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Descriptive Analyses of Phonological Development in Typically Developing Hindi-Speaking Children

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Abstract

Phonology refers to the speech sound systems of a language. It involves the study of classification and organization of speech sounds in a language. The term 'phonemic' refers to speech sound use (functions/behavior/organization of the speech sound system). Most of the previous research reveals that phonological skills develop with age and thus older children had more accurate speech and fewer error patterns in their speech. However, in Indian contexts, limited studies are noted in the area of language development in typically developing Hindi-speaking children. Thus, the present study aimed to obtain extensive phonological data among in Hindi-speaking typically developing children across four age groups 4-4.5years, 4.5-5 years, 5-5.5 years, and 5.5-6 years. Following the guidelines of LARSP on sample collection, a series of toys and pictures were used and data was collected by video recording the interaction between the clinician and the client.

The results revealed that phonology develops significantly with the age. Thus, older children had more accurate production and fewer error patterns in their speech relative to younger group. A comparison with related studies has been discussed clearly in the paper which reveals a number of studies supporting the finding. The present study has significant implications for the assessment of developmental speech disorders among Hindi-speaking group of Indian population

Keywords: Phonological development, Indian population

Introduction

Language refers to a systematic and conventional use of sounds (signs or symbols) for the purpose of communication and expression (Crystal, 1995[1]). It is defined as a complex and dynamic system of conventional symbols that is used in various modes for thought and communication (American Speech and Hearing Association, 1996[2]). It refers to a rule based system of symbolic

communication involving a set of small unit (syllables or words) that can be combined to yield an infinite number of larger language forms (Hoff & Naigles, 2002[3]).

During the development of language among typically developing children, the phonological and communicative acquisitions precede and thus prepare the child with the process of language acquisition. Infants are not only responsive towards speech but they are also skilled at making speech discrimination, right at the infancy stage. By 4-6 months a child begins to babble until the first words arrive at 1-1.6 years. Babbling appears to lead the child into words. Before words appear, children seem to have already acquired some communicative skills, generally requesting and asserting skills (Bruner, 1975[4]; Bates, 1976[5]). Consequently, the first words are produced between 10-15 months of age. These are hard to distinguish from the 'protowords'. These words may be context bound, situation-specific or function-specific and referential (Hoff, 2009[6]). Among initial words, the noun meanings are much consistent to verb meanings (Gertner & Boroditsky, 2001[7]).

Language development is a process starting early in human life. Infants start without language, yet by 4 months of age, babies discriminate speech sounds and engage in babbling. The goal for many researchers who study language development is perhaps less grandiose than discovering how the mind works, but is more immediate. Success in modern industrialized society depends on good verbal skills and acquiring the verbal skills that society requires is problematic for some children (Hoff, 2009[6]).

Development of Phonology

Phonology refers to the speech sound systems of a language. It involves the study of classification and organization of speech sounds in a language (Vihman, 1996[8]). Phonology encompasses all aspects of the sound system including the speech production and perception. Phonological structure has two components, a limited repertoire of sounds (phonemes) representing various classes (based on physiological and acoustic characteristics) and a set of phonotactic rules defining how these phonemes can be arranged into syllables (Hodson & Paden, 1981[9]).

As children expand their vocabulary of words, they also demonstrate an emerging phonological system. The development of phonology is not an immediate process. Children cannot immediately learn the entire array of phonemes instead they progress gradually from mastery of the simpler sounds and then arrangement to these sounds into more complex ones. Developmental phonologists have observed that a young child usually makes these substitutions and omissions in predictable ways. Thus, even the child's technique for coping with speech inadequacies is systematic (Markman, Wasow & Hansen, 2003[10]).

Phonological development refers to the acquisition of speech sound form and function within the language system (Mandel, Jusczyk & Pisoni, 1995[11]). The acquisition of various speech sounds is intricately connected to the child's overall growth in language (Bauman-Waengler, 2004[12]). The speech sound development refers, primarily, to the gradual articulatory mastery of speech sound forms within a given language. The child's language development is commonly divided into pre-linguistic behavior, vocalizations prior to the first true words and linguistic development, which starts with the appearance of these first words. Error patterns (sometimes referred to as phonological processes) are a measure frequently used to describe a child's phonological system. Originating in Natural Phonology (Stampe, 1969[13]) and widely adopted in the field of child phonology (Ingram, 1986[14]), phonological processes are defined as a set of mental operations that change or omit phonological units as the result of the natural limitations and capacities of human vocal production and perception (Burt, Holm & Dodd, 1999[15]).

