam group.

Table 4.5
Descriptive statistics (Median percent and inter quartile range) of diphthong types in Malayalam

Diphthong Types	Malayalam Age range (in months) 4:0 to ≤ 6:0 Group I		>6;0 to ≤ 8:0 Group II		>8;0 to ≤ 10:0 Group III		>10;0 to≤ 12:0 Group IV	
N= 10	Mdn	IQR	Mdn	IQR	Mdn	IQR	Mdn	IQR
OD	33.33	5.36 - 70.00	26.41	5.77 - 60.59	50.00	25.00 - 70.45	14.29	6.25 - 52.78
CD	0.00	0.00 -14.46	0.00	0.00 - 0.76	--------	----------	8.33	0.00 - 15.48
HHD	23.61	0.00 - 58.24	65.94	17.94 - 71.02	44.44	18.94 - 71.43	57.14	25.00 - 80.68
CNTD	23.21	9.62 - 41.67	12.94	0.00 - 23.56	0.00	0.00 - 9.92	11.11	0.00 -15.48

Note: HHD- Height Harmonic Diphthongs, CNTD- Central Diphthongs, CD- Closing Diphthongs, OD-Opening Diphthongs
Note: --- phonetic behaviors not present

As observed from Table 4.5, the oldest age group produced more number of closing diphthongs compared to the three younger age groups. The mean rank comparisons were not computed, since the participants producing closing diphthongs were few in the younger age groups. Diphthongs /au/ and /ai/ are the only two closing diphthongs that have been reported to be commonly spoken by native speakers of Malayalam (Kumari, 1972; Punnosse, 2010). The diphthongs are described with reference to the jaw opening and closing and are presented in Fig. 4.7

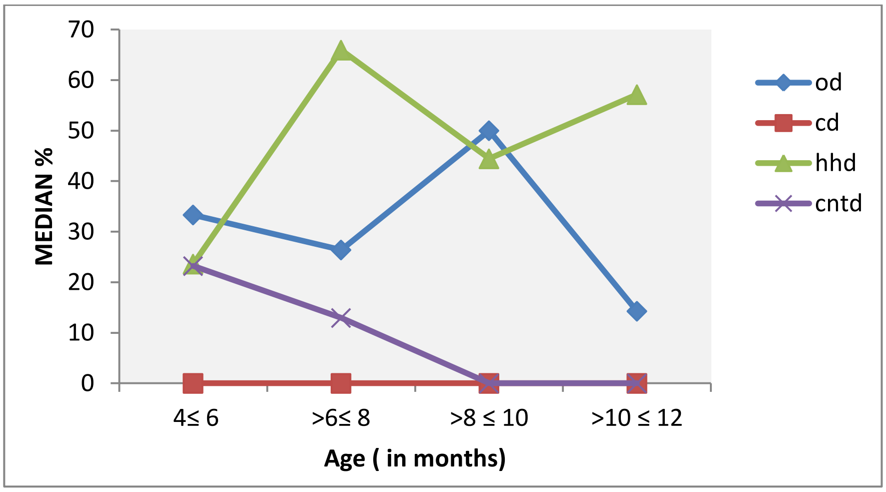

Figure 4.7 Shows diphthong types in Malayalam

It can be observed from Table 4.5 and Fig.4.7, that the frequently occurring diphthongs were the OD and HHD types in all the four age groups. CD and CNTD had limited frequency of occurrence. Considering a 60% criteria for the diphthong to be emerging, it was observed that OD and HHD emerged as early as 4 to 6 months and continued to be present in the 3 older age groups. CD were produced by few participants in all the 4 age groups. CNTD emerged at 4 to 6 months and reduced with advance in age. The Malayalam participants showed high variability in the occurrence of the types of diphthongs in all the age groups.

To examine the significant difference in the occurrence of diphthong types across the four age groups in Malayalam, non parametric tests were carried out. Kruskal-Wallis test was employed for overall comparison of diphthongs across all four age groups in Malayalam. The test revealed significant effect of age for central diphthong types [χ^2 (3) = 9.908, p= .024]. Since central diphthongs were significant, Mann-Whitney U test was performed across each pair of age groups in Malayalam as shown in Table 4.6.

Table 4.6
Age group comparison of Central Diphthongs in Malayalam

Age pairs (in months)		$\lvert Z \rvert$
4-6 with	6-8	1.595
	8-10	**2.704***
	10-12	**2.300***
6-8 with	8-10	1.506
	10-12	1.094
8-10 with	10-12	0.869

***** Significant at $p < .05$

The results revealed that Group I had significantly higher production of Central diphthongs compared to the older groups III and IV as shown in Table 4.6. This is because the youngest age group had high production of the rudimentary central vowel [ə] compared to the two older age groups who had phonetically more advanced combinations. Secondly, it could also be that infants in the younger age groups have more of tongue bulk in the center of the oral cavity permitting for only rudimentary articulations compared to a more matured articulatory motor control in older infants (Davis & McNeilage, 1994; Godson, 2004; Holzman, 1997).

No significant effect of age was present for opening diphthongs [χ^2 (3) = 2.265, p= .631], height harmonic diphthongs [χ^2 (3) = 3.357, p= .270] and closing diphthongs [χ^2 (3) = 5.132, p= .113]. However, as the central diphthongs showed an effect of age, *the hypothesis that there is no significant difference in the phonetic behavior of diphthongs across age in Malayalam is rejected.*

4.2.3 Consonants

4.2.3.1 Comparison of consonants across age in Hindi participants

The frequency of occurrence of a variety of consonants was computed. A total corpus of 4713 phonetic behaviours in Hindi produced by 40 participants consisted of 1076 consonants including singletons and extracted from various syllable shapes. Among these consonants, 176 were produced by Group I (4-6 months), 296 by Group II (6-8 months), 355 by Group III (8-10 months) and 249 by the oldest group of participants, Group IV (10-12 months). So overall, it can be stated that consonant production increased with increase in age. The Median (*Mdn*) percent and inter-quartile range (*IQR*) for the combined scores of boys and girls for place and manner of articulation of consonants in Hindi are presented in Tables 4.7 and 4.8. All 40 participants produced at least one or more types of consonants and as a result were considered for further analysis. As evident from Tables 4.7 and 4.8, the median percent (0.00) indicated minimal or no production for some consonants by a majority of the participants in each of the four age groups. A high standard deviation is obtained for the same indicates non normal distribution in the Hindi group.

Since the data had high variability, the median percent was considered for true representation. Based on the median percent scores for consonants extracted from various syllable shapes, they were classified for place and manner of articulation. Participants of Group I (4 to 6 months) had the highest percent median score for unvoiced glottal fricative [h] followed by voiced bilabial nasals [m] and velar [g]. Group II (6 to 8 months), Group III (8 to 10 months) and Group IV (10 to 12 months) showed the highest percent median score for voiced bilabial nasal [m].

Considering the 60% criteria for the phonetic behavior to be emerging, bilabial nasal [m] and glottal fricative [h] emerged as early as 4 to 6 months and continued to be present till 10 to 12 months. Bilabial stop [b] and velar stop [g] emerged at 6 to 8 months. Bilabial stop [p], dental stops [d̪] and [t̪] emerged at 8 to 10 months and continued to be present till 10 to12 months. Palatal glide [j] emerged at 10 to 12 months though produced by few participants in the younger age groups.

Table 4.7
Descriptive statistics (Median percent and inter quartile range) for place of articulation of consonants in Hindi

Place Of Articulation N =10	Hindi group (Age in months)							
	4:0 to ≤ 6:0 Group I		>6;0 to ≤ 8:0 Group II		>8;0 to ≤ 10:0 Group III		>10;0 to≤ 12:0 Group IV	
	Mdn	**IQR**	**Mdn**	**IQR**	**Mdn**	**IQR**	**Mdn**	**IQR**
Bilabials	25.16	12.78 - 63.75	37.09	21.13 - 50.00	27.39	13.59 -70.39	41.05	26.61- 51.65
Alveolars	0.00	0.00 - 1.09	1.97	0.00 - 24.45	0.00	0.00 -12.99	0.94	0.00 - 4.19
Dentals	0.00	0.00 - 9.02	10.32	0.00 - 33.65	21.43	6.00 - 33.73	29.09	17.90- 41.96
Palatals	0.00	0.00 - 1.67	0.00	0.00 - 5.36	2.88	0.00 - 10.23	3.04	0.00 - 14.14
Velars	8.57	0.00 - 27.90	9.40	2.68 - 21.09	9.01	5.86 - 21.54	1.32	0.0 4.72
Glottals	32.07	15.00 - 53.57	12.61	0.00 - 41.96	10.19	7.53 - 22.99	8.17	5.60 - 20.20

Table 4.8

Descriptive statistics (Median percent and inter quartile range) for manner of articulation of consonants in Hindi

Manner Of Articulation N =10	Hindi group (Age in months) 4:0 to ≤ 6:0 Group I		>6;0 to ≤ 8:0 Group II		>8;0 to ≤ 10:0 Group III		>10;0 to≤ 12:0 Group IV	
	Mdn	**IQR**	**Mdn**	**IQR**	**Mdn**	**IQR**	**Mdn**	**IQR**
Stops	29.17	0.00-40.87	40.18	17.11-51.79	51.19	32.24-63.57	44.11	36.11-71.12
Glottal Fricatives	32.07	15.00-53.57	12.61	0.00-41.96	10.19	7.53-22.99	8.17	5.60-20.20
Affricates	---------	----------	0.00	0.00-1.79	0.00	0.00-2.63	0.00	0.00-0.56
Nasals	22.62	9.78-50.00	32.14	17.51-45.83	21.73	3.12-41.94	12.70	9.79-34.71
Glides	0.00	0.00-1.67	0.00	0.00-4.96	7.07	0.00-9.56	4.59	0.00-14.71
Laterals	-------	-------	0.00	0.00-5.77	0.00	0.00-1.19	0.94	0.00-3.03

Note: ----- phonetic behaviour indicates not present

This finding draws close parallels with the reports of Locke (1983) that /h/, / d̲ /, /b/, /m/, / t̲ /, /w/, and /j/ were reported as the most frequently occurring consonant-like sounds in English learning infants. Anjana and Sreedevi (2008); Sreedevi and Jyothi (2013) in Kannada observed that Another relevant finding in Hindi participants was the production of stops and nasals. This can be related to the study of Evans–Morris (1998) and Foster-Cohen’s (1998) that child’s articulation of consonant sounds tends to develop from a pattern that commences with pursing the lips together like the making of bilabial sounds of [m], [p], [b]. These productions of bilabial sounds would then expand to become other types of consonant sounds that would then start from the front tongue position such as those sounds beginning with alveolars [t], [d] and [n]. Subsequently, the child moves on to create sounds that use the position at the back of the tongue, thus producing sounds like velars [k], [g] and [ŋ]. At a later stage, the child would then acquire the other sounds like [l̩] and [r] which can only be articulated with a higher level of physical coordination. The consonants in the order of place of articulation were bilabials, glottals, dentals, velars, palatals and alveolars**.**

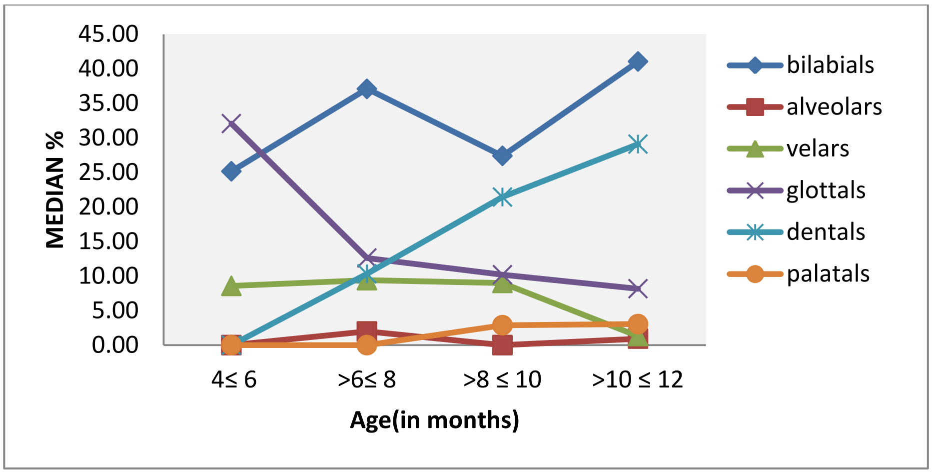

Figure 4.8 Place of articulation of consonants in Hindi

As observed from Figure 4.8, the high occurrence of dentals (unvoiced dental /t̠/) in the oldest age group of 10-12 months can be related to the reports of Ramkrishna et al. (1963) where the frequency of occurrence of dental /t̠/ was high in the adult language of Hindi and the present finding can be associated to the native native language influence. Davis and McNeilage (1994), Evans–Morris (1998) and Foster-Cohen (1998) claim that during the babbling period of 7 to 12 months infants exhibited a strong pattern of tongue fronting. This is probably because by then, children began to explore other sounds whereby the tongue rolled and picked up shape as reported by Kuang (2007), relating to the better motor co-ordination of the tongue. Also, around six months onwards, the mandible grows downwards giving space for the tongue to move and elevate (Nishimura, Mikami, Suzuki & Matsuzawa, 2003).

As seen from Figure 4.9, consonant productions are mainly confined to the order; stops [p,b, k, g, ṭ and ḍ], nasals [m], glottal fricative [h] and glides [j,w]. This is in support of the findings of Robb and Bleile (1994); Davis and MacNeilage's (1995) that English learning infants from 6 months onwards chiefly tend to produce stops, followed by nasals and glides. Levitt and Uttman (1992) compared the babbling of one infant reared in an English and one reared in a French environment at ages 0;5, 0;8, 0;11 and 1;2 and found that both children produced stops most frequently. This pattern was consistent with cross-language tendencies observed by Locke (1983).

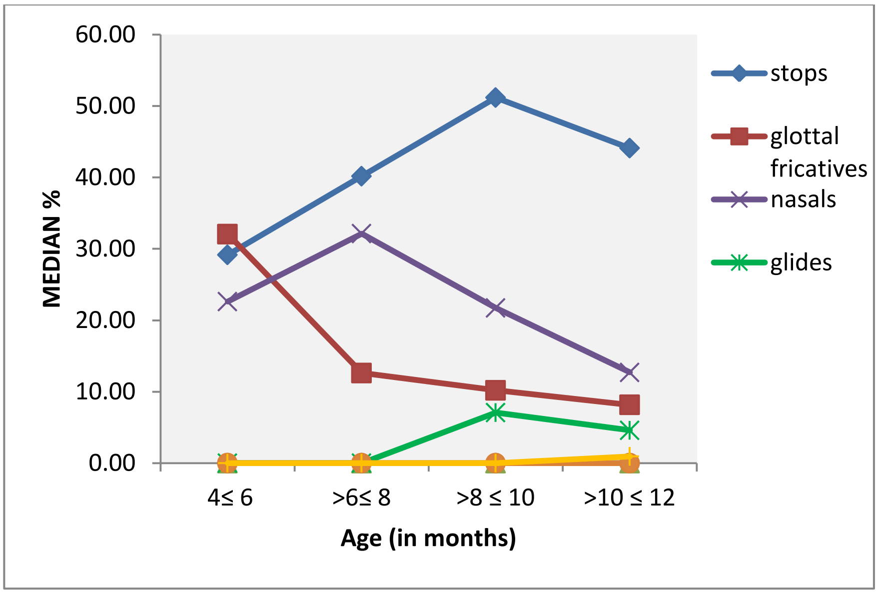

Figure 4.9 Manner of articulation of consonants in Hindi

It can be observed from Figures 4.8 and 4.9, glottal fricatives ([h]) was high in the youngest age group of 4-6 months as it is easy to produce and it faded in the older age groups. Following the next highest consonant was the bilabial nasal ([m]), similar to earlier studies by Jakobson (1968); Evan-Morris, (1998); Foster – Cohen, (1999); De-Boysson-Bardies (1999) who reported that bilabial nasal /m/ was acquired first because it was easier to articulate compared to other sounds. Meier

(1997) reported that infants may produce “jaw wags,” rhythmic multicycle episodes of mouth open-close alternation– a phenomenon similar to lip smacks – as early as 5 months of age. In the present study, it was observed that bilabial /m/ was primarily produced by most infants for pleasure. According to Gregory, Tabain and Robb (2015), first the anatomy of the infant vocal tract necessitates nasal breathing. Second, [m] is produced with the mouth closed as in to say that there is no constriction with the tongue. Further on they added that due to infants’ early sucking behaviors’ the myelination of the motor nerves in the lips occurs sooner than other parts of the oral cavity. Thus, the infants show the ability to make lip formation for /m/ and produce it more easily.

The findings of the present study also relate to the reports of Shyamala and Basanti (2003) of Hindi and Kannada learning infants, that stops and nasals had a higher frequency of occurrence. Glides, fricatives and affricates were among the less frequently occurring consonants. Tobias (1997) studied 22 Turkish learning infants from 12 to 33 months and found stops and nasals were acquired earlier as 12 months than affricates, fricatives and glides. He also observed that amongst the plosive sounds, bilabials and the alveolars preceded the velar which is also similar to the present study. On crosslinguistic comparison, Kern and Davis (2014) tabulated consonant frequencies for five sets of four children in Dutch, French, Romanian, Tunisian Arabic and Turkish language environments. A total of 57,472 consonants were tabulated. The occurrences of manner of articulation were stops, nasals, glides, oral fricatives and glottal fricatives. For place of articulation, the occurrences were coronals, labials, dorsals and glottals. Hence, all these supporting evidences highlight the universal features of babbling.

As observed from the babbling samples, there were irregular occurring consonants [ʧ, n, ʤ, k, ṭ, r and ŋ].The relatively infrequent consonants were produced by few participants in one or the other four age groups. Glides were present in all the four age groups. Laterals and affricates were not observed in the youngest age group but were sparingly produced by the three older age groups. The occurrence of infrequent consonants can be related to Vihman's (1985) report that these irregular complex consonants can be considered infrequent or not present at all during the babbling period. The infrequent consonants such as [s], [l̩], [r], [ʧ], [ʤ] are also considered to be the late eight sounds that are acquired (Bleile, 2007).

To examine the significant differences in the occurrence of place and manner of consonants across the four age groups in Hindi, non parametric tests were carried out. Kruskal-Wallis test was employed for overall comparison of consonants for place and manner of articulation across the age groups in Hindi. The test revealed significant differences between ages for place of articulation; **dentals** [χ^2 (3) =12.607, p=.006] and manner of articulation; **stops** [χ^2 (3) =8.168, p=.043]. Since Kruskal-Wallis test was significant for dentals (*place of articulation*) and stops (*manner of articulation*), Mann- Whitney U test was performed to examine the significant difference across each pair of age groups in Hindi as shown in Table 4.9.

Table 4.9

Age group comparison of dentals and stops in Hindi

Age pairs (in months)		**Dentals**		**Stops**	
		|Z|	***p***	**|Z|**	***p***
4-6 with	6-8	1.784	.074	1.405	.160
	8-10	**2.549***	.011	**2.426***	.015
	10-12	**3.371***	.001	**2.235***	.025
6-8 with	8-10	0.493	.622	1.211	.266
	10-12	1.477	.140	1.324	.186
8-10 with	10-12	1.323	.186	0.151	.880

*****Significant at $p < .05$

As seen in Table 4.9, for dentals, on pair-wise comparison of 4 to 6 months (*Mdn* = 0.00) group with the two older age groups of 8 to 10 (*Mdn* = 21.43) and 10 to 12 (*Mdn* =29.09) months, revealed significant higher production in the older age groups. Similarly for stops, on pair-wise comparison of 4 to 6 months (*Mdn* =29.17) group with the two older age groups of 8 to 10 (*Mdn* =51.19) and 10 to 12 (*Mdn* = 44.11) months, revealed significant higher production in the older age groups.

However, some place (alveolars, palatals) and manner (affricates, laterals and glides) of articulation among the other types of consonants showed a median of 0.00 (Table 4.7 & 4.8), and mean ranks were used for comparisons across age groups. As seen from Table 4.7, the mean rank comparisons showed that there was a higher production of palatals in Group II (10.90) than Group I (10.10). Group III (11.60) had higher production of alveolars than Group I (9.40). For manners of articulation with a median of zero, the mean ranks of Group III (11.20) had a higher production of affricates compared to Group II (9.80) and Group IV (9.40). The younger age groups had the highest productions of laterals and glides. The test was not significant for place dimensions such as **bilabials [**χ^2 (3) =.307, p=.959], **alveolars** [χ^2 (3)

=2.799, p=.424], velars [χ^2 (3) =7.283, p=.06], **glottals** [χ^2 (3) =3.467, p=.325], **palatals** [χ^2 (3) =4.914, p=.178], and manner dimensions such as **nasals** [χ^2 (3) = 1.562, p= .668], **fricatives** [χ^2 (3) =3.467, p=.325], **affricates** [χ^2 (3) =4.593, p=.204], **glides** [χ^2 (3) =6.956, p=.073],**trills** [χ^2 (3) =2.054, p=.561], **laterals** [χ^2 (3) =2.762, p=.430]. However, as dentals and stops showed an effect on age, *the hypothesis that there is no significant difference in the phonetic behavior of place and manner of articulation of consonants across age in Hindi is rejected.*

4.2.3.2 Comparison of consonants across age in Malayalam participants

A total corpus of 4788 phonetic behaviours produced by 40 participants in Malayalam consisted of 1132 consonants including singletons and extracted from various syllable shapes in the babbling samples from 4 to 12 months of age. Among these, 238 consonants were produced by Group I (4-6 months), 332 by Group II (6-8 months), 284 by Group III (8-10 months) and 278 by the oldest group of participants of Group IV (10-12 months). It was seen that the number and type of consonant productions varied across age groups. It was observed that the voiced and voiceless cognates made their increased appearances as age increased.

The median (*Mdn*) percent and inter-quartile range (*IQR*) for the combined scores of boys and girls for place and manner of consonants in Malayalam are presented in Tables 4.10 and 4.11. Similar to the Hindi group, all 40 participants in the Malayalam group also produced at least one or more consonant and were considered for further analysis. As evident from Tables 4.10 and 4.11, the median percent (0.00) indicated minimal or no production of certain consonants by some of the participants in each of the four age groups with a high standard deviation indicating the distribution to be non normal in the Malayalam group.

Table 4.10

Descriptive statistics (Median percent and inter quartile range) for place of articulation of consonants in Malayalam

Place Of Articulation N=10	Malayalam group (Age in months)							
	4:0 to ≤ 6:0 Group I		>6;0 to ≤ 8:0 Group II		>8;0 to ≤ 10:0 Group III		>10;0 to≤ 12:0 Group IV	
	Mdn	IQR	Mdn	IQR	Mdn	IQR	Mdn	IQR
Bilabials	38.89	15.86 - 62.50	21.09	11.92 - 35.39	38.29	12.99 -61.10	30.94	20.77- 42.92
Alveolars	----	------	0.00	0.00-0.61	0.00	0.00-8.16	1.14	0.00 -3.04
Dentals	-----	------	13.69	0.00 - 33.26	25.33	7.74-33.78	37.50	9.14-51.68
Palatals	----	------	6.02	0.00 - 11.11	2.67	0.00 -10.25	3.92	0.00 - 8.79
Velars	22.50	0.00 - 38.89	21.68	3.00 - 25.81	2.57	0.00 - 9.82	6.67	2.27-11.59
Glottals	44.17	0.00 - 52.50	29.59	2.03- 46.09	19.08	4.14 -31.95	10.22	2.27-18.33

Note: ------indicates phonetic behavior not present

Table 4.11

Descriptive statistics (Median percent and inter quartile range) for manner of articulation of consonants in Malayalam

Manner Of Articulation N =10	Hindi group (Age in months)							
	4:0 to ≤ 6:0 Group I		>6;0 to ≤ 8:0 Group II		>8;0 to ≤ 10:0 Group III		>10;0 to≤ 12:0 Group IV	
	Mdn	IQR	Mdn	IQR	Mdn	IQR	Mdn	IQR
Stops	29.17	0.00-40.87	40.18	17.11-51.79	51.19	32.24-63.57	44.11	36.11-71.12
Glottal Fricatives	32.07	15.00-53.57	12.61	0.00-41.96	10.19	7.53-22.99	8.17	5.60-20.20
Affricates	---------	----------	0.00	0.00-1.79	0.00	0.00-2.63	0.00	0.00-0.56
Nasals	22.62	9.78-50.00	32.14	17.51-45.83	21.73	3.12-41.94	12.70	9.79-34.71
Glides	0.00	0.00-1.67	0.00	0.00-4.96	7.07	0.00-9.56	4.59	0.00-14.71
Laterals	-------	-------	0.00	0.00-5.77	0.00	0.00-1.19	0.94	0.00-3.03

Note: ------indicates phonetic behaviour not present

The consonants are described with reference to their voicing, place and manner of articulation. As the data displayed high variability, median percent was considered for true representation. Based on the median percent scores, among the consonants produced by the 4 groups in Malayalam, unvoiced glottal fricative ([h]) showed the highest percent median score in the younger age groups followed by bilabial stops in Group III (8 to 10 months). Voiced dental stop ([d̪]) was observed to have the highest median score in the oldest age group.

Based on the 60% criteria for the phonetic behavior to be emerging, it was observed that bilabial nasal [m], glottal fricative [h] and velar stop [g] emerged as early as 4 to 6 months. Voiced dental stop [d̪] emerged at 6 months. Bilabial stop [b], bilabial glide [w]and palatal glide [j] emerged at 8 to 10 months. Unvoiced velar stop [k] and dental stop [t̪] emerged at 10 to 12 months. This is analogous to the findings of Anjana and Sreedevi (2008); Sreedevi and Jyothi (2013) that glottal fricative [h] frequently occurred in younger infants and an increase of production of voiced dental [d̪] towards the older age groups. It was observed that glottal fricative [h] was utilized frequently from 4 months onwards. This could probably be due to its ease of production and does not require any elaborate articulatory movements (Holzman, 1997).

Fig. 4.10 shows the occurrence of place of articulation for consonants across the 4 age groups. In the present study, bilabials, glottals, dentals, velars, dentals, palatals and alveolars made their hierarchical appearances for place of articulation. This is similar to the reports of Kerns and Davis (2009) that Tunisian infants had more frequent use of fricatives especially glottal fricative [h] compared to stops. Locke (1983) surveyed 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], coronal stops, labial stops, dorsal stops, labial and coronal nasals and glides. Affricates and liquids were extremely rare. These reports support the universal nature of babbling.

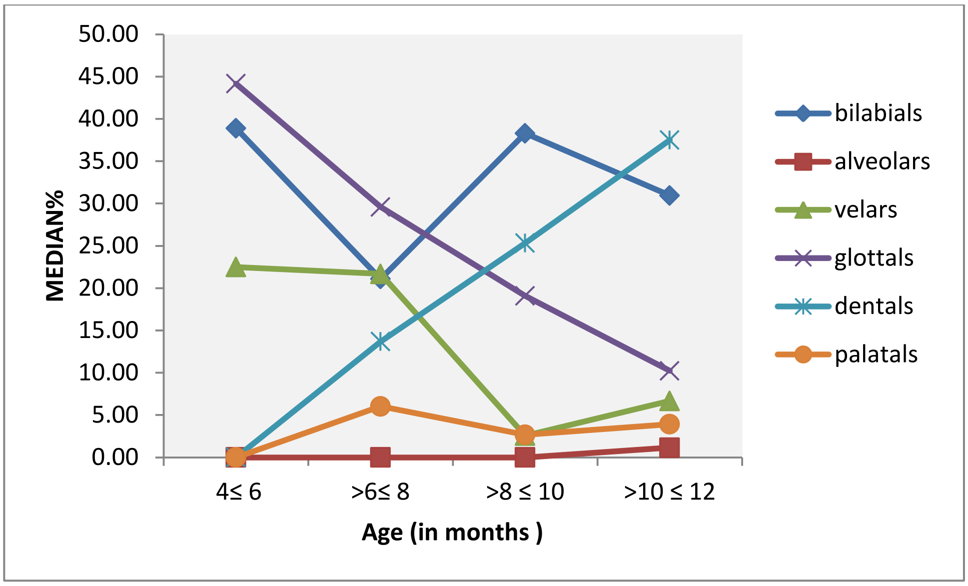

Figure 4.10 Place of articulation of consonants in Malayalam

Locke (1983) asserted that preferences found in the English-learning infants tended to be confined in infants' babbling in 14 other language environments. Except for the frequency of [h], and somewhat higher frequencies for fricatives and liquids, similar patterns were found in a large-scale study of six English-learning infants, including analysis of a total of 15,690 consonants by Davis and MacNeilage (1995). They found the occurrence for manner of articulation were in the order of stops, nasals, glides and other consonants, consisting primarily of liquids and fricatives. In the present study, the order of consonant productions for manner of articulation were stops [p,b,k,g, t̪ and d̪], glottal fricatives [h], nasals [m,n], glides [j],trills [r] and affricates [ʤ]. Nasal [m] was frequently produced from 4 months onwards; it did not fade away as age advanced. This is similar to the reports of babbling studies of Evan- Morris (1998); Foster- Cohen (1999) and De-Boysson-

Bardies (1999) that bilabial nasal [m] was acquired first among the other consonants supporting the universal phenomenon as shown in Figure 4.11. An added similarity of the present study to the reports of Davis and Mac Neilage, (2000) in English; Tobias (1997) in Turkish; Shyamala and Basanti (2003) in Hindi and Kannada; Anjana and Sreedevi (2008) and Sreedevi and Jyothi (2013) in Kannada learning infants, is that stops and nasals occurred high in frequency.

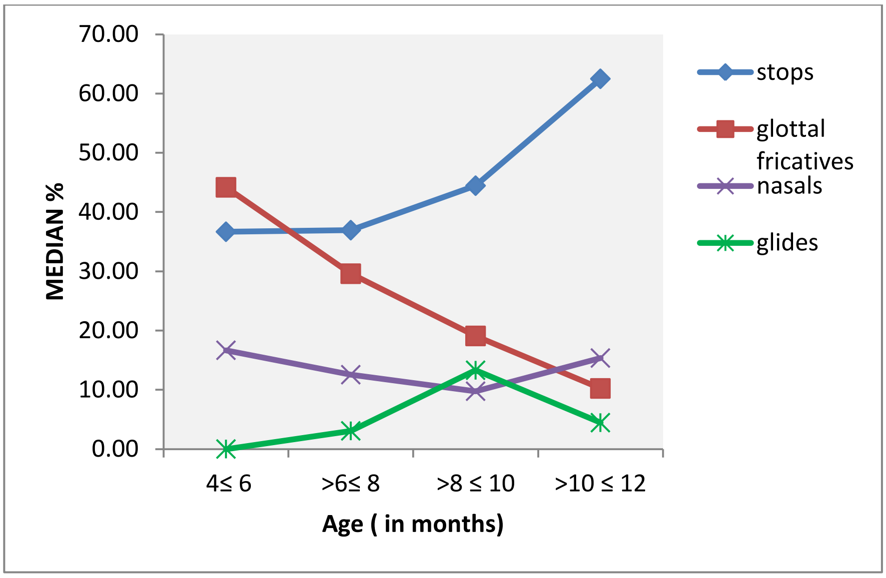

Figure 4.11 Manner of articulation of consonants in Malayalam

Another finding in the present study was that towards the later stages of babbling the appearance of additional variety of voiceless consonants [h, t̲ ,k,j and p] were obscured by the higher frequency of other voiced consonants such as [d̲, b, and m], signifying that the additional consonants were not only more varied but also more advanced in difficulty. This could be attributed to the fact that some sounds are attainable when the vocal organ is more developed (Godson, 2004; Kuang, 2007).

The relatively infrequent consonants (n, ḍ, ʧ, ʤ, w, ḷ, r, ʃ) made their appearances sparingly in one or the other 4 age groups. Glides were not produced in the youngest age group and occurred in the 3 older age groups; affricates were only produced by participants in Group II (6 to 8 months) and were not present in the other age groups and trills occurred in the 2 older age groups. These similar reports across languages can be related to the universal nature in babbling. Sreedevi and Irfana's (2013) study on phonemes in adult Malayalam speakers show a reduced occurrence of consonants such as /n, ḍ, ʧ, ʤ, w, ḷ, r, ʃ / which can be related to the infrequent production of these consonants in the present study of Malayalam learning infants depicting a native language influence for the phonemes.

