Phonological Development in Bangla: A Normative Study

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Abstract: This study investigates the various phonological processes operational in the speech of 90 native Bangla spoken children between the age of 3;0 - 3;11 years. The speech of all children was recorded during the administration of the developed word list and was transcribed for analysis. Equality of proportions was used to investigate the observed pattern of variation in speech.

Overall this study has established two aspects of speech development: age at which the error patterns were suppressed and the percentage of children exhibiting the obtained phonological processes. Processes like medial consonant deletion, unstressed syllable deletion, /l/ deletion, vowel unrounding, alveolar fronting, denasalization, stopping (except stopping of affricates and fricatives), palatalization and monothongization were eliminated by 3 years 5 months, while nasalization, backing of stops, initial consonant deletion, and coalescence were not found in age beyond 3 years and 9 months. Processes like vowel rising, nasalization, stopping, nasal assimilation, stop assimilation, velar fronting, and deaffrication decreased significantly as the chronological age progressed from 3 to 4 years. Other processes like cluster reduction, epenthesis, final consonant deletion, deaspiration, /r/ deletion, affrication (of fricatives), liquid replacement, and fronting of retroflex were considered to persist beyond 4 years of age. The results however refute the fact that, the mastery of phonological system is completed by 4 years of age. Native Bangla speaking children continues to use simplification for clusters, final consonants, fricatives, liquids, retroflex sounds, and the aspirated counterparts of stops, even after the age of four.

The results thus provide a profile of the underlying rules a typically developing child uses, which can be served as a basis for planning remediation. Also information about typical errors helps to delineate the normal course of acquisition; consequently, a child's atypical phonologic development can be evaluated against normal or typical error patterns.

Keywords: Bangla, phonological development, phonological processes, error patterns.

INTRODUCTION

Phonology is the component of language that is concerned with the rules governing the structure, distribution and sequencing of speech sounds and the shape of syllables [1]. It is regarded as one of the major components of language, alongside morphology, syntax, semantics and pragmatics. Phonology encompasses two elements: overt and covert speech [2]. Overt speech is the formation or articulation of sounds, generated by the movement of speech muscles. Covert speech is the formulation of sound sequences based on the knowledge of the sound system. When a child does not develop the ability to produce some or all sounds necessary for speech that are normally used at his or her age, phonological disorder occurs. Phonological disorder is one of the most prevalent communication disorders diagnosed in the preschool and school age population, affecting approximately 10% of children [3]. Approximately 7-8% of children aged between 3 and 11 years old are diagnosed with articulation disorders and males are affected two to four times more often than their female peers [4]. Speech Language Pathologists (SLPs) are interested in the study of normal phonological development for the purpose of differentiating normal and disordered children and for effective planning of intervention programmes.

There was a shift in the description of children's speech from a segmental approach to a phonological process approach after Stampe [5] introduced the theory of natural phonology. The theory of Natural Phonology has had a significant role in the development of phonology. The original definition of this concept was: "A phonological process merges a potential opposition into that member of the opposition which least tries the restrictions of the human speech capacity" [5]. "A phonological process is a mental operation that applies in speech to substitute for a class of sounds or sound sequences presenting a common difficulty to the speech capacity of the individual, an alternative class identical but lacking the difficult property" [6]. The theory proposes that phonology is based on a set of universal phonological

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processes, which interact with each another; some are active and some are suppressed. When children learn to produce adult words, they simplify the patterns of words in a way that is manifested by an innate universal system of phonological processes regardless of language. Once their production abilities and perception of the adult system improve, children gradually eliminate these simplification rules one by one using suppression.

Various classification systems of phonological processes have been developed [7-12]. In general, phonological processes can be divided into three categories: i) syllable structure, ii) assimilation or harmony and iii) substitution. Syllable structure processes produce changes in the constitution of the syllables of standard adult forms. For instance, weak syllable deletion, cluster reduction, final consonant deletion and glottal replacement [12]. Assimilation or harmony processes are the process that occur when an earlier sound influences a later one or vice versa [9]. The processes within this category include labial, alveolar and velar assimilation. Substitution processes involve replacement of one sound by another sound without being influenced by the surrounding phonemes. Examples of substitution processes are stopping, fronting, backing and gliding.

Examination of the types of error that occur in children's phonological development showed that children's productions were related to the adult forms in systematic ways. The use of phonological process analysis provides a simple and economical way of describing the differences in the structural and segmental aspects of a child's phonology [11]. This phonological process approach, therefore, became the most common procedure in describing children's phonological acquisition, and phonological rules were derived to describe the relationships [13]. Ever since, many researchers have used phonological process analysis to describe the speech pattern of both normal and disordered children [7, 8, 10, 11, 12, 14]. Two methods are usually employed in the studies of phonological processes: longitudinal and cross-sectional. Both methods have their strengths and limitations and are able to complement each other in providing rich and valuable information about children's phonological development. Table **1** summarizes both

Table 1: Cross-Sectional and Longitudinal Studies of Phonological Processes

Authors	Year	Number of subjects		Age of Participants (Intervals)	Data Collection	Sample Type (Stimuli)	Test/ Materials	Criterion Used	
		Normal	Disordered					Age Group	Occurrence of Tokens
Schwarts *et al*.	1980	3	3	1;07-1;09	Longitudinal	Conversation (play)	Toys, Books	At least 2 children	2 occurrences to be considered productive
Grunwell	1981	15	15	0;9-4;06	Complilation	-	-	-	-
Hodson & Paden	1981	60	60	4;00-4;11	Cross-sectional	Single Word (Objects)	The Assessment of Phonological Processes (Hodson, 1980)	3 levels Level 1: 50-60 Level 2: 30-40 Level 3: 5-20	NA
Prater & Swift	1982	60	0	1;09-4;00	Cross-sectional	Single Word (Pictures)	The Phonological Process Analysis (Weiner, 1979)	-	Mean usage: divided into (or) 20%
Dyson & Paden	1983	40	0	1;11-2;11	Longitudinal	Single word (Objects/ Questions)	Objects	NA	NA
Haelsig & Madison	1986	50		2;10-5;02	Cross-sectional	Single word (Pictures)	The Phonological Process Analysis (Weiner, 1979)	20%	20%

longitudinal and cross-sectional studies of phonological processes.

The developmental data on phonological processes should represent a specific population for the purpose of validity and reliability. Review of studies demonstrates that there is an enormous amount of data on the phonological development of English speaking children. The scarcity of available studies in multilingual country like India raised the need to investigate the phonological development within Indian children. Though limited studies on phonological processes in Indian languages have been done [15-18], but the developmental pattern of phonological process among Bangla speaking Indian children has been not studied till date.