From shortly after birth to around one year, a typically developing infant starts to make speech sounds. At around two months, the baby will engage in cooing which is followed by babbling at around four months. In this 0-8 months range, the child is engaged in vocal play of vegetative sounds, laughing, and cooing. Once the child hits the 8-12 month range the child engages in canonical babbling This jargon babbling with intonational contours the language being learned (Owens, 2012[16]). From 12-24 months, babies can recognize the correct pronunciation of familiar words. Babies will also use phonological strategies to simplify word pronunciation. By 24-30 months awareness of rhyme emerges as well as rising intonation. By 36-60 months, phonological awareness continues to improve as well as pronunciation. By 6–10 years, children can master syllable stress patterns which helps distinguish slight differences between similar words (Eva, 2011[17]).

Moreover, another important issue appears to be the development of Prosodic Words. This appears to be depending on the distribution of word and foot structures found in the target language. Recent research by Paul (2007) [18] has also examined the development of syllable structures. The research indicated that coda consonants are more likely to be produced in stressed and final syllables, both of which exhibit increased duration, suggesting that this facilitates the articulation of more segments. Another research has focused on the acquisition of word-final clusters, raising questions about the competing contributions of frequency, morphology, and structural/sonority/articulatory factors in predicting the course of cluster acquisition across languages (Paul, 2007[18]).

Recent studies that focus on the similar area of phonology acquisition deal with the relationship between perception and production (Fikkert, 2007[19]). Infant speech perception suggests that segmental inventories and knowledge about phonetic and prosodic structure is largely acquired in

the absence of a lexicon. In fact, it needs to be acquired before lexical learning can even start, as it guides word segmentation. However, research in child production has argued that children gradually build up a system of phonological contrasts, phonotactics and prosodic structure.

McNamara & Antony (2010) [20] revealed that Phonological contrasts and Phonotactics which develop at early stages, guide the word segmentation and all other lexical feature development in future.

There is an increasing evidence that bilingual children are able to separate their languages from the earliest stages of language production, but very little data come from phonological acquisition studies. Johnson & Lancaster (1998) [21] investigated the lexical forms and speech sound production of a child learning Norwegian and English bilingually from birth.

To acquire the native language, a child must do two things: Learn the words of the language and extract the relevant phonological characteristics of those words. Some lines of investigation concentrate exclusively on how the words of the language are acquired (e.g., Carey & Bartlett, 1978[22]; Dollaghan, 1985[23]; Heibeck & Markman, 1987[24]; Jusczyk & Aslin, 1995[25]; Rice & Woodsmall, 1988[26]), whereas other lines of research examine how the sounds of the language emerge (e.g., Dinnsen, Chin, Elbert, & Powell, 1990[27]; Smit, Hand, Freilinger, Bernthal, & Bird, 1990[28]; Stoel-Gammon, 1985[29]). Storkel & Morrisette (2002)[30] investigated the importance of the link between lexical and phonological acquisition and by applying cognitive models of spoken word processing to development. Lexical and phonological variables that have been shown to influence perception and production across the lifespan are considered relative to their potential role in learning by preschool children. The model appears to offer insights into the complex interaction between the lexicon and phonology and may be useful for clinical diagnosis and treatment of children with language delays.

Sound Acquisition

Children's speech sound development can be analyzed in two ways: phonetic versus phonemic acquisition. The term 'phonetic' refers to speech sound production (articulatory/motor skills). The term 'phonemic' refers to speech sound use (functions/behavior/organization of the speech sound system). Most previous research has conducted phonemic analyses on consonants. In a phonemic approach, children's production of sounds in word contexts are usually examined in terms of degree of production accuracy and the percentage of children of an age group who reached the level of accuracy in phoneme production. Researchers need to decide: whether a sound has to be produced correctly in all word positions (word initial,-medial and -final) or only in word-initial and -final position (e.g.,

Wellman, Case, Mengert & Bradbury, 1931[31]; Poole, 1934[32]; Templin, 1957[33], required correct production in three positions; Prather et al., 1975[34]; Smit et. al., 1990[28], required correct production in only two positions); the required minimum percentage of children of an age group who can produce a sound correctly as defined in the first criterion (e.g., 75% in Wellman et al., 1931[31]; Templin, 1957[33]; Prather et al., 1975[34]; 100% in Poole, 1934[32]). Table 1 summarizes the criteria used, demographic characteristics and age of sound acquisition in some of the well-cited studies. Variations exist between the sample size, age range of the subjects, elicitation techniques, criteria used and data presentation.