To examine the significant difference in consonants, Kruskal Wallis test was employed for overall comparison of consonants for place and manner dimensions across the four age groups. The test revealed significant effect of age for place dimensions such as **dentals** [χ^2 (3) =17.837, *p*=.000*]*, **palatals** [χ^2 (3) =9.653, *p*=.022] and manner dimensions **glides** [χ^2 (3) =11.365, *p*=.010]. Mann- Whitney U test was performed to exemplify the significant difference across each pair of age groups for these consonants as shown in Table 4.12

Table 4.12
Age group comparison of consonants in Malayalam

Age pairs (in months)		**Dentals**		**Palatals**		**Glides**	
		|Z|	***p***	|Z|	***p***	|Z|	***p***
4-6 with	6-8	**2.796***	.005	**2.796***	.005	1.951	.051
	8-10	**3.724***	.000	**2.796***	.005	**2.867***	.004
	10-12	**3.724***	.000	**2.796***	.005	**2.565***	.010
6-8 with	8-10	0.914	.361	.390	.696	1.904	.057
	10-12	1.600	.110	0.508	.612	0.958	.338
8-10 with	10-12	1.210	.226	0.000	1.000	1.098	.272

***** Significant at $p < .05$

On pair wise comparison, dentals showed a higher production in Group II (*Mdn*=13.69), Group III (*Mdn*=25.33) and Group IV (*Mdn*= 37.50) compared to no productions in theyoungest group. Similarly, palatals had a higher production in the older age groups, Group II (*Mdn*=6.02), Group III (*Mdn*= 2.67) and Group IV (*Mdn*=3.92) compared to no productions in Group I. Glides showed higher productions in the 2 older age groups, Group III (*Mdn*=13.29) and Group IV (*Mdn*= 4.45) than Group II (*Mdn*= 3.06) and no productions in Group I. Overall, it was observed that as age advanced, there was an increase in motor co ordination and exposure to native language, more number of participants produced consonants. It can also be noted that voiced stops were more frequently produced in babbling. This is in agreement with Locke's (1983) observation of more voiced stop consonants in babbling than unvoiced counterparts.

No significant effect was present for the following consonants (*place of articulation*); **bilabials [**χ^2 (3) =2.287, p=.515 .], **alveolars** [χ^2 (3) =7.107, p=.069.], **velars** [χ^2 (3) =4.148, p=.246 .], **glottals** [χ^2 (3) =2.139, p=.544.] and (*manner of articulation*); **Nasals** [χ^2 (3) =.950, p=.813], **stops** [χ^2 (3) =4.684, p=.196], **fricatives** [χ^2 (3) =2.140, p=.544], **affricates** [χ^2 (3) =4.005, p=.261], **trills** [χ^2 (3) =3.000, p=.392], **laterals** [χ^2 (3) =5.747, p=.125]. These consonants had median scores of zero across the age groups as shown in Table 4.10 and 4.11, the mean ranks for alveolars was higher in Group III (11.80) than in Group II (9.20). The oldest group of participants had higher production of trills. However, as dentals, palatals and glides showed an effect on age, *the hypothesis that there is no significant difference in the phonetic behavior of consonants across age in Malayalam is rejected.*

4.2.4 Simple syllable shapes

4.2.4.1 Comparison of simple syllable shapes across age in Hindi participants

Table 4.13 shows the descriptive statistic findings of median (Mdn) percent and inters quartile range (*IQR*) for the combined scores of boys and girls for simple syllable shapes in Hindi. A total corpus of 4713 phonetic behaviours in Hindi produced by 40 participants consisted of 1083 simple syllables. Among these, 133 syllables were produced by Group I (4-6 months), 275 syllables by Group II (6-8 months), 380 syllables by Group III (8-10 months) and 295 syllables by the oldest group of infants Group IV (10-12 months). It can be noticed that the frequency of occurrence decreased in the oldest age group compared to the younger age groups suggesting the emergence of more complex utterances (Reeny & Sreedevi, 2013) possibly due to a matured articulatory control (Holzman, 1997).

From Table 4.13, it can be observed that the major syllable types with the highest percent median score was monosyllable CV that emerged as early as 4 to 6 months and continued to be present even at 10 to 12 months. Though CV syllable shape was significantly high, the most preferred syllable type in both 6 to 8 months and the 8 to 10 month age groups was the di-syllable VCV which also emerged at 4 to 6 months. This is analogous to the reports of Sreedevi and Jyothi (2013) in Kannada learning infants of 6 months onwards that showed frequent patterns of bi-syllabic utterances of VCV syllables with gradual progression in their occurrence as age increased.

Table 4.13

Descriptive statistics (Median percent and inter quartile range) of simple syllable shapes in Hindi

Syllable Shapes	Hindi							
	Age range (in months)							
	4:0 to ≤ 6:0 Group I		>6;0 to ≤ 8:0 Group II		>8;0 to ≤ 10:0 Group III		>10;0 to≤ 12:0 Group IV	
N=10	Mdn	IQR	Mdn	IQR	Mdn	IQR	Mdn	IQR
CV	50.00	18.84 -76.56	33.24	23.08 -46.46	36.33	30.22 -50.61	58.02	22.40-71.77
VC	5.39	0.00 -30.83	10.26	3.26 -23.07	9.18	0.86 -10.63	0.00	0.00-8.27
CVC	-----	-----	10.26	-----	0.00	-----	0.00	0.00-4.77
VCV	30.30	10.94 -57.50	42.21	27.93 -66.56	39.29	27.01 -60.04	24.32	7.50-54.17
CVV	----	-----	1.28	0.00 -6.20	0.70	0.00-3.89	3.13	0.00-12.03
CCV	-----	----	0.89	0.00 -6.02	0.00	0.00 -8.30	0.00	0.00-2.20

Note: ---- indicates no production of utterance

In the present study, interestingly for the older age group, monosyllable CV had the highest percent median score, which was similar to Group I. There was a minimal decline in its production in the mid age groups. This is similar to the reports of Anjana and Sreedevi (2008) with a minimal decline in productions of CV syllable in the age groups between 7 to 9 months and an increase in the 9 to 12 months in Kannada learning infants. It could be seen from Table 15, the older infants of 10 to 12 months produced almost all six varied types of syllable shapes compared to the other younger age groups. Thus the types of syllables shapes increased with age.

Closed syllables like CVC, VVC and VCC were rare in all participants. This is similar to the findings of Sreedevi and Jyothi (2013) in Kannada learning infants of 4 to 12 months that monosyllables like VC and CVC occurrences were rare.

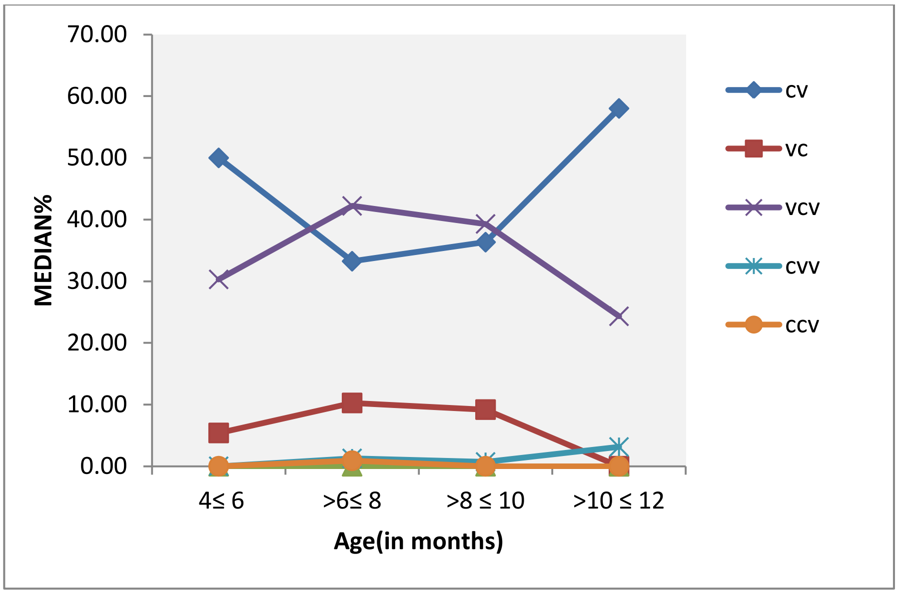

Figure 4.12 Simple syllable shapes in Hindi

It can be observed from Fig. 4.12, that monosyllable CV was high in the youngest age group as well as in the oldest age group. This is in support of the findings by Rupela and Manjula (2006); Anjana and Sreedevi (2008) in Kannada; Davis and McNeilage (1995); Stoel-Gammon (1989) and Smith et al, (2010) in English learning infants who found a majority to be CV syllables in the babbling samples. MacNeilage et al. (2000) states that CV syllable is so important that it is often given the status of the only universal syllable type. The simple CV and VCV syllable shapes were higher in its frequency of occurrence in the 6 to 8 and 8 to 10 months age bands. This may be due to the easier combination of vowels with syllable CV, resulting in di syllabic productions. The higher age group depicting a higher occurrence of CV could be the result of its presence as a pre-requisite for its combinations for other complex syllable structures not only linked to later phonological development, but also to first words (McCune & Vihman, 2001; Vihman & Greenlee, 1987; Vihman & Miller, 1988).

The findings are also in agreement with the reports of Anjana and Sreedevi (2008) in Kannada, wherein VCV syllables such as [abe], [etu] made a predominant appearance between 8 to 12 months. Closed syllable CVC such as [kæk], [bab] made its appearance from 6 months onwards but was low in its frequency of occurrence. Overall in the present study, other closed syllables VC and CVC occurrences were minimal in production across all the age groups. This is also in support with the findings of Anjana and Sreedevi (2008) a cross sectional study; Sreedevi and Jyothi (2013), a longitudinal study, who found VC and CVC occurrences to be rare across all the age groups of Kannada learning infants. This finding is similar to babbling of infants exposed to English, consonant-vowel (CV) structures are most common, followed by closed vowel patterns of VC and CVC (Stoel-Gammon, 1987, 1989). In the present study, other closed syllables VCC e.g [umm] and VVC e.g [eam] occurred in the younger age and in the higher age groups they appeared in combination with other major syllable shapes.

To determine the significant difference in the production of syllable shapes across the four age groups in Hindi, statistical analysis using non parametric test was employed. Kruskal Wallis test was carried out for overall analysis of syllable shapes across all 4 age groups in Hindi. The test revealed no significant effect of age for any of the simple syllables shapes; syllable CV [χ^2 (3) = 4.132, p= .557], VC [χ^2 (3) = .442, p= .256], CVC [χ^2 (3) = 4.046, p= .257], VCV [χ^2 (3) = 1.835, p= .607], CVV [χ^2 (3) = 1.827, p= .609] and CCV [χ^2 (3) = 4.001, p= . .261]. This could be due to the variability in production of syllable shapes across all the age groups. That is to say some syllable shapes were less in number though produced by more participants and vice versa. *Thus, the hypothesis that there is no significant* *difference in the phonetic behavior of simple syllable shapes across age in Hindi is accepted.*

4.2.4.2 Comparison of simple syllable shapes across age in Malayalam participants

The median (*Mdn*) percent and inter-quartile range (*IQR*) for the combined scores of boys and girls for simple syllable shapes in Malayalam are presented in Table 4.14. The total corpus of 4788 phonetic behaviours in Malayalam produced by 40 participants consisted of 1219 syllables. Among these, 228 syllables were produced by Group I (4-6 months), 294 syllables by Group II (6-8 months), 339 syllables by Group III (8-10 months) and 358 syllables by the oldest group of participants Group IV (10-12 months). It could be seen that as age increased there was a linear increase in the frequency of simple syllable shapes.

Table 14.14
Descriptive statistics (Median percent and inter quartile range) of simple syllable shapes in Malayalam

Syllable Shapes	Malayalam							
	Age range (in months)							
	4:0 to ≤ 6:0 Group I		>6;0 to ≤ 8:0 Group II		>8;0 to ≤ 10:0 Group III		>10;0 to≤ 12:0 Group IV	
	Mdn	IQR	Mdn	IQR	Mdn	IQR	Mdn	IQR
CV	55.49	47.26-72.83	60.40	46.04 -84.71	48.68	43.86 -63.97	55.89	42.43 - 65.63
VC	6.51	0.00 - 8.84	6.34	0.00 - 8.39	0.00	0.00-6.61	1.96	0.00 - 5.33
CVC	0.00	0.00-1.79	----	-----	0.00	0.00-0.77	------	------
VCV	28.69	13.81- 44.05	32.66	9.94 - 41.69	37.71	23.04 -50.69	33.58	24.52 - 47.81
CVV	0.00	0.00-6.85	1.42	0.00 - 4.22	3.62	0.00 -5.68	0.00	0.00-5.17
CCV	------	-------	0.00	0.00-1.14	0.00	0.00-0.69	-----	------

As evident from Table 4.14, (considering the 60 % criteria) syllable CV had the highest percent median score, followed by di syllable VCV for all the 4 age groups and emerged as early as 4 months and continued to be present until 12 months. A similar report by Smith et.al, (2010) shows that the highest percentage of canonical syllables was consonant-vowel (CV) patterns in the English learning infant group from 6 to 14 months. The findings are also similar to that of the Hindi group in the present study and support the studies by Anjana and Seedevi (2008) and Kent and Bauer (1985), Sreedevi and Jyothi (2013) who reported CV and VCV syllables to be the most occurring syllable type in infants from 6 to 12 months. In the 4 to 6 month age group, the highest percent median score was predominant for monosyllable CV. The older two age groups also displayed monosyllable CV as predominant with the highest percent median score, the least in occurrence was syllable shape CCV. VC also emerged at 4 months and reduced in production with advance in age. Syllable shapes CVC, CCV, VVC and VCC were rare in all participants.

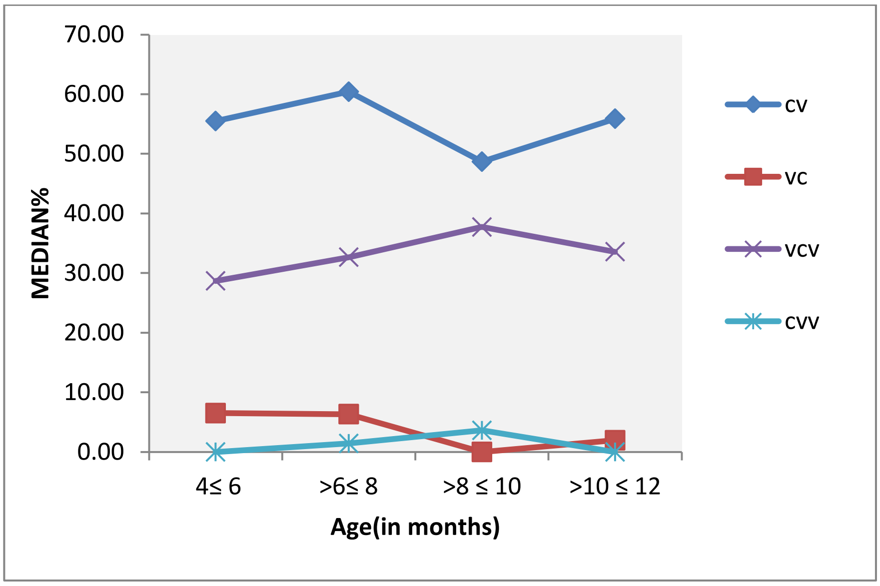

Figure 4.13 Simple syllable shapes in Malayalam

Fig. 4.13 represents syllable shapes in the Malayalam group. A specific pattern could be seen for the frequency of occurrence of the types of syllable shapes. Monosyllable CV was predominant in all the four age groups, followed by syllables

VCV, VC and CVV. Though syllables CVC, CCV and VVC emerged as early as 4 months; they were the least occurring syllable patterns in all age groups. This is in consonance with the findings of Anjana and Sreedevi (2008); Sreedevi and Jyothi (2013) that syllables VC, CVV, CVC, CCV, and VVC were minimal in production in Kannada learning infants. It could be seen that the Malayalam group followed a specific chain of preferred open syllables such as CV and VCV.

To examine the significant difference in the occurrence of syllable shapes across the four age groups in Malayalam, statistical analysis using non parametric tests was applied. Kruskal Wallis test was carried out for overall analysis of syllable shapes across the four age groups in Malayalam. Similar to the Hindi group, the test revealed no significant effect of age for any of the simple syllables shapes; syllable **CV** [$\chi^2(3) = 1.570$, $p= .666$], **VC** [$\chi^2(3) = 2.624$, $p= .453$], **VCV** [$\chi^2(3) = 1.523$, $p= .677$], **CVV** [$\chi^2(3) = .714$, $p= .870$]. This could be due to a less production of these syllable shapes by the participants across all the age groups. *Thus, the hypothesis that there is no significant difference in the phonetic behavior of simple syllable shapes across age in Malayalam is accepted.*

4.2.5 Reduplicated and Variegated babbles

4.2.5.1 Comparison of reduplicated and variegated babbles across age in Hindi participants

The descriptive statistic findings of median (*Mdn*) percent and inter quartile range (*IQR*) for the combined scores of Hindi learning boys and girls for reduplicated and variegated phonetic behaviours are presented in Table 4.15. A total corpus of 4713 phonetic behaviours produced by 40 participants in Hindi consisted of 1031 reduplicated babbles and 147 variegated babbles from 4 to 12 months of age. Among the variegated utterances, 10 were place variegations (e.g /dagi/), 126 manner variegations (e.g /bemabi/) and 9 were voicing variegations (e.g /gika /).

Table 4.15
Descriptive statistics (Median percent and inter quartile range) of complex syllables in Hindi

Hindi								
	Age (in months)							
Complex Syllables	4:0 to ≤ 6:0 Group I		>6;0 to ≤ 8:0 Group II		>8;0 to ≤ 10:0 Group III		>10;0 to≤ 12:0 Group IV	
N=10	Mdn	IQR	Mdn	IQR	Mdn	IQR	Mdn	IQR
Reduplicated	90.00	65.39-100.00	62.79	87.54-100.00	94.39	71.59-100.00	86.97	76.24-97.73
Variegated	10.00	8.00-15.00	37.20	22.00-39.00	5.60	0.00- 10.67	13.02	2.27-13.76

The complex utterances with reference to their type and frequency are discussed. As shown in Table 4.15 and Fig. 4.14, among the two major types of complex behaviours of reduplicated babbles and variegated babbles produced by the four groups in Hindi, reduplicated babbles showed higher percent median score in all age groups. Reduplicated babbles emerged as early as 4 months and continued to be present until 12 months. This is in support of the finding by Davis and Mac Neilage (1995) in English; Anjana and Sreedevi (2008) in Kannada, who reported half or more of all vocal patterns in babbling were reduplicated babbles.

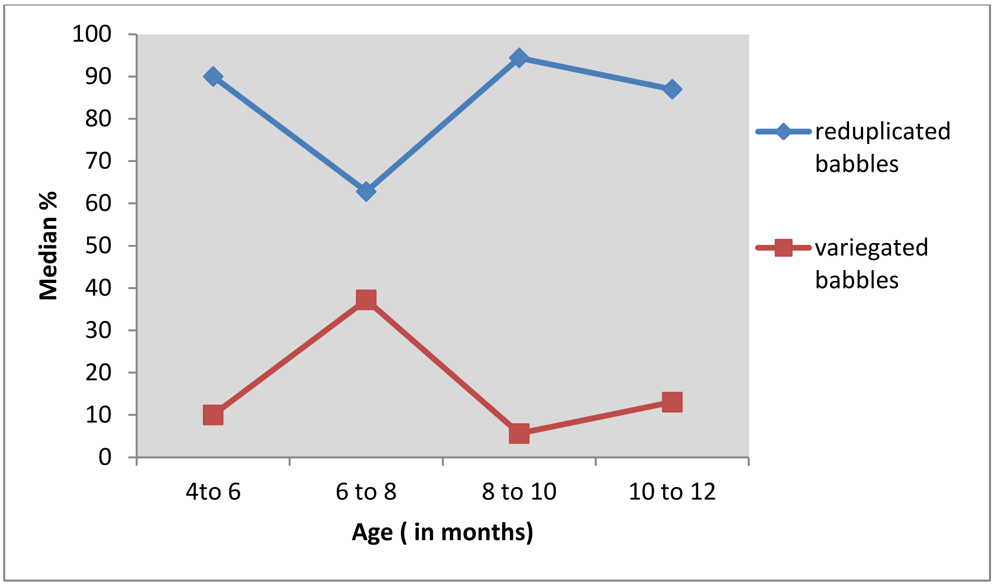

Figure 4.14 Complex syllables in Hindi

Contrary to the reduplicated babbles, variegated babbles did not have an increased production with age. Considering the 60% criteria, variegated babbles emerged at 8 to 10 months of age, they were produced marginally and vice -verrsa by few participants in the 2 younger age groups. This suggests the emergence of canonical babbling where infants have a strong motor control and articulatory exploration for speech sound productions which appear by 8 to10 months (Oller, 1986). According to MacNeilage and Davis (1996), variation in the amplitude of one or more phases of mandibular elevation or depression during an utterance is the main source of variegation in babbling.

The variegated babbles were further classified into place, manner and voicing variegation types. Among the variegated types of behaviors in Hindi participants, Group IV (10 to 12 months) showed emergence (*60% criteria*) of manners of articulation such as stops, glides, nasals, fricatives and laterals although they appeared sparingly as early as 4 to 6 months. Hence, with advance in age the manners of articulation also improved indicating the emergence of a variety of consonant types. This is in support with the findings by Mitchell and Kent (1990) and Davis and MacNeilage (1995) in English; Anjana and Sreedevi (2008) in Kannada who found that most consonantal changes were in manner of articulation, which primarily involves the amount of mouth opening. In the present study, place variegation type was absent in the youngest age group but were minimally produced in the other three older age groups. The place variegation was mainly stops with velars, bilabials, dentals and alveolars. Voicing variegation was also minimally produced by few participants. Redford, MacNeilage, and Davis (1997) also reported that manner variegation exceeded place variegation (46.5% to 24.3%) in six infants of 6 to 8 months. In the present study, place and voicing variegation were less frequently produced.

To determine the significant difference in the occurrence of reduplicated babbles, variegated babbles and its types across the four age groups in Hindi, statistical analysis using non parametric tests were applied. Kruskal Wallis test was carried out for overall analysis of these complex utterance types. As observed in Table 4.16, the test revealed significant effect of age for reduplicated babbles [χ^2 (3) = 7.940, p= .047] and variegated babbles [χ^2 (3) = 2.499, p= .047].

No significant difference was present for the three types of variegated babbles across age in Hindi; Place variegation [χ^2 (3) = 2.558, p= .465], Manner variegation [χ^2 (3) = 2.597, p= .458] and Voicing variegation [χ^2 (3) = 2.543, p= .453] across the four age groups though consonant varieties increased with advance in age. Hence Mann- Whitney U test was performed to show the significant difference of reduplicated and variegated babbles (Table 18).

Table 4.16
Age group comparison of reduplicated and variegated babbles in Hindi participants

Age Pairs (months)		|Z| Reduplicated babbles	|Z| Variegated babbles
4-6 with	6-8	1.493	**2.236***
	8-10	1.030	0.183
	10-12	1.120	1.464
6-8 with	**8-10**	**1.986***	**2.324***
	10-12	**2.774***	1.837
8-10 with	10-12	0.230	1.420

***** Significant at $p < .05$

As seen in Table 4.16, on comparison of 4 to 6 months with the 6 to 8 months, the 4 to 6 months (*Mdn*=10.00) was significantly lower in its productions for variegated utterances compared to 6 to 8 months (*Mdn*=37.20). Comparison of 6 to 8 months (*Mdn*=62.79) with the immediate older age groups 8 to 10 months (*Mdn*=94.39) and 10 to 12 months (*Mdn*=86.97), revealed significantly higher productions of reduplicated babbles in the older age groups. This suggests that as age advances, babbles increase; hence the difference between the younger and older age groups is evident. Comparison of 6 to 8 months (*Mdn*=37.20) with the immediate older age group 8 to 10 months (*Mdn*=5.60) revealed significantly higher productions of variegated utterances in the 6 to 8 months age group. However, on statistical comparison of the 2 older age groups (i.e. 8 to 10 and 10 to 12 months) revealed no statistical significance for both types of complex babbles in the later stages of babbling.

It could be seen from Table 4.15, there was co-occurrence of reduplicated and variegated babbles as early as 4 to 6 months, and there were non linear differences across all the four age groups for variegated babbles though appeared as early as 4 to 6 months. The higher productions of reduplicated babbles in participants are because they preferred to repeat the same syllable within vocalizations more than producing different consonants and/or vowels. In the present study, it can be inferred that as age increased the production of reduplicated babbles increased and continued to dominate variegated babbles even in the older group to a large extent. Stoel-Gammon and Cooper (1984) reported the frequency of reduplicated babbles actually rises slightly until the age range 10-13 months and later begins to fall. In contrast, the rate of production of variegated babbles falls slightly around 10-13 months of age and then starts to rise. The rate of production of variegated babbles is larger than the rate of reduplicated babble production at 14 months onwards. Probably because of this reason, more of reduplicated babbles were seen than variegated babbles in the age groups up to 12 months in the present study. As reduplicated and variegated babbles had significant effect on age, *the hypothesis that there is significant difference in the phonetic behavior of variegated babbles and its types of babbles across age in Hindi is rejected.*

4.2.5.2 Comparison of reduplicated and variegated babbles across age in Malayalam participants

The median (*Mdn*) percent and inter quartile range (*IQR*) for the combined scores of boys and girls in Malayalam for reduplicated and variegated babbles are presented in Table 4.17. A total corpus of 4788 phonetic behaviours produced by 40 participants in Malayalam consisted of 907 reduplicated babbles and 110 variegated babbles from 4 to 12 months of age. Among the variegated babbles, 14 were place variegations (e.g /d̪ɛda:/), 79 manner variegations (e.g /hɛja/) and 20 voicing variegations (e.g /d̪ɛt̪at̪a/) types of phonetic behaviours were produced.

The reduplicated babbles depicted higher percent median scores in all 4 age groups and emerged at 4 to 6 months. As shown in Table 4.17 and Figure 4.15, the Malayalam participants also portrayed an increase in the reduplicated babbles with increase in age and continued to dominate in the older groups to a large extent. The findings are similar to other Dravidian studies (Anjana & Sreedevi, 2008; Sreedevi & Jyothi, 2012) in Kannada.

Table 4.17
Descriptive statistics (Median percent and inter quartile range) of complex syllables in Malayalam

Malayalam								
Complex Syllables	**Age (in months)**							
	4:0 to ≤ 6:0 Group I		**>6;0 to ≤ 8:0 Group II**		**>8;0 to ≤ 10:0 Group III**		**>10;0 to≤ 12:0 Group IV**	
N=10	**Mdn**	**IQR**	**Mdn**	**IQR**	**Mdn**	**IQR**	**Mdn**	**IQR**
Reduplicated	75.00	65.39-100.00	90.00	87.54-100.00	86.24	71.59-100.00	90.39	76.24-97.73
Variegated	25.00	22.00-26.00	10.00	0.00-15.00	13.76	0.00- 15.67	9.61	2.27-13.76

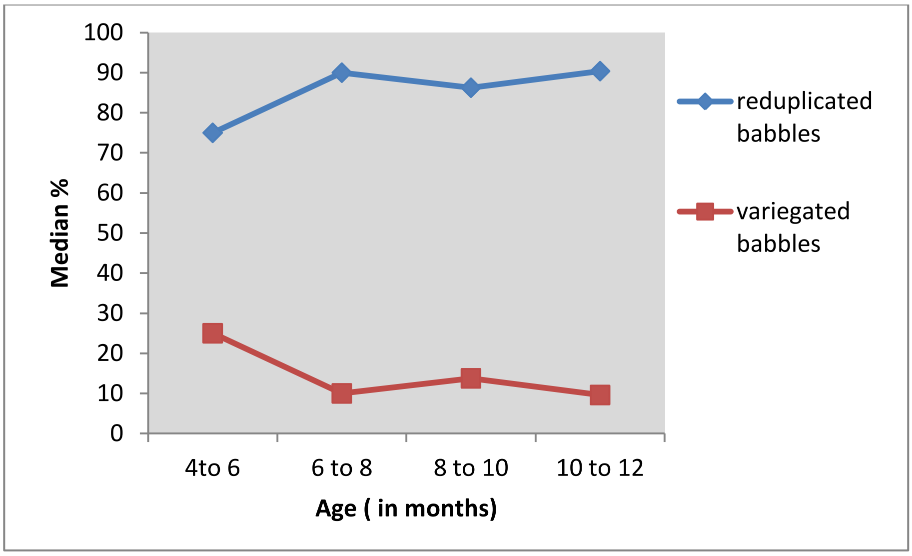

Figure 4.15 Complex syllables in Malayalam

As shown in Table 4.17 and Fig. 4.15, in the present study the variegated babbles were much lower in their frequency of production compared to reduplicated babbles. However, it can be seen that the median percent score was highest for the youngest group but were produced by few participants. Based on the 60% criteria, variegated babbles emerged at 6 to 8 months. Earlier supporting studies have shown that there is about as much variegated babbling in the first part of the babbling stage as in the second (Smith et al., 1989; Mitchell & Kent, 1990; Davis &Mac- Neilage, 1995). This can be related to the appearance of variegated babbles in the younger age groups from 4 to 6 months onwards.

Similar to the Hindi group, the variegated babbles were classified into place, manner and voicing variegation types. Among the variegated types of babbles, manner variegation emerged at 6 to 8 months and continued to be present until 12 months. This is in support with studies in English (Mitchell & Kent, 1990), Kannada (Anjana & Sreedevi, 2008; Sreedevi & Jyothi, 2012). Place and voicing variegations were produced by few participants in each of the 4 age groups, however had made their appearances from 6 months onwards.

The manners of articulation produced by Group II (6 to 8 months) were nasals, glides and glottal fricatives. Group III (8 to 10 months) had manner variegations of nasals and glottal fricatives. The oldest age Group IV (10 to 12 months) produced the same manners of articulation as the previous age group with a toting up of fricatives, glides and laterals. Hence, the emergence of a variety of consonants was seen with increase in age and also more number of participants produced variegation as age advanced. Place variegations were produced by few participants in Groups I and II (bilabials, dentals & velars), Group III (bilabials, dentals & velars) and in Group IV (bilabials, dentals, velars). There were none who produced voicing variegations in Group I. However, voicing variegation was produced by few participants in each of the other three age groups.

To determine the significant difference in the occurrence of reduplicated babbles, variegated babbles and variegation types across the four age groups in Malayalam, statistical analysis using non parametric tests were applied. Kruskal Wallis test was carried out for overall analysis of these complex syllables across all 4 age groups. As observed in Table 4.18, the test revealed significant effect of age only for reduplicated babbles [χ^2 (3) = 9.397, p= .024].

No significant effect of age for variegated babbles [χ^2 (3) = 4.825, p= .185] and variegated types; Place variegation [χ^2 (3) = 2.173, p= .537], Manner variegation[χ^2 (3) = . 5.980, p= .113] and Voicing variegation [χ^2 (3) = 2.336, p= .506] was observed . Mann- Whitney U test was performed to exemplify the significant difference of reduplicated babbles across each pair of age groups in Malayalam as shown in Table 4.18. The reduplicated babbling exceeded variegated babbling and the variegated babbles had uneven productions across the age ranges.

Table 4.18

Age group comparison of reduplicated babbles in Malayalam participants

Age Pairs (months)		│Z│
		Reduplicated utterances
4-6 with	**6-8**	**2.694***
	8-10	**2.339***
	10-12	**2.378***
6-8 with	8-10	0.719
	10-12	0.151
8-10 with	10-12	0.448

*Significant $p < .05$

As shown in Table 4.18, the youngest age group 4 to 6 months (*Mdn*=75.00) had significantly lower production of reduplicated utterances compared to the other 3 older age groups (Group II, *Mdn*=90.00; Group III, *Mdn*=86.24; Group IV, *Mdn*=90.39). Similar finding was also reported in studies by Anjana and Sreedevi (2008); Sreedevi and Jyothi (2012) in Kannada. On observation of Table 4.18, there was no significant difference of Group II (6 to 8 months) and Group III (8 to 10 months) to the oldest age group, Group IV (10 to 12 months) for reduplicated utterances. This was because of the emergence of early word forms by 8-10 months itself. This finding is similar to the Hindi group. As variegated and its types have no effect on age*, the hypothesis that there is no significant difference in the phonetic behavior of variegated babbles and its types across age in Malayalam is rejected Reduplicated babbling had significant effect on age, hence the hypothesis there is significant difference in the phonetic behaviour of reduplicated babbles across age in Malayalam is accepted.*

4.2.6 Early words

4.2.6.1 Comparison of early words across age in Hindi participants

Few participants of the Hindi group produced early word forms such as proto words and true words sparingly from 6 months onwards, these word forms were produced by 2 participants each. The next higher age group of 8 to 10 months had 8 proto words but no true word productions by 3 participants. However the older age group of 10 to 12 months had a whopping production of 50 proto words and 36 true words which yet did not meet the 60% criteria, since there were only 5 participants in each who produced them. These early word productions are provided in Appendix G. As noticed, protowords produced by the participants were centred on the child's basic needs. This was similar to the findings by Shishira, Sushma and Sreedevi (2014) in Kannada speaking children of 12 to 24 months. The median (*Mdn*) percent and inter quartile range (*IQR*) for the combined scores of boys and girls in Hindi for early word forms are presented in Table 4.19.