Bangla, together with Assamese and Oriya, belongs to the eastern group within the Magadhan subfamily of Indo-Aryan languages. Along with its close congeners, Oriya and Assamese, Bangla crystallized from the Magadhi Apabhramsa, roughly between AD 1000 and 1200 [19]. This Eastern New Indo-Aryan language is native to the region of eastern South Asia known as Bengal, which comprises present-day Bangladesh, the Indian state of West Bengal, and parts of the Indian states of Tripura and Assam. With nearly 193 million speakers in total, Bengali is one of the most widely spoken languages, ranking seventh among the most widely spoken languages in the world.

Historically, the entire Magadhan group is distinguished from the remaining Indo-Aryan languages by a sound change involving sibilant coalescence. Specifically, in Magadhan, there occurred a falling together of three sibilant elements (inherited from common Indo-Aryan): dental /s/, palatal /ʃ/ and retroflex /ʂ/ [20]. Among modern Magadhan languages, the coalescence of these three sounds is manifested in different ways: for e.g., the modern Bangla reflex is the palatal /ʃ/. The Modern Bangla also shows evidence of historical regression in the articulation of what was a central vowel /a/ in common Indo-Aryan, and is realized as /ɔ/. The vowel inventories of Modern Bangla, Assamese and Oriya show no phonemic distinction of /i/ and /ɪ/, /u/ and / ʊ̄ /, this feature is due to a historical coalescence of the long and short variants of the high vowels, which were distinguished in common Indo-Aryan languages. The phonemic inventory of modern standard Bangla marks it as a fairly typical Indo-Aryan language. Figure **1** and Table **2** depicts the phoneme inventory of standard colloquial Bangla as given by Bhattacharya [21], based on the language spoken in Kolkata, which is the accepted norm [19]. The organization of the consonant system in terms of five basic points of articulation (velar, palatal, retroflex, dental and labial) is characteristic, as is the stop/flap distinction in the retroflex series.

As discussed by Klaiman [20], in the consonant inventory, Bangla can be regarded as unusual only in having a palatal sibilant phoneme in the absence of a dental sibilant. The phoneme in question is realized as a palatal /ʃ/ in all environments, except before the segments /t/, /t^h/, /n/, /r/, and /l/, where it is realized as a dental i.e., as /s/. Nasalization as a distinctive non-segmental feature of the vowel system is typical of Bangla and other modern Indo-Aryan languages. In actual articulation, the nasality of the Bangla nasalized vowel segments tends to be fairly weak, and is certainly not as strong as the nasality of vowels in standard French. All the seven pure vowels in Bangla have their nasalised counterparts as shown in Table **3**.

Table 2: Consonant Phonemes of Bangla

Consonants	Bilabial		Dental		Alveolar		Retroflex		Alveolo-palatal		Velar		Glottal	
	vl	vd	vl	vd			vl	vd	vl	vd	vl	vd		
Stops	p	b	t̪	d̪			ʈ	ɖ			k	g		
Affricates									ʧ	ʤ				
Aspirated	p^h	b^h	$t̪^h$	$d̪^h$			$ʈ^h$	$ɖ^h$	$ʧ^h$	$ʤ^h$	k^h	g^h		
Fricatives									ʃ				H	
Nasals		m				N						ŋ		
Trill						R	ɾ							
Lateral						L								
Semi-vowel		w							y					

*Where 'vl' corresponds to voiceless &'vd' corresponds to voiced.

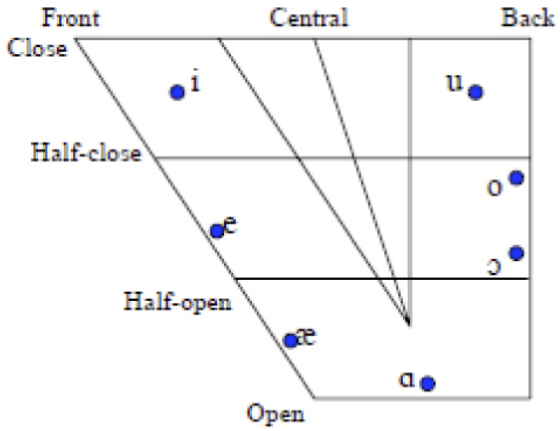


Figure 1: Bangla vowels in diagram.

Table 3: Nasalized Counterpart of Bangla Vowels

	Front	Central	Back
High	ĩ		ũ
High mid	ẽ		õ
Low mid	æ̃		ɔ̃
Low		ã	

The Bangla obstruent inventory includes the distinctive character of voicing and aspiration. In Bangla, the members of the four strong group ('barga') are identified as voiceless unaspirated, voiced unaspirated, voiceless aspirated, voiced aspirated [22,23]. Similarly aspiration is also a distinctive feature in Bangla as it distinguishes sounds which have similarity in other respects, so /b/ and /b^h/ will be considered as two different phonemes in Bangla. In Bangla, only plosives or stops are aspirated. Fricatives are not aspirated, nor are nasals, laterals, trills and approximants [24].

Thus, Bangla shares several commonalities with its sister languages and much less commonalities with various other languages of the world, but, along with these commonalities, it also presents its own set of phonemic inventory with its unique phonological rules.

METHODOLOGY

Participants

A total of 90 children (45 Male and 45 Female) between the ages of 3;0 - 3;11 years were selected randomly as participants, and were divided into three groups of four month age interval. Each group comprised of 30 children, including 15 girls and 15 boys, as shown in Table **4**.

All the children were native speakers of Bangla (spoken in and around two states of India, i.e., West Bengal & Tripura along with Bangladesh), were residing and attending normal school in and around the urbanized city "Kolkata", and belonged to middle socioeconomic status. Younger children could not be included due to the reasons that children below 3 years are not admitted in schools, moreover the average age at which children are brought for speech and language evaluation is more than 3 years. None of the children had history of any ear, nose or throat pathologies and all of them had their hearing sensitivity within normal limits bilaterally (thresholds of 15dB HL or lower), ascertained by hearing screening at standard audiometric frequencies. In addition, the participants had no observable oral peripheral weakness and no abnormality in speech and language, as verified independently by qualified speech language pathologists using The Receptive-Expressive Emergent Language Test, Second Edition; REEL-2 [25].

