

**PHONOTACTIC PATTERNS IN CONVERSATIONAL SPEECH OF TYPICALLY
DEVELOPING CHILDREN AND CHILDREN WITH PHONOLOGICAL
IMPAIRMENT: A COMPARISON**

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Abstract

Typically developing children learn the phonotactic rules as they grow, whereas children with phonological impairment show phonetic as well as phonotactic limitations. The study aimed to analyze and compare the phonotactic patterns in conversational speech samples for syllable length, word shape, word length and integrity of phonotactic patterns in Hindi speaking typically developing children and children with phonological impairment. Participants were assigned to two groups. Group I (Study group) consisted of 4 Hindi speaking children with phonological impairment in the age range of 3 to 5 years. Group II (control group) consisted of 20 age matched typically developing children. Conversational speech sample was collected from each of the children from each group. 100 utterances were selected and transcribed using IPA. The transcribed sample was analyzed and percentage occurrence of various syllable shape, word shape, word length was calculated. Results revealed that the syllable shapes that were evident in both the groups were CV, CVC, VC, V, CCV, CVCC and VCC. No significant difference between the groups in terms of word length was observed. Monosyllabic structures were found to be more frequent when compared to bisyllabic structures and tri-syllabic words in both the groups. Error analysis revealed no mismatch between the syllable shapes of the target word and ones produced except few instances in CVC and CCVC structures. No significant difference between the syllable shape and word shape were observed in both the groups suggesting that the phonotactic integrity in subjects with phonological impairment was preserved.

Key words: Phonotactic patterns, syllable shape, word shape, phonetic integrity.

All possible sequences or types of sounds and morphemes do not occur in any single language. These restrictions are called 'phonotactics' or 'distributional constraints' by the structuralists and morpheme structure (MS) rules (Halle, 1968) or morpheme structure conditions (Stanley, 1967) by the generative phonologists. Words derive their structure not only from the sounds they include, but also from the organization of those sounds within the word. This organization is nothing but the phonotactic rules of the word, which describe the shape and sequence of its elements (Velleman, 1998). Languages spoken all over the world have their own phonotactic structure. Every language in the world has certain preferred word and syllable pattern, as well as patterns that are not preferred or even allowed. In generative phonology, two main functions are assigned to a morpheme structure: the 'possible' and 'impossible'. This explains why specific redundant patterns are seen in the lexicon of languages with regard to their segments and sequences of segments.

Typically developing children implicitly learn the rules of their language including phonotactic patterns as they develop. The most interesting and fascinating aspect of language development is the rapidity and apparent ease with which children acquire adult like form and rules of their native language. On the other hand, many children with disordered phonologies experience

phonotactic as well as phonetic limitations. While dealing with individuals with disordered phonology, major focus has been on individual sounds and not on how these sounds interact in the word i.e. phonotactic patterns. Many investigators (Bernhardt, 1994; Bernhardt & Stoel- Gammon, 1994; Velleman, 1998, and Velleman, 2002) have stressed the importance of addressing assessment and treatment of phonotactic errors in children with disordered phonologies. Ingram (1978) stressed the need to focus on syllable and word structures while correcting the phonological process errors in children, as the errors observed in such children is basically a reflection of errors in the syllable or word structures. For example, simplification of syllable structure gives rise to consonant cluster reduction and final consonant omission, deletion of unstressed syllable and reduplication suggests poor word integrity. Ingram (1978) further stated that the segmental complexity experienced as difficulty in executing a variety of speech sounds within the word interacts very closely with the complexity of the given syllable in terms of its shape and this in turn could harm the word processes that are evidenced as harmony patterns. As segmental complexity increases, syllable complexity may decrease and vice versa.

Many investigators have observed that phonological development in early years of a child is exclusively word or syllable based and

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does not refer to the segmental level. Velleman (1998) cites that many speech language clinicians observe that children of any age are able to generalize much better when sounds are targeted at syllable and / or word level rather than in isolation. Thus, before initiating a speech remediation program for children with impaired phonology it is essential to have a sound knowledge about the phonotactic constraints in a given language and how it develops in typically developing children.