Table 4.19
Descriptive statistics (Median percent and inter quartile range) of early words in Hindi

Early word forms	**Hindi**			
	Age range (in months)			
	8;0 to ≤ 10:0 Group III		**>10;0 to ≤ 12:0 Group IV**	
N=10	**Median**	**IQR**	**Median**	**IQR**
Proto words	0.00	0.00-100.00	26.47	0.00-74.28
True words	------	-------	17.14	0.00-60.29

Note: ---- indicates no production

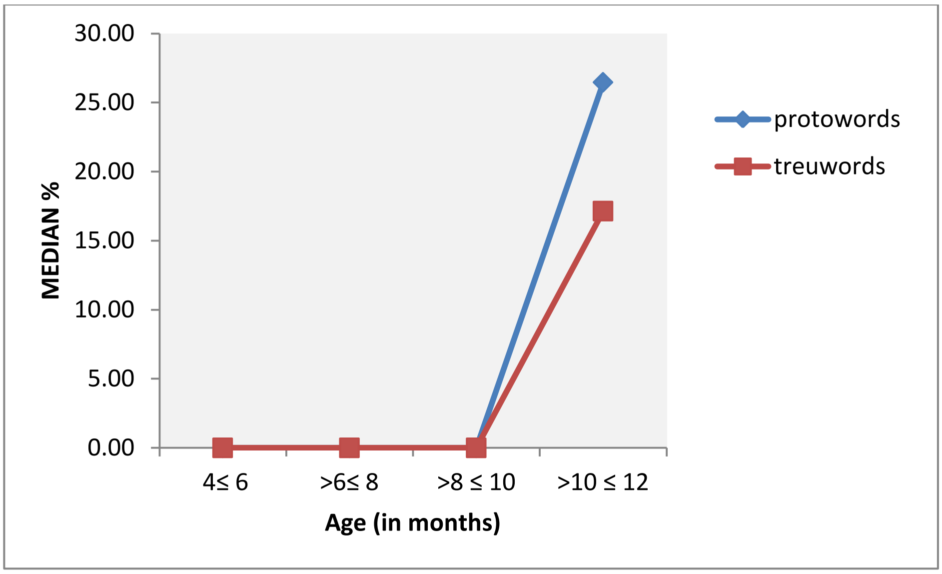

Figure 4.16 Early word forms in Hindi

As seen in Table 4.19, it is implicit that proto words increased in occurrence from 8 months onwards, suggesting an increase in the emergence of word forms in the later stages of babbling. In the next age group of 10 to 12 months, early word forms comprised a total of 36 true words and 50 proto words; although they were produced by few participants *(i.e did not meet 60% criteria*).

As stated earlier, it was interesting to note that infants aged 6-8 months also exhibited a few word forms. The early emergence of word forms may be due to the added language stimulation by the non working mothers. This is in support of a study by Bergelson and Swingely (2012) that by 6 months, infants already began to link words to their referents. They hypothesized that younger infants were leaning towards the higher age group (above 7 months). The presence of early word forms in the younger age group (6 to 8 months) and absence in the immediate age group (8 to 10 months) is perhaps due to the cross sectional design considered in the present study. In other words the two age groups consisted of different participants.

In the present study the complexity in word productions advanced with age (Reeny & Sreedevi, 2014; Stoel- Gammon, 2011) although Mann- Whitney U test revealed no significant difference across age for proto words for Group III (8 to 10 months) and Group IV (10 to 12 months) in Hindi. Group III, i.e 8 to 10 months was lower in production of proto words (eight words) compared to the 10 to 12 month age group, having produced 50 proto words. *Thus, the hypothesis that there is no significant difference in the phonetic behavior of protowords and truewords across age in Hindi is accepted.*

4.2.6.2 Comparison of early words across age in Malayalam participants

This section discusses the early word forms of proto words and true words produced by the Malayalam group. Group I (4 to 6 months) and Group II (6 to 8 months) had no early word form productions. Although they appeared from 8 months onwards, they were produced by few participants with 3 proto words and 3 true words. The 60% criteria was met by the oldest age Group IV (10 to 12 months), for true words (24) but not for proto words. In the present study, protowords were found to include one-two syllable productions to approximate more true speech like patterns rather than just a few random series of verbal strings. This is in consonance with the findings put forth by Menn (1983); Laakso et al (2010); Shishira, Sushma and Sreedevi (2014) who report protowords to comprise of just 1-2 syllables with limited articulatory movements performed but which closely approximate adult speech like productions and have a concrete linguistic communicative meaning to the child. The median (*Mdn*) percent score of boys and girls for early word forms are depicted in Table 4.20.

Table 4.20
Descriptive statistics of early word forms for the oldest age group in Malayalam

Early word forms	**Malayalam**	
	Age range (in months) >10;0 to ≤ 12:0 **Group IV**	
N=10	***Mdn***	**IQR**
Proto words	00.00	0.00-44.64
True words	100.00	55.35-100.00

.

As observed from Table 4.20 and Fig. 4.17, the oldest age group 10 to 12 months had a higher production of proto words and true words albeit with a higher standard deviation. This implies syllabic patterns formed concrete and meaningful complex utterances of the infants' vocabulary with advance in age. True words were present in all infants and were relatively higher in their frequency as compared to the proto words.

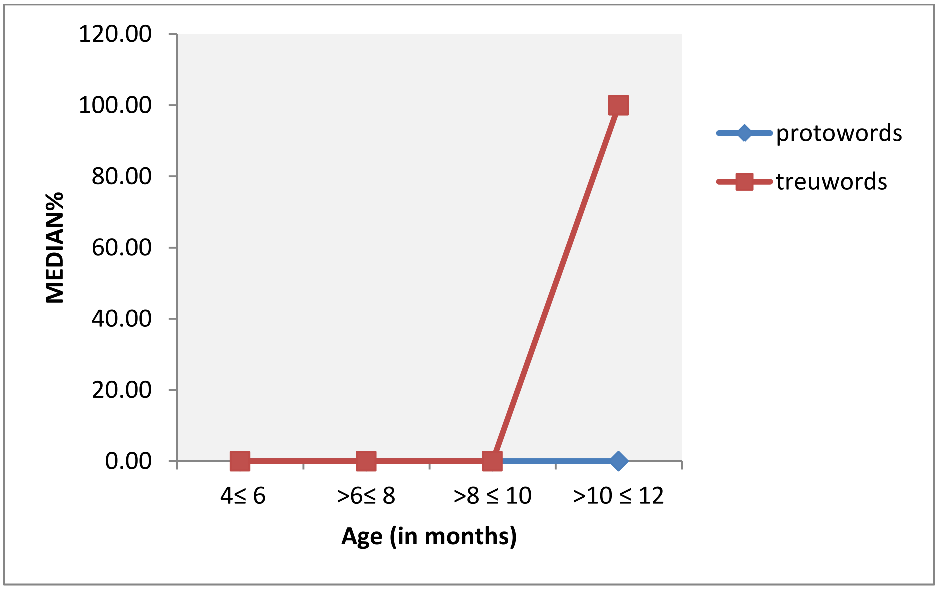

Figure 4.17 Early word forms in Malayalam

The participants in the oldest age group (10 to 12 months) demonstrated more of monosyllabic and bisyllabic true words (Appendix G) which were similar to reduplicated babbling like strings of phonemes. This finding is in accordance with a study by Stoel Gammon and Cooper (1984) who report infants use a limited number of patterns during their first few words. This finding is further augmented by a report by Elbers and Ton (1985) who recorded play pen monologues of a one year Dutch boy and found that the infant had learnt four new words in a span of six weeks, the selection and production of which were all based on the prior babbling strings. Bisyllabic words with occasional occurrence of multisyllabic words were evidently seen in the participants. These findings are in accord with Rupela and Manjula's (2006) study, where in bisyllabic true words were found to emerge at 6-12 months; becoming predominant by 18 months. In the present study, reflecting on the grammatical category, true words were mainly noun class of words in the younger age group with the grammatical class extending to verbs, tenses, gender markers etc in greater frequencies in the older age groups which were also analogous to the reports of Rupela and Manjula (2006); Shishira, Sushma and Sreedevi (2014) in Kannada learning children. Statistical comparison was not carried out as only the infants of 10-12 months group had significant productions and the hypothesis could not be tested.

4.3. To compare the early linguistic vocalizations and phonetic repertoire of infants between the two languages studied (Hindi and Malayalam).

4.3.1 Comparison of vowels between the languages Hindi and Malayalam

It was observed in the previous section of the second objective, that although both Hindi and Malayalam participants shared the same vowel segments i.e the most occurring central and front vowels [ə, ə:, a, a:, æ, æ:, e, e:] and the least occurring back vowels [i, u and ɔ] including their longer counter parts, which made up to 14 vowels in all, they differed in frequency and emergence for the type of vowel dimensions. Front, central and back vowels were different in their frequency of occurrence in all the four age groups across the languages. This is similar to the reports of Levitt and Utman (1992) in English and French learning infants, as for vowels, both group of infants produced the same vowels (11 in all), though with different frequencies of occurrence. Roug, Landberg and Lundberg (1988) studied vowels in English learning infants of 1 to 20 months of age and found that the vast majority of the vowels were front and central vowels /a, æ, e, u and i/ and their longer counterparts. Because languages share many of the same segments, it is not clear whether the infants' productions are similar because of the similar sounds to which they were exposed, or because, as Locke (1983) would argue, certain sound patterns are particularly common in the languages of the world because they reflect the child's and the adult's natural phonetic proclivities.

On comparing the data, among the most occurring vowels across Hindi and Malayalam it can be inferred that, in Group I, Group II, Group III and Group IV, central vowels ([ə]) showed the highest percent median score in the Hindi group. For the Malayalam learning group, the front vowels ([e and e:]) exhibited the highest percent median score.

Irwin (1948) reported mid central vowel [ə] and mid front vowel [e] to account for 70% of the vowel production during the first years in 95 English speaking infants studied. Mid-central and mid front vowels [ə, e] often used in babbling before 10 months were also reported in Mandarin speaking infants (Jeng, 1979; Yue-Hashimoto,1980). On similar lines, in a study by De-Boysson et. al (1999), 10 month old infant vowel productions were drawn from four linguistic communities of Arabic, Chinese, English and French, found that categories of mid front vowels accounted for the vast majority of vowels, which is similar to the findings of the present study again, indicating a universal phenomenon for vowel emergence in babbling.

Considering the 60% criteria, the Hindi group depicted the emergence of front and central vowels by 4 to 6 months and continued to be present till 10 to 12 months. In the Malayalam group, it was observed that front vowels emerged from the youngest age group and continued to be present with advance in age. However, central vowels also emerged by 4 to 6 months. The back vowels were produced minimally by fewer participants in all the 4 age groups in both languages.

The occurrence of vowels showed a wide variability which has been well documented in the literature. Davis and Mac Neilage's (1995) longitudinal study with 6 infants (3 males, 3 females) from monolingual English-speaking homes revealed wide individual variability in the use of vowels. In the present study, overall, the vowel repertoire found in the babbling samples of the infants from the age range of 4 to 12 months were [æ, ∂, a, e, i, u, o]. The findings are also in par with the studies by Shyamala and Basanti (2003) and Anjana and Sreedevi (2008) in Kannada which revealed that the cardinal vowels /i/, /e/, /a/ /æ/, /∂/, /u/ and /o/ also made their appearance by 6-12 months of age in infants. The findings of the present study are similar to these reports indicating the universal nature in vowel production. Vowel production has been examined largely within Indo-European languages such as English, French and Spanish. It is not certain whether the lower left quadrant vowel space is a universal characteristic in infant vowel production patterning.

Moreover, studies on infant patterns have not been compared to native language sound patterns consistently. No comparison with native language frequencies is available in the large infant databases as reported by Kern and Davis (2007) for five Indo-European languages or in the English database analyzed by Davis and MacNeilage (1995). It is difficult to argue conclusively that infant speech patterns are based only on production limitations without comparison with adult input frequencies.

In the current study, the high front vowels [i], [i:], high back vowels [u], [u:], and low mid vowels [ɔ], [ɔ:] occurred sporadically in both Hindi and Malayalam language learning groups. However, made their appearance as age increased. This could be related to the acoustic study by Rvachew et al., (2008) on Canadian English and Canadian French learning infants who showed increased occurrence of corner vowels [i] and [u] at 12 months onwards, reflecting maturational changes in speech motor control along with language exposure (Englund & Behne,2006; Khul et al., 1997). Overall, 43% of the entire phonetic repertoire constituted the singleton vowels in Hindi group whereas 57% in the Malayalam learning group. The findings elucidated indicate a lot of similarities and differences across the two languages studied. Statistical analysis using Mann-Whitney U test was carried out to exemplify the significant difference of vowels for each age group across the two languages as shown in Table 4.21.

Table 4.21

Comparison of vowels between Hindi and Malayalam participants

Vowels	**4:0 to ≤ 6:0 months**		**>6;0 to ≤ 8:0 months**		**8;0 to ≤ 10:0 months**		**>10;0 to ≤ 12:0 months**	
	|Z|	**p**	|Z|	**p**	|Z|	**p**	|Z|	**p**
Front	1.814	.070	**2.609***	.009	1.437	.151	1.436	.151
Central	**2.368***	.018	**2.609***	.009	1.679	.093	1.960	.050
Back	0.108	914	0.486	.627	0.121	.904	0.559	.576

*Significant at $p < .05$

In Group I (4 to 6 months), central vowels showed significant difference ($|Z|$=2.368; p=.018) between Hindi (*Mdn* = 70.00) and Malayalam (*Mdn* =27.14) with a higher occurrence in the Hindi group. In Group II (6 to 8 months) also, central vowels ($|Z|$=2.609; p=. 009) was significantly higher in the Hindi group (*Mdn* = 69.62) in comparison with the Malayalam group (*Mdn* =12.14). However front vowels ($|Z|$=2.609; p=. 009) showed significantly higher occurrence in the Malayalam group (*Mdn*= 87.86) compared with the Hindi group (*Mdn* =30.38). For Group III (8 to 10 months) and Group IV (10 to 12 months) there was no significant difference for any of the vowels in both languages. Therefore, it was observed that though the types of vowels are same in both the languages, the frequency of their occurrence varied across languages. *Thus, the hypothesis that there is no significant difference of vowels between the languages Hindi and Malayalam is rejected.*

To summarize, the infants in the Hindi and Malayalam groups shared the same vowel patterns though they were different in their frequency of occurrence in all the four age groups. The results also revealed that central vowels dominated across the four age groups in Hindi, whereas front vowels were predominant in Malayalam, both emerging as early as 4 months. Both the groups also exhibited the least occurring vowels as [i, i:, ɔ, ɔ:,u and u:]. As these vowels were less present in other studies as well, these findings of the present study leaned towards the universal nature of babbling. It was also observed that as age increased, the production of singleton vowels decreased indicating emergence of linguistically advanced utterances or word forms.

4.3.2 Comparison of diphthongs between the languages Hindi and Malayalam

This section deals with the similarities and differences observed in diphthongs for the two language groups of Hindi and Malayalam. There is a general consensus in literature that diphthongs are dynamic entities, more than monothongs (Harrington & Cassidy, 1994). In the present study, it was observed that the Opening diphthongs, Closing diphthongs, Height Harmonic diphthongs and Central diphthongs were present in the early pre-linguistic period which marks Lings (1989) statement that diphthongs frequently occur in children's early repertoire. Fig. 4.18, dipsplays the overall median percent scores in both the diverse languages of Hindi and Malayalam.

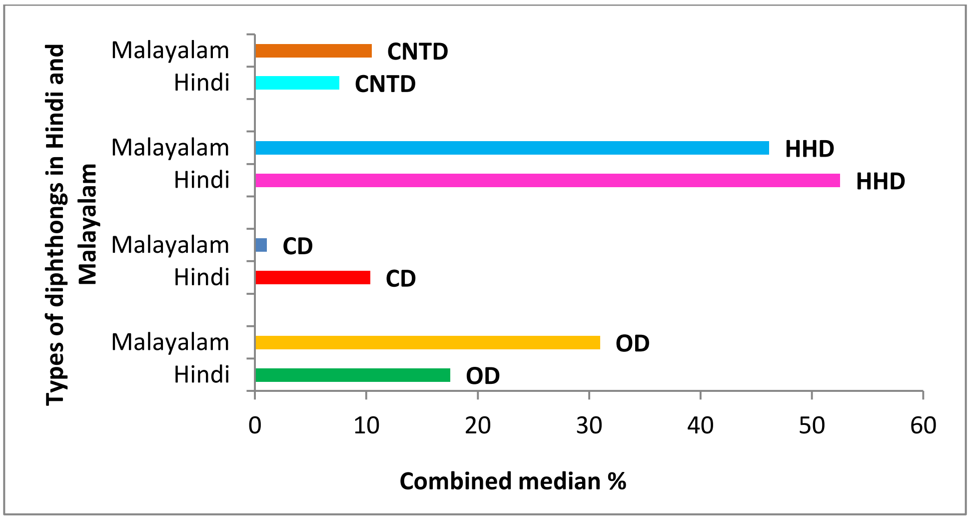

Figure 4.18. Diphthong types in Hindi and Malayalam groups.

Infants easily attain the sequence of production of OD, CD, HHD and CTND by mandibular movement as assumed in the Frame dominance account (MacNeilage et al., 1997) which involve tongue height, for the constituent vowels of the diphthong. A look at Fig. 4.18 shows HHDs were the highest occurring types of diphthongs followed by ODs, CNTDs and CDs in both Hindi and Malayalam. It can be seen that HHDs demand more co-ordination of lip rounding and tongue movement.

Based on the 60% criteria, the Hindi group depicted the emergence of Opening diphthongs at 6 to 8 months and continued to be present till 10 to 12 months. Closing diphthongs emerged at 10 to 12 months. Central diphthongs emerged at 4 to 6 months and Height Harmonic diphthongs also emerged at 4 to 6 months and continued till 10 to 12 months. For the Malayalam group, it was observed that OD and HHD emerged early as 4 to 6 months and continued to be present in the 3 older age groups. CD showed no emergence although they were produced sparingly by the participants in all the 4 age groups and CNTD emerged at 4 months.

On comparison of diphthong types between the two languages studied, it was evident that in both OD and HHD were higher in occurrence. HHD was higher in the Hindi group whereas OD was higher in the Malayalam group. More specifically, it was noted that towards the later stages of babbling, the participants in the Hindi group revealed Closing Diphthongs to be significantly higher in occurrence in the older age groups of 8 to 10 and 10 to 12 months compared to the youngest age group of 4 to 6 months. This was in consonance with the reports of Shyamala and Basanthi (2003) in Hindi and Sreedevi and Jyothi (2013) in Kannada learning infants who had more productions of these diphthongs in the later stages of babbling. Closing diphthongs are found to occur universally in adult spoken languages such as in

Malayalam (Kumari, 1972 & Punnosse, 2010); Liverpool English (Watson, 2007); British English (Kerswill, Torgesen & Fox, 2006); Singapore English (Leimgruber, 2009). This supports the fact that infant productions are influenced by linguistic exposure as there is close similarity in productions of infants and adults (Bardies et al, 1989; Locke, 1983 & Lindblom, 1984).

For the Malayalam group, the Height Harmonic Diphthongs and the Opening Diphthongs were higher in all the groups. This manner of acquisition could be in lines with the investigations of Foster- Cohen,1999; De-Boysson-Bardies,1999, Fromkin,2003 and Godson,2004 who proposed that more frequent and earlier the sound emerged, the easier it was produced. In the current study, overall the Height Harmonic diphthongs decreased as age increased which provides an insight on the complexity of utterances during the later babbling period (Reeny & Sreedevi, 2013). Mann-Whitney U test was carried out to investigate the significant difference of diphthong types across languages in each of the four age groups, as shown in Table 4.22.

Table 4.22
Comparison of diphthongs between Hindi and Malayalam participants

Types of diphthongs	**4:0 to ≤ 6:0 months**		**>6;0 to ≤ 8:0 months**		**8;0 to ≤ 10:0 months**		**>10;0 to ≤ 12:0 months**	
	|Z|	**p**	|Z|	**p**	|Z|	**p**	|Z|	**p**
OD	**2.070***	.038	0.000	1.000	**2.235***	.025	0.123	.622
CD	0.331	.741	1.305	.192	1.724	.085	**2.266***	.507
HHD	**2.158***	.031	0.303	.762	1.365	.172	1.187	.544
CNTD	0.493	.622	0.664	.507	0.606	.235	0.562	.574

*Significant at $p < .05$

As shown in Table 4.22, across Group I of Hindi and Malayalam, (4 to 6 months) Opening diphthongs **[OD]** ($|Z|$= 2.070; *p*=.038), showed significantly higher occurrence in Malayalam (*Mdn*=33.33) compared to Hindi (*Mdn*=0.00) and Height Harmonic Diphthongs **[HHD]** ($|Z|$= 2.158; *p*=.031) were significantly higher in occurrence in Hindi (*Mdn*=54.00) compared to the Malayalam group (*Mdn*= 23.61).

Only Group II (6 to 8 months) showed no significant difference across the two diverse languages for diphthongs. For Group III (8 to 10 months) Opening diphthongs **[OD]** ($|Z|$= 2.235; *p*=.025) were significantly higher in occurrence in Malayalam (*Mdn*= 50.00) compared to the Hindi group (*Mdn*= 17.50). In Group IV (10 to 12 months) closing diphthongs **[CD]** ($|Z|$= 2.266; *p*=.023) were significantly higher in its occurrence in Hindi (*Mdn*=36.67) compared to Malayalam (*Mdn*= 8.33). OD, CD and HHD showed significant difference across both languages whereas Central Diphthongs did not show significant difference. *Thus, the hypothesis that there is no significant difference of diphthongs between the languages Hindi and Malayalam is rejected.*

To summarize, the participants in both the language learning groups exhibited all the four diphthong types differing in their frequency of occurrence. The results revealed Height Harmonic Diphthongs (HHD) had the highest percent median score in first three age groups and Closing Diphthongs (CD) had the highest percent median score in the oldest group of 10 to 12 months in the Hindi learning group. Diphthong types such as Opening Diphthongs (OD) and Height Harmonic Diphthongs (HHD) dominated in all the four age groups in the Malayalam learning group with the latter dominating in the oldest age group of 10 to 12 months.

4.3.3 Comparison of consonants between the languages Hindi and Malayalam

Both Hindi and Malayalam participants had a total of 18 consonants, including emerging and less frequently produced. They assorted in variety and frequency of occurrence across all age groups in both the languages. Considering the 60% criteria, the Hindi group had 8 emerging consonants [m, h, b, g, p, d̪, t̪, j] and the Malayalam group had 9 emerging consonants [m, g, h, d̪, b, w, j, k, t̪]. Other consonants such as [w] and [k] though occurred more frequently were produced by few participants in the Hindi group and consonant [p] in the Malayalam group. The less frequently occurring consonants were [/ŋ/, /r/, /ʤ/, /ʧ/, /ʃ/, /ḷ/, /ṭ/,/ḍ/] in both the language groups.

With reference to the Western studies, certain trends in the occurrence of consonants were found to be similar to the findings of the present study. Locke (1983) reported that /h/, /d̪/,/b/,/m/,/p/ /t̪/,/k/,/j/,/w/ were the most frequently occurring consonant-like sounds in the late babbling period. This could be because children learn new phonemes in order to connect them to form new words they learn (Storkel & Morrisett, 2002). It could be observed that as age advanced there was an increase in a variety of consonants produced leading to first word productions during the early linguistic period. The higher variability in production of consonants in the language groups was due to its occurrence in multisyllabic structures.

Certain common trends that were noted were a decline in the occurrence of back consonants such as glottal fricatives [h], velars [k] and [g] and an increase in the occurrence of front consonants such as dental /t̪/ in Hindi and its voiced cognate /d̪/ in Malayalam. These findings are similar to the descriptions of Oller (1980), that production of back consonants decline, while production of front sounds increase with advance in age implying a universal nature in babbling.

However, it could be seen that glottal fricative /h/ was the most occurring consonant in both the language groups followed by bilabial nasal /m/. In the Hindi group, velar stop /k/ minimally appeared at 6 months and disappeared as age advanced. This finding is similar to the reports of Kuang (2007) in Mandarine Chinese learning infants that velar stops such as /k/ was used less frequently and was attributed to the insufficient input from the caregivers. Also another feature could be its difficulty in production (Godson, 2004), hence it can be deduced that voiced velar stop /g/ was also difficult to generate. For the Malayalam group, /k/ was less frequent too, which can be related to the reports of Anjana and Sreedevi (2008) wherein velars were less frequently occurring in the age range of 6 to 8 months. Nevertheless in the Malayalam group, the unvoiced /k/ emerged and occurred more frequently in the higher age groups of 10 -12 months which could be related to the reports of Sreedevi and Irfana (2013) that velar unvoiced stop /k/ was highest in occurrence in the adult spoken language of Malayalam suggesting the influence native language on the later stages of babbling. Contrary to /k/, its voiced counterpart /g/ is less emphasized and it emerged at 6 months in Hindi and early as 4 months in Malayalam learning infants, and alleviated towards the later stages of babbling.

The least frequent occurring consonants such as /r/, /ʤ/, /ʧ/, /ḷ/, /ṭ/,/ḍ/,/ʃ/,/ŋ/,/w/ were present in both language groups. Vihman (1985) and Kuang (2007) reported that these infrequent speech sounds were acquired later in children as they were the most difficult sounds to produce or could be due to reduced frequency of occurrence in the language. In the present study, the Hindi group had production of manners of articulation in the order of stops, nasals, glottal fricatives, glides, laterals and affricates. The places of articulation were bilabials, glottals, dentals velars, palatals and alveolars. For the Malayalam group, the prominent manners of articulation were stops, glottal fricatives, nasals and glides. Trills and affricates were produced by few participants. Place of articulation were majorly confined to bilabials, glottals, dentals and velars. Palatals and alveolars were minimally present. Laterals and affricates were produced more by the Hindi group and trills were more in the Malayalam group. Cross sectional studies of phoneme acquisition in English; indicate nasals, stops and glides are mastered early, whereas liquids, fricatives and affricates develop later (Smit, Hand, Freilinger, Bernthal & Bird, 1990). Other than English, it indicated a general trend that holds across other languages (Arab: Amayreh & Dyson, 1998; Cantonese: So & Dodd, 1995; Turkish: Topbas, 1997; Kannada: Anjana & Sreedevi, 2008; Hindi: Shyamala & Basanthi, 2003).

In the present study overall there was a higher production of voiced consonants than unvoiced consonants in both the linguistically diverse languages of Hindi and Malayalam which is similar to the reports of Anjana and Sreedevi (2008) in Kannada and Locke (1983) in English learning infants. Robb and Belie (1994) observed infants from 8 to 16 months and found consonants were mainly voiced. Shyamala and Basanti (2003) reported a substantial increase of voiced consonants such as [b], [m], [ḍ], [ḷ], [g] and [r] in Hindi learning infants as early as 6 to 12 months of age. Locke (1983) presumes that the articulatory factors play a role in the voiced and unvoiced feature acquisition. The predominance of voiced stops in babbling may be a consequence of insufficient articulatory control for the production of unvoiced sounds, which requires the vocal folds to be held apart. According to Warren’s findings (1976), voiceless consonants have increased intra oral breath pressure. The sub-glottic air pressure is lost at the level of vocal folds for voiced consonants; they do not have the capacity to build up air that voiceless sound such as /p, t, k/ necessitate. Hence, the increased production of voiced consonants. Mann-Whitney U test was carried out to exemplify the significant difference consonants for language comparisons within each of the four age groups in both Hindi and Malayalam as shown in Table 4.23.

Table 4.23
Comparison of consonants between the languages in Hindi and Malayalam participants

Consonants	4:0 to ≤ 6:0 months		>6;0 to ≤ 8:0 months		8;0 to ≤ 10:0 months		>10;0 to ≤ 12:0 months	
	|Z|	**p**	**|Z|**	**p**	**|Z|**	**p**	**|Z|**	**p**
Place of articulation								
Bilabials	0.266	0.791	1.287	0.198	0.151	0.880	0.907	0.364
Alveolars	1.451	0.147	1.877	0.061	0.341	0.733	0.040	0.968
Velars	0.851	0.395	0.835	0.404	1.936	0.053	1.701	0.089
Glottal	0.153	0.878	0.766	0.444	0.567	0.570	0.227	0.820
Dentals	**2.163***	0.031	0.154	0.877	0.265	0.791	0.567	0.571
Palatals	1.451	0.147	1.407	0.160	0.117	0.907	0.232	0.817
Manner of articulation								
Nasals	0.304	0.761	1.815	0.070	0.719	0.472	0.756	0.450
Stops	1.448	0.148	0.189	0.850	0.340	0.734	0.756	0.450
Fricatives	0.153	0.878	0.766	0.444	0.567	0.570	0.227	0.820
Affricates	0.000	1.000	0.108	0.914	**2.164***	0.030	0.608	0.543
Glides	0.608	0.543	1.241	0.215	1.366	0.172	0.457	0.648
Trills	1.000	0.317	1.000	0.317	0.000	1.000	1.000	0.317
Laterals	1.000	0.317	0.216	0.829	0.839	0.402	0.496	0.620

*Significant at $p < .05$

In Group I (4 to 6 months) dentals (│Z│= 2.163; p=.031) were significantly higher in the Hindi group (*Mdn*=0.00) in comparison with the Malayalam group that had no production at all. Group II (6 to 8 months), there was no significant difference for consonants between the two language groups. For Group III (8 to 10 months) affricates ($|Z|$ = 2.164; p=.030) was significantly higher in its occurrence in Hindi (*Mdn*=0.00) compared to Malayalam group that had no production. Group IV (10 to 12 months) also did not show any significant difference in consonant occurrence between both the language groups. As Groups 1 and III had significant differences, *the hypothesis that there is no significant difference in occurrence of consonants between the languages Hindi and Malayalam is rejected.*

To summarize the findings on consonants, stop consonants [p, b, k, g] and nasal consonants [m, n] are the most common consonants produced during babbling in the two languages studied which are similar to reports in other languages (Vihman, 1986; Locke, 1983; Davis & Mc Neilage, 1995). Comparisons of consonant phoneme frequencies from Jin (1993) and Mines et al. (1978) reveal the following patterns. In their study, the frequency of labial and fricative consonants is higher in English than in Korean which is similar to the findings in the present study of Hindi and Malayalam. The present study also portrayed complex consonants such as liquids [r, l̥], affricates [ʧ, ʤ], fricative [ʃ] which were infrequent analogous to the reports of Vihman, Macken, Miller, Simmons and Miller (1985) in English learning infants of 6 to 12 months. . This has demonstrated capacities for learning and retaining regularities in the phonetic structure of their native language by around age 0;10, as evidenced in looking time paradigms (Aslin, Saffran & Newport, 1998; Saffran, Aslin & Newport, 1996).

4.3.4 Comparison of simple syllable shapes between the languages Hindi and Malayalam

The participants in the language learning groups of Hindi and Malayalam presented differences in the quality and quantity of syllable shapes. The Hindi group displayed an uneven trend in its frequency of production of syllable shapes as seen in Fig. 4.19, compared to Malayalam participants who displayed a definite trend in its frequency of production of syllable shapes as seen in Fig. 4.20.

