Original Research Article

Frequency of Occurrence of Preferred Consonant-Vowel Combinations in Hindi and Malayalam Learning Infants: A Preliminary Study

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ABSTRACT

The world's languages are diverse; however its sound system exhibits underlying commonalities. The phonotactic combinations of consonant and vowel have shown universal tendencies. A preferred pattern was first observed by MacNeilage and Davis (Davis & MacNeilage, 1995; MacNeilage, 1998; MacNeilage & Davis, 1990). Phonological inventories have shown that consonants at three places of articulation (labial, coronal & velar) are nearly universal , as are vowels at three degrees of fronting (front, central, back) (Jackobson, 1968; Lindblom, 1986, Maddieson, 1984,1997). These CV preferences could be the patterns of adult speech into their babbling. The influence of ambient language in babbling is known to occur at very early stages of infant speech development (Boysson-Bardies, Halle, Sagart& Durand, 1989; Whalen, Levitt & Wang, 1991).In this context, it is quite essential to investigate the CV preferences suggesting a developmental check in the early prelinguistic period in shaping speech acquisition. The present paper is focused on the appearances of consonant and vowel preferences during the pre linguistic period till the age of 12 months in infants of Hindi and Malayalam monolingual speaking families. 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 IndoEuropean language majorly spoken throughout India, precisely in Northern India) and Malayalam (A Dravidian language spoken in Southwest of India) speaking families. Audio recording of the babbling utterances were carried out to obtain a minimum of hundred utterances from each infant. The data was analysed using IPA to obtain the frequency and type of consonant- vowel utterances. The CV preferences were classified into 9 preferred combinations. Frequency of occurrence of CV combinations varied across age ranges, however increased in the higher age group of 10 to 12 months in both the language groups.

Keywords: CV preferred combinations, Frequency of occurrence, Hindi, Malayalam, infants.

INTRODUCTION

[1] 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. [2] Research has shown the C-V interactions are present in early phonological development. [3-4]

Much work on CV co articulation has been carried out on European languages

like German, [5] American English, [2] French, Swedish and English. [6] Japanese compared with French, Swedish, Ecuadorian- Quincha, and Brazilian-Portuguese. [2] In similar lines, [7] studied CV occurrences in early speech development of normal Cantonese speaking children.

For the work on CV co articulation, [5] 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 Leon 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. [2] In addition, [2] studied 6 English-learning infants during babbling. 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).

The effect of lexicon has an effect on CV combination production may be language-based. According to, [6] CV pattern production is influenced by the ambient language being studied. For French, Swedish, and Yoruba children, the LC pattern is preferred. In American children, the LF 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.

[8] also considered lower frequency consonants (fricatives, liquids, and affricates, often very late to appear in typical speech development) 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). [9] 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. [10] investigated data on 14 languages available on the ULSID (UCLA Lexical and Syllabic Inventory Database; [11] 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.

[7] 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 [1] have 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 &

English. [12] 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. [13] 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. [6,14] Monolingual infants initially produce more open syllables than closed syllables, [6] 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. [2,9] Labial consonants were replaced by alveolars when followed by front vowels. [3]

On the contrary, [4] showed children 18 to 24 months, association between velars and back vowels was evident, but bilabial-central vowel and alveolar- front vowel associations were not supported. [15] showed that CV associations were strong for children aged 10-12 months, but weakened by 16 to 24 months [16] proposed phonological approach with children aged 12- 35 months 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 [17] 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 [2,9] and in Romanian speaking infants [1] reported patterns in French, Romanian and Dutch speaking infants and suggested the ambient language may influence vocal development in babble. [1] observed velar central patterns emerged before first year in infants from Mandarin speaking community and velar back patterns

were predominant and emerged after the first year. The report by [17] is consistent with the findings by [2] demonstrating a lack of velar production in their study of typically developing male infant.

Aim

Much of the research on CV coarticulation emphasizes on the children's ability to articulate different CV combinations. Work done in relation to the F/C theory regards much of the speech produced by children as babbling, even if the children have reached the age of 3;06. [2-3,19] One of the aims of the present study is to provide evidence to argue on the production of various CV patterns in young children from 4 to 12 months in 2 diverse Indian languages Hindi and Malayalam. The study would also indicate if F/C theory could be applied to the early productions in infancy. The study uses a cross-sectional design, to determine the combination of patterns to reveal the universality of CV in early speech in the Indian context.