Table 1. *An overview of studies on phoneme acquisition*

	Wellman (1931)	Poole (1934)	Templin (1957)	Olmsted (1971)	Prather (1975)	Smit (1990)
Subject no.	204	65	480	100	147	997
Age range	2;0–6;0	2;6–8;6	3;0–8;0	1;3–4;6	2;0–4;0	3;0–9;0
Area	Iowa	Michigan	N/A	N/A	Seattle	Iowa/Nebraska
Speech mode	S and I	S and I	S and I	S	S	S
Word-position	I, M, F	I, M, F	I, M, F	I, M, F	I, F	I, F
% age group	75%	100%	75%	50%?	75%	N/A
Acquired first	m, n, b, f, w, h	m, p, b, w, h	m, n, ŋ, p, f, w, b	—	m, n, ŋ, p, h	m, n, p, b, d, w
Acquired last	ŋ, θ, ð, ʒ, dʒ	θ, s, z, ɹ	ð, z, ʒ, dʒ	ŋ, ð, ʒ, tʃ, dʒ	v, θ, z, dʒ	ŋ, s, z, ɹ
m	3	3;6	3	<4	2	3
n	3	4;6	3	<4	2	3;6 f, 3 m
	>6	4;6	3	>4	2	7–9
p	4	3;6	3	<4	2	3
b	3	3;6	4	<4	2;8	3
t	5	4;6	6	<4 I, F; >4 M	2;8	4;6f, 3;6m
d	5	4;6	4	<4	2;4	3f, 3;6m
k	4	4;6	4	<4	2;4	3;6
g	4	4;6	4	<4	3	3;6f, 4m
f	3	5;6	3	<4	2;4	I: 3;6; F: 5;6
v	5	6;6	6	<4	>4	5;6
θ	>6	7;6	6	<4 M, F; >4 I	>4	6f, 8m
ð	6	6;6	7	>4	4	4;6f,7m
s	5	7;6	4;6	>4	3	7–9
z	5	7;6	7	<4 M, F; >4 I	>4	7–9
ʃ	No info.	6;6	4;6	<4	3;8	6f, 7m
ʒ	6	6;6	7	>4	4	No info.
tʃ	5	No info	4;6	<4 F; >4 I, M	3;8	6f, 7m
dʒ	6	No info	7	<4 M; >4 I, F	>4	6f, 7m
l	4	6;6	6	<4 I; >4 M, F	3;4	I:5f, 6m; F:6f, 7m
ɹ	5	7;6	4	<4	3;4	8
w	3	3;6	3	<4	2;8	3
j	4	4;6	3;6	No info	2;4	4f, 5m
h	3	3;6	3	No info	2	No info

Notes:
1. For the row word position, I, M and F refers to word-initial, -medial and -final positions.
2. % age group refers to the minimum percentage of children of an age group required in deciding the acquisition of phoneme.
3. In the Speech mode row, S and I refer to spontaneous production or imitation.
4. In the results section, Olmstead (1971) and Smit *et al.* (1990) list different age of acquisition for some of the phonemes at different word positions. Smit *et al.* also list different age of acquisition for some of the phonemes by girls (indicated by f) and boys (indicated by m).
5. The number of sounds listed for the rows 'sounds acquired first' and 'sounds acquired last' is limited to about 5 sounds.

Among the six studies, the findings of Wellman et al. (1931) [31] and Templin (1957)[33] are most similar: the same age of acquisition was reported for seven sounds, with a difference of 1 year on 11 sounds and a difference of 2 years on two sounds.

The resemblance may reflect use of the same criteria. The differences in age of acquisition of some sounds, however, could reflect a difference in the two tests in the complexity of target words (Ingram, Christensen, Veach & Webster, 1980[35]). Syllable length, together with familiarity of the lexical items, may have affected phoneme production. Ingram et al. (1980) [34] found that accuracy of word-initial fricatives is reduced in words with greater syllable length while Badar (2002) [36] found that phoneme production consistency also tends to deteriorate with increasing syllable complexity. This factor may also account, in part, for differences in the reported age of acquisition in different studies. Prather et al. (1975) [37] consistently found earlier age of acquisition for the same sounds than other studies. This may reflect the inclusion of a lower age group of children in their study. Smit et al. (1990) [28] were the only ones to include children who were receiving intervention for articulation in the cohort in an effort to more closely represent the population on which to base norms. Their criteria for determining age of acquisition are unclear. They used a 90% accuracy level (i.e., correct production of a sound against the number of attempts to produce a target sound) when deciding the age of acquisition. However, they do not specify the percentage of each age group required to be able to use the sound correctly to assign age of acquisition. Despite differences in their sample size, elicitation methods, criteria used in the analysis and findings, these studies have consensus on the status of some sounds. As shown in table 1, children tend to acquire /m, n, p, b, w/ earlier than other sounds while /h, th, s, z, dz, / seem to be among the last group of sounds they acquire. This is consistent with findings of some studies using a distinctive feature approach.