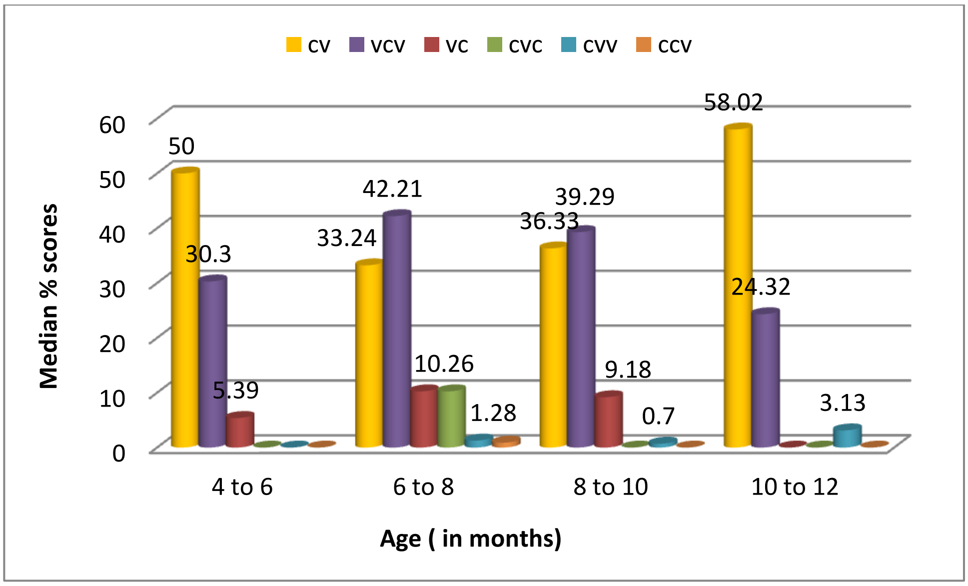

Figure 4.19 Syllable shapes in Hindi

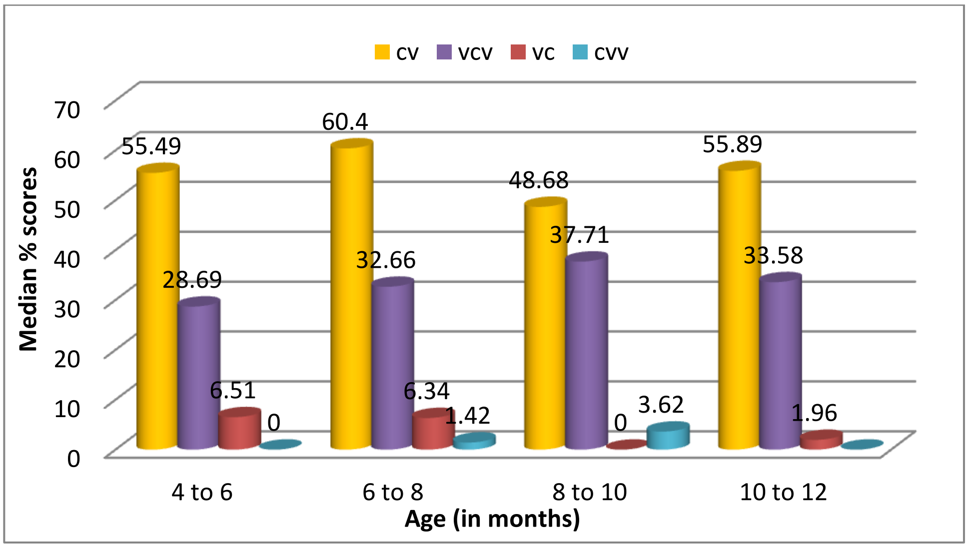

Figure 4.20 Syllable shapes in Malayalam

On the whole, the frequency of occurrence of syllable shapes was about 1219 in the Malayalam group, which was relatively high compared to the Hindi group with a frequency of occurrence of 1038 syllable shapes. The Hindi group exhibited six types of syllable shapes that included CV, VC, CVC, VCV, CVV and CCV patterns whereas the Malayalam group exhibited only four syllable shapes, CV, VC, VCV and CVV.

Both the language groups displayed syllable CV with the highest percent median score across all age groups and emerged as early as 4 months, except for age Group II and Group III in Hindi that depicted emerging syllable VCV with the highest percent median score. This is in support of Kent and Bauer's (1985) study which revealed CV and VCV that accounted for approximately 94% of the syllable shapes produced at the end of the babbling period. Children tend to favor open (CV) as opposed to close (CVC) syllable types (Kent & Bauer, 1985; Locke, 1983; Oller & Eilers, 1982; Stoel-Gammon, 1985; Vihman, 1992).

In the present study, other less frequent syllable shapes such as VVC and VCC emerged from 8 months onwards and disappeared in the older age group in Hindi whereas less frequently produced syllable shapes CVC, CCV and VVC were present as early as 4 to 6 months onwards in the Malayalam group. These syllable shapes were less in production by few participants in both language groups and hence were not considered for statistical analysis. Thus, the results of the present study share similar trends of occurrence of consonant vowel combinations that occur during the exploration stage at about 4 to 6 months as reported by Oller (1980). And during the end of the babbling period open syllables or syllables ending in a vowel are the most frequently occurring syllable shapes in the current study and was also observed by Bauman- Waengler (2000) in English. These early syllable shape similarities across languages indicate the universal nature of babbling. Mann-Whitney U test was carried out to exemplify the significant difference of syllable shapes for language comparisons within each of the four age groups as shown in Table 4.24.

Table 4.24
Comparisons of syllable shapes between Hindi and Malayalam participants

Syllable shapes	**4:0 to ≤ 6:0 months**		**>6;0 to ≤ 8:0 months**		**8;0 to ≤ 10:0 months**		**>10;0 to ≤ 12:0 months**	
	|Z|	**p**	|Z|	**p**	|Z|	**p**	|Z|	**p**
CV	0.949	.343	**2.911***	.004	1.588	.112	0.302	.762
VC	0.618	.536	1.639	.101	1.915	.055	0.041	.967
VCV	0.113	.910	1.399	.162	0.605	.545	0.530	.596
CVV	0.355	.723	0.363	.716	.634	.526	1.131	.258

*Significance at $p < .05$

The test revealed significantly higher production for syllable shape CV ($|Z|$=2.911; *p*=.004) in Malayalam (*Mdn*=60.40) compared to the Hindi group (*Mdn*=33.24) in Group II (6 to 8 months) though CV was the highest in both the languages. The high occurrence of syllable CV could be accounted for the presence of more open syllables in the adult language of Malayalam indicating the influence of native language. *The hypothesis that is there is no significant difference of syllable shapes between the languages Hindi and Malayalam is rejected.*

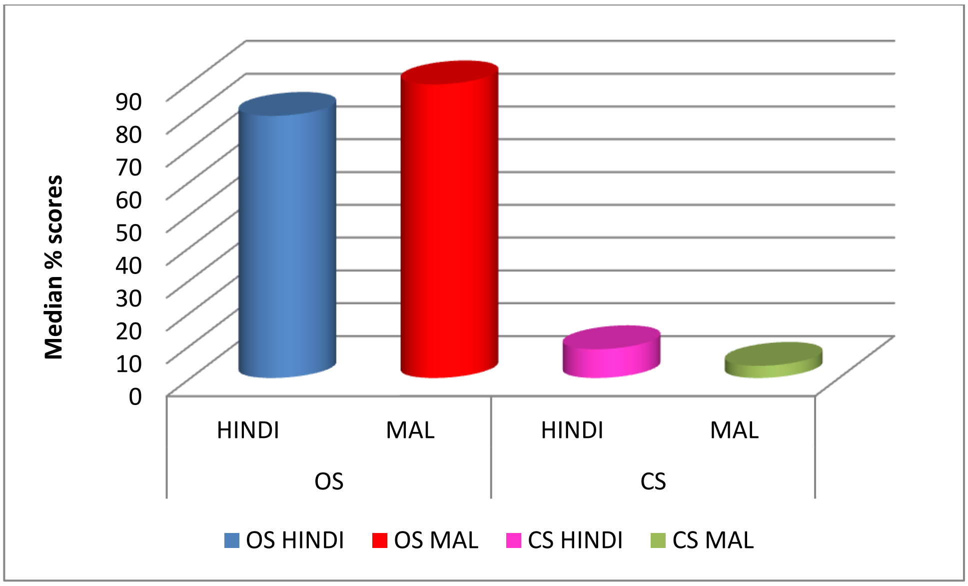

Figure 4.21 Overall median percent scores for open and closed syllables in Hindi and Malayalam
(OS- Open Syllables and CS- Closed Syllables)

To recapitulate, the present study depicted CV syllable as the basic and predominant unit of syllable production in the early vocalizations of participants in both Hindi and Malayalam. Hindi participants had a production of eight types of syllable shapes compared to the Malayalam group with a production of four types of syllable shapes. However, the Malayalam group had a higher frequency of occurrence of syllable shapes than the Hindi group. The present study also showed that the Hindi participants displayed a variety of syllable combinations and the Malayalam group followed a preference for more of open syllable productions suggesting an influence of the native language as seen in Fig. 4.21. Other syllable shapes VVC, VCC CVC, CCV and VVC were less in production in both the language learning groups.

4.3.5 Comparison of reduplicated and variegated utterance types between Hindi and Malayalam

Major similarities and differences of the two language learning groups, Hindi and Malayalam are the highlights of this section. The study reveals co-occurrence of both reduplicated and variegated babbles as early as 4 to 6 months onwards. This is similar to the findings of Smith et al., (1989) in English learning infants of 6 to 10 months that both types of vocalizations co-occur and two distinct stages do not exist. Reduplicated babbling accounted for half or more of all vocal patterns in Hindi and Malayalam participants which is in support of the reports of Davis and Mac Neilage (1995) and Smith et al, (1989) on infant vocal production. Overall in both the language learning groups, as depicted in Figure 23, the reduplicated babbles had a higher percent median score compared to the variegated babbles. It can be noted that, although there was an increase in the occurrence of reduplicated and variegated babbling with age, the variegated babbles did not exceed the occurrence of reduplicated babbling even in the older age groups in both languages. This is analogous to the reports of Anjana and Sreedevi (2008) wherein the production of reduplicated babbles was high even in the older age groups of 10 to 12 months.

To determine the language differences for complex babbles within each age group, non parametric test was employed. Statistical analysis was carried out using Mann- Whitney U test. On overall language comparison, results revealed no significant difference between the two languages Hindi and Malayalam for complex babbles.

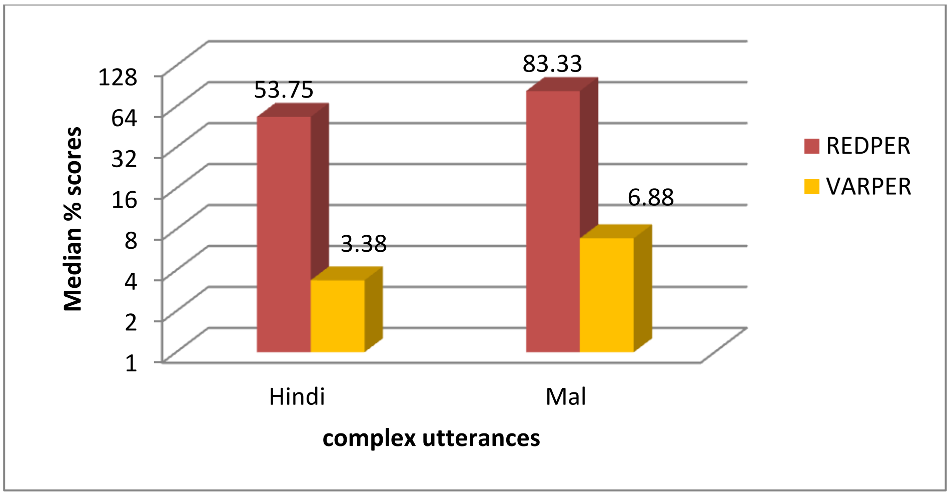

Figure 4.22 Overall median percent scores for complex syllables in Hindi and Malayalam
(R- Reduplicated utterances and V- Variegated utterances)

Another similarity was that manner variegation dominated in both language learning groups and place and voicing variegation types were reduced in their productions in both languages of Hindi and Malayalam. This finding is similar to the cross linguistic study by Kerns and Davis (2011) wherein, infants had consonant manner changes that predominated over place changes in four languages, Romanian Tunisian, Dutch and Turkish.

To comment on the differences across Hindi and Malayalam complex babbles, as seen from Figure 4.22, overall observation based on median percent scores, both types of complex behaviours were higher in Malayalam compared to the Hindi participants. The researcher hypothesizes that it might be due primarily to increased language stimulation by more number of non-working mothers in the Malayalam group (27) compared to the Hindi group (19) as a whole; however, this finding needs to be validated with a larger corpus in both languages.

Although the participants in Hindi and Malayalam groups shared the same types of complex babbles, they varied in their frequency of occurrence for variegation types. Followed by the manner variegation, in the 10 to 12 months age band (Group IV) in both language groups, voicing variegation was high in the Hindi group whereas place variegation scored high in the Malayalam group by few participants. Voicing variegation is comparatively less in Malayalam participants probably because; the overall occurrence of consonants in them was majorly voiced. Hence, it could be speculated that shifting from voiced to unvoiced and vice versa is reduced in these participants. The reduction in production of voicing variegation in Malayalam group is possibly because the adult Malayalam speakers tend to produce voiced sounds as weakly voiced which reduces the distinction between voiced and unvoiced sounds. For example, adult speakers produce the word /gi: t̲a/ as /gi:d̲a/. Thus the present study substantiates the influence of native adult language. Mann-Whitney U test was carried out to exemplify the significant difference of these complex behaviours within each of the four age groups as shown in Table 4.25.

Table 4.25
Comparison of reduplicated and variegated syllables betweenn Hindi and Malayalam participants

Complex syllables	**4:0 to ≤ 6:0 months**		**>6;0 to ≤ 8:0 months**		**8;0 to ≤ 10:0 months**		**>10;0 to ≤ 12:0 months**	
	|Z|	**p**	|Z|	**p**	|Z|	**p**	|Z|	**p**
Reduplicated	0.981	.326	**3.163***	.002	.038	.969	0.417	.676
Variegated	0.725	.468	1.523	.128	1.494	.135	0.417	.676

*Significant at $p < .05$

The test revealed there was significantly higher production of reduplicated babbles in the 6 to 8 months in the Malayalam group (M=82.85, *Mdn*=90.00) compared to the Hindi group (M=49.92, *Mdn*=62.79).

Table 4.26
Comparison of variegated types of babbles between Hindi and Malayalam participants

Variegated types	**4:0 to ≤ 6:0 months**		**>6;0 to ≤ 8:0 months**		**8;0 to ≤ 10:0 months**		**>10;0 to ≤ 12:0 months**	
	|Z|	**p**	|Z|	**p**	|Z|	**p**	|Z|	**p**
Place variegation	1.000	0.317	0.073	.942	0.108	.914	0.695	.487
Manner variegation	0.911	0.362	**2.338***	.019	0.739	.460	0.119	.905
Voicing variegation	1.000	0.317	1.453	.146	1.451	.147	0.561	.575

*Significant at $p < .05$

Manner variegations dominated all the four age groups in both the language groups and depicted significant difference for the variegated types of babbles in Group II as shown in Table 4.26. Manner variegation ($|Z| = 2.338$; $p = .019$), showed significantly higher occurrence in the Hindi group (M=96.83, *Mdn*=100.00) of 6 to 8 months compared to the Malayalam (M=79.17, *Mdn*=100.00) group. Voicing and place variegations were relatively high in production in the 10 to 12 months age group for Hindi and Malayalam groups respectively because of increased production of consonant types. *Thus, the hypothesis that there is no significant difference of reduplicated and variegated types of utterances between the languages Hindi and Malayalam is rejected.*

4.3.6 Comparison of early words between the languages Hindi and Malayalam

The similarities and differences observed in Hindi and Malayalam groups for early word forms are discussed in this section. To comment on the similarities, among the early word forms, holophrastic words were not present in both languages. Another similarity was the presence of a higher number of proto words and true words in the oldest age group of 10 to 12 months in both the language learning groups, indicating linguistically advanced complexities. The Hindi and Malayalam groups were noticed to exhibit early word productions which were either monosyllabic, bisyllabic or multisyllabic (bisyllabic vocabulary predominating mono and multisyllabic words).It was interesting to note that true word productions of participants in both language groups clustered around their basic needs and the immediate matters around them. On a grammatical note, these words seemed to primarily incline towards noun class of words (Appendix G), which were also similar to the findings of Shishira, Shushma and Sreedevi (2014).

On the observations of differences, overall productions of proto words and true words were higher in Hindi learning participants compared to Malayalam group. Protowords in the present study comprised primarily of 1-2 syllable productions. This is similar to the findings by Menn (1983) and Laakso et al (2010) which closely approximate speech like productions and have a concrete linguistic communicative meaning to the child. True word productions were similar to reduplicated babbling like strings of phonemes. This finding is in accordance with a study by Stoel-Gammon and Cooper (1984) who report infants to use a limited number of patterns during their first few words. This finding is further augmented by a report by Elbers and Ton (1985) that an infant Dutch boy had selection and production of words which were based on the earlier preparation of babbling strings. Hence, these similarities across the languages can be inferred as universal nature in babbling.

As elaborated earlier, the Hindi group depicted a non linear progression whereas the Malayalam group depicted a linear progression for both types of early word forms. In the 10-12 month group, proto words were relatively higher in their frequency of occurrence compared to true words in the Hindi group; and vice versa in the Malayalam group. It is to be noted here that, true words were produced by all 10 participants in the Malayalam group and by few participants in Hindi in this age range.

The present study revealed significant emergence of proto and true words from 8 months onwards which correlate with the reports of Bergelson and Swingely (2012) stating that infants from this age are known to be capable of learning the sound forms of words and retaining them over long intervals whereas infants of 6 months and below have shown limited word form knowledge. The word form productions minimally surfaced from 6 months onwards in the Hindi group as opposed to that from 8 months in the Malayalam group. The researcher presumes that this could probably be due to more number of non working mothers (6) in this age group of Hindi facilitating increased language stimulation. Another remarkable finding of the present study was the steady rise in the frequency of varied word shapes and complex consonantal combinations in the older participants which was also similar to the reports of Shishira, Sushma and Sreedevi (2014). Vihman and Kunnari, (2006) explained children's emerging word learning skills and accurate consonant production skill on word learning to occur on the basis of 'vocal motor schemes' (VMS). These were explained as generalized articulatory plans indexed by children's ability to consistently produce a given consonant over a period of time. Thus as children grow, they are able to efficiently carry out the vocal motor schemes thereby exhibiting increased word and consonant production skills.

Mann-Whitney U test was carried out to exemplify the significant difference of early word forms for language comparisons within each of the age groups. No significant difference was present for protowords in the 6 to 8 and 10 to 12 month age groups for Hindi and Malayalam participants. No significant difference was present for true words in the younger age groups for Hindi. However, the test showed significantly higher production of true words ($|Z|$=2.717; p=.007) in Hindi compared to Malayalam in the oldest age group of 10 to 12 months. This is due to the higher production of truewords (36) in Hindi though by only few participants compared to production by all 10 participants in Malayalam (24). *Thus, the hypothesis that there is no significant difference of protowords and truewords between the languages Hindi and Malayalam is rejected.*

To sum up, proto words and true words were present in Hindi and Malayalam groups (Appendix G). Holophrastic words were absent in both languages. The present study contributes to our better understanding of language acquisition that an early age of 6 months, infants have already begun to link words to their referents. Overall, a relatively higher production of proto words and true words were present in the Hindi group compared to the Malayalam group.

The following points are the difference between the current study and other studies on babbling.

Compared to earlier studies, the present study focused on two different Indian language families (i.e. Indo- European [Hindi] and Dravidian [Malayalam]). Earlier studies have mainly focused on infants from 6 months onwards. Babbling studies are mainly longitudinal, whereas the present study is a cross-sectional design. Other studies have had few number of participants (a minimum of 6 to 10), the present study consisted of 80 participants, 40 in each language group. All types of babbling utterances (vowels, diphthongs, consonants, syllable shapes, complex utterances, and early word forms) were considered in the present study. There is a dearth of research on diphthongs in children less than one year. The present study observed four types of diphthongs. Co-occurrence of reduplicated –variegated utterances was identified as early as 4 months and does not exist in two separate stages in speech development.

Chapter 5
Summary and Conclusions

The present study aimed to explore the early phonetic characteristics of participants with a native language background of two linguistically diverse Indian languages Hindi and Malayalam. A cross-sectional population of Hindi and Malayalam infants from 4 to 12 months of age was enrolled in the present study and was divided into four groups. A total of 80 participants comprised of 40 participants in each of the two languages. Each of the four age groups 4:0 to ≤ 6:0, >6;0 to ≤ 8:0, >8:0 to ≤ 10:0 and >10:0 to ≤ 12:0 months included 10 participants of 5 boys and 5 girls. The participants were selected from Hindi and Malayalam speaking belts. General history, details of speech-language, auditory, play and cognitive skills were obtained through parental interview along with consent for participation in the study. A developmental screening checklist (Swapna et.al, 2010) was administered to screen all the infants before considering them as participants in the study. A language free test- The Language Proficiency scale (Ramya Maitreyee & Goswami, 2009) was administered on the parents to obtain proficiency of their native language.

Audio recordings were carried out when the participants were fed and were in a comfort state. Parents were asked to interact naturally with the child during the recording. Approximately 45 to 50 utterances were recorded from infants at 4 to 6 months of age. For infants beyond 6 months of age, it was ensured that at least a minimum of 100 utterances were recorded. The audio recordings were analyzed using the VLC media player software and transcribed using IPA (International Phonetic Alphabets, 2005). Data extracted included types and frequency of vowels, diphthongs, consonants, simple syllable shapes, reduplicated-variegated babbles and early word forms. Analyses was carried out by transcription and data reduction, to consider the type of phoneme produced, calculation of various syllabic behaviours from simple monosyllables to complex syllabic structures, rank ordering them and establishing proto words/ true words based on McCune's and Vihman's procedure which included observations and parental reports. A 60% criteria was employed to indicate the phonetic behavior to be emerging (i.e 6 out of the 10 participants producing the phonetic behavior).

For the data transcribed, inter-judge and intra-judge reliability were obtained for 10% of the samples of each participant. Cronbach's Alpha co-efficient for all the parameters showed > 0.7 scores on reliability measures. Statistical analysis was carried out using SPSS 18 software (Statistical Package for Social Sciences, version 18). As the data showed non-normality on Shapiro-Wilk's test, the analysis was followed by non-parametric tests such as Kruskal – Wallis and Mann-Whitney U test. All participants were included for analysis since the sample showed minimal or no production by participants. Median percentage values were considered, as the mean frequency of the phonetic repertoire varied in each child. Mean ranks were specified to compare the significance of the groups based on Mann-Whitney test for median values 0.00. The salient findings of the present study are discussed with reference to the phonetic behavior in participants from the age range of 4 to 12 months in Hindi and Malayalam under the specific objectives as follows:

5.1. To compare the pre-linguistic vocalizations and phonetic repertoire across gender within the languages Hindi and Malayalam.

The descriptive statistics of mean, median and standard deviation scores in all four age groups in Hindi and Malayalam were computed. The non parametric Mann

Whitney U test was applied to examine the significant difference across gender. The test revealed no significant difference across gender ($p > .05$) in both languages for all the four age groups; hence the scores for boys and girls were combined for further analysis and gender was not treated as a variable in the study. The next section of the second objective which is

5.2. To compare the pre-linguistic vocalizations and phonetic repertoire across age within the languages Hindi and Malayalam.

As non parametric statistics were applied, median percentages are used for descriptions and comparisons. When median=0.00, the effect was described based on mean ranks for group comparisons. The utterances are first described for Hindi followed by Malayalam.

5.2.1 Vowels

A total corpus of 4713 phonetic behaviours produced by 40 Hindi participants consisted of 1072 singleton vowels. It was seen that as age advanced, there were relatively less number of singleton vowels in the older two groups including a span of 8 to 12 months. Central vowels ([ə]) emerged at 4 to 6 months and had the highest median percent score in all the age groups. On pair wise comparisons, there was no significant effect of age for any of the vowels.

The total corpus of 4788 phonetic behaviours produced by 40 Malayalam participants comprised of 1378 singleton vowels. Front vowels ([e], [e:]) also emerged as early as 4 to 6 months and had the highest median percent score in all the age groups. Statistical analysis revealed no significant effect of age for any of the vowels.

The participants in both Hindi and Malayalam group produced mid central vowels /ə, ə:/, low front vowels /æ, æ :/, and mid front vowels /e, e:/ frequently in all the age groups. The high front vowels [i]and [i:], high back vowels [u] and [u:] and mid back vowels [ɔ] and [ɔ:] were produced by few participants only in both languages.

5.2.2 Diphthongs

A total of 557 diphthongs were produced in the corpus of 4719 phonetic behaviours by the Hindi group. The number of diphthongs decreased as age increased. Height Harmonic Diphthongs (HHD) and Central diphthongs emerged at 4 to 6 months. HHDs had the highest percent median score in the first three age groups. Opening Diphthongs (OD) emerged at 6 to 8 months and continued to be present till 10 to 12 months. Closing Diphthongs (CD) emerged in the oldest age group, and was significantly higher compared to the three younger age groups.

A total of 465 diphthongs were produced in the corpus of 4788 phonetic behaviours by the Malayalam participants. It was seen that the number of diphthongs decreased in the two older age groups. Frequently occurring diphthongs were the OD and HHD types in all the four age groups with a significantly higher production of CNTD in the youngest age group. The participants in both language groups exhibited all the four diphthong types differing in frequency across the four age groups. It was observed that as age advanced, the production of diphthong types decreased indicating the emergence of other complex behaviours.

5.2.3 Consonants

A total of 1079 consonants included consonants produced in isolation and consonants extracted from various simple syllable shapes produced by Hindi participants. These participants had a consonantal repertoire of 18 consonants which included emerging and less frequently produced consonants. Overall, the number of consonant production increased with increase in age.

Based on the 60% criteria, the emerging consonants in Group I (4 to 6 months) were bilabial nasal [m], glottal fricative [h]. Group II (6 to 8 months) bilabial stop [b] and velar stop [g] emerged. At 8 to 10 months (Group III), bilabial stop [p] and dental stops [d̲] and [t̲] emerged. In the oldest age Group IV (10 to 12 months), palatal glide [j] emerged.

The Malayalam group had a total of 1132 consonants produced. These participants also had a consonantal repertoire of 18 consonants which included emerging and less frequently occurring consonants. Unvoiced consonants were scantily present even towards the later stages of babbling. Consonants such as bilabial nasal [m], velar stop [g], glottal fricative [h] emerged as early as 4 months. Dental stop [d̲] emerged at 6 to 8 months. Bilabial stop [b], bilabial glide [w] and palatal glide [j] emerged at 8 to 10 months. Velar stop [k] and dental stop [t̲] emerged at 10 to 12 months. In both the language groups the infrequent consonants were [n, ṭ, ḍ, ḷ, ʧ, ʤ, ŋ, r, ʃ]

5.2.4 Simple syllable shapes

A total of 1083 simple syllables were produced by the Hindi participants. The frequency of occurrence decreased in the oldest age group compared to the younger age groups. Overall, the syllable shape CV emerged at 4 to 6 months and was the highest occurring syllable in all age groups. VCV syllables emerged at 6 to 8 months were higher in production in the mid age groups, though sparingly occurred in the youngest age group. However, on statistical analysis, Kruskal Wallis test revealed no significant effect of age for any of the simple syllables shapes.

Syllables accounted for a total of 1219 produced by the Malayalam participants. It could be seen that as age increased there was a linear increase in the frequency of syllable shapes. Similar to the Hindi group, syllable CV also emerged as early as 4 to 6 months and had the highest percent median score for all the 4 age groups, followed by di syllable VCV that emerged at 6 to 8 months. Similar to the Hindi group, Kruskal Wallis test revealed no significant effect of age for any of the simple syllables shapes in Malayalam.

5.2.5 Reduplicated and Variegated utterances

A repertoire of 1031 reduplicated babbles and 147 variegated babbles from 4 to 12 months of age were produced by the Hindi participants. Among the variegated utterances that emerged at 8 to 10 months, 10 place variegations, 126 manner variegations and 9 voicing variegation types of utterances were produced. Variegated babbles were also produced by few participants in the 2 younger age groups. The frequency of reduplicated babbles emerged in the youngest age group and increased with age. Among the variegated types of babbles, the manner variegation emerged at 10 to 12 months, though produced by few participants in the 3 younger age groups, indicating the emergence of a variety of consonants. Place variegation type was absent in the youngest age group but were minimally produced in the other three older age groups. A high production of voicing variegation was observed in the 10 to 12 months age group by few participants. As age increased there was a significant higher production of reduplicated utterances.

For the Malayalam participants, 907 complex behaviours were reduplicated babbles that emerged at 4 to 6 months and 110 variegated babbles emerged at 6 to 8 months. Among the variegated babbles, 14 were place variegations, 79 manner variegations and 20 voicing variegations, indicating manner variegation to be the emergent and dominant type of variegation from 6 to 8 months. The variegated utterances were present as early as 4 to 6 months which included nasals and stops but were much lower in their frequency of production and were produced by more number of participants as age increased. On statistical analysis, the test revealed significantly higher production of reduplicated utterances as age increased.

5.2.6 Early word forms

The Hindi participants produced early word forms such as proto words from 6 months onwards and true words were present only in the oldest age group. Mann-Whitney U test revealed no significant effect of age for proto words. The Malayalam group, the younger age groups had no early word form productions. From 8 months onwards, there were word productions by few participants. However, the oldest age group had higher number of true words and protowords produced by more number of participants.

5.3 To compare the pre-linguistic linguistic vocalizations and phonetic repertoire of infants between the two languages studied (Hindi and Malayalam).

5.3.1 Vowels

Both Hindi and Malayalam infants shared the same vowel segments i.e the most occurring central and front vowels [ə, æ, a, e, ə:, æ:, a:, e:,] and the least occurring vowels [i, u and ɔ] including their longer counter parts, which made up to fourteen vowels in all. Among the most occurring vowels in Hindi and Malayalam participants it was found that, central vowels ([ə]) were significantly higher in the Hindi group, whereas front vowels ([e], [e:]) were higher in production in the Malayalam group. The high front vowels [i], [i:], high back vowels [u], [u:], and low mid vowels [ɔ], [ɔ:] occurred infrequently in both Hindi and Malayalam language groups.

5.3.2 Diphthongs

Overall, HHDs were the most dominant and emerging types of diphthongs in both Hindi and Malayalam learning groups at 4 to 6 months. Towards the later stages of babbling, Closing Diphthongs and Height Harmonic Diphthongs were significantly higher in occurrence in both language groups. The type and frequency of diphthongs varied in both the language groups as age advanced.

5.3.3 Consonants

Hindi and Malayalam groups had a consonantal repertoire of 18 consonants. Overall, the Hindi group had 8 emerging consonants [m, h, b, g, p, d̪, t̪, j] and Malayalam group had 9 emerging consonants [m, g, h, d̪, b, w, j, k, t̪]. Other consonants such as [w] and [k] though occurred more were produced by few participants in the Hindi group and consonant [p] in the Malayalam group. The less frequently occurring consonants were [/ŋ/, /r/, /ʤ/, /ʧ/, /ʃ/, /ḷ/, /ṭ/,/ḍ/] in both language groups. Glottal fricative /h/ was the most occurring consonant in both language groups followed by bilabial nasal /m/. In the Hindi group, the order of manners of articulation were stops, nasals, glottal fricatives, glides, laterals and affricates and places of articulation were bilabials, glottals, dentals, velars, palatals and alveolars. For the Malayalam group the manners of articulation in the descending order were stops, glottal fricatives, nasals, glides and places of articulation were- bilabials, glottals, dentals and velars. The Hindi group as well as the Malayalam group, dominated in voiced consonants that emerged as early as 4 to 6 months.

5.3.4 Simple syllable shapes

The frequency of occurrence of syllable shapes in the Malayalam group was relatively high compared to the Hindi group which had an increase in the number of syllable shapes. The Hindi group exhibited six types of syllable shapes (CV, VC, CVC, VCV, CVV and CCV) whereas the Malayalam group exhibited four syllable shapes (CV, VC, VCV and CVV) and had more production of open syllables. Both language groups had a high production of syllable CV that emerged early as 4 to 6 months and syllable shapes VVC, VCC CVC, CCV and VVC were less in production.

5.3.5 Reduplicated and variegated babble types

In both language groups, reduplicated babbles had a higher percent median score compared to the variegated babbles. On overall language comparison, results revealed no significant difference between the two languages Hindi and Malayalam for complex behaviours. However, both types of complex behaviours were higher in Hindi compared to the Malayalam participants. Another similarity was that manner variegation dominated in both the language groups followed by place and voicing variegations.