METHOD

A total of 80 children from Hindi and Malayalam native speaking families participated in the study. The subjects were divided into four groups according to age: 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). Each group consisted of ten children comprising of 5 boys and 5 girls. All children demonstrated normal development according to the Developmental Screening Checklist [20] for receptive and expressive communication skills, auditory, motor and cognitive skills. 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. [21]

Vocalizations were recorded using a Sony Mz51 voice recorder. Recordings were carried out in a quiet environment in the participant's home. Parent-child interactions were kept at minimal. The recordings were transferred to a VLC media player of a computer. Analysis was then carried out for

each participant according to the classified Consonant-Vowel combinations.

This section on preferred consonant-vowel combinations is based on the hypothesis of Frame Content Theory by. [2] This states that in infant babbling productions are attributed to vocal tract changes as the infant matures. Certain consonants make associations with vowels during babbling. Hence, the preferences in combinations produced by the infants of Hindi and Malayalam groups. In the present study consonants were grouped according to place of articulation, into labials (p, b, m), coronals (t, d, n), and velars (k, g).Vowels were grouped with reference to the front-back dimension of the vocal tract, into central (a, a: ,ə, ə:), front (i, I, e,e: æ, æ:) and back (u, U, o, O, ɔ, ɔ:).CV combinations were given three consonant categories and three vowel categories, hence, nine different types of CV

combinations, namely, labial-central (LC), labial-front (LF), labial-back (LB), coronal-central (CC), coronal front (CF), coronalback(CB),velar-central(VB),velar-front(VF),andvelar-back(VB).

RESULTS AND DISCUSSION
a)   Preferred consonant-vowel combinations in Hindi learning infants

Table 1 and Figure 1 displays the frequency of CV segments of 40 infants across the four age groups. Overall analyzed CV segments totaled 333 for the Hindi learning infants. Out of which Group I comprised of 34 segments, Group II consisted of 53 segments, Group III, 111 segments and Group IV, 135 segments. It could be inferred that as age advanced there was an increase in the type and frequency of CV combinations.

Table 1: *Frequency of occurrence of CV segments across the age groups in Hindi learning infants*

Hindi Group									
Age (in months)	CV Segments								
	LC (n)	CC(n)	VC(n)	LF(n)	CF(n)	VF(n)	LB(n)	CB(n)	VB(n)	Total (N)
4 to 6	10(7)	3(2)	10(3)	3(2)	6(2)	2(1)	0	0	0	34(17)
6 to 8	14(5)	6(3)	15(3)	3(2)	10(3)	1(1)	1(1)	2(1)	1(1)	53(20)
8 to 10	34(9)	36(7)	19(4)	5(3)	14(4)	1(1)	1(1)	1(1)	0	111(30)
10 to 12	48(9)	21(6)	25(6)	7(4)	17(5)	9(3)	5(2)	1(1)	2(1)	135(37)
Total	106(30)	66(18)	69(16)	18(11)	47(14)	13(6)	7(4)	4(3)	3(2)	333(104)

Note – (n) represents the no. of infants producing the CV combinations
*Notes*LC=Labial Central, CC= Coronal Central, VC= Velar Central, LF=Labial Front, CF=Coronal Front, VF=Velar Front, LB=Labial Back, CB=Coronal Back, VB=Velar Back
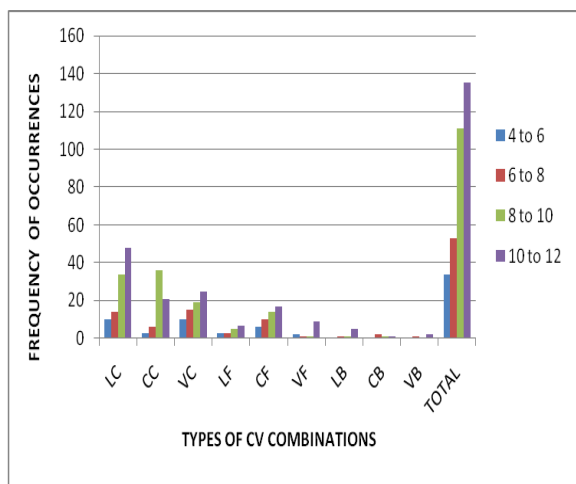