Preparation of Test Material

To elicit single word responses from the children, a total of 118 words were selected from the word list of Articulation Test in Bangla [26], which was subjected for a pilot study, whereby 6 adult native Bangla Speakers (3 parents and 3 nursery teachers) judged them based on a 3 point familiarity scale. Only the words which were rated as familiar by at least 5 out of 6 participants (more than 80% from each group) were included in the final word list. The final word list thus consisted of 114 words, which took into account 35 (all

Table 4: Age Groups for the Present Study

Groups	Age range	Group composition	Mean	SD
Group A	3Y - 3Y 3M	15 male & 15 female	38.65M	1.47M
Group B	3Y 4M -3Y 7M	15 male & 15 female	42.27M	1.14M
Group C	3Y 8M - 3Y 11M	15 male & 15 female	45.74M	1.98M

*Y: years; M: months; SD: standard deviation.

7 vowels and 28 consonants) phonemes of Bangla in initial, medial and final positions (with a few exceptions for e.g. vowel /æ/ in the final position etc), nasalized counterpart of 2 vowels (/ã/ and /ĩ/), 5 diphthongs, along with 30 consonant sequences, which consisted of 4 geminates (/pp/, /nn/, /dd/, and /ll/); 24 two member consonant sequences (/nk^h/, /nʈ/, /ndʒ/, /nh/, /ns/, /ŋg/, /nɖ/, /kʃ/, /kr/, /kʈ/, /kg^h/, /ʃr/, /ʃn/, /ʃm/, /br/, /ks/, /nd/, /st/, /rdʒ/, /mr/, /ʈr/, /ʈl/, /lg/, and /bl/) occurring in word initial and word medial positions only, since they do not occur in the word final position and 2 three member consonant sequences (/str/, /skr/) occurring in word medial and initial positions respectively.

Colour pictures representing the 114 target words which were portrayed on 5 × 8 inches cards with white background, comprised the stimulus test cards used for the study.

Instruments

SONY ICD-PX720 digital recorder along with a lapel microphone was used to record the responses of the participants.

Data Collection

The speech samples were collected in a quite classroom/staffroom individually. Selected participants were seated comfortably and the lapel microphone (connected to the SONY ICD-PX720 digital recorder) was fastened to his/her collar. The following instructions were given to each child: “I will show you a set of pictures one at a time and you will name them aloud”, followed by which the recorder was switched on. The carrier phrase “”What is this?” was used to elicit responses. In case the child failed to spontaneously utter the target response, questions expected to elicit the target responses were asked. If the child was still unable to utter the target response or said “I do not know”, delayed imitation task was considered. Maximum effort was done to elicit spontaneous production of the target word. On an average thirty minutes were required to record responses for each participant.

Each of the recorded speech samples was transcribed by the examiner using broad transcription method. Since, auditory perceptual judgment was used for the purpose of transcription, two more judges who were qualified Speech-Language Pathologists and also a native Bangla speaker were requested to transcribe the same samples. A percentage of agreement was calculated. A 90% agreement level was used as the criterion and the agreement level was found between 90-94% across children, thus the transcriptions by the examiner were considered reliable.

Identification, Analysis, and Comparison of Phonological Processes

All of the phonological processes operating in each child for the target words as evident in the transcribed data were identified by the examiner. Phonological processes were counted even in the event of a single occurrence and were judged on whole word basis and not on the basis of any individual phonemes.

The number and percentage of children using a particular phonological process in each age group was tabulated and appropriate statistical measures were used to compare the percentage of children using the each identified phonological processes across the three groups. The phonological processes thus found for each age group was categorized into three major groups that is, syllable structure processes, assimilatory or harmony deviations, and feature contrast or substitution processes.

Statistical Analysis

The statistical technique “equality of proportions” was used

1. To compare the percentage of correct responses, and

2. To compare the percentage of participants using each phonological process among the three pairs of groups, which comprised of Group A & B; Group B & C; and Group A & C.

RESULTS

To examine the occurrence of phonological processes in 3-3;11 years Bangla speaking children, the study was completed in several steps. Firstly, the percentage of correct responses for each group namely Group A, B & C was calculated. Table **5** tabulates the mean and standard deviation of the same.

Table 5: Mean and Standard Deviation of Percentage of Correct Responses of the Three Groups

Groups	Mean percentage	SD
Group A	51	8.92
Group B	67	5.41
Group C	73	5.37

As depicted in Table **5** the highest average percentage of correct response was obtained for Group C that is 73%, the lowest value was obtained for the youngest group i.e. Group A corresponding to 51%, while the value of mean percentage of correct response for the Group B was found to be 67%.

After obtaining the percentage of correct responses for each group separately the statistical measure "equality of proportions" was carried to objectively determine whether a significant difference existed within the pairs of groups (that is Group A & B and Group B & C). The computed values for the both pairs were found to be greater than 1.645 ($z_{0.05}$) which indicated that significant difference existed within both the pairs of groups.

Following this, qualitative analysis was performed and the results obtained are tabulated under the following sections:

A. Analysis of Phonological Processes

Qualitative analysis of phonological processes operating in the children from Groups A, B & C were done separately, following which a comparison of the same across groups was completed.

1. Analysis of Phonological Processes Exhibited by Group A

A total of thirty two different processes have been identified to occur in this age group. But only fourteen processes were found to occur more commonly among the children. These include final consonant deletion, cluster reduction, epenthesis, nasal assimilation, affrication, deaspiration and stopping, /r/ deletion, stop assimilation, liquid replacement, velar fronting, deaffrication, fronting of retroflex, and vowel raising.

Other processes like unstressed syllable deletion, initial consonant deletion, metathesis, coalescence, /l/ deletion, velar assimilation, labial assimilation, nasalization, backing of stops, gliding, and monothongization were exhibited by less number of participants. Rest of the deviations noticed, namely medial consonant deletion, voicing assimilation, vowelization, alveolar fronting, denasalisation, palatalization were exhibited by a maximum of three participants from the group.

2. Analysis of Phonological Processes Exhibited by Group B

Qualitative analysis of all the samples of children between 3 years 4 months and 3 years 7 months of age uncovered as many as twenty one processes operating among these children.

Deviations like final consonant deletion, cluster reduction, deaspiration, /r/ deletion, epenthesis, stop assimilation, nasal assimilation, affrication, stopping, velar fronting, fronting of retroflex, liquid replacement, and deaffrication were found to be present in many participants of this age group in this study.

Processes which were found in fewer participants of this group includes syllable reduction, metathesis, velar assimilation, stopping of affricates, and vowel rising. While deviations like initial consonant deletion, coalescence, nasalization, backing of stops, vowelization, and gliding were observed in a maximum of three participants in this group.