5.3.6 Early words

Among the early word forms, holophrastic words were not present in both language groups. The protowords emerged at 6 to 8 months in Hindi and at 8 to 10 months in the Malayalam group, whereas, true words emerged at 8- 10 months in Hindi and 10- 12 months in the Malayalam group.

In conclusion, studies in the Indian context on infant phonetic behavior have focused on investigating the type and frequency of phonetic repertoire either in one language and/or on children above the age of 1 year and very few studies have profiled the phonetic behavior of infants less than a year. The findings of the present study would help the speech language pathologists to provide clinical services to a linguistically and culturaly diverse population. There is an increased awareness to educate parents who are sensitive to even the child's early speech development. Determining the phonetic behavior of infants from the age of 4 months to 12 months with a native background of Hindi and Malayalam is a first attempt in the Indian context solely focused on the pre-linguistic stage. Understanding the emergence and nature of phonetic repertoire in infants will help to provide a better understanding of early phonological development. The order of emerging phonetic behavior based on the 60 % criteria for various phonetic behaviours are presented in Appendix J for Hindi and Malayalam groups. The present study reveals the universal nature of babbling as well as the nativity of the ambient language in both language groups and is summarized in Table 5.1 and 5.2.

Table 5.1
Depicts the universal features of babbling observed in Hindi and Malayalam

Universal findings in Hindi and Malayalam participants
1. Front and central vowels increased in frequency and back vowels were low in frequency.
2. Vowel types /i, iː, u, uː,ɔ,ɔː/ were low in frequency of occurrence.
3. Variability in production of vowels among the participants
4. Closing diphthongs such as /ai/ and /au/ were higher in occurrence in participants towards the older age ranges of 10 to 12 months.
5. Towards end of the babbling period open syllables are the most frequently occurring syllables shapes.
6. Bilabials and dentals preceded velar sounds
7. Stops dominated in both languages. Fricatives and affricates were among the less frequently occurring consonants.
8. Reduced occurrence of consonants such as /n, ḍ, ʧ, ʤ, ʃ, ṭ, ḍ, r, ḷ, ŋ /
9. CV was the most dominant type of syllable shape production followed by di-syllable VCV.
10. High occurrence of unvoiced glottal fricative /h/ in the early stages of babbling and decreased as age advanced.
11. Reduplicated babbles showed higher percent median score than variegated babbles
12. Manner variegation was the dominant type of variegation.
13. Place and voicing variegation types were reduced
14. Production of true words during the end of the babbling at 10 to 12 months

Note: CV- Consonant-Vowel, VCV-Vowel-Consonant-Vowel

Table 5.2
Depicts the language specific features observed in Hindi and Malayalam

Features	Language group
1.Central vowels were predominant	**Hindi**
2.Front vowels were predominant	**Malayalam**
3. Emerging order of occurrence of consonants [m, h, b, g, p, d̪, t̪, j]. Order of MOA- Stops, nasals, glottal fricatives, glides, laterals and affricates Order of POA- bilabials, glottals, dentals, velars, palatals and alveolars	**Hindi**
4.Emerging order of consonants [m, g, h, d̪, b, w, j, k, t̪] Order of MOA- stops, glottal fricatives, nasals, glides Order of POA- bilabials, glottals, dentals, velars	**Malayalam**
5.Laterals [r, ḷ]and affricates [ʧ] were more in occurrence in few participants	**Hindi**
6.Trills [r] were more in occurrence	**Malayalam**
7. Unvoiced dental sound /t̪/ was high in occurrence in the older age groups.	**Hindi**
8.Unvoiced /k/ occurred more frequently in the higher age group of 10 to12 months	**Malayalam**
9. Voicing variegation was less	**Malayalam**
10. Voicing variegation present	**Hindi**

Note- emerging order is based on the 60% criteria
MOA- Manner of Articulation, POA- Place of Articulation

5.4 Implications of the study

The study augments the understanding of phonological development during the pre- linguistic period in two linguistically diverse languages of India. There are limited numbers of studies on the normal acquisition of speech sounds in early infancy in Indian languages. This would be one of the first attempts to investigate the emergence of speech sound patterns in two diverse groups of languages in the

Indian subcontinent, Hindi and Malayalam. Also the findings will reveal the similarities and differences in the phonetic repertoire across the two languages. The findings obtained on the emergence of phonetic behaviours will be vastly relevant in the clinical practices of communication disorders. The established order of the emerging phonetic behavior can employed for assessment of early phonological skills in infants at risk for communication developmental delays. This study also supports the view point that pre linguistic behavior is both universal and ambient in nature.

5.5 Future Recommendations

i. Similar study can be conducted in other Indian languages.

ii. The study can be replicated with more number of participants.

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Appendix A

All India Institute of Speech and Hearing, Naimisham Campus

Manasagangothri, Mysore- 570006

Doctoral thesis on

Emergent phonetic behavior of Hindi and Malayalam speaking children in the age range of 4 to 12 months: A cross linguistic study

Information to the parents/ caregivers

I, Ms. Reeny Roy have undertaken the research study entitled **“Emergent phonetic behavior of Hindi and Malayalam speaking children in the age range of 4 to 12 months : A cross linguistic study”** under the guidance of Dr. N. Sreedevi, Reader, Dept. of Speech Language Sciences, AIISH, Mysore-6. I request you to participate in the study. Information will be collected through an interview and an audio recording for duration of 30 minutes to 1hour in one sitting. I assure you that this data will be kept confidential. Your co-operation in the study will help in providing a norm for phonological development and to provide management for normal speech language development.

I have informed about the aims, objectives and the procedures of the study. The possible risks- benefits of my son/daughter in the study are clearly understood by me. I understand that I have a right to refuse participation of my son/daughter or withdraw my consent at any time. I am also aware that subjecting to this investigation of my son/daughter may not result to any benefit to me. I have the freedom to write to the Chairman, AEC, in case of any violation of these provisions.

I, ..., the undersigned, give my consent of my son/ daughter’s participation to this study.

Signature of Parent/ Guardian

Signature of Witness

(Name and Address)

Signature of Investigator

Name and Designation

Date

APPENDIX B

NIMH Socio-Economic Status Scale, Revised Version
(Venkateshan, 2011)

A	Pooled Monthly Income	Score
1.	Rs. 5000 or below	1
2.	Rs. 5001- RS. 10000	2
3.	Rs. 10001- Rs. 15000	3
4.	Rs. 15001 –Rs.20000	4
5.	Rs.20001 & above	5
B	**Highest Education**	**Score**
1.	Illiterate	1
2.	Primary/ Secondary School	2
3.	Matriculation	3
4.	Graduation	4
5.	Post Graduation & Above	5
C	**Occupation**	**Score**
1.	Unskilled labor/ Unemployed/Daily Wager	1
2.	Semi-skilled worker/Class IV Service	2
3.	Skilled/Technical/Class III Service	3
4.	Professional/Class II Service/Blue Collared jobs	4
5.	SpecialiZed/Class I Services/White Collared jobs	5
D	**Family Properties (Immovable & Movable)**	
1.	Nil or Below Rs. 5000	1
2.	Between Rs. 50000 to Rs. 1.5 lakhs	2
3.	Between Rs. 1.5 lakhs to Rs. 2.5 lakhs	3
4.	Between Rs.2.5 lakhs to Rs. 5.0 lakhs	4
5.	Above Rs. 5.0 lakhs	5
	Total	

***Note*: Circle the appropriate score and enter sum into the cell against "Grand Total"; Interpretative Norms for Obtaining Overall SES: 0 -4 is SES I; 5-8 is SES II; 9 -12 is SES III; 13-16 is SES IV; 17-20 is SES V.**

Appendix C

Parent child interaction

Duration spend with the child		
Father		
Mother		
Interaction with the child		
	Mother (No. of hours)	Father (No. of hours)
Play with toys		
Talking to child		
Feeding and Talking		
Engage in play activities		
For working mothers/ non working mothers		
Details of caregiver		
Education		

Appendix D

Total frequency of vocal production by Hindi and Malayalam participants

Hindi participants

4:0 to ≤ 6:0 months

Boys	F	Age	Girls	F	Age
1HB	79	5.7days	**1HG**	87	6mths
2HB	123	5.14days	**2HG**	124	5.15days
3HB	99	4.3days	**3HG**	107	5mths
4HB	94	6mths	**4HG**	56	6mths
5HB	82	4mths	**5HG**	66	4.10days

>6;0 to ≤ 8:0 months

Boys	F	Age	Girls	F	Age
1HB	**92**	6.24days	**1HG**	**156**	7mths
2HB	**102**	7.27days	**2HG**	**133**	7mths
3HB	**130**	6.5days	**3HG**	**109**	8mths
4HB	**112**	7.15days	**4HG**	**180**	7.15days
5HB	**106**	7mths	**5HG**	**115**	8mths

8;0 to ≤ 10:0 months

Boys	F	Age	Girls	F	Age
1HB	**92**	8.2days	**1HG**	**123**	9mths
2HB	**195**	9mths	**2HG**	**150**	8.2days
3HB	**112**	9.28days	**3HG**	**102**	8.3days
4HB	**122**	8.5days	**4HG**	**151**	9.10days
5HB	**93**	8.5days	**5HG**	**90**	10mths

>10;0 to ≤ 12:0 months

Boys	F	Age	Girls	F	Age
1HB	**195**	12mths	**1HG**	**135**	12mths
2HB	**117**	11.10days	**2HG**	**100**	11mths
3HB	**101**	11mths	**3HG**	**151**	11mths
4HB	**122**	11.10days	**4HG**	**130**	11.28days
5HB	**117**	11mths	**5HG**	**166**	11.10days

Malayalam participants

4:0 to ≤ 6:0 months

Boys	F	Age	Girls	F	Age
1HB	65	5mths	**1HG**	152	5mths
2HB	88	6mths	**2HG**	132	4.2days
3HB	99	5mths	**3HG**	106	5mths
4HB	99	5.23days	**4HG**	61	4mths
5HB	161	5.28days	**5HG**	114	4mths

>6;0 to ≤ 8:0 months

Boys		Age	Girls	F	Age
1HB	**143**	7.10days	**1HG**	**123**	7mths
2HB	**110**	7.18days	**2HG**	**89**	6.5mths
3HB	**90**	7mths	**3HG**	**152**	7.5mths
4HB	**151**	6.10days	**4HG**	**90**	7.5mths
5HB	**107**	6.5mths	**5HG**	**118**	7.5mths

8;0 to ≤ 10:0 months

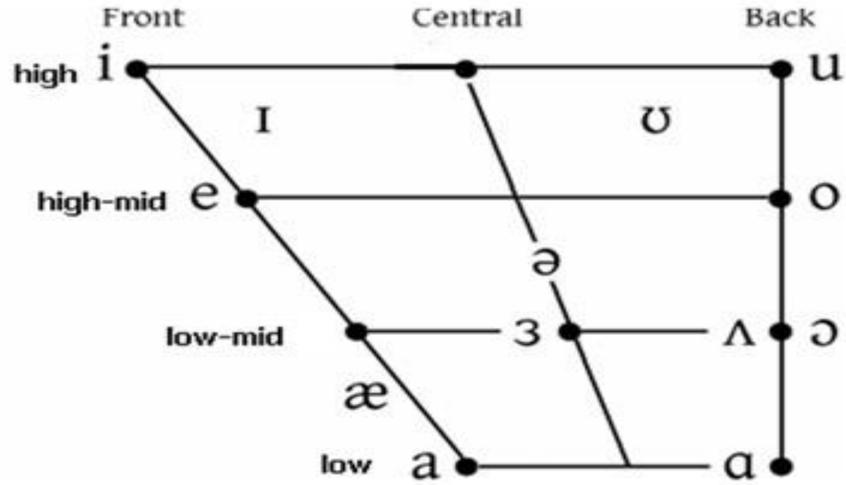
Boys	F	Age	Girls	F	Age
1HB	**141**	9mths	**1HG**	**199**	8.5mths
2HB	**138**	9.11days	**2HG**	**141**	10mths
3HB	**89**	9mths	**3HG**	**87**	10mths
4HB	**119**	8.22days	**4HG**	**94**	8.5mths
5HB	**114**	8mths	**5HG**	**110**	10mths

>10;0 to ≤ 12:0 months

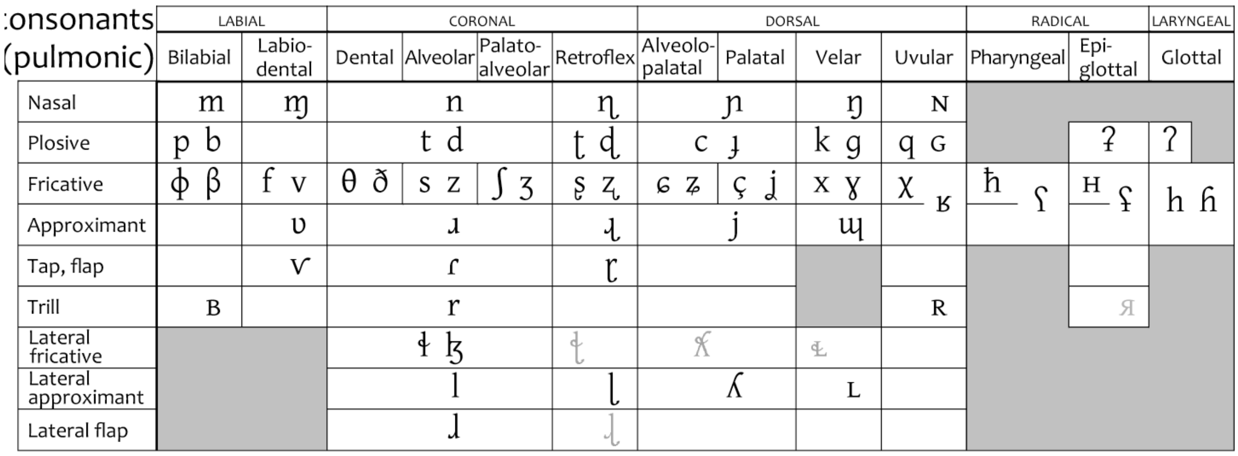
Boys	F	Age	Girls	F	Age
1HB	**87**	9mths	**1HG**	**112**	8.5mths
2HB	**196**	9.11days	**2HG**	**101**	10mths
3HB	**96**	9mths	**3HG**	**93**	10mths
4HB	**253**	8.22days	**4HG**	**118**	8.5mths
5HB	**108**	8mths	**5HG**	**97**	10mths

Appendix E

Vowel Chart and International Phonetic Alphabet Chart



The INTERNATIONAL PHONETIC ALPHABET (2005)



Consonants (pulmonic)	LABIAL		CORONAL				DORSAL				RADICAL		LARYNGEAL
	Bilabial	Labio-dental	Dental	Alveolar	Palato-alveolar	Retroflex	Alveolo-palatal	Palatal	Velar	Uvular	Pharyngeal	Epi-glottal	Glottal
Nasal	m	ɱ	n			ɳ	ɲ		ŋ	ɴ			
Plosive	p b		t d			ʈ ɖ	c ɟ		k ɡ	q ɢ		ʡ	ʔ
Fricative	ɸ β	f v	θ ð	s z	ʃ ʒ	ʂ ʐ	ɕ ʑ	ç ʝ	x ɣ	χ ʁ	ħ ʕ	ʜ ʢ	h ɦ
Approximant		ʋ	ɹ			ɻ	j		ɰ				
Tap, flap		ⱱ	ɾ			ɽ							
Trill	ʙ		r							ʀ		ᴙ	
Lateral fricative			ɬ ɮ			ꞎ	ʎ̝		ʟ̝				
Lateral approximant			l			ɭ	ʎ		ʟ				
Lateral flap			ɺ			ɭ̆							

Where symbols appear in pairs, the one to the right represents a modally voiced consonant, except for murmured ɦ.
Shaded areas denote articulations judged to be impossible. Light grey letters are unofficial extensions of the IPA.

(*http://upload.wikimedia.org/wikipedia/en/5/5e/IPA_consonants_2005.png*)

Appendix F

Diphthong types In Hindi and Malayalam in all four age groups

Table F1

Diphthong types produced by Hindi participants across four age groups

Diphthong types	**4:0 to ≤ 6:0 months**	**>6;0 to ≤ 8:0 months**	**8;0 to ≤ 10:0 months**	**>10;0 to ≤ 12:0 months**
HHD	/ee:/, /ee/, /əə/	/ee:/, /ee/, /əə/,/aa:/,/ə:ə/	/əə/, /aa:/, /ə:ə/, /ee/,/uu/,	/ee/ , /aa:/ e:e/
CNTD	/æe/, /ae/	/æe/, /æə/ , /əe/	/æe/, /æə/, /əe/, /æe:/	/æe/, /æə/, /əe/,/aæ/,
CD	/au/ and /ai/	----	/ai/, /eI/,/ æu /	/ æu/, /a:u/, /a/i, /eI/, /əI/, /aI/. / əU/
OD	/əa/, /əæ/,/Iæ/	/ əa/, /əæ/, /Iæ/, /Ie/,/æe/	/əa/, /əæ/,/ Iæ/, /Ie/, /æe/, /uɛ /,/uə/	/əa/, /əæ/,/Iæ/./Ie/, /ue/, /uə/, /e:ɔ/, /əɔ/

Note: HHD- Height Harmonic Diphthongs, CNTD- Central Diphthongs, CD- Closing Diphthongs, OD-Opening Diphthongs

Table F2

Diphthong types produced by Malayalam participants in the four age groups

Diphthong types	**4:0 to ≤ 6:0 months**	**>6;0 to ≤ 8:0 months**	**8;0 to ≤ 10:0 months**	**>10;0 to ≤ 12:0 months**
HHD	/ ææ:/, /aa:/,/ee:/, /ee/, /əə/	/ee:/, /ee/, /əə/,/aa:/,/ə:ə/,/uu:/	/ææ:/,/əə/, /aa:/, /ə:ə/, /ee/	/ee /, /aa:/,/e:e/, /ɔɔ:/,/uu:/
CNTD	/æɛ/, /ae/, /əe /	/æe/, /æə/, /əe/	/æe/, /æə/, /əe/, /æe:/	/æe/, /æə/, /əe/, /aæ/
CD	/au/,/ai/,/a:i/	/ ai /	/ai/	/ æu/, /a:u/, /ai/,/au/, /ɔu/,/ əU/
OD	/əa/, /əæ/,/Iæ/, /eɔ/	/ əa/, /əæ/,/ eæ/, /ea:/,/æɛ/	/əa/,/ əæ/,/ Iæ/:, /Ie:/,/ æe/, /ue/ ,/uə/	/əa, əæ,ia, ua, e:ɔ, əɔ/

Note: HHD- Height Harmonic Diphthongs, CNTD- Central Diphthongs, CD- Closing Diphthongs, OD-Opening Diphthongs

Appendix G

Proto words and True word productions in Hindi and Malayalam learning infants

Age Groups	Hindi learning infants		Malayalam learning infants	
	Protowords	**Truewords**	**Protowords**	**Truewords**
>6;0 to ≤ 8:0 months	/ t̪i t̪i:/- give, / t̪a t̪I/- bye	/mama/-mom, /papa/-dad, / d̪I d̪I/- sister	-	-
8;0 to ≤ 10:0 months	/ɛmɛmæ:/-mom, /bə/- balloon /appa/-dad	-	/am:ma/-mom, /əba/-bye, /mImI/-fish	/mam:ma/- mom /vava/- baby, /bɛbI/-baby
>10;0 to ≤ 12 months	/t̪i:/-tree, /ha/-eyes, /daI/-dog, /kaI/- carrot, /d̪aI/-dad, /d̪Iya/-give, /papa/- dad,/pɔd̪ə/-powder, ɔd̪ə/- that side, /t̪Ikɔtə/-pet name /əma/-mom, /d̪əd̪ə/- give, / d̪ad̪I/-dad, / d̪ad̪æ/-dad, /u:/-bow bow, /jɛjɛ/- meow, /m:a/-flying kiss, /ka/-uncle, /pa/-plane, /dadI/- dad , / d̪ad̪a/-dad	/æppa/- dad, /nana/ -grandpa /kaka/-uncle, /papa/- dad, /hɛtu/-Jesus, /təbə/-t.v, /tIku/- name, /hakɛ/- okay, , /əI/- jai , /dədədə/-give /t̪It̪I/-give, /tat̪I/- bye,/mama/- mom, /papa/- dad, / d̪Id̪I/- sister, /ɛmɛmæ:/-mom, /bə/-balloon, /amma/-mom, /bu:/-bow /əma/- mom, / d̪əd̪ə/- give bow, /amma/-mom, , /æpəl/-apple, /bələn/ - balloon, /nja/- meow, /papa/- dad, /mama/- mom, /kjaə:/- what	/əmma/-mom, /kəkə/-crow, /kakɛ/-crow, /papa/-papaya, /ɛd̪ɛ/-give	/atʃa:/- dad, /am:a/ - mom, /amma/-mom, /appa/-dad, /amma/-mom, /kaka/-crow, /əmma/- mom, /umma/-mom, /ma:/- mom, /papa/- daddy, /ma/-mom,/papa/- dad, /æma:/-mom, /æ:ppa/-dad

Appendix H

Descriptive statistics of Mean percent (M) and S.D (S.D) for Hindi and Malayalam across the four age groups

Table H1
Comparison of vowels in Hindi

Vowels	Hindi							
	Age range (in months)							
	4:0 to ≤ 6:0 months		>6;0 to ≤ 8:0 months		8;0 to ≤ 10:0 months		>10;0 to ≤ 12:0 months	
N=10	**M**	**S.D**	**M**	**S.D**	**M**	**S.D**	**M**	**S.D**
FRONT VOWELS	42.07	25.38	35.61	26.94	49.09	23.43	56.63	25.30
CENTRAL VOWELS	57.93	25.38	64.39	26.94	50.91	23.43	43.37	25.30
BACK VOWELS	0.56	1.24	0.43	0.94	2.21	2.38	2.72	3.55

Table H2
Comparison of vowels in Malayalam

Vowels	Malayalam							
	Age range (in months)							
	4:0 to ≤ 6:0 months		>6;0 to ≤ 8:0 months		8;0 to ≤ 10:0 months		>10;0 to ≤ 12:0 months	
N=10	**M**	**S.D**	**M**	**S.D**	**M**	**S.D**	**M**	**S.D**
FRONT VOWELS	63.91	26.93	76.33	22.06	67.21	26.37	70.85	21.22
CENTRAL VOWELS	36.09	26.93	23.67	22.06	32.79	26.37	29.15	21.22
BACK VOWELS	1.43	3.55	3.33	10.54	3.04	4.96	4.02	8.63

Table H3

Comparison of diphthongs in Hindi

Diphthongs	Hindi							
	Age range (in months)							
	4:0 to ≤ 6:0 months		>6;0 to ≤ 8:0 months		8;0 to ≤ 10:0 months		>10;0 to ≤ 12:0 months	
N=10	**M**	**S.D**	**M**	**S.D**	**M**	**S.D**	**M**	**S.D**
OD	10.12	15.25	28.53	19.66	18.93	14.48	24.79	20.17
CD	7.21	11.14	8.90	12.35	9.46	18.34	32.70	23.31
HHD	59.39	17.13	53.68	25.91	64.74	24.61	35.54	32.19
CNTD	23.26	18.26	8.89	12.83	6.85	8.67	6.95	9.09

Table H4

Comparison of diphthongs in Malayalam

Diphthongs	Malayalam							
	Age range (in months)							
	4:0 to ≤ 6:0 months		>6;0 to ≤ 8:0 months		8;0 to ≤ 10:0 months		>10;0 to ≤ 12:0 months	
N=10	**M**	**S.D**	**M**	**S.D**	**M**	**S.D**	**M**	**S.D**
OD	36.79	34.06	34.25	34.37	46.35	27.51	31.03	32.74
CD	5.86	8.54	0.96	2.21	1.66	5.27	7.83	7.95
HHD	27.92	28.26	52.04	32.08	46.78	32.38	52.28	32.49
CNTD	29.42	25.07	12.73	11.87	5.19	7.60	8.84	9.24

Table H5

Comparison of place of articulation of consonants in Hindi

Place of Articulation	Hindi							
	Age range (in months)							
	4:0 to ≤ 6:0 months		>6;0 to ≤ 8:0 months		8;0 to ≤ 10:0 months		>10;0 to ≤ 12:0 months	
N=10	**M**	**S.D**	**M**	**S.D**	**M**	**S.D**	**M**	**S.D**
Bilabials	37.64	32.36	34.19	15.83	37.76	31.03	39.15	19.93
Alveolars	4.18	11.79	9.33	13.13	7.57	13.10	1.87	2.20
Velars	12.52	14.55	13.97	15.47	12.38	8.02	3.35	5.11
Glottals	36.73	30.49	21.21	24.20	16.79	16.37	15.93	19.33
Dentals	3.81	4.98	17.41	18.91	20.98	16.11	29.22	14.82
Palatals	5.11	13.98	3.88	8.48	4.53	5.11	10.48	17.61

Table H6

Comparison of place of articulation of consonants in Malayalam

Place of Articulation	Malayalam							
	Age range (in months)							
	4:0 to ≤ 6:0 months		>6;0 to ≤ 8:0 months		8;0 to ≤ 10:0 months		>10;0 to ≤ 12:0 months	
N=10	**M**	**S.D**	**M**	**S.D**	**M**	**S.D**	**M**	**S.D**
Bilabials	42.12	35.21	24.95	17.14	40.32	25.18	33.49	15.30
Alveolars	0.00	0.00	0.64	1.41	3.20	4.69	1.76	2.12
Velars	26.69	30.81	17.90	13.11	8.97	16.49	12.63	20.82
Glottals	31.19	27.75	27.67	21.44	19.41	15.31	13.84	16.14
Dentals	0.00	0.00	18.28	20.27	22.50	14.16	32.43	21.39
Palatals	0.00	0.00	10.56	18.60	5.60	7.05	5.62	7.46

Table H7

Comparison of manner of articulation of consonants in Hindi

Manner of Articulation	Hindi							
	Age range (in months)							
	4:0 to ≤ 6:0 months		>6;0 to ≤ 8:0 months		8;0 to ≤ 10:0 months		>10;0 to ≤ 12:0 months	
N=10	**M**	**S.D**	**M**	**S.D**	**M**	**S.D**	**M**	**S.D**
Stops	31.16	30.43	30.81	16.80	25.00	21.78	20.58	15.86
Nasals	22.81	19.11	35.16	21.72	48.50	21.89	50.41	25.33
Affricates	36.73	30.49	21.21	24.20	16.79	16.37	15.93	19.33
Glottal Fricatives	0.00	0.00	2.25	5.13	1.61	2.69	1.03	2.58
Glides	5.11	13.98	2.19	3.93	5.69	4.67	10.45	16.84
Laterals	0.43	1.37	3.21	10.16	0.00	0.00	0.00	0.00
Trills	3.75	11.86	5.16	10.97	2.41	6.14	1.60	1.85

Table H8

Comparison of manner of articulation of consonants in Malayalam

Manner of Articulation	Malayalam							
	Age range (in months)							
	4:0 to ≤ 6:0 months		>6;0 to ≤ 8:0 months		8;0 to ≤ 10:0 months		>10;0 to ≤ 12:0 months	
N=10	**M**	**S.D**	**M**	**S.D**	**M**	**S.D**	**M**	**S.D**
Stops	25.25	23.20	17.63	14.84	16.25	15.66	14.47	10.51
Nasals	40.13	27.46	42.66	20.60	46.35	26.57	60.83	21.98
Affricates	31.19	27.75	27.67	21.44	19.41	15.31	14.06	16.22
Glottal Fricatives	0.00	0.00	6.73	18.73	0.00	0.00	0.38	1.22
Glides	3.44	10.87	4.67	4.96	14.94	12.13	8.80	9.23
Laterals	0.00	0.00	0.00	0.00	0.00	0.00	0.30	0.96
Trills	0.00	0.00	0.64	1.41	3.05	4.72	1.16	1.54

Table H9

Comparison of voicing of consonants in Hindi

Voicing	Hindi							
	Age range (in months)							
	4:0 to ≤ 6:0 months		>6;0 to ≤ 8:0 months		8;0 to ≤ 10:0 months		>10;0 to ≤ 12:0 months	
N=10	**M**	**S.D**	**M**	**S.D**	**M**	**S.D**	**M**	**S.D**
Voiced	60.62	30.54	69.70	19.30	72.63	17.36	66.83	17.02
Unvoiced	39.38	30.54	30.30	19.30	27.37	17.36	33.17	17.02

Table H10

Comparison of voicing of consonants in Malayalam

Voicing	Malayalam							
	Age range (in months)							
	4:0 to ≤ 6:0 months		>6;0 to ≤ 8:0 months		8;0 to ≤ 10:0 months		>10;0 to ≤ 12:0 months	
N=10	**M**	**S.D**	**M**	**S.D**	**M**	**S.D**	**M**	**S.D**
Voiced	62.70	26.64	58.80	20.74	72.60	18.44	64.83	16.81
Unvoiced	37.30	26.64	41.20	20.74	27.40	18.44	35.17	16.81

Table H11

Comparison of syllable shapes in Hindi

Syllable Shapes	Hindi							
	Age range (in months)							
	4:0 to ≤ 6:0 months		>6;0 to ≤ 8:0 months		8;0 to ≤ 10:0 months		>10;0 to ≤ 12:0 months	
N=10	**M**	**S.D**	**M**	**S.D**	**M**	**S.D**	**M**	**S.D**
CV	49.03	29.47	36.08	15.35	39.71	17.62	52.58	29.14
VC	13.02	14.35	13.34	13.16	10.09	12.36	4.75	7.45
CVC	------	-----	13.34	1.75	1.61	5.10	2.39	4.33
VCV	35.06	29.23	43.71	24.49	42.28	17.52	31.86	28.86
CVV	2.43	4.56)	3.19	3.96	2.84	4.65	6.16	8.23
CCV	0.45	1.43	3.11	3.10	3.45	5.23	2.23	5.43

Table H12
Comparison of syllable shapes in Malayalam

Syllable Shapes	Malayalam – Age range (in months)							
	4:0 to ≤ 6:0 months		**>6;0 to ≤ 8:0 months**		**8;0 to ≤ 10:0 months**		**>10;0 to ≤ 12:0 months**	
N=10	**M**	**S.D**	**M**	**S.D**	**M**	**S.D**	**M**	**S.D**
CV	59.47	19.96	62.80	17.41	52.97	18.38	56.63	14.53
VC	6.43	7.69	4.82	3.86	3.23	5.26	3.12	3.89
CVC	1.59	3.39	0.31	0.99	1.88	4.97	0.76	2.43
VCV	29.12	17.13	28.44	14.59	37.89	17.76	34.72	15.37
CVV	3.01	4.39	2.31	2.85	3.20	3.02	2.43	4.00
CCV	0.34	1.09	1.28	2.85	0.80	1.79	2.30	7.29

Table H13
Comparison of reduplicated and variegated babbles in Hindi

Complex syllables	Hindi – Age range (in months)							
	4:0 to ≤ 6:0 months		**>6;0 to ≤ 8:0 months**		**8;0 to ≤ 10:0 months**		**>10;0 to ≤ 12:0 months**	
N=10	**M**	**S.D**	**M**	**S.D**	**M**	**S.D**	**M**	**S.D**
Reduplicated	85.21	9.61	49.92	27.9	90.37	8.25	81.56	17.2
Variegated	14.78	9.62	50.00	27.95	9.62	8.26	18.43	17.30

Table H14
Comparison of types of variegated babbles in Hindi

Types of variegated babbles	Hindi – Age range (in months)											
	4:0 to ≤ 6:0 months			**>6;0 to ≤ 8:0 months**			**8;0 to ≤ 10:0 months**			**>10;0 to ≤ 12:0 months**		
N=10	**M**	**S.D**	**Mdn**	**M**	**S.D**	**Mdn**	**M**	**S.D**	**Mdn**	**M**	**S.D**	**Mdn**
Place	------	-----	-----	3.17	5.50	0.00	33.33	51.64	0.00	4.98	10.89	0.00
Manner	84.00	35.78	100.00	96.83	5.50	100.00	66.67	51.64	100.00	75.31	24.45	76.22
Voicing	16.00	35.78	0.00	-------	------	-----	-------	-------	-----	19.71	25.22	3.85

Mdn-Median percent

Table H15

Comparison of reduplicated and variegated babbles in Malayalam

Complex syllables	Malayalam							
	Age range (in months)							
	4:0 to ≤ 6:0 months		>6;0 to ≤ 8:0 months		8;0 to ≤ 10:0 months		>10;0 to ≤ 12:0 months	
N=10	M	S.D	M	S.D	M	S.D	M	S.D
Reduplicated	78.62	14.12	82.85	18.35	85.99	6.59	88.31	9.18
Variegated	21.38	14.12	17.15	18.35	14.01	6.59	11.69	9.18