Another research by Dodd, Holm, Hua & Crosbie (2003) [37] aimed to provide normative data for the phonological development of British English-speaking children. The results revealed that phonological skills developed with age and thus older children had more accurate speech and fewer error patterns in their speech. Moreover, the analyses of gender differences during the study revealed that girls displayed higher levels of phonological accuracy compared to boys. Also, children from higher socio-economic families had superior phonological skills than their peers from lower socio-economic families.

Research in Indian Context

In the Indian contexts, limited studies are noted in the area of language development in Hindi-speaking children. Within the area of Speech-Language Pathology, the topics that have drawn the

interest of Indian researchers over the past few decades include the acquisition of language in children, and the disorders of language in children and in adults (Karanth, 1993[38]). These studies are documentative in nature and are aimed at determining the level of normality of language development. The area of language disorders has witnessed sporadic attempts at test construction and standardization (Jayaram, 1993[39]). It has been noted that work in the areas of language acquisition, has been conducted in collaboration with linguists (Karanth, 1993[38]). Aspects of acquisition on phonology and syntax in languages like Tamil (Venugopal, 1981[40]), Kannada (Sreedevi, 1976[41]; Subramanya, 1978[42]; Prema, 1979[43]; Vijayalaxmi, 1981[44]; Uma, 1993[45]), Hindi (Varma, 1979[46]; Roopa, 1980[47]); and Marathi (Ghore, 1982[48]) have been documented. These studies have generally described the acquisition of some aspects of phonology, morphology or syntax in a few children in the age range of 2 to 6 years.

A few more comprehensive studies of language acquisition both cross sectional and longitudinal have been undertaken by people from allied disciplines (Karanth, 1993) [38]. Within the area of child language acquisition, the effects of bilingualism (Thirumalai and Chengappa, 1986[49]), and development of a pragmatic model of language acquisition (Narasimhan, 1981[50]) have been attempted. There has been an attempt at providing a language developmental index, by looking at responses of children to certain language tasks, based on Gessel's model (Bevli, 1983[51]). This study mainly reports on lack of stimulation in rural areas in preschool years and hence less able functioning compared to urban children. Most of these studies have attempted to focus on the available syntactic knowledge of children at the time of the study.

To conclude, it is evident from the above literature that most of the research in the area of language analysis and characteristics is carried out through dissertations and unpublished research papers. Thus, it is very important to carry out detailed linguistic analyses on a large scale in order to develop formal data to be used in future for clinical purposes.

Hindi: A Language Spoken in Northern Parts of India

Hindi, or more precisely *Modern Standard Hindi*, is a standardized and Sanskritised register of the Hindustani language (Hindi-Urdu). Hindustani is the native language of people living in Delhi, Haryana, Western Uttar Pradesh, Bihar, north-eastern Madhya Pradesh, and parts of eastern Rajasthan, and Hindi is one of the official languages of India. Hindi is the fourth largest language in the world by native speakers. Hindi is a direct descendant of Sanskrit through Prakrit and Apabhramsha. It has been influenced and enriched by Dravidian, Turkish, Farsi, Arabic, Portugese and English. In poetry and songs, it can convey emotions using simple and gentle words. It can also be

used for exact and rational reasoning. More than 180 million people in India regard Hindi as their mother tongue. Another 300 million use it as second language. People who identify as native speakers of Hindi include not only speakers of Standard Hindi, but also many speakers of Hindi languages family, who consider their speech to be a dialect of Hindi. In the 2001 Indian census, 258 million people in India reported Hindi to be their native language; as of 2009, the best figure *Ethnologue* could find for speakers of actual Hindustani Hindi (effectively Khariboli dialect less Urdu) was a 1991 figure of 180 million. The Constitution of India has effectively instituted the usage of Hindi and English as the two languages of communication for the Union Government. Most government documentation is prepared in three languages: English, Hindi, and the primary official language of the local state, if it is not Hindi or English.

As evident from above information, among the above studies very limited phonological data is available on children speaking in Hindi language. Hence, it is difficult to visualise and describe language acquisition among the Hindi-speaking typically developing children. It is essential that systematic, observational and experimental study of language acquisition in children in these Hindi-speaking children needs to be conducted for developing both assessments and intervention programmes. The trends of research in the field of speech and language development, assessment and intervention have focused on confirming deviance or disorder from comparison with typically developing population and in the recent years the relationship between language performance on phonological awareness, Morphology and pragmatic development. Thereby, the present study focuses on developing a data on phonological development in Hindi-speaking typically developing children and thus tries to improvise the language analysis data among this group of children.