3. Analysis of Phonological Processes Exhibited by Group C

Phonological processes analysis of the participants of this group revealed twenty three processes. Amongst these, the process that were present in most of the participants includes cluster reduction, final consonant deletion, epenthesis, stop assimilation, nasal assimilation, affrication (mostly affricates replacing fricatives), deaspiration, stopping (mostly stopping of the fricative /ʃ/ was observed to be present in this group), liquid replacement, and deaffrication (affricates replaced by stops).

Processes that were observed to be used by few participants of this group are syllable reduction, /r/ deletion, metathesis, stopping (mostly affricates), velar fronting, vowel raising, gliding, and fronting of retroflex. Place assimilation (velar & labial), voicing assimilation, and vowelization were exhibited by a maximum of three participants.

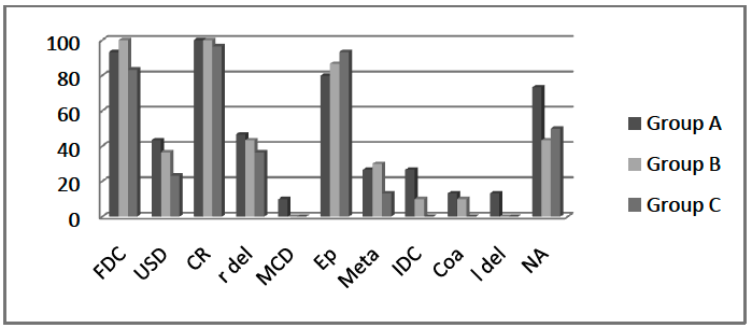
4. Comparison of the Phonological Processes Obtained Across Groups

Since the maximum chance of occurrence of any particular phonological processes was same, the average frequency of occurrence of each phonological processes were obtained for the three groups separately. Table **6** tabulates the average frequency of occurrence of few commonly occurring processes and a few language specific processes like deaspiration since Bangla phonology contains aspiration as a contrastive feature.

To further compare the results obtained in three groups, the percentage of children using particular

Table 6: Average Frequency of Occurrence of Phonological Processes in Group A, B & C

Phonological Processes	Average frequency of occurrence		
	Group A	Group B	Group C
Final Consonant Deletion	6.8	7.3	4.87
Cluster Reduction	8.2	7.5	5.7
Deaspiration	6.77	5.82	5.52
Stop Assimilation	1.57	2.42	2.3
Nasal Assimilation	1.47	0.9	0.67
Affrication	2.37	1.27	1.32
Epenthesis	2	1.92	2.12
Velar fronting	1.67	0.57	0.2
Lateral Replacement	2.2	3.9	2.02



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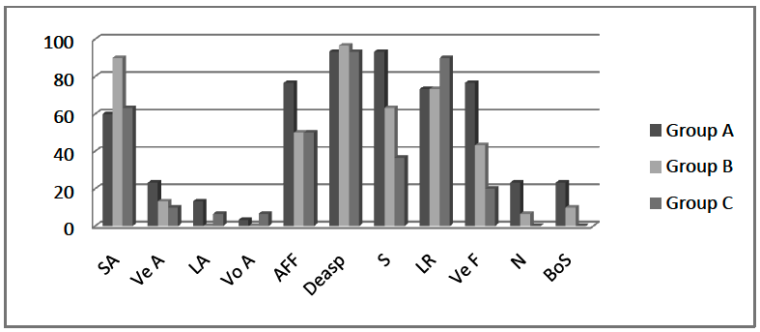

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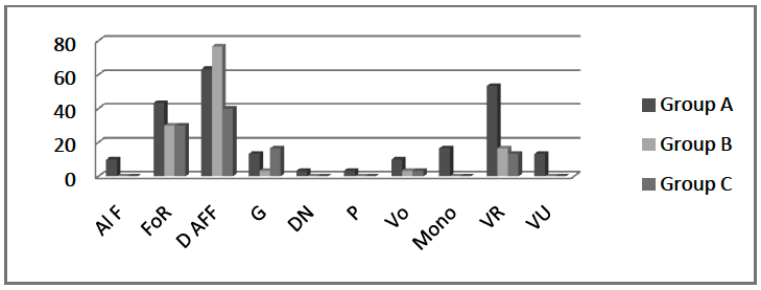

c

Figure 2: a: Percentage of participants using different phonological processes across the three groups.

b: Percentage of participants using different phonological processes across the three groups.

c: Percentage of participants using different phonological processes across the three groups.

processes for all the 3 groups were obtained. These values are graphically depicted in Figure **2a**, **2b**, & **2c**.

B. Classification of the Obtained Phonological Processes

The number and the corresponding percentage of children exhibiting each phonological process are tabulated in Table **7**. An attempt was made to classify the obtained processes into three sub-groups in accordance to the classification system used by Ramadevi [27] for Kannada language. Thus the processes obtained were sub-grouped as following:

1. Most frequently occurring processes: this included the processes exhibited by more than 60% of the children.

Table 7: Number and Percentage of Children Exhibiting Phonological Processes Across the Three Groups

		GROUP A		GROUP B		GROUP C	
Si. No.	**Phonological Processes**	**No of C**	**% of C**	**No of C**	**% of C**	**No of C**	**% of C**
1	FCD	28	93.3	30	100	25	83.3
2	USD	13	43.3	11	36.6	7	23.3
3	CR	30	100	30	100	29	96.6
4	/r/ del	14	46.6	13	43.3	11	36.6
5	MCD	3	10	0	0	0	0
6	Ep	24	80	26	86.6	28	93.3
7	Meta	8	26.6	9	30	4	13.3
8	ICD	8	26.6	3	10	0	0
9	Coa	4	13.3	3	10	0	0
10	/l/ del	4	13.3	0	0	0	0
11	NA	22	73.3	13	43.3	15	50
12	SA	18	60	27	90	19	63.3
13	VeA	7	23.3	4	13.3	3	10
14	LA	4	13.3	0	0	2	6.6
15	VoA	1	3.3	0	0	2	6.6
16	AFF	23	76.6	15	50	15	50
17	Deasp	28	93.3	29	96.6	28	93.3
18	S	28	93.3	19	63.3	11	36.6
19	LR	22	73.3	22	73.3	27	90
20	VeF	23	76.6	13	43.3	6	20
21	N	7	23.3	2	6.6	0	0
22	BoS	7	23.3	3	10	0	0
23	DAFF	19	63.3	23	76.6	12	40
24	Vo	3	10	1	3.3	1	3.3
25	VR	16	53.3	5	16.6	4	13.3
26	VU	4	13.3	0	0	0	0
27	FoR	13	43.3	9	30	9	30
28	AlF	3	10	0	0	0	0
29	G	4	13.3	1	3.3	5	16.3
30	DN	1	3.3	0	0	0	0
31	P	1	3.3	0	0	0	0
32	Mono	5	16.6	0	0	0	0

*C: Children.