As children grow older, they learn more complex syllable and word shapes. It is often seen that children with disordered phonology show developmentally inappropriate or unusual phonotactic constraints. Hence, it is essential to know how these patterns are developed in typically developing children in order to facilitate comparison between normal and disordered population. India is a multilingual country with 114 languages belonging to four distinct linguistic families: Indo-Aryan, Dravidian, Tibeto-Burman and Austro-Asiatic. The phonotactic structure of most of these languages is not known. Addressing this issue is especially relevant when it comes to the question of rehabilitation of children exhibiting phonological impairments. In this study a preliminary attempt is made to analyze the emerging phonotactic patterns in Hindi speaking typically developing children in the age range of 3 to 5 years in spontaneous elicited mode of communication and compare the same with the pattern seen in children with phonological impairment in the same age range. Studies in this direction are very scarce in Indian languages. Vani and Manjula (2006) and Neethipriya (2007) studied the phonotactic patterns in typically developing children speaking Kannada and Telugu languages respectively. But these studies did not attempt to compare the phonotactic patterns seen in typically developing children with the patterns seen in phonologically impaired children. The present study aims to analyze the phonotactic patterns seen in typically developing Hindi speaking children in the age range of 3 to 5 years and compare the same with the phonotactic patterns of age matched children with phonological impairment. Specifically, the phonotactic patterns of syllable shape, word shape, word length and integrity of phonotactic patterns in conversational speech samples of Hindi speaking typically developing children and children with phonological impairment were compared.

Method

Subjects: The participants included 2 groups based on whether they had a phonological impairment:

Group I (Study Group) consisted of 4 native speakers of Hindi with phonological impairment in the age range of 3 to 5 years with age appropriate language skills. The subjects were screened for age appropriate speech, language skills based on history, clinical observation and language assessment tool (LPT-Hindi, Karanth, 1984). The subjects were also screened for sensory impairment (hearing loss and/or visual impairment) and cognitive-linguistic deficits based on clinical observation. Oral mechanism examination (OME), and test for diadochokinetic rate of speech was carried out. Oro- motor deficits, developmental deficits and behavioral problems were assessed in the clinical observation session.

Group II (Control group) comprised of 20 typically developing individuals, matched for age and gender of the subjects in the experimental group. They were screened for any sensory motor abnormalities or impairments in structural or functional aspects of speech. All participants were native speakers of Hindi.

Material and Procedure: An informed consent was obtained in writing from the parents/ caregivers of all the subjects. Conversational speech samples were collected from each child in a quiet room. Interaction with the child involved asking questions to the child regarding his/ her daily activities and indulging in general conversation using toys and pictures appropriate to their mental age. Speech was recorded (Sony-MZ-55) using a digital voice recorder with an external microphone. For the purpose of phonotactic analysis, a portion of each speech sample, that is, at least 100 fluent utterances per child was transcribed using broad transcription IPA (International Phonetic Alphabet).

Analysis: The speech samples of the subjects were transcribed using broad IPA. A sample of 100 fluent utterances per child was selected and the words were analyzed for different syllable shapes, word shapes and syllable length. The occurrence of various syllable shapes, word shapes and clusters were calculated using the formula given by Velleman (1998):

$$\frac{\text{No. of CV syllables}}{\text{total no. of syllables}} \times 100 = \text{Percentage of CV syllables}$$

$$\frac{\text{No. of monosyllabic words}}{\text{Total no. of words}} \times 100 = \% \text{ monosyllabic words}$$

$$\frac{\text{No. of initial Consonant Cluster}}{\text{Total no. of Consonant Cluster}} \times 100 = \% \text{ initial Consonant cluster}$$

Similar analysis was carried out for various syllable shapes, word shapes and presence of different clusters. After the percentage was calculated for each type of syllable shapes, group means were calculated separately for the groups of subjects for comparison. Further, the word lengths were analyzed for different word shapes. An error analysis was carried out wherein the phonological errors (syllables and words) from the speech sample of the study group were analyzed separately for different syllable and word shapes.