Aim of the Study

The present study aims to obtain extensive language data in Hindi-speaking typically developing children with the objectives of:

1. *Analysing the phonological development across children among four age groups;*

   4-4.5years, 4.5-5 years, 5-5.5 years, and 5.5-6 years

2. *A comparison of phonological processes among the children belonging to above groups.*

Methodology

The study envisaged obtaining a audio-video taped conversational sample with typically developing children and subjecting the language data to analysis. The analyses are planned at phonetic and phonological levels.

Subjects

Twenty typically developing children participated in the present study. These children were native speakers of Hindi, within the age range of 4 years to 6 years. They attended a normal school and had no history of speech, language and hearing problems. These children were further grouped into 4 subgroups of 6 monthly age range; five children each in age levels of *4-4.5years, 4.5-5 years, 5-5.5 years, and 5.5-6 years*

Data Collection and Analysis

Following the guidelines of LARSP (Crystal, D., Fletcher, P., & Garman, M., 1976[52]; 1989[53]) on sample collection, a series of toys and pictures were used.

Interaction of clinician-child and parent-child during play for about 25 to 30 minutes was done. Only one child was interacted at a time. Initial 20 minute of spontaneous speech elicitation or free conversation and final 10 minutes of elicited responses for prompted situations, with topics not related to immediate surroundings.

Each of the utterance of the Therapist (T) and Pupil/subject (P) was transcribed verbatim, within few hours of recording on the same day. Each of the sentence was written down on a separate line and marked as either T's or P's utterance appropriately. The clues provided during the recording session were also written down during transcription. The transcribed data was then be checked twice by the investigator for accuracy, when in doubt another qualified speech-language pathologist rechecked the transcription. The sample thus obtained was scanned to cover phoneme development as well as presence of phonological processes for all the groups.

Hindi vowels and consonants were selected from an established test in Hindi, Lingustic Profile Test (Karanth, 1983[38]). This test under section-1.B 'Phonetic expression' consists of 52 target sounds for evaluation in different word positions, initial and medial. The target sounds selected for phonetic analysis corresponds to the description of Hindi phonology. In all 10 vowels, 2 diphthongs and 21 consonants in different positions were selected. The presence or absence of these phonemes was checked. In case of articulation errors, the words were analysed for phoneme substitution, omission, distortion or addition. Also, presence of phonological processes was noted and described in detail during the analyses.

Results

The comparisons of presence and absence of phonemes has been made within and across the four age groups. The results for all the groups are clearly indicated in the tables, as follows:

Consonants

Table 2: Mean Scores of phonemes and Percentage of children using the phonemes across various Age groups