2. Frequently occurring processes: comprised of processes operational in 20 to 40% of the children.

3. Occasionally occurring processes: took into account the processes that occurred in less than 20% of the children.

C. Comparison of the Obtained Phonological Processes

Comparison of the percentage of children exhibiting each phonological process among the three pairs of groups (i.e., Group A & B; Group B & C; and Group C & A) was done. The statistical method "equality of proportions" was used to objectively define the presence of any significant difference among the groups on the basis of percentage of children exhibiting a particular process. The computed values for the following processes were found to be greater than 1.645 ($z_{0.05}$).

1. Vowel rising was found to decrease significantly in Group B and Group C as compared to Group A, while no significant difference was obtained between Group B and Group C.

2. Percentage of children using velar fronting in Group B and Group C was observed to be significantly less than that in Group A, indicating correct production of velars in the older groups.

3. Significantly more children of Group B were observed to use stop assimilation as compared to Group A. But since, the percentage of children using SA in the oldest group showed significant decrease as compared to Group B, it is considered as a decreasing deviation among the children of the study.

4. Percentage of children using nasal assimilation in Group B was found to decrease significantly as compared to Group A.

5. Nasalization was observed to be used by significantly less percentage of children of the oldest group as compared to the younger groups.

6. Deaffrication which was found to increase in the children aged between 3 years 5 months and 3 years 9 months as compared to Group A, was found to significantly decrease in the oldest group, suggesting that significantly greater percentage of children were able to master the articulation of affricates in this group.

7. The percentage of children using stopping was witnessed to significantly decrease in the older groups as compared to the youngest group also signifying correct production of other manner classes of phonemes.

However, statistically significant differences were not obtained for rest of the processes. The processes that demonstrated a statistically significant decreasing trend are tabulated in Table **8**.

Table 8: Summary of Phonological Processes which Showed Significant Decrease

Decreasing processes	Vowel rising, nasalization, stopping, nasal assimilation, stop assimilation, velar fronting, and deaffrication (increased in Group B followed by subsequent decrease in Group C)

DISCUSSION

This study was intended to investigate the occurrence of phonological processes in 3;0-3;11 years Bangla speaking children. To execute the study, the phonological processes occurring in each child were analyzed by the examiner on a whole word basis, that is, all the phonemes of the target word were analyzed and not just the target phoneme, to efficiently maximize the phonological information obtained from single word responses [28]. Several phonological processes were identified in each age group. Nevertheless, a lot of participants from each group produced many target words correctly. Results obtained from Table **5** clearly indicate increase in percentage of correct responses from Group A to Group C. This implies that as children grow, they learn more about the phonological rules of the language and in the mean time the speech motor system matures leading to improved motor skills and articulatory precision.

The qualitative analysis of the phonological processes in the different age groups reveals (as evident from Table **6**) that almost all the processes found shows decrease in the average frequency of occurrence in the children of the older age group.

Further it can be inferred from Figure **2a**, **b**, & **c** that as many as ten processes present in Group A were suppressed. In Group B among these two processes namely labial and voicing assimilation reoccurred in

Table 9: Processes that were Suppressed by 3 Years 4 Months & 3 Years 8 Months

Processes suppressed by 3 years 4 months	Processes suppressed by 3 years 8 months
Medial consonant deletion, /l/ deletion, vowel unrounding, alveolar fronting, denasalization, stopping (except stopping of affricates and fricatives), palatalization and monothongization.	Nasalization, backing of stops, initial consonant deletion, and coalescence

Group C, but was only noticed in less than 10% of the children and thirteen processes were suppressed in group C as compared to Group A. Also four processes (nasalization, backing of stops, initial consonant deletion, and coalescence) that were present in less than 10% of the participants in Group B were not found in group C. The processes that were found to be suppressed are listed in Table **9**.

All the processes found to be operational in 3- 3;11 year old native Bangla speaking children as tabulated in Table **7** are further discussed under the following three major category namely:

a. Syllable structure processes,

b. Assimilatory or harmony processes, and

c. Substitution or feature contrast processes.

a. Syllable Structure Processes

1. Final Consonant Deletion (FCD)

This deviation was found to be prevalent in almost all the children of the present study. It was found to be present in 93% of children in Group A, in all the children of Group B, and 83% of the children of Group C.

Although, this process had been observed to be suppressed by the age of three years in most of the studies done on English speaking children [11, 29, 30, 31], studies done in Indian languages supports the persistence of this process, as found in the current study. Persistence of FCD beyond 3 years 4 months is found to be contradictory to results obtained in some studies, where it has been noted as a decreasing process [17, 32], but is substantiated by a few other studies. This includes, a study by Sameer [16] in which FCD was reported to be amongst persisting processes in 3-4 year old Hindi speaking children. Another cross-sectional developmental study done by Haynes and Moran [33] on FCD occurrence in Southern Black Children found the process to persist well beyond the age of 4 years.

2. Cluster Reduction (CR)

Occurrence of CR in all the children of Group A and Group B and in 96.6% of children of Group C reflects the well evidenced fact that acquisition of clusters is far from completion at the end of 3 years [9, 10, 11, 29, 30, 34, 35, 36, 37, 38, 39, 40, 41, 42]. Also it was noted that younger group tend to delete one of the phonemes from the cluster for e.g., /istri/ was realized as /isti/ where as in older children it was realized as /istiri/.

3. Unstressed Syllable Deletion (USD)

The word list consisted of a few multisyllabic words (e.g., /ʃɔroʃoti/ which was produced as /ʃɔʃoti/) in which the weak syllable was deleted by few children. It was found to occur in 43.3 % of the children of Group A, in 36.6% of the children from Group B while 23.3% of the children from Group C exhibited this process, and was grouped under frequently occurring processes. These results are in consonance with the findings of Haelsig and Madison [36].

4. /r/ Deletion (/r/ del)

This process was present in 46.6%, 43.3%, and 36.6% of the children from Group A, B, and C respectively and was sub-grouped under frequently occurring processes. Many of the children of the study were found to delete */r/*, for e.g., */ʤʰui/* for */ʤʰuri/; /bʰæ/* for */bʰæra/*. Ramadevi [27] reported it to be suppressed by the end of 3 years of age in Kannada speaking children. These findings may be attributed to the fact that acquisition of /r/ is not completed till 4 years of age in Bangla speaking children [26].