Results and Discussion

The speech samples of all the subjects in both study and control group were analyzed by the first investigator for different phonotactic patterns. Intra-judge and inter-judge reliability measures were carried out. Intra-judge reliability included the first investigator repeating the process of transcription on 10% of the sample after a week. Inter-judge reliability measure involved an experienced Speech Language pathologist who was oriented and provided training to analyze phonological processes, transcribe 10% of the sample. Both the reliability measures were found to be above 85%. The results are presented under the following sections:

- I. Comparison of syllable shapes in the speech of typically developing children and children with phonological impairment
 - II. Comparison of word shape and word length in the speech of typically developing children and children with phonological impairment
 - III. Comparison of phonotactic integrity in the speech of typically developing children and children with phonological impairment
- I. Comparison of syllable shapes in the speech of typically developing children and children with phonological impairment:**

The type and frequency of occurrence of various syllable shapes in the speech samples of typically developing children (TD) who served as the control group and the children with phonological impairment (PI) were computed. The mean percentage occurrence of various syllable shapes and the SD was also computed. The same is shown in Table 1 and Figure 1. The different syllable shapes that were evident in the samples included: Vowel (V), Consonant-Vowel (CV), Vowel-Consonant (VC), Consonant-Vowel-Consonant (CVC), Consonant-Consonant-Vowel (CCV), Consonant-Vowel-Consonant-Consonant (CVCC), Consonant-Consonant-Vowel-

Consonant (CCVC) and Vowel-Consonant-Consonant (VCC).

As is seen from Table 1 and Figure 1, the syllable shapes which were observed to be the most frequently occurring pattern included the V, CV, VC, and CVC. Mann Whitney U Test was carried out to compare the mean percentage scores of the two groups. A significant difference was seen in V syllable shape at $p < 0.05$. No significant difference in the other syllable shapes was evident between the two groups. This suggests that the mean percentage occurrences of various syllable shapes (except V) were similar in both the groups studied.

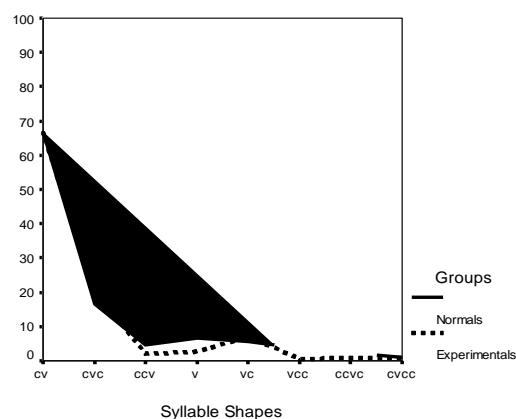


Figure1: Mean percentage occurrence of syllable shapes in TD and PI groups

Table 1: Mean percentage occurrence of different syllable shapes in TD and PI group

Syllable Shape	TD		PI	
	Mean % occurrence	SD	Mean % occurrence	SD
V	6.70	2.05	2.68	0.74
CV	66.97	5.93	66.90	3.65
VC	5.48	1.59	6.98	2.57
CVC	16.46	4.50	20.66	2.11
CCV	4.50	2.07	2.0	1.68
CVCC	0.85	0.39	0.92	0.48
CCVC	0.00	-	0.69	-
VCC	0.00	-	0.64	-

II. Comparison of word shape and word length in the speech of typically developing children and children with phonological impairment.