				4-4.5years		*4.5-5 years*		*5-5.5 years*		*5.5-6 years*	
MANNER	**PLACE**	**VOICING**	**EX.**	**Mean**	**% Score**	**Mean**	**% Score**	**Mean**	**% Score**	**Mean**	**% Score**
Stops	**Bilabial**	**Voiceless**	**p**	**3**	**100**	**3**	**100**	**3**	**100**	**3**	**100**
		Voiced	**b**	**3**	**100**	**3**	**100**	**3**	**100**	**3**	**100**
	Alveolar	**Voiceless**	**t**	**1.6**	**53.3**	**3**	**100**	**3**	**100**	**3**	**100**
		Voiced	**d**	**1.6**	**53.3**	**3**	**100**	**3**	**100**	**3**	**100**
	Velar	**Voiceless**	**k**	**3**	**100**	**3**	**100**	**3**	**100**	**3**	**100**
		Voiced	**g**	**3**	**100**	**3**	**100**	**3**	**100**	**3**	**100**
Affricates	**Palatal**	**Voiceless**	**ch**	**1.8**	**60**	**2.8**	**93.3**	**3**	**100**	**3**	**100**
		Voiced	**dz**	**2.2**	**73.3**	**2.8**	**93.3**	**3**	**100**	**3**	**100**
Fricatives	**Labiodental**	**Voiceless**	**f**	**3**	**100**	**3**	**100**	**3**	**100**	**3**	**100**
		Voiced	**v**	**1.2**	**40**	**3**	**100**	**3**	**100**	**3**	**100**
	Interdental	**Voiceless**	**th**	**3**	**100**	**3**	**100**	**3**	**100**	**3**	**100**
		Voiced	**dh**	**3**	**100**	**3**	**100**	**3**	**100**	**3**	**100**
	Alveolar	**Voiceless**	**s**	**1.6**	**53.3**	**2.6**	**86.6**	**2.8**	**93.3**	**3**	**100**
		Voiced	**z**	**0**	**0**	**0.4**	**13.3**	**2.2**	**73.3**	**2.6**	**86.6**
	Palatal	**Voiced**	**zh**	**0**	**0**	**1.8**	**60**	**3**	**100**	**3**	**100**
	Velar	**Voiceless**	**h**	**3**	**100**	**3**	**100**	**3**	**100**	**3**	**100**
		Voiced	**x**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Nasal	**Bilabial**		**m**	**3**	**100**	**3**	**100**	**3**	**100**	**3**	**100**
	Alveolar		**n**	**3**	**100**	**3**	**100**	**3**	**100**	**3**	**100**
	Velar		**n'**	**1.2**	**40**	**2**	**66.6**	**2.4**	**80**	**3**	**100**
			n.	**0**	**0**	**0**	**0**	**0.8**	**26.6**	**2**	**66.6**
Liquids	**Alveolar**	**Lateral**	**l**	**3**	**100**	**3**	**100**	**3**	**100**	**3**	**100**
		Flap	**rd**	**0**	**0**	**0**	**0**	**1.4**	**46.6**	**1.4**	**46.6**
		Trill	**r**	**0**	**0**	**1.2**	**40**	**3**	**100**	**3**	**100**
	Palatal	**Retroflex**	**rh**	**0**	**0**	**0**	**0**	**1.4**	**46.6**	**2**	**66.6**
Semi-vowels	**Bilabial**		**w**	**1.2**	**40**	**3**	**100**	**3**	**100**	**3**	**100**
	Palatal		**y**	**2.6**	**86.6**	**3**	**100**	**3**	**100**	**3**	**100**
Aspiration	**Bilabial stop**	**Voiceless**	**ph**	**3**	**100**	**3**	**100**	**3**	**100**	**3**	**100**
		Voiced	**bh**	**3**	**100**	**3**	**100**	**3**	**100**	**3**	**100**
	Interdental	**Voiceless**	**th**	**0.8**	**26.6**	**1.4**	**46.6**	**3**	**100**	**3**	**100**
		Voiced	**dh**	**0**	**0**	**0.6**	**20**	**3**	**100**	**3**	**100**

	Fricative										
	Alveolar stop	**Voiceless**	**t'h**	**0**	**0**	**0.8**	**26.6**	**3**	**100**	**3**	**100**
		Voiced	**d'h**	**0**	**0**	**0.4**	**13.3**	**3**	**100**	**3**	**100**
	Velar stop	**Voiceless**	**kh**	**2**	**66.6**	**2.2**	**73.3**	**3**	**100**	**3**	**100**
		Voiced	**gh**	**2**	**66.6**	**2.2**	**73.3**	**3**	**100**	**3**	**100**
	Palatal affricate	**Voiceless**	**chh**	**0**	**0**	**0.8**	**26.6**	**3**	**100**	**3**	**100**
		Voiced	**dzh**	**0**	**0**	**0.6**	**20**	**3**	**100**	**3**	**100**

Across Group Comparison

As per Table 2, it is noted that phoneme development across various age groups takes place in the following manner:

1. **Stops**

a) **Bilabial stops** as well as **Velar stops** (both voiceless and voiced) develop completely within 4 years of age in all the word positions.

b) **Alveolar stops:** In 4-4.5years the alveolar stops develop only in 53.3% of children and that too only in initial position. In the remaining children, these sounds develop completely only after 4.5 years of age.

2. **Palatal Affricates**

In 4-4.5 years, the **voiceless palatal affricates** develop only in 60% of children, mainly in initial and final position. The occurrence of these sounds increases to all positions with 93.3% of children producing these sounds. Then, the development of these sounds completes in all positions by 5 years of age.

The **voiced palatal affricates** are present in about 73.3% of children within 4-4.5 years of age, mainly in initial position. Slowly, by 4.5years, these sounds start developing in final position too though development in medial position is limited for about 93.3% of children. Like the voiceless sounds the voiced palatal affricates also complete the development by 5 years of age.

3. **Fricatives**

a) **Labio-dental fricatives (LDF)**: The voiceless LDF develop in all the word positions by 4 years itself. However, the voiced LDF develop in initial and final position in only 40% of the children by

4 years of age. In the rest 60% of the children, these sounds develop only after 4.5years, in all the word positions.

b) **Inter-dental fricatives (IDF)**: The voiceless as well as voiced IDF develop by 4 years of age.

c) **Alveolar fricatives (AF)**: The development of voiceless AFs just begins at 4 years and completely only after 5.5years in all the word positions. However, the voiced AFs begin to occur only by about 5 years of age and complete its development only after 6 years.

d) **Palatal fricatives (PF)**: the voice PF begins to develop only after 4.5years of afe and completes its development by 5.5 years in all the positions.

e) **Velar Fricatives (VF)**: The voiceless VF completes its development by 4.5 years of age. However, the voice VF starts to develop only after 6 years of age.