Table H16

Comparison of types of variegated babbles in Malayalam

Types of variegated babbles	Malayalam											
	Age range (in months)											
	4:0 to ≤ 6:0 months			>6;0 to ≤ 8:0 months			8;0 to ≤ 10:0 months			>10;0 to ≤ 12:0 months		
N=10	M	S.D	Mdn	M	S.D	Mdn	M	S.D	Mdn	M	S.D	Mdn
Place	11.11	19.25	0.00	0.83	2.64	0.00	18.18	36.69	0.00	18.75	35.63	0.00
Manner	88.89	19.25	100.00	79.17	41.81	100.00	73.78	36.39	92.86	66.25	47.49	100.00
Voicing	------	------	------	20.00	42.16	0.00	8.04	17.68	0.00	15.00	27.77	0.00

Mdn-Median percent

Table H17

Comparison of early words in Hindi

Early words	Hindi							
	Age range (in months)							
	4:0 to ≤ 6:0 months		>6;0 to ≤ 8:0 months		8;0 to ≤ 10:0 months		>10;0 to ≤ 12:0 months	
N=10	M	S.D	M	S.D	M	S.D	M	S.D
Protowords	-----	-----	-----	-----	30.00	48.30	38.02	42.75
Truewords	-----	-----	-----	-----	-----	-----	31.98	40.33

Table H18
Comparison of early words in Malayalam

Early words	Malayalam							
	Age range (in months)							
	4:0 to ≤ 6:0 months		>6;0 to ≤ 8:0 months		8;0 to ≤ 10:0 months		>10;0 to ≤ 12:0 months	
N=10	**M**	**S.D**	**M**	**S.D**	**M**	**S.D**	**M**	**S.D**
Protowords	-----	-----	-----	-----	-----	-----	15.95	26.32
Truewords	-----	-----	-----	-----	-----	-----	84.04	26.32

Appendix I

Mann-Whitney test results for gender comparisons of phonetic repertoire in Hindi and Malayalam learning groups

Table I1
Gender comparison of vowels in Hindi

Vowels	4:0 to ≤ 6:0 months		>6;0 to ≤ 8:0 months		8;0 to ≤ 10:0 months		>10;0 to ≤ 12:0 months	
	|Z|	p	|Z|	p	|Z|	p	|Z|	p
/e/	0.636	.525	0.419	.675	0.522	.602	1.156	.248
/e:/	0.106	.916	1.149	.251	1.163	.245	0.841	.401
/æ/	0.731	.465	1.163	.245	0.106	.916	1.509	.131
/æ:/	1.358	.175	0.539	.590	0.952	.341	0.629	.530
/ə/	1.257	.209	0.940	.347	1.362	.173	0.525	.599
/ə:/	0.731	.465	0.104	.917	0.733	.463	0.419	.675
/a/	0.525	.599	0.314	.753	1.803	.071	0.420	.674
/a:/	0.643	.521	0.149	.881	1.078	.281	0.235	.814

* Significant at $p < .05$

Table I2
Gender comparison of vowels in Malayalam

Vowels	4:0 to ≤ 6:0 months		>6;0 to ≤ 8:0 months		8;0 to ≤ 10:0 months		>10;0 to ≤ 12:0 months	
	|Z|	p	|Z|	p	|Z|	p	|Z|	p
/e/	0.952	.341	1.302	.086	0.313	.754	0.104	.917
/e:/	1.048	.295	0.629	.530	0.522	.602	1.257	.209
/æ/	0.943	.346	1.567	.117	0.419	.675	1.048	.295
/æ:/	1.567	.117	1.567	.117	0.315	.753	0.629	.530
/ə/	0.524	.600	1.530	.126	0.780	.435	1.003	.316
/ə:/	0.740	.459	1.375	.169	0.000	1.000	0.104	.917
/a/	1.003	.316	1.584	.077	1.379	.168	0.780	.435
/a:/	0.529	.597	0.780	.435	0.530	.596	1.117	.134

* Significant at $p < .05$

Table I3

Comparison of diphthongs across gender in Hindi

Types of diphthongs	4:0 to ≤ 6:0 months		>6;0 to ≤ 8:0 months		8;0 to ≤ 10:0 months		>10;0 to ≤ 12:0 months	
	|Z|	p	|Z|	p	|Z|	p	|Z|	p
OD	1.530	.126	0.524	.600	0.943	.346	0.210	.834
CD	1.003	.316	0.471	.638	1.894	.058	1.149	.251
HHD	0.313	.754	0.105	.917	1.786	.074	0.841	.401
CNTD	1.627	.119	0.334	.738	1.293	.196	0.783	.434

* Significant at $p < .05$

Table I4

Comparison of diphthongs across gender in Malayalam

Types of diphthongs	4:0 to ≤ 6:0 months		>6;0 to ≤ 8:0 months		8;0 to ≤ 10:0 months		>10;0 to ≤ 12:0 months	
	|Z|	p	|Z|	p	|Z|	p	|Z|	p
OD	1.091	.247	1.152	.249	1.676	.094	1.107	.268
CD	1.059	.290	0.149	.881	1.000	.317	1.023	.306
HHD	1.798	.072	1.149	.251	1.776	.076	0.735	.462
CNTD	0.000	1.000	0.740	.459	1.294	.196	1.023	.306

* Significant at $p < .05$

Table I5

Comparison of consonants across gender in Hindi

Consonants	4:0 to ≤ 6:0 months		>6;0 to ≤ 8:0 months		8;0 to ≤ 10:0 months		>10;0 to ≤ 12:0 months	
	|Z|	p	|Z|	p	|Z|	p	|Z|	p
[m]	1.997	.046	0.104	.917	1.257	.209	0.940	.347
[p]	1.491	.136	0.000	1.000	0.647	.518	0.323	.746
[b]	0.149	.881	2.227	.026	1.149	.251	0.862	.389
[w]	0.000	1.000	1.000	.317	0.235	.814	0.386	.700
[ṭ]	0.000	1.000	0.000	1.000	1.000	.317	1.000	.317
[ḍ]	0.000	1.000	0.386	.700	0.149	.881	0.000	1.000
[k]	0.643	.521	0.894	.371	0.386	.700	1.000	.317
[g]	0.780	.435	1.273	.203	1.048	.295	0.386	.700
[h]	0.629	.530	0.647	.518	0.731	.465	0.313	.754
[d̪]	2.353	.019	0.780	.435	2.095	.036	1.571	.116
[t̪]	1.000	.317	0.149	.881	0.106	.916	0.940	.347
[n]	0.000	1.000	1.928	.054	1.000	.317	0.149	.881
[ʧ]	0.000	1.000	1.000	.317	0.000	1.000	1.000	.317
[ʤ]	0.000	1.000	1.491	.136	1.181	.238	1.000	.317
[j]	0.149	.881	0.149	.881	1.894	.058	0.106	.916
[r]	1.000	.317	1.000	.317	0.000	1.000	0.000	1.000
[ḷ]	1.000	.317	1.491	.136	1.491	.136	1.226	.220
[ŋ]	0.000	1.000	1.000	.317	0.000	1.000	1.000	.317
[ʃ]	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000

* Significant at $p < .05$

Table I6

Comparison of consonants across gender in Malayalam

Consonants	4:0 to ≤ 6:0 months		>6;0 to ≤ 8:0 months		8;0 to ≤ 10:0 months		>10;0 to ≤ 12:0 months	
	|Z|	p	|Z|	p	|Z|	p	|Z|	p
[m]	0.313	.754	0.731	.465	0.522	.602	1.149	.251
[p]	0.000	1.000	0.111	.911	0.111	.911	0.780	.435
[b]	2.785	.005	1.894	.058	0.838	.402	0.522	.602
[w]	1.000	.317	0.149	.881	1.798	.072	0.111	.911
[ṭ]	0.000	1.000	0.000	1.000	1.000	.317	0.000	1.000
[ḍ]	0.000	1.000	0.000	1.000	0.000	1.000	1.000	.317
[k]	0.149	.881	0.471	.638	0.149	.881	0.647	.518
[g]	1.273	.203	0.317	.751	0.334	.738	1.928	.054
[h]	0.970	.332	1.257	.209	0.000	1.000	0.629	.530
[d̪]	0.000	1.000	0.108	.914	0.952	.341	0.313	.754
[t̪]	0.000	1.000	1.226	.220	0.780	.435	1.362	.173
[n]	0.000	1.000	0.000	1.000	2.353	.019	1.491	.136
[ʧ]	0.000	1.000	1.000	.317	0.000	1.000	1.000	.317
[ʤ]	0.000	1.000	0.149	.881	0.000	1.000	0.000	1.000
[j]	0.000	1.000	1.671	.095	0.431	.666	0.557	.577
[r]	0.000	1.000	0.000	1.000	0.000	1.000	1.000	.317
[ḷ]	0.000	1.000	1.491	.136	1.059	290	2.353	.019
[ŋ]	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
[ʃ]	0.000	1.000	0.000	1.000	0.000	1.000	1.000	.317

* Significant at $p < .05$

Table I7

Comparison of syllable shapes across gender in Hindi

Syllable shapes	4:0 to ≤ 6:0 months		>6;0 to ≤ 8:0 months		8;0 to ≤ 10:0 months		>10;0 to ≤ 12:0 months	
	|Z|	p	|Z|	p	|Z|	p	|Z|	p
CV	1.886	.059	0.940	.347	0.522	.602	1.149	.251
VC	1.379	.168	0.524	.600	0.525	.599	0.000	1.000
CVC	0.000	1.000	1.000	.317	1.000	.317	0.643	.521
VCV	1.402	.198	0.731	.465	0.940	.347	0.841	.401
CVV	1.928	.054	0.111	.911	1.003	.316	0.108	.914
CCV	1.000	.317	1.448	.147	1.059	.290	0.900	.368

* Significant at $p < .05$

Table I8

Comparison of syllable shapes across gender in Malayalam

Syllable shapes	4:0 to ≤ 6:0 months		>6;0 to ≤ 8:0 months		8;0 to ≤ 10:0 months		>10;0 to ≤ 12:0 months	
	|Z|	p	|Z|	p	|Z|	p	|Z|	p
CV	1.362	.173	1.776	.076	0.943	.346	1.402	.116
VC	0.431	.666	1.379	.168	0.471	.638	0.780	.435
CVC	1.491	.136	1.000	.317	1.491	.136	1.000	.317
VCV	1.358	.175	1.149	.251	0.733	.463	1.776	.076
CVV	0.824	.410	0.557	.577	1.509	.131	1.059	.290
CCV	1.000	.317	1.491	.136	0.149	.881	1.000	.317

* Significant at $p < .05$

Table I9

Comparison of reduplicated and variegated utterances across gender in Hindi

Complex utterance	4:0 to ≤ 6:0 months		>6;0 to ≤ 8:0 months		8;0 to ≤ 10:0 months		>10;0 to ≤ 12:0 months	
	|Z|	p	|Z|	p	|Z|	p	|Z|	p
Reduplicated	1.448	.147	1.789	.060	1.078	.281	0.314	.753
Variegated	1.894	.058	1.789	.060	1.078	.281	1.781	.075

* Significant at $p < .05$

Table I9.1

Comparison of variegated types of utterances across gender in Hindi

Variegated types of utterance	4:0 to ≤ 6:0 months		>6;0 to ≤ 8:0 months		8;0 to ≤ 10:0 months		>10;0 to ≤ 12:0 months	
	|Z|	p	|Z|	p	|Z|	p	|Z|	p
Place variegation	0.000	1.000	1.000	.317	1.500	.134	1.491	.136
Manner variegation	1.617	.106	1.736	.066	0.000	1.000	1.611	.107
Voicing variegation	1.000	.317	0.000	1.000	0.000	1.000	0.239	.811

* Significant at $p < .05$

Table I10

Comparison of reduplicated and variegated utterances across gender in Malayalam

Complex utterance	4:0 to ≤ 6:0 months		>6;0 to ≤ 8:0 months		8;0 to ≤ 10:0 months		>10;0 to ≤ 12:0 months	
	|Z|	p	|Z|	p	|Z|	p	|Z|	p
Reduplicated	1.928	.054	0.104	.917	1.048	.295	0.943	.346
Variegated	1.928	.054	1.149	.251	1.048	.295	1.152	.249

* Significant at $p < .05$

Table I10.1

Comparison of variegated types of utterances across gender in Malayalam

Variegated types of utterance	4:0 to ≤ 6:0 months		>6;0 to ≤ 8:0 months		8;0 to ≤ 10:0 months		>10;0 to ≤ 12:0 months	
	|Z|	p	|Z|	p	|Z|	p	|Z|	p
Place variegation	1.000	.317	1.000	.317	1.491	.136	0.386	.700
Manner variegation	1.736	.066	1.736	.066	1.856	.063	0.924	.356
Voicing variegation	.000	1.000	1.500	.134	1.491	.136	1.500	.134

* Significant at $p < .05$

Table I11

Comparison of protowords and truewords across gender in Hindi

Early words	**4:0 to ≤ 6:0 months**		**>6;0 to ≤ 8:0 months**		**8;0 to ≤ 10:0 months**		**>10;0 to ≤ 12:0 months**	
	|Z|	**p**	|Z|	**p**	|Z|	**p**	|Z|	**p**
Protowords	0.000	1.000	1.000	.317	0.655	.513	1.006	.314
Truewords	0.000	1.000	1.491	.136	0.000	1.000	0.447	.655

* Significant at $p < .05$

Table I12

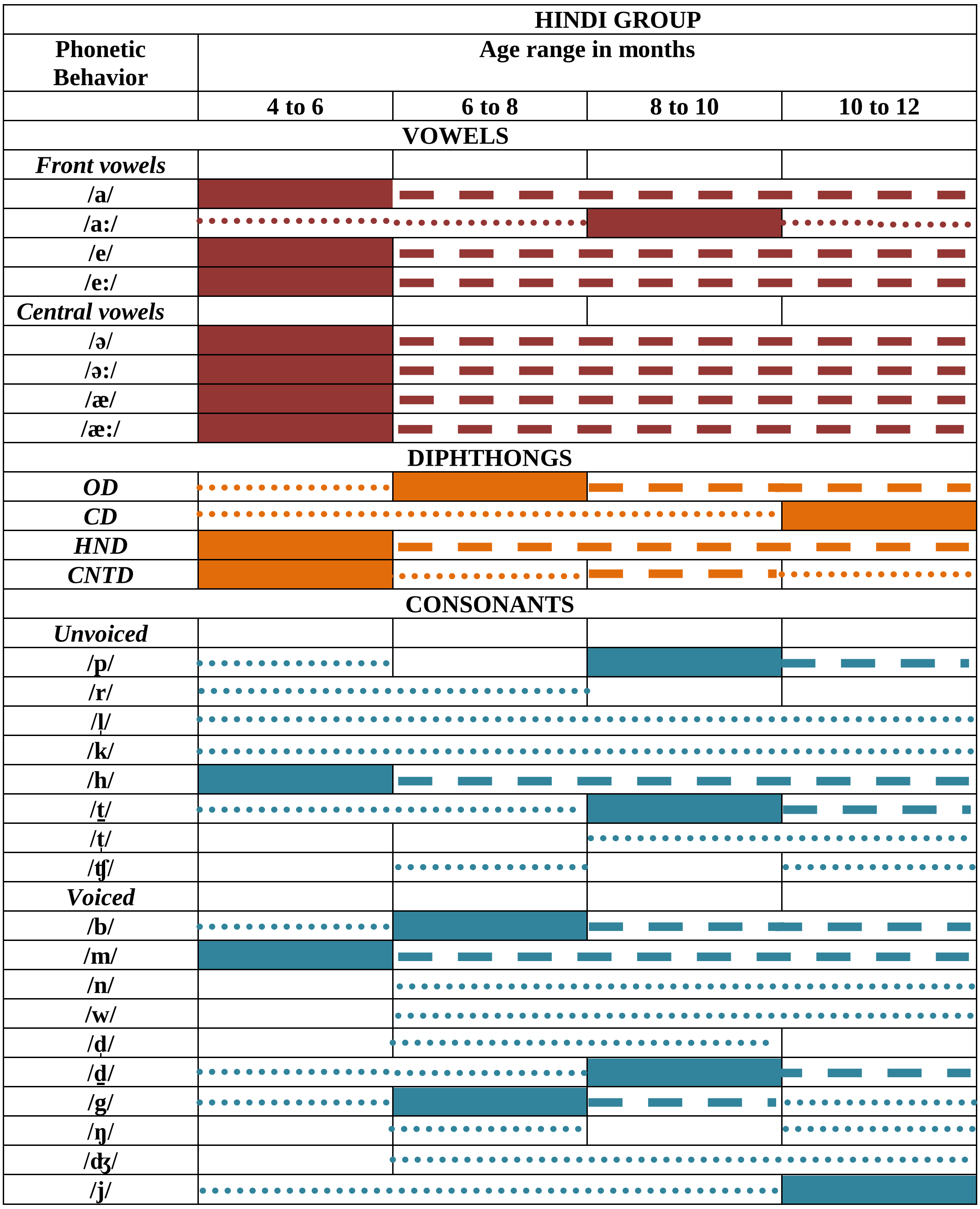
Comparison of protowords and truewords across gender in Malayalam

Early words	**4:0 to ≤ 6:0 months**		**>6;0 to ≤ 8:0 months**		**8;0 to ≤ 10:0 months**		**>10;0 to ≤ 12:0 months**	
	|Z|	**p**	|Z|	**p**	|Z|	**p**	|Z|	**p**
Protowords	0.000	1.000	0.000	1.000	0.149	.881	0.386	.700
Truewords	0.000	1.000	0.000	1.000	1.491	.136	0.386	.700

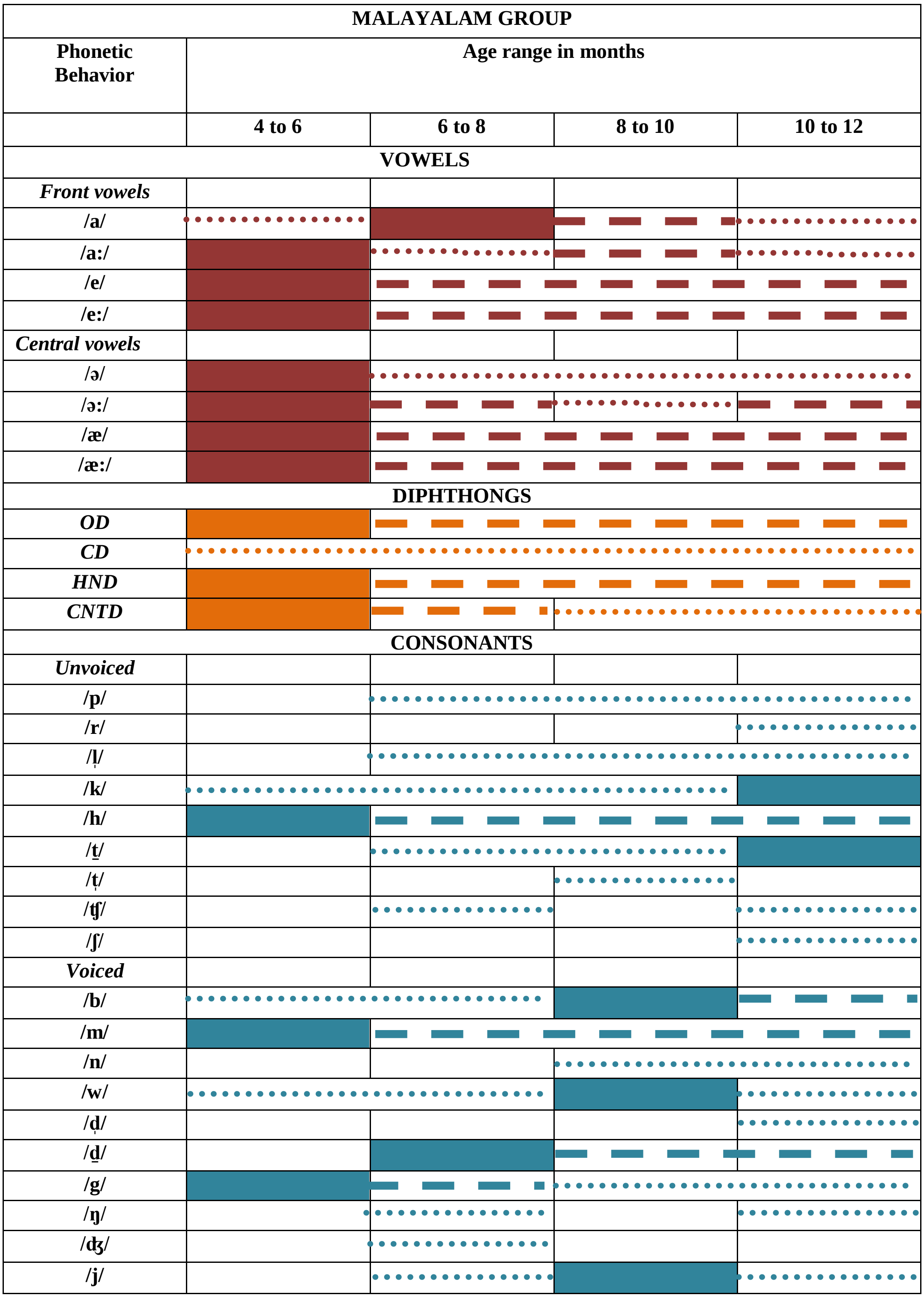
* Significant at $p < .05$

Appendix J

Order of emerging phonetic behavior in Hindi group



Note: Norms are based on 60% criteria (i.e 6 out of 10 participants in each of the 4 age groups) to indicate the phonetic behavior as emerging in both Hindi and Malayalam.



Filled box - Phonetic behavior emerged (produced by 60% or more participants); Phonetic behavior continuing to be present for 60% or more of the participants; Phonetic behavior present for less than 60% of the participants; blank not present.

Publications

Emergence of Syllabic Patterns in Babbling

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Abstract

Acquisition of speech sounds during child's development refers to the gradual mastery of speech sounds within a given language. During the initial stages of the infant's life, the vocalizations produced are highly varied from the well formed adult speech. The study aims to investigate the appearances of speech patterns during early vocalizations at the pre linguistic period. The participants included in the study comprise of 8 infants, two boys and two girls each in the age range 4-6months and 10-12months. The participants were selected from native Malayalam speaking families. An informed consent was obtained from parents/ caregivers for the participation of the children. The researcher carried out the audio recording of the babbling utterances. Analyses of the sample were carried out using IPA transcriptions. The data obtained was classified as singleton vowels and consonants, bisyllabic and multisyllabic utterances containing strings of vowels, variegated and reduplicated multisyllabic utterances. The numbers of utterances were higher and varied in the 10-12 month age group compared to 4-6 month age group. Statistical significance was not attained because of the large variations among the individual participants.

Keywords: Babbling**,** Syllable shapes, ambient language

Introduction

The study of human infant vocal behaviour has grown substantially in recent years and much is now known about the acquisition of speech and language in the early years of life. According to this theoretical notion, babbling is a random series of vocalizations in which many different sounds are produced with no apparent order or consistency. On the emergence of syllable shapes on early vocal utterances, infants begin to utter longer patterns of speech sounds as they grow. Reduplication of CV syllables occurs initially during the babbling stages. At the later stages of babbling, around 10-12 months, combination of speech sound patterns become elaborate and variegated.

A Brief Review

Onset of babbling is distinct with the appearance of syllabic productions with varied combinations of vowels and consonants. In a typical utterance, consonants and vowels rarely appear in isolation but are produced serially. Acoustic studies of early babbling have provided support for the idea of a predominance of mandibular over lingual movement in early canonical babbling (McNielage & Davis, 1995).

The combination of consonant-and vowel-like sounds is said to begin during 4 to 6 months. During the later babbling period, open syllables or syllables ending in a vowel are the most frequently occurring syllable shapes (Bauman-Waengler, 2000). Kent and Bauer's (1985) study revealed that V, CV, VCV and CVCV syllable structures accounted for approximately 94% of all the syllables produced at the end of babbling period. They also emphasized that closed syllables were found to be very limited in the repertoire of the infant at this stage of development.

Rank ordering of multiple syllable structures were also carried out, Stoel-Gammon's (1989) study with ten infants at four month intervals from 6-18 months of age showed the following rank orderings: reduplication, place variegation, and manner variegation at 6-9 and 10-13 months; place variegation, manner variegation and reduplication at 14-17 months. Whereas, Mitchell and Kent (1990) found multi syllables in rank order as reduplication, manner changes, mixed place and manner changes and lastly place changes at 7, 9, and 11 months.

Researchers have supported the fact that babbling is a predictor of language complexity as well as an indicator of language delay. Number of studies has indicated a correlation between complexity and amount of babbling with later language proficiency (Camp, Burgess, Morgan, & Zerbe, 1987; Stoel- Gammon, 1989; Whitehurst, Smith, Fischel, Arnold, & Lonigan, 1991; Thal, Oroz, & McCaw, 1995; Mirak & Rescorla, 1998).

Reduced/delayed babbling or an abnormal vocalization development might be related to an abnormal spoken language development. Jensen, Boggild-Andersen, Schmidt, Ankerhus and Hansen (1988) studied the development of infants who were at risk for a developmental delay (low birth weight, low Apgar score, neonatal cerebral symptoms) and compared them to infants not at risk. The infants at risk produced significantly fewer consonant-like segments and less reduplicated babbling than children not at risk. A larger proportion of the children at risk also scored below age level on a language test. Hence, Oller, Eilers, Neal and Cobo-Lewis (1998) argue that a late babbling onset might possibly function as an early marker of abnormal development. Westermann and Miranda (2004) support these findings by indicating there is growing evidence that the pre-linguistic stage significantly influences the later development of phonological skills in children. The review of literature suggests that babbling is a predictor of later language complexity as well as language delay.

Indian Studies

There are limited reported studies in the Indian context on the emergence of syllabic productions in the early phonetic repertoire other than Kannada. It is an established fact that early vocalizations have an effect of the adult ambient language (De Boysson –Bardies et., al 1989; Mattock, Rvachew, Alhaidary & Polka, 2008). India being a multilingual country, there is a need to study the emergence of early syllabic productions in other major Indian languages also. There is no reported literature on the phonetic characteristics of babbling in Malayalam hence the present study was taken up. The purpose of the study was to determine the patterns of syllabic productions in babbling for infants from Malayalam babbling families.

In the Indian context, a cross linguistic study in Hindi and Kannada was carried out by Shyamala and Basanti (2003). They reported that five vowels /i/, /e/, /a/, /u/ and /o/ in Kannada made their appearance during 6-12 months. In Hindi, only four vowels (/i/, /e/, /a/ and /u/) including their longer counterparts were seen. For consonants, the Kannada group had twelve consonants in their phonetic repertoire with higher frequency of stops and nasals. However, the Hindi group had fifteen consonants with additional sounds /t/, /s/ and /r/. The differences in phonetic repertoire across languages, as early as in the babbling stage were evident in this study. However, the syllable shapes were not studied in detail.

In Kannada, the predominant syllable shapes on 30 babbling infants, found by Anjana and Sreedevi (2008) were V, C, CV, CVC, VC and VCV. The singleton vowel utterances were more frequent in the younger age group and declined from 9-10 months. CV patterns were highest in 6-7 month age group and closed syllables like VC and CVC occurrences were rare across all the age groups; VCV syllables predominated in the higher age group, associating with the fact that open ended syllables are frequent in Kannada (Hiremath, 1980). Reduplicated babbles were predominant from the age of 6-9 months. The variegated babbles made their first appearance at 8-9 months. In the 10-11 month group, for multi syllable productions place variations occurred more frequently. A combination of place and manner variations occurred more frequently in 11-12 month age group. The differences in these findings with other languages like English (Stoel-Gammon, 1989; Mitchell & Kent 1990) which has predominant manner variations is because of the differences in the linguistic structure of the two languages.

Method

Participants and Inclusion criteria

Eight typically developing infants were audio recorded from native Malayalam speaking families, two boys and two girls at 4-6 months and at 10-12 months. Malayalam belongs to the Dravidian family of four major languages with a rich literacy tradition.

According to 2011 census, Malayalam is spoken by 33,066,392 people, primarily in the state of Kerala. http://www.lmp.ucla.eduAn informed consent was obtained from the caretakers/ parents for the participation of the children in the study. Care was taken to ensure that the participants had normal development and had not been exposed to any other languages. Participants were identified from native Malayalam speaking families and were assessed using the Developmental Screening Checklist (Swapna, Jayaram, Prema, & Geetha, 2010) for receptive and expressive communication skills, auditory, motor and cognitive skills. It was mandatory that both the parents were educated up to a minimum of 10th grade. The proficiency of the native language of the parents was assessed using the Language Proficiency Questionnaire: An adaptation of LEAP-Q in the Indian context by Ramya Maitreyee and Goswami (2009).

Measures Considered in the Study

Based on transcription of the babbling data, the types and frequency of syllable shapes and the frequency of reduplicated and variegated utterances were calculated.

Procedure: Audio recordings were carried out by the investigator in a fairly quiet room with minimal distractions at the respective homes of the participants. Vocalization samples were recorded when the child was fed and in a comfort state. Parents were asked to interact naturally with the child. No additional play materials were introduced into the environment to capture the infants' typical vocalizations in familiar surroundings. The infant was stimulated more with toys and facial expressions than verbal utterances to avoid verbal imitation. Sony M55 audio recorder was utilized for recording each participant's vocalizations. All the recordings were transferred to a computer and were analyzed using the VLC media player software.

Data analysis: The recorded samples were transcribed by the primary investigator using broad and narrow International Phonetic Alphabet (2005). Sounds such as grunts, gurgles, laughs, shrieks and whisper, etc. were excluded from transcription. A criterion for the transcribed sample was utilized, to consider a phone/ syllable to be present in the infants' vocalizations. It is known that the complexity and frequency of vocal utterances will increase with age. Hence even a one-time production of a vowel/consonant/syllable shape was considered as to be present in the infants' productions at 4-6 months whereas three or more productions of a vowel/consonant/syllable shape was considered to be present in the infants' productions at 10-12 months. After identifying the phones/ syllables, the types of syllable shapes and their frequency of occurrence were calculated. Later the syllable shapes were rank ordered in an ascending order. From the multisyllabic utterances, reduplicated and variegated babbling utterances were identified and their frequency of occurrence was obtained. Inter and intra transcriber reliability was calculated for 10% sample of each participant. Cronbach's alpha co-efficient for inter and intra transcriber reliability was 0.8 for 10% of the sample analyzed for each individual participant.

Results and Discussion

The aim of the current study was to determine the patterns of syllabic productions in babbling of infants from native Malayalam speaking families. The measures considered in the study were the types and the frequency of syllable shapes and the frequency of reduplicated and variegated utterances. From the transcribed samples, the number and type of syllable patterns for the age groups 4-6 months and 10-12 months age groups were obtained and are depicted in Table 1.

Table 1

Number and frequency of various syllable shapes across the two age groups

SYLLABIC PATTERNS	AGE GROUPS	
	4-6 MONTHS	10-12 MONTHS
Singleton Vowels	9	9
Singleton Consonants	-	2
Dipthongs (VV)	12	6
CV	12	26
VC	2	1
CVC	2	-
VCV	11	18
CVV	-	6
VVV	2	4
CVCV	-	14
VCCV	2	-
String of vowels (> 3)	-	3
String of consonants (nasalized bilabials)	-	4
Multisyllables (> 4 phonemes)	-	40
Reduplicated utterances	-	18
Variegated utterances	-	22

'-' indicates not present.

Table 1 shows the syllabic patterns produced by the participants in both the age groups. The singleton vowel types were /a/, /æ/, /æ: /, /ə/, /ə:/ /ɛ/and /ɛ:/ which were predominantly present in both the age groups. All the vowels seen in the study were low vowels which can be related to the acoustic studies of early babbling which have provided support for the idea of a predominance of mandibular over lingual movement in early canonical babbling (McNielage & Davis, 1995). Singleton consonants were /m/ and /mm: / which were consistently produced by the 10-12 month age group.

Dipthongs were frequent in the 4-6 month age group but decreased to half its frequency in at 10-12 months. The CV syllable structures were significantly higher in the 10-12 month age group compared to the 4-6 month age group. The VC structures were limited in occurrence in both the age groups. CVC pattern was present in the 4-6 month age group but did not make its appearance at 10-12 months indicating a preference for open syllable utterances. This finding is similar to the study by Anjana and Sreedevi (2008) in which the CVC syllables were present from 6-9 months, but were not seen during 10-12 months.