The mean percentage occurrence of different word shapes and the mean percentage occurrence of word length were computed and the same is represented in Table 2 and Figures 2, 3 & 4. The word length in the words spoken by the group of children in both the groups was limited to the following: Monosyllables, Bisyllables and Trisyllables. It is interesting to note that all these were evident in both PI as well as TD group. Further, in the monosyllable structures, the CV and CVC occurred more frequently and in both

the groups compared to the other syllable shapes that are listed in Table 2. In the Bisyllabic group, the CV, CV chains occurred more frequently compared to the other word shapes. In tri-syllable group, only two patterns (CV, CV, CV & CVC, CVC, CVC) were evident in both the groups. It can be inferred that there seems to be a developmental trend seen in both the groups of subjects and the pattern of word shapes that emerged in both the groups were the same.

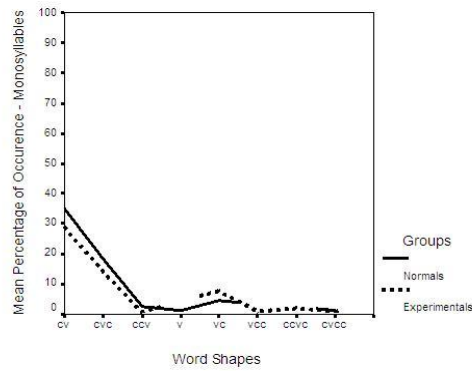


Figure 2: Percentage occurrence of Monosyllabic words in the TD and PI groups

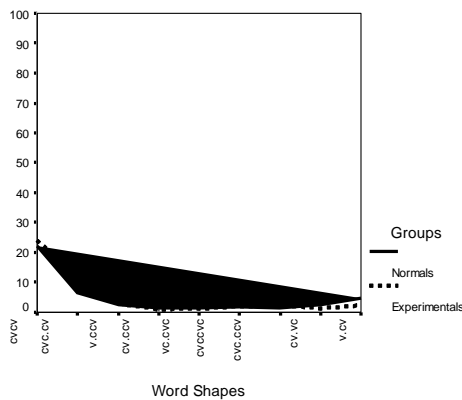


Figure 3: Percentage occurrence of Disyllabic words in the TD and PI groups

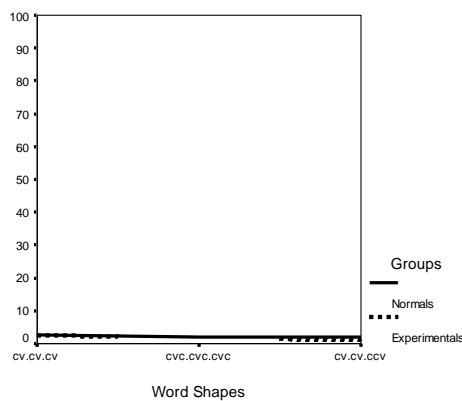


Figure 4: Percentage occurrence of Tri-syllabic words in the TD and PI groups

It is evident that in typically developing children as well as children with phonological impairment who were in the age range of 3 to 5 years, the word shapes that were acquired were restricted to tri-syllables. Since the study did not include children in the higher age groups, it is not possible to comment on the acquisition of syllable lengths such as quadric, penta and other polysyllables. However, the trend observed up to 5 years (the upper age limit of children studied speaking Hindi language) is similar to that reported in Kannada speaking children (Vani & Manjula, 2006) and Telugu speaking children (Neethipriya, 2007).

The results in this study is different from the observation of Vani and Manjula, (2006) in Kannada speaking children and Neethipriya (2007) in Telugu speaking children, who commonly observed that in monosyllable word shapes CV followed by VC and CVC occurred in that order. In the Hindi speaking children of both groups in this study only CV and CVC occurred in a hierarchy. The VC structures were seen less frequently in both the groups. This suggests that the PI group of children showed a pattern which is similar to that of their normal counterparts (TD), further supporting the observation that acquisition of the word shape of the native language was not deviant in these children. The frequency of occurrence of consonant clusters CCVC in Mono syllables and CCV, CVC in tri-syllables were very few in both the groups, suggesting that they were emerging patterns in Hindi speaking children. This trend is similar to what is reported in Kannada and Telugu by Vani and Manjula, (2006) and Neethipriya (2007) respectively.

