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Nature of vowels and diphthongs in babbling of Malayalam infants

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Abstract

Recent studies of human infant vocal behaviour have shown an influence of the ambient language on the early stages of vocalizations. 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 focused 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

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patterns of babbling into true words of the target language. Canonical 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, ε, 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 [ε, 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 focused 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]
- 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 RamyaMaitreyee 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.

[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.
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).

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 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.

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

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

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**

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

Age range (in months)	Diphthongs				
	Mean frequency of diphthongs	Mean frequency of types of diphthongs			
		OD[3]	**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 3. Mean Frequency of occurrence of diphthongs and its types

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

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

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).

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 adult language in Malayalam (Sreedevi & Irfana,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. http://slbltsu.hull.ac.uk/awe/index.php?title=Different_classifications_of_diphthong

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 (RamyaMaitreyee & 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 at this early stage. 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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