The VCV syllabic structures were frequently produced by both the age groups. The VVV structure increased to almost twice the number in frequency in the 10-12 month age group. These findings correlated with earlier studies (Bauman-Waengler, 2000; Anjana & Sreedevi , 2008) that during the later babbling period, open syllables or syllables ending in a vowel are the most frequently occurring syllable shapes. The findings are also similar to Kent and Bauer's (1985) study which emphasized that closed syllables were found to be very limited in the repertoire of the infant at this stage of development.

Multisyllables CVCV, VCCV, strings of vowels (greater than three), strings of consonants (greater than three) increased in frequency at 10-12 months compared to the 4-6 month age group which had a predominance of VCCV syllabic production. In the present study, as expected at 4-6 months, reduplicated and variegated utterances were not present. However, in the 10-12 month period both type of utterances were present with higher frequency of occurrence of reduplicated babbling which is in consonance with Anjana and Sreedevi (2008).

To summarise, the results suggest no significant difference between boys and girls across both the age groups 4-6 months and 10-12 months. The study also shows the predominant production of VCV structure in the early pre- linguistic period in

Malayalam. As age increases it is observed that there is a high production of multisyllabic patterns that reflect the ambient language of the adult (Anjana & Sreedevi, 2008; De Boysson –Bardies et.,al 1989; Mattock, Rvachew, Alhaidary & Polka, 2008). Less number of participants was taken up in the study which indicated a major statistical drawback; hence the paper does not reveal any statistical procedure. However, for future research, the study could utilize a larger sample size for which a wider variety of production patterns could be obtained and appropriate statistical procedures could be incorporated.

The study would augment the understanding of phonological development during the pre- linguistic period in Malayalam. There is limited number of studies on the emergence of syllabic patterns in early infancy in Indian languages. This is one of the first attempts to investigate the emergence of syllabic patterns in Malayalam, one of the major Dravidian languages in the Indian subcontinent. The findings obtained will be vastly relevant in clinical practices of communication disorders.

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Nature of vowels and diphthongs in babbling of Malayalam infants

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Abstract

The recent study of human infant vocal behaviour has shown an influence of the ambient language on the early stages of vocalizations (Oller, 2000). The influence of the ambient language has a certain subset of vocalizations of which can be produced with their vocal tract (MacNeilage & Davis, 2001). In this context, it is quite essential to gain insights into the vocal tract articulatory dimensions of infants. This would suggest some developmental check that may shape speech acquisition. Present paper is focussed on the appearances of vowels and diphthongs during early exploration period of babbling extending till 12 months of age in infants of native Malayalam speaking families. The participants comprised of 20 infants, 5 girls each in the age range 4 to 12 months from native Malayalam (A Dravidian language spoken in Southwest of India) speaking families. The audio recorded babbling data of the participants were analysed using IPA (2005) to obtain the frequency and type of vowel and diphthong utterances. Vowels were classified according to tongue height and tongue advancement dimensions. Diphthongs were classified according to the degree of opening or/and closing positions. On statistical analysis, results for tongue height and tongue advancement dimensions, the frequency of occurrence was high for mid front vowels followed by low centre vowels and least for high back vowels. Overall results indicated a reduction in the singleton vowels and diphthongs in infants of older age range indicating emergence of more complex syllabic patterns and word forms in them. These findings on normal phonological development would be highly relevant for clinical practice in the area of communication disorders in young infants.

Keywords Diphthongs, Early vocal production, Malayalam, Tongue advancement, Tongue height, Vowels

1. Introduction

The patterns of infant vocalizations in the recent years have increasingly gained attention. Much is now known about the acquisition of speech and language in the early years of life. The appearances of vowels and consonants in infant phonetic repertoire have known to be universal in almost all the world's languages (Jacobson, 1968). Research has supported the influence of the ambient language environment on the child's later language development. Such exposure has been known to have moulded the patterns of babbling into true words of the target language. Canonical

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babbling is a random series of vocalizations in which many different sounds are produced with no apparent order or consistency.

Canonical babbling is defined as rhythmic alterations between consonant and vowel- like properties, giving a percept of rhythmic speech that simulates adult output without conveying meaning (Davis & MacNeilage, 1995; Oller, 2000). Longitudinal studies on canonical babbling to first words have shown continuity (Oller, 1980; Stark, 1980; Stoel-Gammon & Cooper, 1984; Vihman, Ferguson & Elbert, 1986). This continuity supports babbling to first words as benchmarks for a child's mastery of the ambient language. Research has shown that Consonant-Vowel interactions are present in the early phonetic repertoire (Stoel- Gammon, 1983; Davis & MacNeilage, 1990; Tyler, 1996). Vowels and diphthongs may provide additional insights to the issue of universal patterns of development. These patterns obtained during babbling could provide a retrospective view into Khul's native language magnetic model (Khul & Meltzoff, 1996). Khul's theory suggests that native language skills improve towards the end of the first years of life showing a continuity between early phonetic measures and later language skills.

Diphthongs do play a vital role in phonological development. Lindau, Norlin and Svantesson (1985) found that diphthongs occur in approximately one-third of the world's languages. Ling (1989) stated that diphthongs frequently occur in children's early words. Ingram's (1997) hypothesis suggest that diphthongs with least featural complexity (i.e least difference between the two constituent vowels) will be acquired first. It is assumed that children will have to "mark" the difference between the two constituent diphthong vowels in their underlying representation. Therefore, according to the generative phonology, it is suggested that children acquire unmarked features before marked ones and the phoneme with the least featural complexity (least marked features) would be acquired first (Ingram,1997).

Early phonetic behaviors on vowel patterns were studied using spectral analysis. De Boysson-Bardies, De Halle, Sagart, & Durand (1989) performed spectral analysis using formant measurements for vowels on 10 month old preverbal infants' drawn from four linguistic communities-Arabic, Chinese, English, and French, found that the categories of front-low and mid-central vowels accounted for the vast majority of vowels from all four groups. Acoustic analysis revealed characteristic patterns of vowel production for each group within those limits, with more high-front vowels for English, and more low-back vowels for Chinese. The investigators interpreted these differences in vowel production to show that infants begin to position their lips and tongue in a manner specific to the language of their environment even before they produce word-forms modeled on adult speech. Acoustic studies of early babbling have provided support for the idea of a predominance of mandibular over lingual movement in early canonical babbling (McNielage & Davis, 1995).

Variability in vowel and consonant patterns has been reported in both longitudinal and cross sectional studies as well. Davis and Mac Neilage's (1995) longitudinal study with 6 infants (3 males, 3 females) from monolingual English-speaking homes revealed much individual variability in the use of vowels. According to the tongue height dimension, mid vowels, particularly [^, Y and E], predominated in 3 subjects, while high vowels, particularly [u, Y and I], predominated in the remaining 3 subjects. In relation to tongue advancement, front vowels, particularly [E, Θ and I], predominated in 4 subjects, and the mid vowels [a, ^, ə], predominated in the remaining 2 subjects. The most commonly used vowels in the canonical babbling period were identified as [^, ə, E, ɛ, Y, I and Θ].

Similarly, another cross-sectional study by Anjana and Sreedevi (2008) was carried out in Kannada from 6 months to 12 months of age with an age interval of one month . They found that vowel repertoire [I, e, æ, a, u, o] showed variability across age groups. Vowel [i] made more frequent appearances in all the six age groups compared to the other front vowels [e] and [ae]. The central vowel [a] made predominant appearance across all age groups. The back vowels [u] and [o] were lower in their frequency of appearance in all the age groups.

A longitudinal study by Sreedevi and Jyoti (2012) was conducted in Kannada. They observed seven vowels [I, e, æ, a, u, o, ɔ] which were highly variable in frequency across the nine participants. Vowel data showed that the appearance of low vowels dominated from 3 - 12 months which were followed by mid vowels.
Vowels from the lower left quadrant of the vowel space such as mid and low front and central vowels are most often observed during early phonological development at 10-18 months (Bhur, 1980; Lieberman, 1980; Bickly, 1983; Kent & Bauer, 1985; Davis & Mac Neilage, 1990; Stoel- Gammon & Harrington, 1990). Davis et al., (1990) suggests the low to mid front and front to central vowel productions as " pure dynamics". Tse (1991) found that his subject acquired longer vowels [ɛ, a, i] at an earlier age. of 14 to 36 months for Cantonese. He found maximally contrasted vowels /i/ and /a/ to be acquired first. According to Jacobson's (1968/1941) prediction front –rounded vowels do not appear before unrounded vowels during the early mastery of vowels. Wong (2001) found that coronal vowels were produced in the earliest age period of 10-15 months, this finding is supported by Bhur's study (1980) that claimed the musculature of lips, jaw and frontal portion of the tongue develop at a faster rate compared to the lowering of the larynx and rear portion of the tongue. Height dimensions in vowels are easily attained by mandibular movements at 10-15 months (Matyear 1997) and for backness Bhur (1980) the rear portion of the oral cavity develops at a slower rate; hence the coronal and dorsal contrasts develop at a later stage of the phonological development at around 24-27months. However, the present study investigates the nature of singleton vowels in the early pre-linguistic period of 4 to 12 months. . The patterns observed in the above studies relate much to the emergence of vowels and consonants and not on the nature of diphthongs.

It has been proposed that learning from the ambient language influences and shape vocalizations in late babbling periods. Appearances of the ambient language in the infants early vocalizations has been examined for utterance and syllabic structures (Boysson- Bardies, 1993; Kopkalli- Yavuz & Topbac, 2000) and Vowel repertoire (Boysson- Bardies, Halle, Sagart & Durand, 1989 and 1992). Levitt & Utman (1992) compared one French and one English learning infant. The French infant favoured front low vowels and the English infant preferred mid central vowels, consistent in their ambient languages. Khul's native language magnet (NLM) model encompasses infant vocalizations. It is hypothesized that infants listening to the ambient language store perceptually derived representations of speech sounds they hear which in turn serve as a target for production (Khul & Metzloff,1996). Therefore, it is expected that the phoneme in a child increases when the frequency of occurrence of that phoneme is high with the ambient language. The high front vowels are frequent in English (Bernhardt & Stamberger, 1998), so they are acquired first. By contrary, vowels [u], is the least frequent in Cantonese (Fok, 1979). The late mastery may be attributed to its low frequency of occurrence in the ambient language.

The effect of ambient language was also noted in vowel and diphthong development in 40 Cantonese speaking children aged 10 to 27 months (Wong, 2001). The results suggested a hierarchy of vowel feature development with decreasing order of height > backness > roundness. Diphthongs with round and dorsal elements appeared in the later stages.

Westermann and Miranda (2004) support the above findings by indicating there is growing evidence that the pre-linguistic stage significantly influences the later development of phonological skills in children. Hence literature suggests that babbling is a predictor of later language complexity as well as language delay.

Studies on infant vocalizations report that early laryngeal vocalizations such as vegetative and reflexive sounds are differentiated from “speech like” vocalizations after the first trimester in life (Davis & MacNeialge,1990; Eilers,1992; Oller,2000). Findings also suggest that infants gain increasing control over speech mechanism resulting in increased vocal play from 3 - 4 months onwards which continues beyond the first year of life. Investigating the phonetic behavior as early as 4 months would present the emerging patterns of vowels and diphthongs providing an insight to the phonetic and phonotactic patterns in the developing phonological system. Hence the present study intends to study the vocal behavior of infants from 4 – 12 months of age which is a significant phase of the pre-linguistic period. Research findings have indicated that pre-linguistic vocalizations to a large extent depend on the ambient language as every language has its own phonotactic patterns.

There is dearth of studies in the Indian context on the appearance and nature of vowels and diphthong productions in the early phonetic repertoire period. In the Indian context, a cross linguistic study in Hindi and Kannada was carried out by Shyamala and Basanthi (2003). They reported that five vowels /i/, /e/, /a/, /u/ and /o/ in Kannada made their appearance during 6-12 months. In Hindi, only four vowels (/i/, /e/, /a/ and /u/) including their longer counterparts were seen during the same period. The differences in phonetic repertoire across languages, as early as in the babbling stage were evident in this study. Diphthongs were not considered in their study. To date, research has focussed on singleton vowels and only a few studies have paid attention to the nature of diphthongs. India being a multilingual country, there is a need to study productions in other major Indian languages such as Malayalam also. The emergence of early vowels and diphthong must be studied. There is no reported literature on the phonetic characteristics of vowels and diphthongs in Malayalam as early as the prelinguistic period; hence the present study was taken up. The purpose of the study was to examine the patterns of vowels and diphthongs and their frequency in infants from 4 to 12 months using a cross-sectional design.

The aim of the present study is to investigate the emergence of vowels and diphthongs of infants with a native language background of Malayalam from 4 to 12 months of age using a cross-sectional design. The objectives of the study were:

- To determine the nature of vowels and diphthongs in infants, between the ages 4;0-6;0, 6;0-8;0, 8;0-10;0 and 10;0-12;0 months in Malayalam[1]

[1] Malayalam belongs to the Dravidian family of four major languages with a rich literacy tradition. According to 2011 census, Malayalam is spoken by 33,066,392 people, primarily in the state of Kerala. Malayalam language consists of eleven vowels. The front vowels are /i, i:, e, e:/. The short vowels are /I and e/ and the long vowels include /i: and e:/. The central vowels are /ə, a and a: / and the back vowels.

- To investigate the type and frequency of vowels and diphthongs as a function of age.

2. Methodology

2.1. Participants and inclusion criteria

Twenty infants were audio recorded from native Malayalam speaking families, five girls in each age group at 4-6 months, 6-8 months, 8-10 months and at 10-12 months. An informed consent was obtained from the caretakers/ parents for the participation of the infants in the study. Care was taken to ensure that the participants had typical development and had not been exposed to any other languages. Participants were identified from native Malayalam speaking families and were assessed using the Developmental Screening Checklist (Swapna, Jayaram, Prema, & Geetha, 2010) for receptive and expressive communication skills, auditory, motor and cognitive skills. It was mandatory that both the parents were educated up to a minimum of 10th grade. The proficiency of the native language of the parents was assessed using the Language Proficiency Questionnaire: An adaptation of LEAP-Q in the Indian context by Ramya Maitreyee and Goswami (2009).

2.2. Measures considered in the study

Based on transcription of the babbling data, the type and frequency of vowels and diphthongs utterances were calculated from the babbling sample of each of the 20 participants.

2.3. Procedure

Audio recordings were carried out by the investigator in a fairly quiet room with minimal distractions at the respective homes of the participants. Vocalization samples were recorded when the child was fed and in a comfort state. Parents were asked to interact naturally with the child. No additional play materials were introduced into the environment to capture the infants' typical vocalizations in familiar surroundings. The infant was stimulated more with toys and facial expressions than verbal utterances to avoid verbal imitation. Sony M55 audio recorder was utilized for recording each participant's vocalizations for 1 hour to obtain a minimum of 100 utterances. All the recordings were transferred to a computer and were analyzed using the VLC media player software.

2.4. Data analysis

The recorded samples were transcribed by the primary investigator using broad and narrow International Phonetic Alphabet (2005). Sounds such as grunts, gurgles, laughs, shrieks and whisper etc. were excluded from transcription. A criterian for the transcribed sample was utilized, to consider a phon/ syllable to be present in the infants' vocalizations. It is known that the complexity and frequency of vocal utterances will increase with age. Hence even a one-time production of a vowel/diphthong was considered as to be present in the infants' productions at 4-6 months, two or more productions at 6-10 months, whereas three or more productions

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Concerning the vowel system, length is contrastive and four diphthongs or vowel clusters occur. The syllable structure of Malayalam is given by the following (items in parentheses are optional): (C) (C) (C) V(C).

of a vowel/ diphthong was considered to be present in the infants' productions at 10-12 months. After identifying the phons, their frequencies were calculated. Inter and intra transcriber reliability was calculated for 10% sample of each participant. Cronbach's alpha co-efficient was found to be 0.66 and 0.75 for inter and intra transcriber reliability respectively.

3. Findings and Discussion

The present study considered 20 participants for the analysis of early phonetic repertoire from 4 to 12 months of age. Participants were sub divided into four age bands with an interval of 2 months i.e 4 to 6 months, 6 to 8 months, 8 to 10 months and 10 to 12 months. The recorded data was phonetically transcribed using International Phonetic Alphabet (2005) which yielded a total of 2106 phonemes in the entire phonetic repertoire of the twenty infants. The transcribed data was subjected to further statistical analysis using various non- parametric tests. Based on the frequency of occurrence of vowels and diphthongs, the results are discussed on the following lines:-

(1) The types and frequency of singleton vowels and vowels based on tongue height dimension in all age groups (2) Types and frequency of vowels based on tongue advancement dimension in all age groups (3) Types and frequency of diphthongs.

The total corpus of 2106 phonemes, consisted of 720 vowels in the babbling samples of 20 infants from 4 to 12 months of age. The vowels were mainly singleton occurrences. Tongue height classifications were as high, mid, low vowels and tongue advancement classification was as front, back and central vowels. The mean frequency of singleton vowels in each age group and vowels based on tongue height dimensions are shown in Table 1. Mean Frequency of singleton vowels based on tongue advancement dimension in all age groups is depicted in Table 2 and the mean frequency of the occurrence of diphthongs and its types is provided in Table 3.

Table1. Mean Frequency of occurrence of singleton vowels and frequency based on tongue height

Age range (in months)	Mean Frequency Of Singleton Vowels	Frequency Based On Tongue Height		
		HIGH	MID	LOW
(Group1) $>4 \leq 6$	229	0	107	122
(Group2) $>6 \leq 8$	202	4	137	61
(Group3) $>8 \leq 10$	183	26	79	78
(Group4) $>10 \leq 12$	106	8	51	47
TOTAL	720	38	374	308

Age range (in months)	Diphthongs				
	Mean frequency of diphthongs	Mean frequency of types of diphthongs			
		OD[6]	**CD**	**HHD**	**CNTD**
(Group 1) **>4 ≤ 6**	29	11	3	12	3
(Group 2) **>6 ≤ 8**	31	0	4	28	1
(Group 3) **>8 ≤ 10**	21	3	1	17	0
(Group 4) **>10 ≤ 12**	25	1	2	22	0
TOTAL	**106**	**15**	**10**	**79**	**4**

Table 2. Mean Frequency of occurrence of singleton vowels based on tongue advancement

Table 3. Mean Frequency of occurrence of diphthongs and its types

Age range (in months)	Vowel Tongue Advancement Dimensions		
	FRONT	**BACK**	**CENTRE**
	Frequency	Frequency	Frequency
(Group1) >4 ≤ 6	154	0	75
(Group 2) >6 ≤ 8	187	0	15
(Group3) >8 ≤ 10	129	3	51
(Group 4) >10 ≤12	97	0	9
TOTAL	**567**	**3**	**150**

As seen in Table 1, there was an inverse relationship between frequency of singleton vowels and age. For an alpha level of 0.05 these patterns are significant. The 720 vowels in the vowel corpus were primarily singleton occurrences. The singleton vowels were majorly produced by the 4 to 6 month age band compared to the older groups; this could be attributed to predominant vowel productions in the early phonetic repertoire. This finding is consistent with the reports which have supported the idea of a predominance of mandibular over lingual movement (MacNeilage & Davis, 1995) during the early phases of babbling. It was observed that as age increased the frequency of occurrence of singleton vowels reduced; this finding also relates to the appearance of more complex syllabic patterns of vocalizations towards the later stages of babbling (Reeny & Sreedevi, 2013).

[6] OD-Opening diphthongs, CD-Closing diphthongs, HHD-Height Harmonic Diphthongs, CNTD-Centering Diphthongs

Table 1 also shows the singleton vowels based on the tongue height dimensions categorized as high (/i, i:, u, u:/), mid (/e, e:, o, o:/) and low (/ æ, æ:, a, a:/) vowels from 4 to 12 months old infants. The finding indicates, the mid and low vowels were abundant in the early phonetic repertoire compared to the high vowels /i/ and /u/. This can be related to the anatomical changes in the vocal tract of "pure dynamics frame" (Davis et al., 1990) resulting in low to mid front or vice-versa and front to mid vowel productions with increase in age and may possibly be an indication of its low frequency of occurrence in the ambient language. The overall results indicated that occurrence of singleton vowels decreased in frequency as age increased. The reduction in the singleton vowels towards the latter age range indicated the emergence of more complex syllabic patterns and reduced use of isolated vowels in babbling (Reeny & Sreedevi, 2013).

The data for high, mid and low vowels were subjected to non parametric tests. Kruskal Wallis test for overall group comparison for high, mid and low vowels was significant for mid vowels at $p < 0.05$. No significance was present for high and low vowels. Mann Whitney test for pair wise comparison was significant for groups 1 and 4 for high, mid and low vowels and groups 2 and 4 for mid vowels at $p < 0.05$. Friedman test for within group for high, mid and low vowels was significant for all groups at $p < 0.05$. Wilcoxon Signed Rank test was significant for mid-high and high-low vowels for groups 1 and 2 but no significance was obtained for low-mid vowels at 0.05 level of significance. No such significance was present for group 3. Group 4 was significant at $p <0.05$ for mid-high vowels and not for low-mid vowels and high-low vowels.

Overall, mid and low vowels were the most frequent phones in all the infants across the age groups; this supports the findings of infants of English speaking families (Davis et al., 2002). The observation of early vowels such as mid and low vowels are also consistent with the reports of its appearance located in the lower left quadrant of the vowel space (Bhur, 1980; Lieberman, 1980; Bickly, 1983; Kent & Bauer, 1985; Davis & Mac Neilage, 1990; Stoel- Gammon & Harrington, 1990).

Based on tongue advancement, the vowels were front (/ i, i:, e, e:/) , back (/u, u:,o, o:/) and centre (/a, a:, ə, ə:/) in infants from 4 to 12 months as seen in Table 2. The results indicated that front vowel /e/ was high in occurrence compared to all the other vowels. However, the front vowel /i/ did not have a significant production in all the age groups. This may be related to the late mastery of the front vowel /i/ and its low frequency of occurrence in the ambient language (Irfana & Sreedevi,2013).

Non parametric Kruskal Wallis test for overall group comparison of front, back and centre vowels, indicated significance only for centre vowels at $p < 0.05$. Mann Whitney test for pair wise comparison was significant for groups 1 and 4 for centre vowels at $p < 0.05$. No significance was present for front, back and centre vowels between the other age groups. Friedman test for within group for front, back and centre vowels was significant for all groups at $p < 0.05$. Wilcoxon Signed Rank test was significant for front-centre vowels for all four groups at 0.05 level of significance. Back vowels were not considered due to their negligible occurrence across age groups.

Hence the findings suggest that the front vowels (/e/) were majorly produced by all infants in all age groups followed by the central vowels and the back vowels. This finding is consistent to the data on English and Brazilian Portuguese in which infants at 10 months and above show predominance of front vowels followed by central and back vowels (Teixeira & Davis., 2002).

The results are also equivalent to the study of coronal vowels being produced at the earliest (Wong 2001) which supports Bhur's study (1980), that claimed the musculature of lips, jaw and frontal portion of the tongue develop at a faster rate compared to the lowering of the larynx and rear portion of the tongue. Back vowels were the least produced in this study as the rear portion of the oral cavity develops at a slower rate and the coronal and dorsal contrasts develop at a later stage.

With reference to the diphthongs, they were classified in terms of Opening diphthongs (OD), Closing diphthong (CD), Height – Harmonic diphthongs (HHD) and central diphthongs (CNTD). Opening diphthongs have the second vowel more open than the first i.e. tongue ends lower in the mouth. Closing diphthongs have the second vowel more closed than the first i.e. the tongue ends higher in the mouth. Central diphthongs have both the vowel elements that are more centre in the mouth. The Height Harmonic Diphthongs have both the elements which are either the open vowels or the close vowels.

Non parametric Kruskal Wallis test for overall group comparison for OD, CD, HHD and CNTD showed significance for OD at $p < 0.05$. No significance was present for CD, HHD and CNTD. Mann Whitney test for pair wise comparison was significant for groups 1 and 2 for OD at $p < 0.05$. No significance was present for CD, HHD and CNTD between any of the groups. Friedman test for within group for OD, CD, HHD and CNTD was significant for groups 2, 3 and 4 at $p < 0.05$. Wilcoxon Signed Rank test was significant for Group 2 at $p < 0.05$ for OD-HHD, CD-HHD and CNTD-HHD. Group 3 was significant at $p < 0.05$ for CD-HHD and HHD-CNTD. Group 4 was significant was not significant.

There is a general consensus in literature that diphthongs are dynamic entities, even more than monophthongs (Harrington & Cassidy, 1994). A total of 106 diphthongs were obtained in the phonetic repertoire of the infants studied. The overall diphthongs decreased as age increased which provides as insight on the complexity of utterances during the babbling period. The findings in the present study reveal the interaction of the constituent vowels based on tongue height, advancement and lip rounding dimensions which are attributed to Frame dominance (MacNeilage et al., 1997). It is observed that the Opening diphthongs, Closing diphthongs, Height Harmonic diphthongs, Central diphthongs are present in the early pre-linguistic period which marks Lings (1989) statement that diphthongs frequently occur in children's early repertoire. Infants easily attain the sequence of production of OD, CD, HHD and CTND by mandibular movement as assumed in the Frame dominance account (MacNeilage et al., 1997) which involve tongue height, for the constituent vowels of the diphthong. HHD demands more of the co-ordination of lip rounding and tongue movement. As age increases it is observed that the OD, CD and CNTD decrease and the vowels constitute a more prominent HHD. The decrease in the other types of diphthongs suggest the emergence of various syllabic patterns towards the advanced stages of babbling.

Note: Utilization of Language Proficiency Questionnaire (LEAP-Q)

The sample recordings of the infants were carried out in native speaking Malayalam families. The Language Proficiency Questionnaire-LEAPQ (Ramya Maitreyee & Goswami ,2009) was utilized to assess the native language proficiency of the parent/s in Malayalam. According to the rating, the language proficiency of the parent/s was "perfect" native speakers of Malayalam. Hence the trend of developing speech sounds could be attributed to the influence of the ambient language since the parents of the participants communicated in their native *language with them. Hence, it could be suggested that the infants were reared in a monolingual speaking environment and the exposure to the ambient language could be attributed to the nature and emergence of such vocalizations.*

4. Conclusions

Typically developing infants produce a rich variety of vocalizations during the prelinguistic developmental stages. The infant experiences a continuous change in the structures of the vocal tract, which modifies vocalizations and supports future development (Kent & Miolo, 1995). The present study provides an insight on the nature of vowels and diphthongs that are seldom explored in early babbling period. The appearance of a more common phoneme indicated its emergence towards the target language and the vocal tract articulatory dimensions that suggest shaping speech acquisition. The study also reveals the presence of a boost of singleton vowels and diphthongs in the lower age range of the prelinguistic period and as age increased there was a reduction in singleton phonemes indicative of an emergence in the complexity of syllabic patterns.

4.1. Implications of the study

The study would help to appreciate the nature of phonological development during the pre-linguistic period in Malayalam. There is limited number of studies exploring the emergence of vowels and diphthongs in early infancy in Indian languages. This is one of the first attempts to explore the nature of vowels and diphthongs in infants. Findings obtained will be greatly applicable in clinical practices of communication disorders. In the recent years, speech language pathologists are required to evaluate the vocal acquisition of increasing number of children even less than one year of age. A major difficulty in carrying out these assessments is the lack of norms for typically developing children in this early age range. The challenges of providing services to a linguistic and cultural diverse population like India is compounded by the increased awareness and education of the parents and their increased sensitivity to the child’s early speech development. The findings of pre-linguistic vocalizations also support the fact that babbling is a predictor of language complexity as well as an indicator of language delay. Studies on infant vocalizations report that early laryngeal vocalizations such as vegetative and reflexive sounds are differentiated from “speech like” vocalizations after the first trimester in life. Findings also suggest that infants gain increasing control over speech mechanism resulting in increased vocal play from 3-4 months onwards which continues beyond the first year of life. Hence, the present study serves as a benchmark for the nature of vocalizations of infants from 4 – 12 months of age which is a significant phase of the pre-linguistic period and contributes to later language learning.

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Emergence and patterns of Reduplicated and Variegated Babbling in Hindi and Malayalam: A crosslinguistic study

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Abstract

The study examined the onset and changes in patterns of reduplicated and variegated babbles in infants observed crossectionally. The babbling samples of infants in the age range of 4 to 12 months were audio recorded. The participants comprised of 80 infants, 5 girls and 5 boys each in the age range 4-6months, 6-8months, 8-10months and 10-12months from native Hindi (A Indo-European language majorly spoken throughout India, precisely in Northern India) and Malayalam (A Dravidian language spoken in Southwest of India) speaking families. The samples were then phonetically transcribed by the researcher using International Phonetic Alphabet (2005). The results indicated the presence of reduplicated and variegated babbling coexisted as early as 4 months and continued to co-exist with the increase in age in both the diverse languages. As age increased, the variegated utterances predominated for the place-manner changes compared to place or manner changes in articulation patterns in both the languages. Hence, the study suggests the emergence in the complexity of utterance with age.

Keywords reduplicated babbles, variegated, Hindi, Malayalam, Babbling

1. Introduction

In infants the first step into the production of syllable like output is the canonical babbling. Canonical babbling is defined as rhythmic alternations between consonant and vowel-like properties, giving a percept of rhythmic speech that simulates adult output without conveying meaning (Davis and MacNeilage,1995;Oller,2000).Jackobson's(1941/1968)"discontinuity hypothesis" states that a child typically undergoes a period of silence between the end of the babbling period and development of the first real words is no longer accepted as a fact. Recent research focusing on infant speech development, has repeatedly documented that babbling is not a random behavior, all possible sounds are not produced during the babbling stage, and the transition between the babbling and the first words is not abrupt but continuous (Bauman-Waengler, 2000).

Longitudinal investigations of the transition from canonical babbling to speech have shown continuity between phonetic forms in infant pre-

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linguistic vocalizations and earliest speech forms (Stoel-Gammon & Cooper, 1984; Vihman, Ferguson & Elbert, 1986). This continuity supports the importance of considering canonical babbling as a crucial first step in the young child's journey toward mastery of ambient language phonology.

Patterns in canonical babbling tend to be continuous with vocal patterns in the early language based single word stage. This continuity emphasizes on the importance of considering speech like pre-linguistic babbling as the first step into language complexity. Infants progress through a series of stages of vocal development during the first half year of life, culminating in the appearance of canonical babbling between 4 and 10 months of age, with a median at 6 to 7 months (Oller, 1978; Stark, 1980). Canonical babbling implies either reduplicated or variegated babbling. It is characterized by the production of repetitive, syllable-like output (i.e., [baba] or [daedae]). Oller (1986) noted the following perceptual properties of canonical babbling: (a) at least one fully resonant nucleus (i.e., vowel with an identifiable quality, excluding highly nasalized vowels), (b) one non-glottal margin (consonant other than glottal consonant), (c) duration of syllable and formant transitions that are perceptually consistent with mature syllable production, and (d) normal phonation and pitch range. Normally infants begin canonical babbling with great variability. At about seven months, infants start to make extended sounds that are chopped up rhythmically by oral articulations into syllable-like sequences, opening and closing their jaws, lips and tongue. The ranges of sounds produced are heard as stop-like and glide-like. Fricatives, affricates and liquids are more rarely heard, and clusters are even rarer. Vowels tend to be low and open, at least in the beginning.

Despite controversies regarding the sequential nature of babbling (Holmgren, Lindblom, Aurelius, Jalling, & Zetterstrom, 1986; Smith et al., 1989;Mitchell & Kent, 1990), babbling continues to be divided into two stages. The initial portion of babbling known as reduplicated babbling (Oller's stage 4,Oller,1980) progresses from 7 months to 9 months of age. This form of babbling is characterized by the reduplication of similar consonant-vowe(CV) syllable strings. The CV syllable production in this stage are reduplicated resulting in syllable sequences such as [baba], [kaka], and[tata]. The reduplicated or repeated syllables account for half or more of all vocal patterns in babbling and more than half of the early word forms (Davis, 2002) A variation in the vowel sounds may occur from syllable to syllable; however the consonant tends to remain constant (e.g., [mamu]). The phonetic repertoire at this stage, although limited, may consist of stops, nasals, glides, and the possible contrast with vowels and provide the most prominent break in the acoustic stream of speech sounds. On the other hand, stop production is also relatively undemanding: Syllables such as [ba], [da], and [na] may be articulated through mandibular action alone (Kent, 1992). It is likely that this production milestone represents an advance in: (a) Motoric control, which is maturational, or tied to natural physiological development in the first year; (b) the experience-based integration of visual and auditory perception of adult sequences of open-closed mouth and voice-silence alternation, and (c) the expression of the percept of adult vocalization through global imitation. That is, children see as well as hear stop consonants in adult speech, produce such sounds themselves, and engage in repetitive vocal production or sound play, re-creating their impression of adult speech.