III. Comparison of phonotactic integrity in the speech of children with phonological impairment.

An error analysis was carried out for the phonological errors seen in PI group, to see if the errors at syllabic level in a word matched with the expected syllable shape of that word. This is represented in Table 3. All the four children in the PI group showed no mismatch between the target syllable shape and the ones produced by them in most instances except in one to two instances in CCV and CCVC clusters. This suggests that for simple syllable shapes such as CV, VC and CVC, the phonotactic representations were preserved as per the language norms in these children, suggesting a mature phonotactic ability or integrity in these children just like their normal counterparts.

Table 2: Mean percentage occurrence of shape and length of words in TD and PI children

Word Length	Word Shape	Groups			
		TD		PI	
		Mean	SD	Mean	SD
Mono-syllable	V	1.42	0.50	0.00	-
	CV	35.10	5.43	29.00	5.83
	VC	4.50	2.39	7.75	4.11
	CVC	18.55	5.31	14.25	2.87
	CCV	2.50	1.46	1.0	-
	CCVC	1.33	0.57	2.0	1.41
	CVCC	0.00	-	1.0	-
	VCC	0.00	-	1.0	-
Di-syllable	CV, CV	22.05	6.71	24.00	-
	CV,CCV	1.70	1.05	1.00	4.69
	V,CV	5.00	2.00	2.33	-
	V,CCV	2.69	1.19	3.00	0.57
	CVC,CV	6.60	4.24	11.33	-
	CVC,CVC	1.53	0.64	2.00	2.30
	CCV,CVC	1.66	0.57	0.00	-
	VC,CV	2.00	0.89	3.0	-
					2.16
Tri-syllable	CV,CV,CV	2.53	1.06	3.66	-
	CVC,CVC,	0.00	-	2.00	2.88
	CVC				-

Table 3: Phonotactic integrity in the speech of children with phonological impairment

Misarticulated Syllable	Target Syllable				
	CV	VC	CVC	CCV	CCVC
CV	28	-	-	-	-
VC	-	15	-	-	-
CVC	-	-	28	-	-
CCV	1	-	1	-	-
CCVC	-	-	2	-	2

However, the few instances of scatter observed in the clusters CCV and CCVC suggests the possibility of an emerging/ maturing syllable shapes, thus reflecting on a delay in the acquisition of the higher order syllable shapes such as clusters. To generalize this observation, speech samples of more subjects with PI would be required.

Conclusions

The study revealed a distinct pattern of development of various syllable shapes, word shapes and word length in Hindi speaking typically developing children in the age group 3 to 5 years. When the data was compared with that of children with Phonological Impairment, no significant difference was seen in the syllable shapes and word shapes. The syllable shape which was most prominent in both the group was CV, followed by CVC and then VC. In terms of shapes and length of word, similar pattern was seen in both the groups. Monosyllabic words occurred more frequently, followed by disyllabic and tri-syllabic words. The similarity in terms of syllable shape, word shape and word length between TD children and PI children suggests that phonotactic repertoire in the PI children was not impaired although they did not meet the set

norms in terms of phonological patterns of the language. Very few consonant clusters were exhibited by children in both the groups which included CCV, VCC and CCVC, by the age of 5 years which probably implies that these were yet to mature / or were emerging structures in the developmental sequence. An error analysis of the misarticulated segments in the words of the PI group also revealed that there was clear phonotactic integrity, and the misarticulated segments were more of a phonological nature.

Implications of the Study

There has been no study carried out so far on the Phonotactic patterns in typically developing Hindi speaking children. This study has not only provided phonotactic information in terms of syllable shapes, word shapes and word length in Hindi speaking TD children between 3-5 years but it has allowed for comparison of the phonotactic patterns of Hindi speaking children with phonological impairment. The comparison has shown that phonological and not phonotactic errors predominated in children with PI. However, the inclusion of less number of subjects in the PI group does not facilitate generalization of results. The study needs to be replicated with more number of subjects in TD as well as PI group.

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