5. Medial Consonant Deletion (MCD)

It was found only in the youngest group thus suppressed by 3 years 4 months of age in the children of the study, for e.g., /horin/ was realized as /hoin/. The percentage of children exhibiting the process was very low corresponding to 10% and thus has been grouped under occasionally occurring process even in the youngest group. This result is consistent with the findings of Sameer and Sunil [16, 43] in Malayalam and Kannada speaking children respectively.

6. Epenthesis (Ep)

It can be inferred from Table **5** that epenthesis is among most frequently occurring processes for all the 3 age groups as it has been found to be operational in 80%, 86.6%, and 93.3% of children from Group A, Group B, and Group C respectively. These findings are in consonance with studies done by several researchers [29, 44, 45] who reported epenthesis to be common in the speech of 2 and 3 year olds. The increase in the percentage of the epenthesis may be due to the fact that in older children consonant clusters were simplified by adding a vowel (e.g., /gɛlas/ instead of /glas/) instead of deleting one of the pair (e.g., /gas/ for /glas/).

7. Metathesis (Meta)

It has been grouped under frequently occurring processes for the younger groups with 26.6 & 30 percentage of children exhibiting it in Group A and Group B respectively, and occasionally occurring processes for Group C with 13.3 percentages of children exhibiting it. Metathesis has been grouped under idiosyncratic/ unusual process in the English speaking children [46] but was found to occur in the speech of young children [2, 44, 47]. It was found to be amongst decreasing process in many studies on Indian languages. Barathy and Santhosh [17, 18] reported it to be suppressed by 3 years 5 months in Tamil and Hindi respectively, while it was observed as a decreasing process amongst 4-5 years Kannada speaking children [15].

8. Initial Consonant Deletion (ICD)

It was noted to occur in 26.6% of children from Group A and only in 10% of children from Group B. This was not observed in any of the children in Group C. Thus, it can be said that it was exhibited by the middle group occasionally and was suppressed in the oldest group. These results are supported by the findings of Barathy [17] and Ramadevi [27] who also reported ICD to be suppressed by the end of 3 years in Kannada speaking children.

9. Coalescence (Coa)

It was observed to be exhibited occasionally by the children of the younger groups as it was exhibited by only 13.3% and 10 % of children from Group A and Group B respectively and was eliminated in Group C. This findings are supported by a study done by Dyson and Paden [29] who reported coalescence to occur in the speech of 2- to 3- year- olds.

10. /l/ Deletion (/l/ del)

It was found to be present in only 13.3% of the children of Group A and was eliminated by 3 years 4 months. One of the few examples includes /bɛun/ for /bɛlun/. This is in consonance with the findings of Banik [26] that /l/ is acquired by 3 years of age in native Bangla speaking children.

b. Assimilatory or Harmony Processes

Many assimilatory processes were found to be present in the children of the study. Nasal assimilation (NA) showed a marked decrease in occurrence for the older age groups. Also for the older groups it mostly occurred when the liquid /r/ was replaced by /n/ in the presence of a nasal phoneme for e.g., /nani/ for /rani/. Thus it correlates with the findings that nasals are mastered much earlier [26, 48] than other classes and that they are rarely substituted by other classes.

Other assimilatory processes like labial assimilation (LA) and vowel assimilation (VoA) were found to be occurring in very less number (occasionally in Group A & C and rarely in Group A & C respectively) of children of the present study, indicating that it is rarely exhibited by children of 3-4 years or is nearly mastered in earlier stages of development. VA has been found to be present frequently in the age range of 3- 3½ years by Haelsig and Madison [36] within the English spaking children and was found to be suppressed by 3 years 5 months in a study by Santhosh [18] among Hindi speaking children.

Stop assimilation (SA) was observed to increase markedly in the middle group as compared to the Group A and then decrease markedly in group C. Such finding has not been reported in earlier studies. Velar assimilation (VeA) was found in 23.3% of children from Group A, 13.3% of participants of Group B, and 10% children of Group C. As such it was grouped under occasionally occurring processes for the older groups, indicating that velars are rarely assimilated for other places of articulation. This finding is supported by the results obtained by Haelsig and Madison [36]. They reported velar assimilation as rarely occurring process in children between 3 to 5 year olds and was seen to be primarily occurring in 3-3½ year olds.

c. Substitution or Feature Contrast Processes

1. Deaspiration (Deasp)

Deaspiration was found to be exhibited by 93.3% of children of Group A and Group C and by 96.6 % of

children from group B. It was observed for many words from the word list, e.g., /gada/ instead of /gad^{h}a/ or /tala/ instead of /t^{h}ala/. Deaspiration is not present among English spoken population since English phonology does not have aspiration as a distinctive feature. However, it has been found to be amongst persistent processes in Indian languages like Kannada and Hindi [18, 27, 49, 50].

2. Stopping (S)

This process showed a marked decrease in use by the children of this study as the age advanced. It was found to be operational in 93.3% & 63.3% of children in Group A and Group B respectively and was grouped as most frequently occurring process for these groups, while 36.6% of Group C children exhibited this process thus it was grouped under frequently occurring process for this group. Moreover, stopping of fricatives (E.g., /tap / for /ʃap /) occurred mostly for the oldest group while stopping occurred for other classes as well as fricatives for the younger groups (E.g., / dut̪t̪o / for/ ʤut̪t̪o /) indicating that fricatives are acquired later. This deviation has been reported to be frequently used by children in the age range of 3-4 years [15, 50, 51].

3. Liquid Replacement (LR)

Liquid replacement was sub-classified as most frequently occurring processes for all the three groups. Similar findings have been reported in many Indian studies [17, 18, 49, 50], since the alveolar and the retroflex liquids /r/ and /ɽ/ (respectively) which is acquired later around 4years in Bangla [26] is mostly replaced by the other liquid /l/ (E.g., /g^{h}ola/ for /g^{h}ora/) which is acquired earlier (by 3 years of age). Rather than liquid replacement, gliding of liquids are more commonly observed in English [36, 52, 53].

4. Velar Fronting (VeF)

Use of this process by the children was observed to decrease dramatically across age groups. It was sub-grouped as most frequently occurring process for Group A, frequently occurring process for Group B, and occasionally occurring process for Group C, indicating velars are mastered by 3 years 8 months. These results are supported by age norms provided by Grunwell [52], where velar fronting has been reported as a decreasing process in 3- 3½ year old children.

Few examples of this process from the present study include production of /pak^{h}i/ as / paṭ̪i/, / k^{h}opa/ as / ṭ̪opa /, etc.

5. Nasalization (N)

This process was observed to be frequently occurring in Group A with 23.3% of children exhibiting it & was inferred to be an occasionally occurring process among Group B children where it was exhibited by only 6.6% of children, while it was suppressed in children of Group C, indicating that this process may occur in earlier stages of development in Bangla speaking children. Ramadevi [27] found this process to be consistent among 3 year old Kannada speaking children.