Non-reduplicated or variegated babbling (Oller's stage 5, Oller, 1980) is marked as the second portion of babbling, which begins at approximately 9-

10 months of age and progresses to about the first year. This form of babbling is characterized by continual use of adult-like syllables supplemented by the increasingly varied consonants and vowels within a single vocalization. The CV syllable sequences continue, but the infant combines a variety of CV sequences resulting in productions like [madaga],

[putika], and [tikadi]. The infant's vowel and consonant repertoire increases significantly at this point. In variegated babbling, more manner changes occur than place changes for consonants (Davis &MacNeilage, 1995; Davis & MacNeilage, 2002) and more height than front-back changes for vowels have been shown during babbling and first words (Bickley, 1983; Davis & MacNeilage, 1995, Davis &MacNeilage, 2002). The preference for manner changes for consonants and height changes for vowels is consistent with the

Frame Content hypothesis (MacNeilage& Davis, 1990). The Frame Content hypothesis proposes that the tongue does not move independently from the jaw within syllables, but remains in the same position for the consonant closure and the open or vowel portions of rhythmic cycles. Within syllable consonant vowel characteristics are based on these rhythmic jaw close open close cycles without independent movement of articulators independent of the jaw. Reduplicated and variegated babbling has frequently been included in a single stage of development called canonical babbling because of the difficulty that often arises in distinguishing the two (Smith, Brown-Sweeney

& Stoel-Gammon, 1989; Mitchell & Kent, 1990). Early studies of babbling held that reduplicated and variegated babbling was produced by the infant during different stages (Elbers, 1982; Oller, 1986). Recent studies have found that these two types of babbling co-occur from the onset of canonical babbling, although variegated sequences may not become a dominant category in the child's production until some weeks or even months later.

Thus, Roug, Landburg and Lundburg (1989) found that variegated utterances were present throughout their study, but increased dramatically towards the end of the first year of life or in the second year.

A form of babbling that frequently overlaps with the early period of meaningful speech is characterized by strings of sounds and syllables produced with a variety of stress and intonation patterns. It must be noted that this form of babbling has been called conversational babble, modulated babble, and jargon (Gleason, 1993). Jargon usually begins once the variegated babbling has been reached, at approximately 10 months of age.

The primary difference between variegated babbling and jargon is the infant's increasingly varied and consistent use of intonation, rhythm, and pausing in the latter. Jargon may be thought of as variegated babbling with intonation patterns superimposed on the sound productions.

According to Stoel- Gammon (1989), variegated babbling vocalizations are defined as the pre-linguistic productions that contain two or more different consonant types, disregarding voicing differences. As reported by Hoff (2009), the major milestones of pre-speech vocal development are the productions of canonical syllables (well formed consonant+ vowel combinations), which appear between 6 and 10 months, followed shortly by reduplicated babbling

(repetition of syllables). By the canonical babbling stage in the second half of their first year, young children have already shown evidence of recognizing precise ambient language regularities available from input (Saffran et.al,
1996; Werker & Curtin, 2005).

Stoel-Gammon and Cooper (1984) studied 10 infants at four month intervals from 6-18 months of age. They analyzed consonant place changes as indices of variegation in multi-syllables. A post-hoc analysis showed the following rank orderings: reduplication, place variegation, and manner variegation at 6-9 and 10-13 months; place variegation, manner variegation, and reduplication at 14-17 months. Their results show that the number of reduplicated babbles actually rises slightly until the age range 10-13 months when it begins to fall, finally dropping below the rate of variegated babbling at about 14 months of age. In contrast, the rate of production of variegated babbles falls slightly until 10-13 months of age, when it then starts to rise. By 14-17 months of age, the rate of production of variegated babbles is larger than the rate of reduplicated babble production, but at no time (before 17 months) does the production of reduplicated babbles cease. Similar results were obtained by Mitchell and Kent (1990). They found manner changes to predominate over place changes in babbling of eight infants studied at 7, 9, and 11 months. Frequency of multi syllables in rank order, were reduplication, manner changes, mixed place and manner changes, and place changes. These studies considered consonant series in multisyllabic utterances. These results suggest that the entire babbling period may be similar to the period of first words in containing both reduplicated and variegated forms.

Contrary to Jacobson’s assertion (1941) of no continuity between babbling and first words, investigations have shown canonical babbling to early speech forms have continuity (Locke, 1983; Oller & Steffans, 1993; Vihman et al., 1985, 1986). This supports the continuity of babbling to the child’s first words of the ambient language. A comparison of the children’s output patterns in diverse language environments that provide diverse ambient language learning targets is needed. This type of analysis enables the establishment of potentially universal patterns in canonical babbling based on characteristics of the production subsystems common to young children across language environments. It also highlights the timing and precise nature of early perceptually based learning from social interactions with adult speakers in an ambient language community.

Vocalization patterns across syllables are also considered in the emergence of vocal complexity. In languages, most words contain varied consonants and vowels across syllables; phonological reduplication, or repetition of the same syllable, is infrequent (Maddieson, 1984). Reduplicated babbling accounts for half or more of all vocal patterns in babbling (Davis & Mac Neilage, 1995).

In variegated forms, infants change vowels and/or consonants in two successive syllables. Several studies have shown the concurrent use of both reduplicated and variegated babbling (Mitchell& Kent, 1990; Smith et al., 1989). In variegated babbling, more manner than place changes for consonants (Davis & MacNeilage, 1995, Davis et al., 2002).

Kern and Davis (2009) analysis of five additional languages confirmed the prediction for co-occurrence of reduplication and variegation. While both reduplication and variegation occurred, infants preferred to repeat the same syllable within utterances more than variegate or produce different consonants and/or vowels.

There is dearth of studies in the Indian context on the emergence and patterns of reduplicated and variegated productions in the early phonetic repertoire period. In the Indian context, a study was carried out by Anjana and Sreedevi (2008) in Kannada speaking children. For multi-syllables, they explored the phonetic variation with increase in age. They found the phonetically non-varied multi-syllable babbles were predominant from the age of 6 -9 months. The phonetically varied multi-syllable babbles made their first appearance at 8-9 months. It was found in this age group, only two infants demonstrated variegated babbling, which was characterized by place variations such as [badaba]. The occurrence of variegated babbling increased in the 9-10 month group. In the 10-11 month group, place variations occurred more frequently. A combination of place and manner variations occurred more frequently than place or manner variations alone in 11-12 month age group. A similar finding was observed by Sreedevi and jyoti’s study (2012) in Kannada babbling infants as early as 3 months to 1 year, wherein reduplicated and variegated babbling continued to dominate towards the later stages of babbling. The reduplicated babbling exceeded variegated babbling in all age ranges. The variegated babbling began at 8 – 9 months and gradually increased with age. The most common variegation observed was place changes, followed by manner changes and a combination of place-manner variations. India being a multilingual country, there is a need to study productions in other major Indian languages such as Hindi and Malayalam also. The emergence of reduplicated and variegated utterances shed light about the early linguistic acquisition. There is no reported literature on the phonetic characteristics of reduplicated and variegated utterances in Hindi and Malayalam as early as the pre-linguistic period; hence the present study was taken up. The purpose of the study was to examine the patterns of reduplication and variegation and their frequency in infants from 4 to 12 months using a cross-sectional design.

The aim of the present study is to investigate the emergence of reduplicated and variegated babbling of infants with a native language background of Hindi and Malayalam from 4 to 12 months of age using a cross-sectional design. The objectives of the study were:

a- To determine the nature of reduplicated and variegated babbles in infants, between the ages 4;0-6;0, 6;0-8;0, 8;0-10;0 and 10;0-12;0 months in Hindi[3] and Malayalam[4]

b- To investigate the type and frequency of variegated patterns with respect to age and language

2. Methodology

2.1. Participants and inclusion criteria

Eighty infants were audio recorded from native Hindi and Malayalam speaking families, five boys and five girls in each age group at 4-6 months, 6-8 months, 8-10 months and at 10-12 months. An informed consent was obtained from the caretakers/ parents for the participation of the infants in the study. Care was taken to ensure that the participants had typical development and had not been exposed to any other languages. Participants were identified from native Malayalam speaking families and were assessed using the Developmental Screening Checklist (Swapna, Jayaram, Prema, & Geetha, 2010) for receptive and expressive communication skills, auditory, motor and cognitive skills. It was mandatory that both the parents were educated up to a minimum of 10th grade. The proficiency of the native language of the parents was assessed using the Language Proficiency

Questionnaire: An adaptation of LEAP-Q in the Indian context by Ramya Maitreyee and Goswami (2009).

2.2. Procedure

Audio recordings were carried out by the investigator in a fairly quiet room with minimal distractions at the respective homes of the participants.

Vocalization samples were recorded when the child was fed and in a comfort state. Parents were asked to interact naturally with the child. No additional play materials were introduced into the environment to capture the infants' typical vocalizations in familiar surroundings. The infant was stimulated more with toys and facial expressions than verbal utterances to avoid verbal imitation. Sony M55 audio recorder was utilized for recording each participant's vocalizations for 1 hour to obtain a minimum of 100 utterances. All the recordings were transferred to a computer and were analyzed using the VLC media player software.

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[3]India is a multilingual country having four distinct linguistic communities. These families include Indo Aryan, Dravidian, Tibeto-Burman and Austro-Asiatic. Hindi[1]belongs to the Indo Aryan family of languages which is a subgroup of the Indo European language. According to 2011 census, Hindi is spoken natively by 422,048,642 speakers which is the largest number of speakers of any languages in India.In Hindi, aspiration is phonemic/contrastive in the language, but vowel nasalization is not. The syllable structure of the language is (C)(C)V(C)(C). As such, both word-initial and word-final consonant clusters are permitted. Hindi is a SOV language.

[4]Malayalam belongs to the Dravidian family of four major languages with a rich literacy tradition. According to 2011 census, Malayalam is spoken by 33,066,392 people, primarily in the state of Kerala.The syllable structure of Malayalam is given by the following (items in parentheses are optional): (C)(C)(C)V(C). Malayalam is also a SOV language. http://www.lmp.ucla.edu

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2.3. Data analysis

The recorded samples were transcribed by the primary investigator using broad and narrow International Phonetic Alphabet (2005). Sounds such as grunts, gurgles, laughs, shrieks and whisper etc. were excluded from transcription. A criteria for the transcribed sample was utilized, to consider a phone/ syllable to be present in the infants' vocalizations. It is known that the complexity and frequency of vocal utterances will increase with age. Hence even a one-time production of a vowel/diphthong was considered as to be present in the infants' productions at 4-6 months, two or more productions at 6-10 months, whereas three or more productions of a vowel/ diphthong was considered to be present in the infants' productions at 10-12 months. After identifying the phones, their frequencies were calculated. Inter and intra transcriber reliability was calculated for 10% sample of each participant. Cronbach's alpha co-efficient was found to be 0.80 and 0.85 for inter and intra transcriber reliability respectively.

The recorded samples of the infants was phonetically transcribed using International Phonetic Alphabet (2005) which was subjected to further statistical analysis using various non- parametric tests. Based on the mean percentage of occurrence of reduplicated and variegated utterances, the results are discussed on the following lines.

(1)Frequency of reduplicated and variegated babbles (2) Types and frequency of variegated utterances which includes place, manner and place-manner variegation.

3. Findings and Discussion

Descriptive statistical analysis for reduplicated and variegated utterances was carried out for all the participants in both the languages. Table 1 represents the descriptive statistics of Mean percentage of occurrence, Standard deviation (S.D) and median for reduplicated and variegated utterances in Hindi and Malayalam speaking children.

Table 3.1 Descriptive statistics for reduplicated utterances with respect to age and language

Age Bands	**HINDI**			**MALAYALAM**		
	N	Mean (S.D)	Median	N	Mean (S.D)	Median
Group 1(4 to 6 months)	5	3.20 (3.98)	1.01	3	9.17 (2.70)	10.00
Group II(6 to 8 months)	7	7.43 (7.23)	4.46	9	6.81 (9.15)	3.37
Group III(8 to 10 months)	10	6.96(4.56)	5.28	9	9.15 (8.40)	6.19
Group IV(10 to 12months)	10	15.68(8.92)	12.06	10	12.31(7.82)	10.89

Table 3.2 *Descriptive statistics for variegated utterances with respect to age and language*

AgeBands	HINDI			MALAYALAM		
	N	Mean (S.D)	Median	N	Mean (S.D)	Median
Group 1(4 to 6 months)	7	3.69 (4.15)	1.66	5	6.47 (5.85)	6.15
Group II(6 to 8 months)	9	9.93 (12.83)	3.81	10	9.64 (10.48)	4.76
Group III(8 to 10 months)	10	8.08 (5.54)	6.61	9	11.27 (7.61)	8.84
Group IV (10 to 12 months)	10	17.05 (9.66)	16.83	10	13.21 (5.23)	13.07

Table 3.1 and 3.2 summarize the combined mean percentage of occurrence, standard deviation (S.D) and median on syllable structures such as reduplicated and variegated babbling respectively with respect to age and language. The complexity of these utterances produced by 80 infants was analyzed from 4 to 12 months grouped in four age groups of both languages. The Hindi and Malayalam group comprised of 40 participants each (summing upto 80) with 10 infants in each of the 4 age groups respectively.

3.1.1. Discussion for reduplicated utterances

As seen in table 3.1, for the Hindi and Malayalam groups it could be inferred that there was a slight gradual increase in the mean percentage of occurrence for reduplicated utterances with increase in age. Both Hindi and

Malayalam groups showed slightly different order of mean percentage of occurrence of reduplicated utterances across the 4 age bands. Group I (4 to 6 months) of Hindi participants had a very less percentage of occurrence of reduplicated utterances compared to a more percentage of occurrence of reduplicated utterance in the same age group in Malayalam. Group II (6 to 8 months) however had a slightly similar percentage of occurrences of the reduplicated utterances in both language groups. For Group III (8 to 10 months) the percentage of occurrence of the reduplicated utterances in the Hindi group was low compared to the equivalent age group in Malayalam.

However, for Group IV (10 to 12 months) both the language groups had an increase in mean percentage of occurrence for reduplicated utterances, with Hindi group being slightly higher in its percentage of occurrence than the Malayalam group. It was observed that though the reduplicated utterances declined in the Hindi group at 8 to 10 months, it continued to dominate in the older group to a larger extent. Across all ages observed, within the languages there was high variability in the production of reduplicated utterances suggesting the emergence of complexity in utterances. The findings are similar to the other Indian studies by Anjana and Sreedevi (2008); Sreedevi and Jyoti (2012) in Kannada which is also a Dravidian language of south India. Overall, the reduplicated utterances increased by 6 to 9 months and at the end of the first year the frequency of reduplicated babbling increased even more. This could be due to the emergence of canonical syllables (well formed consonant+ vowel combinations), which appear between 6 and 10 months, followed by reduplicated babbling (repetition of syllables). By the canonical babbling stage in the second half of their first year, young children have already shown evidence of recognizing precise ambient language regularities available from input (Saffran et.al, 1996; Werker & Curtin, 2005).

3.2.1 Discussion for variegated utterances

As seen in Table 3.2, the Hindi and Malayalam groups had a gradual increase in the mean percentage of occurrence of variegated utterances with advance in age. For the Malayalam group, there was a linear increase in the mean percentage of occurrence for variegated utterances with increase in age. Table 3.2 also provides information regarding the presence of variegated utterances as early as 4 to 6 months. Group I (4 to 6 months) had a less mean percentage of occurrence of variegated utterances in Hindi compared to a slightly higher mean percentage of occurrence in the equivalent Malayalam group. Group II (6 to 8 months) showed a similar mean percentage of occurrences of variegated utterances in the 2 languages.

Group III (8 to 10 months) had a low percentage of occurrence in Hindi compared to a high mean percentage of occurrence in the Malayalam group.The variegated utterances had a high mean percentage of occurrences in both the language groups for Group IV (10 to 12 months), with the participants in the Hindi group displaying a high increase in its mean percentage compared to Malayalam. It could be inferred that the variegated utterances dominated in the older age group in both the languages leading to the presence of complex utterances in their native languages. The findings obtained are contrary to the variegated babbling stage (Oller’s stage 5, Oller,1980) which is marked as the second portion of babbling, which begins at approximately 9-10 months of age and progresses to about the first year.

However, the results indicate that variegated babbling has frequently been included with reduplicated babbling in a single stage of development called the canonical babbling because of the difficulty that often arises in distinguishing the two (Smith, Brown-Sweeney &Stoel-Gammon, 1989; Mitchell & Kent, 1990). The emergence of reduplicated and variegated babbling produced by the infants during different stages (Elbers, 1982; Oller,1986) have found to co-occur from the onset of canonical babbling, although variegated sequences may not be a dominant category until some weeks or even months later. Thus, the emergence of variegated babbles in both the languages are in support with the study by Roug, Landburg and Lundburg (1989) who found variegated utterances present throughout their study, but increased dramatically towards the end of the first year of life or in the second year.

3.3 Comparison of age within each language

3.3.1 Kruskal Wallis for comparison of age groups within each language.

3.3.1.1 Reduplicated and Variegated utterances.

Non parametric test Kruskal Wallis was conducted to examine the overall significant difference across age in Hindi and Malayalam for reduplicated and variegated utterances. If there was significant difference, the language group would then be subjected for within group comparisons. Table 3.3.1 depicts the results of Kruskal Wallis for reduplicated and variegated utterances for Hindi and Malayalam speaking children.

Table 3.3.1 *Results of Kruskal Wallis with respect to measures of reduplicated and variegated utterances in Hindi and Malayalam groups.*

	Hindi		**Malayalam**	
Measures	X^2	p	X^2	p
Reduplicated	12.07	0.007**	4.61	0.202
Variegated	11.62	0.009**	4.51	0.211

** highly significantat p< 0.01 level

As seen from table 3.3.1, it is observed that there was significant difference in reduplicated and variegated utterances for Hindi speaking participants across the age groups and no significant difference was present across the age groups for Malayalam speaking participants. Crosslinguistic comparison reveals that the production of reduplicated and variegated babbling was higher in the Hindi group compared to the Malayalam group. Hence, the Hindi group was subjected to further statistical analysis. Mann-Whitney U-test for pair-wise comparisons was carried out for between the age groups as provided in Table 3.3.2

Table 3.3.2 *Mann- Whitney U test for pair-wise comparison between age groups with respect to reduplicated and variegated utterances*

Age Groups	**Reduplicated utterances**		**Variegated utterances**	
	$\lvert z \rvert$	p	$\lvert z \rvert$	p
Group 1 and Group II	1.54	0.12	0.90	0.36
Group 1and Group III	1.96	0.50	2.00	0.045*
Group 1and Group IV	2.69	0.007**	3.02	0.002**
Group II and Group III	0.48	0.68	0.89	0.36
Group II and Group IV	1.95	0.51	1.96	0.05*
Group IIIand Group IV	2.49	0.013*	2.15	0.031*

* significant at 0.05 level
**highly significant at 0.01 level

As seen in table 3.3.2 Mann-Whitney U test was administered to examine the significant difference between the age groups for reduplicated and variegated utterances in the Hindi group. There was high significant difference between Group 1 (4 to 6 months) with Group III (8 to 10 months) for variegated utterances ($\lvert z \rvert = 2.00$; $p < 0.05$), Group 1 (4 to 6 months) and Group IV (10 to 12 months) for reduplicated ($\lvert z \rvert = 2.69$; $p < 0.05$) and variegated utterances ($\lvert z \rvert = 3.02$; $p < 0.05$), between Group III (8 to 10 months) and Group IV (10 to 12 months) for reduplicated ($\lvert z \rvert = 2.49$; $p < 0.05$) and variegated utterances ($\lvert z \rvert = 2.15$; $p < 0.05$). The difference could be due to the onset of variegated babbling in the older age groups accompanying the reduplicated babbling, with a higher percentage of occurrence for the variegated babbling. However there was no significant difference between the groups; Group I (4 to 6 months) with Group II (6 to 8 months) for reduplicated utterances ($|z|$ = 1.54; $p > 0.05$) and variegated utterances ($|z|$ = 9.00; $p > 0.05$), Group II (6 to 8 months) and Group IV (8 to 10 months), though displaying the occurrence of variegated babbling increased with age, it did not exceed the occurrence of reduplicated babbling even in the older groups.

Mann-Whitney Test for comparison of languages within the age groups

Table 3.3.*3 Reduplicated and variegated utterances for the age groups 4-6, 6-8, 8-10 and 10-12 months for Hindi and Malayalam languages.*

Age Groups	**Reduplicated utterances**		**Variegated utterances**	
	$\|z\|$	p	$\|z\|$	p
Group 1(4 to 6 months)	1.64	0.10	0.65	0.51
Group II(6 to 8 months)	0.58	0.56	0.08	0.93
Group III(8 to 10 months)	0.32	0.74	0.89	0.36
Group IV(10 to 12 months)	0.94	0.34	0.90	0.36

As seen in table 3.3.3, Mann-Whitney U –test was administered to examine the significant difference of reduplicated and variegated utterances across the 2 languages within each age group. There was no significant difference within the 4 age groups across Hindi and Malayalam suggesting differences in the complexity of syllabic structures of reduplicated and variegated utterances that increased with age. Although the table 3.3.3 depicts an increase in the occurrence of reduplicated and variegated babbling with age, it could be inferred that the variegated babbling did not exceed the occurrence of reduplicated babbling even in the older age groups. This comparison of the children's output patterns in diverse language environments provides information on the ambient language learning targets. However, the present study is in support with several other studies that have shown the concurrent use of both reduplicated and variegated babbling (Mitchell& Kent, 1990; Smith et al., 1989).

4.1 Type and Frequency of occurrence of variegated utterances

4.1.1 Analysis of Place, Manner and Place-Manner Variegated Utterances

Descriptive statistical analysis was carried out for types of variegated utterances that included place, manner and place-manner variegation across age groups in both the languages. Table 2 represents the Mean percentage of occurrence, Standard deviation (S.D) and median for the types of variegated utterances in Hindi and Malayalam (N=number of speaking children) in all the 4 age groups.

Table 4.1 *Combined Mean percentage of occurrence and Standard deviation (S.D) for the types of variegated utterances in Hindi and Malayalam speaking children.*

	Category		**Group 1 (4 to 6 months)**	**Group II (6 to 8 months)**	**Group III (8 to 10 months)**	**Group IV (10 to 12 months)**
Hindi	**Place**	**N**	-	2	4	5
		Mean (S.D)	-	4.06 (4.94)	1.36 (0.68)	1.97 (1.17)
		Median	-	4.06	1.30	2.00
	Manner	N	-	2	-	2
		Mean (S.D)	-	1.54 (1.38)	-	1.27 (0.74)
		Median	-	1.54	-	1.27
	Place-Manner	N	6	3	4	9
		Mean (S.D)	2.04 (1.67)	7.83 (0.36)	1.19 (0.46)	4.90 (4.70)
		Median	1.17	7.69	1.26	2.22
Malayalam	Place	N	2	1	2	3
		Mean (S.D)	0.84 (0.23)	0.68 (0.00)	1.41 (1.06)	1.00 (0.62)
		Median	0.84	0.68	1.41	0.79
	Manner	N	1	-	2	1
		Mean (S.D)	2.27 (0.00)	-	0.83 (0.24)	0.51 (0.00)
		Median	2.27	-	0.83	0.51
		Mean (S.D)	4.03 (2.32)	3.05 (4.12)	3.71 (2.17)	4.18 (3.07)
		Median	5.05	1.31	3.19	2.76

Table 4.1. The summary of the combined mean percentage of occurrence, standard deviation (S.D) and median on syllable patterns such as place, manner and place-manner changes in variegated babbling respectively with respect to age and language.

4.1.2 Place Variegation

As seen in Table 4.1, for the Hindi group, place changes were not predominant in Group I (4 to 6 months). Group II (6 to 8 months) had a high variability in the productions compared to Group III (8 to 10 months) and Group IV (10 to 12 months). On similar lines, the Malayalam group also had a high production of place variegation compared to the other age groups, followed by group IV (10 to 12 months), group I (4 to 6 months) and least being in group II (6 to 8 months). On cross linguistic comparison across the age groups, it could be observed that the Malayalam participants had a predominance of place variegation pattern in the age band 4 to 6 months than the Hindi group. There was high mean percentage of occurrences of place changes in the age band, 6 to 8 months in Hindi whereas the mean percentage of occurrence was least for the Malayalam group in the same age group. Group III (8 to 10 months) however had a slightly similar percentage of occurrences of place changes in both the languages. The mean percentage of occurrence of place changes was inconsistently high in the production by the Hindi participants in Group IV (10 to 12 months) compared to the Malayalam group. Hence, from the table it could be inferred that the place pattern productions were variable across the age groups in the 2 languages.

4.1.3 Manner Variegation

As depicted in Table 4.1, the Hindi group had no predominant manner variegated productions for Group I (4 to 6 months) and Group III (8 to 10 months). Group II (6 to 8 months) had a high mean percentage of occurrence compared to Group IV (10 to 12 months). For the Malayalam group, there was no predominance of manner variegation in Group II (6 to 8 month). However, a linear decrease in the mean percentage of occurrence was observed for Group I (4 to 6 months), Group III (8 to 10 months) and Group IV (10 to 12 months). On comparison of both the languages across the age groups, for Group I (4 to 6 months) the Hindi group had no manner productions but the Malayalam group displayed a mean percentage of occurrences of manner patterns of 2.27 %. For Group II (6 to 8 months), the Hindi participants had a mean percentage of occurrences of 1.54% of manner variegated utterances whereas no productions were present in the Malayalam group. Similarly, for Group III (8 to 10 months), the Hindi participants had no manner variegated utterances compared to the Malayalam group who had a mean percentage of 0.83%. The Hindi participants in Group IV (10 to 12 months) had a high percentage of occurrence of 1.27% compared to Malayalam group that had a mean percentage of occurrence of 0.51%. Overall, the Malayalam group had a high occurrence of manner variegated production compared to the Hindi group.

4.1.4 Place-Manner Variegation

As displayed in Table 4.1, for the Hindi group, Group I (4 to 6 months) had predominance of place-manner variegated syllables in their productions. In Group II(6 to 8 months) there was a variable increase in the productions of place-manner utterances. However, in Group III (8 to 10 months) there was steep decrease in the productions and Group IV (10 to 12 months) participants had a slight increase in the variability of their productions. For the Malayalam group, Group I (4 to 6 months) there was presence of place-manner patterns, Group II (6 to 8 months), depicted variability in the productions, group III (8 to 10 months) and Group IV (10 to 12 months) had a linear increase of the place-manner productions. Accordingly for both the languages a reverse order of occurrences are depicted, Group I (4 to 6 months) of Hindi participants had a low mean percentage of occurrence

2.04% compared to a high mean percentage of occurrence of 4.03% in Malayalam. For Group II (6 to 8 months), the Hindi group had a high mean percentage of occurrence of 7.83% compared to the mean percentage of occurrence of 3.05% in the Malayalam group. For Group III (8 to 10 months), the Hindi participants had a low mean percentage of occurrence of 1.19% compared to the Malayalam group that had a high mean percentage of occurrence of 3.71%. However the older age Group IV (10 to 12 months) had a high mean percentage of occurrences with increase in age, although the Hindi group displays a high mean percentage of occurrences of 4.90% of place-manner patterns compared to the Malayalam group that had a mean percentage of occurrences of 4.18%. From Table 3 it could be inferred that there was variability in the production of place-manner utterances by the participants in both the languages across the age groups suggesting the emergence and existence in the complexity of utterances.

Non-parametric test, Mann-Whitney was utilized to examine the significant difference between places, manner and place-manner variegation across the 2 languages within each age group.

Table 4.2. Place, manner and place-manner variegated utterances for the age groups 4-6, 6-8, 8-10 and 10-12 monthsfor Hindi and Malayalam groups.

Age Groups	**Place Variegation**		**Manner variegation**		**Place-Manner Variegation**	
	$\lvert z \rvert$	p	$\lvert z \rvert$	p	$\lvert z \rvert$	p
Group 1(4 to 6 months)	1.45	0.15	1.00	0.31	0.75	0.46
Group II(6 to 8 months)	0.60	0.54	1.45	0.14	1.52	0.12
Group III(8 to 10 months)	0.93	0.35	1.45	0.15	2.14	0.032*
Group IV(10 to 12 months)	1.23	0.21	0.73	0.46	1.49	0.14

* Significant at < 0.05 level

As seen in table 4.2, Mann-Whitney U test was administered to examine the significant difference within the age groups for place, manner and place-manner variegation across the 2 languages. Analysis of patterns in variegated utterances revealed no significant difference within the 4 age groups across Hindi and Malayalam for place variegation, and manner variegation suggesting no differences in the patterns of variegated utterances that increased with age. However, Hindi and Malayalam participants showed reverse trends in the occurrence of all the 3 patterns across age groups.

There was a high significance for group III (8 to 10 months) for the pattern of place-manner variegated utterances ($\lvert z \rvert = 2.00$; $p < 0.05$) in both the languages. Place-manner changes predominated in Group III (8 to 10 months) over place changes and manner changes compared to all the age groups. The results of the present study correlates with the studies in theIndian context carried out by Anjana and Sreedevi (2008) which phonetically are varied multisyllable babbles which were more in frequency in 8-9 months. The occurrence of variegated babbling increased in the 9-10 and 10-11 month group although contrary to the pattern of place-manner variations that occurred more frequently in the present study. On similar lines the combination of place and manner variations occurred more frequently than place or manner variations alone in 11-12 month age group which is similar to the current finding. A similar finding was also observed in Sreedevi and Jyoti's study (2012) in Kannada babbling infants as early as 3 months to 1 year, more frequent variegated babbling began at 8 – 9 months and gradually increased with age. The most common variegation observed was place changes, followed by manner changes and a combination of place-manner variations throughout the age range. The findings by Davis and MacNeilage (1995) Davis et al., (2002) indicated that the variegated babbling had more manner than place changes are not in support with the present results obtained. The present study, therefore suggests that there was not much of a difference in both the languages Hindi and Malayalam indicating the presence of universality in the acquisition of the native language in the pre-linguistic period.

Note: Utilization of Language Proficiency Questionnaire (LEAP-Q)

The sample recordings of the infants were carried out in native speaking Malayalam families.The Language Proficiency Questionnaire-LEAPQ (Ramya Maitreyee & Goswami, 2009) was utilized to assess the native language proficiency of the parent/s in Hindi and Malayalam. According to the rating, the language proficiency of the parent/s was "perfect" native speakers of Hindi and Malayalam. Hence the trend of developing speech sounds could be attributed to the influence of the ambient language since the parents of the participants communicated in their native language with them. Hence, it could be suggested that the infants were reared in a monolingual speaking environment and the exposure to the ambient language could be attributed to the nature and emergence of such vocalizations.

6. Conclusion

Typically developing infants produce a rich variety of vocalizations during the prelinguistic developmental stages. The present study provides an insight on the frequency and types of reduplicated and variegated babbles during the pre-linguistic period. The study suggests the presence of variety of utterances as early as 4 months, though unmeaningful but leading to a meaningful production to their first words in their native languages which is also an indicative of an emergence in the complexity of syllabic patterns.

6.1Implications of the study

The present study would help appreciate the nature of reduplicated and variegated babbles in the pre-linguistic period in both diverse Indian languages. There is limited number of studies exploring the various types of babbles in early infancy in Indian languages. This is one of the first attempts to explore the nature of reduplicated and variegated babbles in infants. Findings obtained will greatly be applicable in clinical practices of communication disorders. In the recent years, speech language pathologists are required to evaluate the language acquisition of increasing number of children even less than one year of age. The challenges of providing services to a linguistic and cultural diverse population like India is compounded by the increased awareness and education of the parents and their increased sensitivity to the child's early speech development. The findings of pre-linguistic vocalizations also support the fact that babbling is a predictor of language complexity as well as an indicator of language delay. Studies on infant vocalizations report that early laryngeal vocalizations such as vegetative and reflexive sounds are differentiated from “speech like” vocalizations after the first trimester in life. Hence, the present study serves as a benchmark for the nature of vocalizations of infants from 4 – 12 months of age which is a significant phase of the pre-linguistic period and contributes to later language learning in 2 diverse Indian languages Hindi and Malayalam.

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