4. **Nasal**

All the nasal sounds, mainly **bilabial** and **alveolar nasals** develop within 4 years of age. The **velar nasals** begin to develop a little later in about 5 years and are generally substituted by alveolar nasals till 6 years.

5. **Liquids**

a) **Alveolar laterals (AL**): Completes its development within 4 years in all the positions.

b) **Alveolar flap (AF)**: starts to develop only after 5 years of age and continues to develop beyond 6years

c) **Alveolar trill (AT)**: Starts to develop only after 4.5 years of age and its development completes by about 5-5.5 years

d) **Palatal retroflex (PR)**: Begins to develop only after 5 years and continues its development even after 6years of age.

6. **Semi-vowels**

Bilabial Semi-vowels (BSV) and Palatal Semi-vowels (PSV): Starts to develop only after 4years of age and completely by 4.5years

7. **Aspirated Sounds**

a) **Aspirated Bilabial Stops (ABS):** Both voiced and voiceless develop by 4 years of age.
b) **Aspirated Inter-dental fricatives (AIDF)**: Both voiced and voiceless AIDF begin to develop by 4.5years and completes its development by 5.5 years
c) **Aspirated Alveolar Stop (AAS)**: Both voiced and voiceless AAS begin to develop by 4.5years and completes its development by 5.5 years
d) **Aspirated Velar stop (AVS)**: Both voiced and voiceless begin to develop by 4 years and complete by 5.5years in all positions
e) **Aspirated Palatal affricates (APA)**: Both voiced and voiceless begin to develop by 4.5 years and complete by 5.5years in all positions

Within Group Comparison

Sounds which complete their development at all positions by 4 years of age are:

1. Bilabial stops
2. Velar Stops
3. Voiceless Labio-dental Fricatives
4. Inter-dental Fricatives
5. Voiceless Velar fricatives
6. Bilabial nasal
7. Alveolar Nasal
8. Lateral Alveolar Liquids
9. Aspirated Bilateral Stops

Sounds which develop within 4-6 years of age are:

1. Alveolar Stops
2. Palatal Affrivates
3. Voiced Labio-dental Fricatives
4. Voiceless Alveolar Fricatives
5. Palatal Fricative
6. Semi-vowels (Bilabial and Palatal)
7. All other Aspirated Sounds

By 6 years, all the children complete their phonological repertoire with all sounds present adequately in all the word positions, except for voiced Alveolar Fricatives, voiced Velar Fricatives, velar nasals, alveolar flap and palatal retroflex.

Table 3: Phoneme development chart

4 - 4.5 years	4.5 - 5 years	5 - 5.5 years	5.5 – 6 years
← p →	← t →	← ch →	← s →
← b →	← d →	← dz →	
← k →	← v →	← zh →	
← g →	← w →	← r →	
← f →	← y →		
← th →			
← dh →			
← h →			
← m →			
← n →			
← l →			

Vowels

The acquisition of vowels has been described in the Table 4 below, across various groups:

Table 4: Vowel development chart

VOWELS	4.0-4.5 years	4.5-5.0 years	5.0-5.5 years	5.5-6.0 years
/a/	Acquired	Acquired	Acquired	Acquired
/a:/	Acquired	Acquired	Acquired	Acquired
/i/	Acquired	Acquired	Acquired	Acquired
/i:/	Acquired	Acquired	Acquired	Acquired
/u/	Acquired	Acquired	Acquired	Acquired
/u:/	Acquired	Acquired	Acquired	Acquired
/e/	Substituted by /ae/	Substituted by /ae/	Acquired	Acquired
/o/	Acquired	Acquired	Acquired	Acquired
/o:/	Substituted by /o/	Substituted by /o/	Acquired	Acquired
/ae/	Acquired	Acquired	Acquired	Acquired
/ai/	Substituted by /e/	Substituted by /e/	Acquired	Acquired
/ia/	Acquired	Acquired	Acquired	Acquired
/ie/	Acquired	Acquired	Acquired	Acquired

/ui/	Acquired	Acquired	Acquired	Acquired
/ua:n/	Substituted by /ua:/	Substituted by /ua:/	Acquired	Acquired
/oi/	Acquired	Acquired	Acquired	Acquired
/oe/	Acquired	Acquired	Acquired	Acquired
/iu/	Substituted by /u/	Acquired	Acquired	Acquired

As per Table 4, it is noted that major vowel development completes by the age of 4 years. The across group comparison shows that a few long vowels (/o:/, /e/) as well as complex diphthongs (/iu/, /ua:n/, /ai/) remain substituted by simpler form until 5years of age after which the development completes.