6. Backing of Stops (BoS)

This process was exhibited by 23.3% of children of Group A, 10% of children of Group B and did not occur in children of Group C. This has been identified as an idiosyncratic process in English [46], but has been found to be among less frequently occurring processes by Barathy [17] in Tamil language.

7. Deaffrication (DAFF)

This was found to occur in 63.3% of children of Group A. This value was increased to 76.6% in Group B and then markedly decreased to a value of 40% in Group C. Such increment in the use of this process among 3 years 4 months to 3 years 8 months old children has been substantiated by the findings of Barathy [17]. Examples from the present study include /biṭ̪ana/ for /biʧ^{h}ana/, /ḍ̪uri/ for /ʤ^{h}uri/ etc.

8. Vowelization (Vo)

This was found to be a occasionally occurring process in these groups of children, as evidenced by the findings of this study which reflected very less percentage (10%, & 3.3% for Group A and groups B & C respectively) of children exhibiting the process. Haelsig and Madison [36] reported similar findings of vocalizations to be present in 3 and 3½ year old children.

9. Vowel Raising (VR)

This process was sub-classified under frequently occurring processes for Group A with 53.3% of the children exhibiting the process. The use of this process decreased considerably in Group B & Group C and was sub-classified as occasionally occurring processes, indicating marked decrease of vowel processes and acquisition of low vowels. These findings are substantiated by a study done by Otomo and Stoel- Gammon [54] who reported occurrence of error patterns like vowel tensing and vowel raising in young children of age 30 months.

10. Vowel Unrounding (VU)

This was observed in very few (13.3%) children of the youngest group, and was eliminated in the older groups, indicating round vowels are mastered before 3 years of age. This finding indicates that vowel processes rarely occurs beyond 3 years of age. The above findings are supported by Stoel- Gammon and Pollock [55] who reported accurate vowel production of all vowel targets is achieved by the age of 3 years.

11. Fronting of Retroflex (FoR)

Fronting of retroflex was identified as a frequently occurring process in the present study and other studies done in Indian languages [17, 18, 49, 50]. This may be because retroflexion involves curling back of the tongue, making them more difficult for young children to produce, and as a result these are fronted. Examples from the present study include / t̪ɛble/ for / ʈɛbil/; /d̪im / for / ɖim/ etc.

12. Alveolar Fronting (AIF)

This was observed as an occasionally occurring process in children of Group A and was eliminated in the older groups (Group B & C), indicating mastery of alveolar sounds by 3 years of age. Similar findings are reported by Barathy [17] and Dyson and Paden [29].

13. Gliding (G)

Gliding was found to be an occasionally occurring process in the present study as can be inferred from Table **5** (i.e., 13.3%, 3.3% & 16.3% for Group A, Group B & Group C respectively). This process has been found to be commonly occurring in English speaking children [36,52], where gliding mostly occurs for liquids, but in the present study liquid replacement was found to occur in place of gliding since /l/ is acquired earlier than /r/ [17] and also Bangla phonology does not contain glides.

14. Denasalization (DN)

This was found to be occasionally occurring in Group A children (3.3%) and was eliminated in Group B & Group C, indicating nasal to be acquired earlier [17]. This is further supported by findings of Smit [56], who also reported nasals to be mastered earlier in English speaking children and error patterns affecting nasals to be rare.

15. Palatalization (P)

Like denasalization, palatalization occurred in only one child (3.3%) in Group A and was eliminated in Group B & Group C. These findings are supported by Goldstein and Iglesias [35] who reported palatalization to be rare among 3 year old Spanish speaking children.

16. Monothongaization (Mono)

It was sub-grouped under occasionally occurring process for Group A in which it was exhibited by only 16.6% of the children, and was suppressed in children of Group B & Group C. These results are supported by the findings of Rahul [49], where it was grouped as an occasionally occurring process in 2½ to 3 year old Hindi speaking children.

The results of the present study point to the fact that universal trends in phonological development exists. Cluster reduction which has been described as “the most common and longest lasting stage” in the development of clusters production [10] has been found to persist beyond 4 years of age. In this study, children of the younger group mostly showed true reduction whereas children from Group C used vowels to simplify the consonant cluster (/bɛraʃ/ for /braʃ/). Cluster reduction and epenthesis tend to co-occur, and stop and nasal assimilations are exhibited by most of the participants indicating these classes of sounds are mastered earlier.

Some prominent language specific features have also been Found. These include:

- use of liquid replacement by increased number of children in the present study in contrast to occurrence of gliding in English speaking children since Bangla phonology does not have glides and /l/ is acquired earlier than /r/
- use of fronting of retroflex as retroflexion is less marked than dental stops and
- deaspiration was also found to be among commonly occurring process since Bangla has aspiration as a contrastive feature .

A salient feature that needs to be mentioned is that during 3-3;11 years of age of development, some or other phonological processes from all the three major categories (namely syllable structure processes, assimilatory or harmony processes, and substitution or feature contrast processes) are either eliminated or are evidenced to be used by significantly less number of participants from the older age groups.

CONCLUSION

The study brings to the forefront the language specificity of phonological development in Bangla, thus

further implying the importance of establishment of norms for young children in every language. The outcome provided a clear and objective idea that all the children used simplification processes, but the percentage of children using any particular phonological process tend to decrease as age increased from 3.0 to 3.11 years for most of the observed phonological processes.

The comparison of phonological analysis among the three groups disclosed that a large number of processes were suppressed as the age advanced. Processes like medial consonant deletion, unstressed syllable deletion, /l/ deletion, vowel unrounding, alveolar fronting, denasalization, stopping (except stopping of affricates and fricatives), palatalization and monothongization were eliminated by 3 years 5 months, while nasalization, backing of stops, initial consonant deletion, and coalescence were not found in any of the participants of age beyond 3 years and 9 months. The percentage of participants using processes like vowel rising, nasalization, stopping, nasal assimilation, stop assimilation, velar fronting, and deaffrication decreased significantly as the chronological age progressed from 3 to 4 years. Other processes that were found to be occurring in most of the participants of the oldest age group included cluster reduction, epenthesis, final consonant deletion, deaspiration, /r/ deletion, affrication (of fricatives), liquid replacement, and fronting of retroflex were considered to persist beyond 4 years of age. The results however refute the fact that, the mastery of phonological system is completed by 4 years of age. Native Bangla speaking children continue to use simplification for clusters, final consonants, fricatives, liquids, retroflex sounds, and the aspirated counterparts of stops, even after the age of four.