Fig. 1 Types and Frequency of occurrences of CV combinations across age groups

Six types of associations such as LC, CC, VC, LF, CF, and VF were present in Group I (4 to 6 months). LC (Mdn=1.00, SD= .93)

and VC (Mdn=1.00, SD= 1.88) had the highest frequency count. Among the nine CV associations Group II (6 to 8 months) had a high frequency count for VC (Mdn=1.90, SD=4.0) followed by LC (Mdn=3.40, SD=4.2). Group III (8 to 10 months) had 8 CV associations with a high frequency count for CC (Mdn=3.60, SD=5.64). Group IV (10 to 12 months) depicted the highest frequency count for LC (Mdn=4.80,SD=5.43). Non parametric Kruskal Wallis test was carried out for CV productions across the 4 age groups and revealed no significance at p>0.05. It can be observed that central vowels were preferred to consonants. This is analogous to the findings of, [2] that in preferred CV combinations central vowels seem to be highly favored in babbling. This is probably

a preference for easy production of central vowels which was also present in other languages. [6,14] The other CV combinations such as LB, CB and VB were least in frequency of occurrence indicating late production of back vowels. This is due to the late articulatory acquisition and motor co –ordination for the production of back vowels. This could be related to the [22] study, wherein toddlers displayed late production of back vowels due to late articulatory acquisition and motor skills.

(b) Preferred consonant-vowel combinations in Malayalam learning infants

The frequency of CV patterns of 40 infants across the four age groups in Malayalam is displayed in Table 2 and Figure 2. The CV segments totaled 452 for the Malayalam learning infants. Out of which Group I, Group II, Group III and Group IV comprised of 79, 101, 110 and 162 CV segments respectively. Similar to the Hindi group, it could be inferred that as age advanced there was an increase in the type and frequency of CV combinations.

Table 2 Frequency of occurrence of CV segments across the age groups in Malayalam learning infants

Malayalam Group									
Age (in months)	CV Segments								
	LC (n)	CC(n)	VC(n)	LF(n)	CF(n)	VF(n)	LB(n)	CB(n)	VB(n)	Total(N)
4 to 6	6 (5)		31(5)	4(3)	1(1)	37(5)	0	0	0	79(19)
6 to 8	4(4)	24(5)	19(6)	8(3)	22(5)	23(6)	0	1(1)	0	101(30)
8 to 10	28(5)	33(9)	2(1)	27(6)	15(4)	3(2)	1(1)	0	1(1)	110(29)
10 to 12	33(5)	31(6)	35(4)	16(5)	33(6)	9(4)	4(1)	1(1)	0	162(32)
Total	71(19)	88(20)	87(16)	55(17)	71(16)	72(17)	5(2)	2(2)	1(1)	452(110)

Note– (n) represents the no. of infants producing the CV combinations
Notes: LC=Labial Central, CC= Coronal Central, VC= Velar Central, LF=Labial Front, CF=Coronal Front, VF=Velar Front, LB=Labial Back, CB=Coronal Back, VB=Velar Back
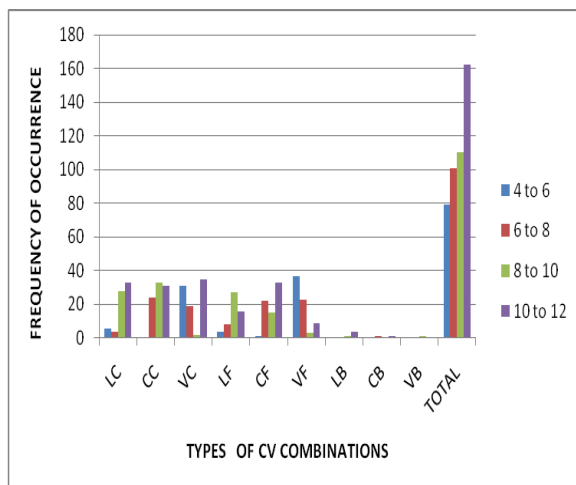