Discussion

The conversational samples of twenty typically developing Hindi-speaking children, aged between 4.0 and 6.0 years, were analyzed to obtain normative data. The main aspect of speech development that was considered is the age of acquisition of sounds (phonetic acquisition) It was hypothesized that phonological skills would develop with age. The results supported this hypothesis. Older children had more accurate production and fewer error patterns were evident in their speech. No gender differences were found in both younger and older age groups.

It was noted in the results that children's speech becomes more accurate as they get older. They articulate more sounds correctly and use fewer error patterns. Analyzing performance in six-monthly age bands revealed a gradual progression of speech accuracy. Significant differences were identified between groups of children aged 4.0-4.5 years; 4.5-5.0 years; 5.0-5.5 years and 5.5–6.0 years. Differences were found between the four age groups on the Mean Scores of phonemes acquired and Percentage of children using the phonemes accurately. The percentage of consonants and sounds that the children produced correctly was noted along with the position (initial, medial and final) in which various sounds were produced accurately. The accuracy of sounds increased with age. The two younger groups differed from the two older groups on the percentage of sounds they produced correctly. Ceiling effects were noted which means that the two older age groups did not differ much on sound accuracy. Moreover, it is noted that the acquisition of vowels gets completed by the age of four. However, few long vowels (/o:/, /e/) as well as complex diphthongs (/iu/, /ua:n/, /ai/) continued to develop until the age of five. Therefore the simple vowels are not assessed explicitly in most

normative studies (Bankson & Bernthal, 1998)[54]. However, James (2001) [55] argued that the acquisition of vowels continues after the age of three. Allen & Hawkins (1980) [56] found that children mastered vowels in stressed syllables by 3 years of age but did not master vowels in unstressed syllables until they were 4–5-years old. Further research is required to describe how normally developing children acquire vowels and the effects of context on accuracy.

The sequence of sound acquisition reported in this study was consistent with previous studies: /m, n, p, b, d, w/ were among the first sounds acquired while /r, h, th/ were the last sounds acquired. The age of acquisition for sounds was similar to Smit, et al. (1990) [28] with two exceptions /v, s/. The earlier age of acquisition for /v/ and /s/ reported in this study was comparable to the ages reported by Prather et al. (1975) [34] and Dodd et.al. (2003) [37]. Earlier ages of acquisition may be due to different criteria used in other analyzes. Smit et al. (1990) [28] analyzed sounds in word initial and final position. They used a 90% accuracy criterion (child had to produce the sound accurately at least 90% of the time) but it is unclear what proportion of children in an age band had to have 90% accuracy for an age of acquisition to be assigned to a sound. The current study implemented a phonetic approach, similar to Dodd et.al. (2003)[37]. The assessors included a sound in a child's inventory if it was produced spontaneously or in imitation. Phonetic acquisition would be expected to occur prior to phonemic mastery. When children are first exposed to a word they may imitate it correctly (e.g., chicken) once the word is a lexical item they may then go on to use a system-level sound substitution (e.g., chicken is pronounced /tI)-en/. Phonetic acquisition of /ts/ has occurred but not phonemic mastery. Also, errors decreased with age, this finding is consistent with Dodd et.al. (2003)[37]. Ninety per cent of the assessed children over 6 years of age had error-free speech. The results of this study are consistent with Dodd et.al. (2003)[37] as they reported that the majority of error patterns resolved rapidly between 2.5 and 4.0 years.

Clinical Implications

Results of this investigation have significant implications for the assessment of developmental speech disorders among Hindi-speaking group of Indian population. Approximately 6% of the pre-school/school population is referred to speech and language therapy because of concerns about their speech skills (Enderby & Phillipp, 1986[57]; Broomfield & Dodd, 2003[58]). Speech and language therapists are required to assess and decide whether a child's speech skills are developing normally. It is essential that reliable and representative normative data is available to make clinical decisions.

The normative data reported in this paper was based on a large representative sample. It included all children to reflect the true population and avoid over-identification of speech difficulties

(i.e., children whose speech skills are at the bottom end of the normal range). No previous studies meet the essential criteria and no other assessments available in India provide recent normative data on Hindi language. Speech and language therapists can use this information to assess speech sound acquisition (phonetic inventory), accuracy (linked to intelligibility), and whether the path of speech development is typical. Effective clinical decisions should be based on the assessment of multiple aspects of a child's speech sound development.

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