Fig.2 Types and Frequency of occurrences of CV combinations across age groups

Five types of associations such as LC, VC, LF, CF and VF were present in Group I (4 to 6 months). VF displayed the highest frequency of occurrence. Velars associated with front vowels are in support of the findings of [2] which had a similar CV production for Korean infants and by [18] for Tunisian and Dutch children. A high frequency of velar-front associations was also found in the Yoruba data of [6] Group II

(6 to 8 months) had 7 CV combinations of which CC (Mdn=.50, S.D=4.6) displayed its highest frequency of occurrence. Group III (8 to 10) infants produced 8 CV combinations. Similar to the infants of Group II, CC (Mdn=2.00, S.D=3.5) was the highest produced combination. Group IV (10 to 12 months) also had 8 CV combinations. The highest frequency of occurrence was present VC (Mdn=0.00,S.D= 6.4) followed by an equal count of LC (Mdn=.50, S.D= 3.4) and CF (Mdn=0.00,S.D=3.4) produced by 5 /10 infants and 6 / 10 infants respectively. Non-parametric Kruskal- Wallis test was carried out for the CV productions across all age groups. The test revealed significant effect of age only for CC {χ^2 (3) = 13.55, p<0.05} production. Since Kruskal Wallis was significant for CC production, Mann-Whitney U test was performed to exemplify the (test) significant difference across each pair of age groups as shown in Table 2.1

Table 2.1 Age comparison of CC production in Malayalam

Age pair(in months)lzl		
4 – 6	6-8	2.485[*]
	8-10	3.742[*]
	10-12	2.798[*]
6-8	8-10	1.506
	10-12	0.834
8-10	10-12	0.422

*Significant at p < 0.05

On pair-wise comparisons, the youngest age group had a significantly higher production of CC compared to the older age groups as shown in Table 2.1.It could be inferred that as age advanced the type and frequency of associations increased and CC productions decreased in frequency of occurrence. Velars with central vowels in Malayalam at 10 to 12 months of age are in support of the American and Swedish data which presented a high frequency of velar-central combinations. [6] LB, CB and VB were the least produced in each age group. [2] found that consonant–vowel association patterns were different between Korean Infant Directed Speech and Adult Directed Speech as well. 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) in Infant Directed Speech.

Comparison of Preferred consonant-vowel combinations across the languages Hindi and Malayalam

In conclusion, the findings of the present study show minimal preferences to the F/C theory in infants from 4 to 12 months in Hindi and Malayalam languages. The children in both the languages had variability in the CV co occurrences. However, both the language learning groups had shown more preference for central vowels which favored the F/C theory. This vowel preference was also present in other languages as well [6,14] French, Swedish and Yoruba) indicating the universal nature in babbling. With regard to the place of articulation of consonants in the CV combinations, labials were preferred in Hindi and velars in Malayalam as age advanced. This can be explained with the findings of [23] who reported a high occurrence of labials in adult Hindi speakers and [24] who reported velars as the highest in frequency of occurrence in conversation samples of adult Malayalam speakers. Thus, there is lenience towards the native ambient language. Another observation was that the exploration on CV preferences in Hindi reveals similar findings with that of other languages like French, Yoruba, American and Swedish, which could be attributed to the similar linguistic structure of these languages as they belong to the Indo-European language family. The observed findings in Malayalam had similarities to other languages like Korean, Mandarin and Cantonese indicative of their origin from the Dravidian language family tree. [7] In the present study, back vowels were not favored for CV combinations in both languages. This can be explained with a study on articulatory acquisition in Malayalam speaking children from 2 to 3 years by, [22] who reported that back vowels were the last to be mastered among the vowels. Hence, the study is also in consonance with the reports of [25] in English, French and Mandarin learning infants, showing preferences of CV combinations more frequent in babbling.

REFERENCES

1. Kent RD, Ferguson DC, Menn L, Stoel-Gammon C. The biology of phonological development. Phonological development: Models, research, implications. 1992:65-90.
2. MacNeilage PF, Davis B. Acquisition of speech production: Frames, then content.
3. Stoel-Gammon C. Prespeech and early speech development of two late talkers. First language. 1989 Jan;9(6):207-23.
4. Tyler AA, Langsdale TE. Consonant-vowel interactions in early phonological development. First Language. 1996 Jun;16(47):159-91.
5. Piske T. Phonological organization in early speech production: Evidence for the importance of articulatory patterns. Speech Communication. 1997 Aug 1;22(2-3):279-95.
6. de Boysson-Bardies B, Hallé P, Sagart L, Durand C. A crosslinguistic investigation of

vowel formants in babbling. Journal of child language. 1989 Feb;16(1):1-7.

7. Chan C. Consonant-vowel co-occurrence in early speech development of normal Cantonese-speaking children.

8. Gildersleeve-Neumann CE, Davis BL. Production versus ambient language influences on speech development in Quichua. In Presentation at the American Speech, Language, and Hearing Association Convention, San Antonio, TX 1998.

9. Davis BL, MacNeilage PF, Matyear CL, Powell JK. Prosodic correlates of stress in babbling: An acoustical study. Child Development. 2000 Sep;71(5):1258-70.

10. Rousset I. *Structures syllabiques et lexicales des langues du monde données, typologies, tendances universelles et contraintes substantielles* (Doctoral dissertation, Université Stendhal-Grenoble III).

11. Maddieson, I. (1984). *Patterns of Sounds.* Cambridge: Cambridge University Press.

12. Maneva B, Genesee F. Bilingual babbling: Evidence for language differentiation in dual language acquisition. In Proceedings of the Annual Boston University Conference on Language Development 2002 (Vol. 26, No. 1, pp. 383-392).

13. Delattre P. Comparing the phonetic features of English, French, German and Spanish: An interim report. Groos; 1965.

14. Vihman MM. Phonological development: The origins of language in the child. Blackwell Publishing; 1996.

15. Steffens ML, Oller DK, Lynch MP, Urbano RC. Vocal development in infants with Down syndrome and infants who are developing normally. American Journal on Mental Retardation. 1992 Sep.

16. Levelt C. Consonant-vowel interactions in child language. In Proceedings of the UBC International Conference on Phonological Acquisition 1996 (pp. 229-239).

17. Stout G, Hardin-Jones M, Chapman KL. An analysis of the frame-content theory in babble of 9-month-old babies with cleft lip and palate. Journal of communication disorders. 2011 Nov 1;44(6):584-94.

18. Kern S, Davis BL. Emergent complexity in early vocal acquisition: Cross-linguistic comparisons of canonical babbling. Approaches to phonological complexity. 2009:353-75.

19. Sussman HM, Minifie FD, Buder EH, Stoel-Gammon C, Smith J. Consonant-vowel interdependencies in babbling and early words: Preliminary examination of a locus equation approach. Journal of Speech, Language, and Hearing Research. 1996 Apr 1;39(2):424-33.

20. Swapna N, Jayaram M, Prema KS, Geetha YV. Intervention module for preschool children with communication disorders to facilitate speech-language domain. In Proceedings of All India Institute of Speech and Hearing, Mysore. 2010.

21. Maitreyee R, Goswami SP. Language proficiency Questionnaire: an adaptation of LEAP-Q in Indian context. Unpublished dissertation, University of Mysore, Mysore. 2009.

22. Divya, P. &Sreedevi, N. Articulatory acquisition in typically developing Malayalam speaking children: 2 -3 years. Students Research at AIISH Mysore: Articles based on Dissertation done at AIISH, Vol.VIII: 2009-2010, Part B,.281-290.

23. Ramakrishna BS. Some aspects of the relative efficiencies of Indian languages: a study from information theory point of view. Dept. of Electrical Communication Engineering, Indian Institute of Science; 1962.

24. Sreedevi N, Irfana M. Frequency of occurrence of phonemes in Calicut and Eranakulam dialects of Malayalam. Journal of the All India Institute of Speech & Hearing. 2013 Jan 1;32.

25. Giulivi S, Whalen DH, Goldstein LM, Nam H, Levitt AG. An articulatory phonology account of preferred consonant-vowel combinations. Language Learning and Development. 2011 Jul 1;7(3):202-25.

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