The findings give strong correspondence towards providing a relational account for the differences existing between the adult Bangla speaker and a typical 3-4 year old Bangla speaking child's pronunciation of a word. Alongside the results provide a baseline for determining delay and/ or deviance in phonologically disordered child. Applicability of the study could be considered in two domains: firstly in assisting and planning target for remediation in accordance with the chronology of processes found to be occurring in this present study and, secondly in supporting the basic principle that phonological development follows a somewhat predictable path, although considerable individual variations existed between the participants.

In future, the study might be extended to include a greater age range, various communities, and other socioeconomic levels. Alongside, to obtain a more complete picture of the phonemic inventory of 3;0 - 3;11 years old native Bangla speaking children, spontaneous speech may be included as a parameter.

REFERENCES

[1] Owens RE. Language development: an introduction. 7th ed. Boston: Allyn & Bacon; 2007.

[2] Edwards M, Shriberg L. Phonology: applications in communicative disorders. San Diego: College-Hill Press; 1983.

[3] Statistics on Voice, Speech, and Language [Internet] 2010 June 7 [updated 2010 June 7; cited 2011 Jan 3]. Available from: http://www.nidcd.nih.gov/health/statistics/pages/vsl.aspx

[4] Tish Davidson. Phonological Disorder [Internet] 2011. [cited 2011 Jan 3]. Available from: http://www.minddisorders.com/Ob-Ps/Phonological-disorder.html

[5] Stampe D. The acquisition of phonetic representation. In: Binnick RT, Davison A, Greene GM, Morgan JL, Eds. Papers from the fifth regional meeting of the Chicago linguistic society. Chicago: Chicago Linguistic Society.1969; pp. 433-44.

[6] Donegan PJ, Stampe D. The study of natural phonology. In: Dinnsen D, Ed. Current approaches to phonological theory. Bloomington: Indiana University Press; 1979, pp. 126 - 73.

[7] Hodson BW. The assessment of phonological processes. Danville IL: Interstate Inc; 1980.

[8] Ingram D. Procedures for the phonological analysis of children's language. Baltimore: University Park Press; 1981.

[9] Khan LM. A review of 16 major phonological processes. J of Language, Speech, and Hearing Services in Schools 1982; 13: 77-85. http://dx.doi.org/10.1044/0161-1461.1302.77

[10] Shriberg L, Kwiatkowski J. Natural process analysis: a procedure for phonological analysis of continuous speech samples. New York: John Wiley; 1980.

[11] Stoel-Gammon C, Dunn C. Normal and disordered phonology in children. Baltimore: University Park Press; 1985.

[12] Weiner F. Phonological process analysis. Baltimore: University Park Press; 1979.

[13] Smith NV. The acquisition of phonological skills in children. British Journal of Disorders of Communication 1974; 9:17-23. http://dx.doi.org/10.3109/13682827409011604

[14] Grunwell P. Phonological Assessment of Child Speech (PACS). Windson: NFER-Nelson; 1985.

[15] Jayashree S. Development of phonological processes in normal 4-5 age group Kannada speaking children [Master thesis]. India: University of Mangalore; 1999.

[16] Sameer P. Development of phonological processes of 3-4 year old children in Malayalam speaking population [Master thesis]. India: University of Mangalore; 1998.

[17] Barathy R. Development of phonological processes of 3-4 years old normal Tamil speaking children. [Master thesis]. India: University of Mysore; 2001. [cited 2011 Jan 15]. Available from: http://203.129.241.86:8080/digitallibrary/HomeAtoZ.do?alphabet=D&recordPage=10&currentPage=1

[18] Santhosh M. Development of phonological processes in the 3-4 years age group. [Master thesis]. India: University of Mangalore; 2001.

[19] Thompson HR. Bengali. In: Brown K, Ogilvie S, Eds. Concise encyclopedia of languages of the world. Oxford: Elsevier Ltd 2006; pp. 148- 150.

[20] Klaiman MN. Bengali. In: Comrie B, Ed. The major languages of South Asia, the Middle East and Africa. London: Taylor & Francis e-library, 2005; pp. 52-61.

[21] Bhattacharrya T. Bangla (Bengali). In: Gray J, Rubino, C, Eds. Encyclopaedia of World's languages: Past and present (Facts about the Word's languages. New York: H. W. Wilson Press, 2000; pp. 65- 71.

[22] Haque ME. Bayakaron monzuri. Dhaka: Mowla Brothers; 2003.

[23] Chaki J. Bangla bhashar byakaran. Kolkata: Ananda Publishers; 2001.

[24] Barman B. Distinctiveness of aspiration in Bangla. Daffodil International University Journal of Business and Economics 2008, 3 (2): 191-203.

[25] Bzoch KR, League R. Receptive-Expressive Emergent Language Scale (REEL). 2nd Ed. Austin, Tex: PRO-ED; 1991.

[26] Banik A. Test of articulation and discrimination in Bengali [Master thesis]. India: University of Mysore; 1988.

[27] Ramadevi K J S. Phonological profile in Kannada: A study on hearing impaired [PhD thesis]. India: University of Mysore; 2006.

[28] Klein HB. Procedure for maximizing phonological information from single-word responses. J of Language, Speech, and Hearing Services in Schools 1984, 15: 267-74. http://dx.doi.org/10.1044/0161-1461.1504.267

[29] Dyson A, Paden E. Some phonological acquisition strategies used by two-year-olds. Journal of Childhood Communication Disorders 1983, 7: 6-18. http://dx.doi.org/10.1177/152574018300700102

[30] Grunwell P. Clinical phonology. Rockville, Maryland: Aspen Systems; 1982.

[31] Ingram D. Phonological disability in children. New York: American Elsevier; 1976.

[32] Grunwell P. Natural phonology. In: Ball MJ, Kent RD, Eds. The new phonologies: developments in clinical linguistics. San Diego, CA: Singular Publishing Group, 1997; pp. 35-75.

[33] Haynes WO, Moran MJ. A cross-sectional developmental study of final consonant production in Southern Black children from preschool through third grade. J of Language, Speech, and Hearing Services in Schools 1989; 20: 400-6. http://dx.doi.org/10.1044/0161-1461.2004.400

[34] Dodd B. The differential diagnosis and treatment of children with speech disorder. London: Whurr Publishers; 1995.

[35] Goldstein BA, Iglesias A. Phonological patterns in normally developing Spanish-speaking 3- and 4-year-olds of Puerto Rican descent. J of Language, Speech, and Hearing Services in Schools 1996; 27: 82-90. http://dx.doi.org/10.1044/0161-1461.2701.82

[36] Haelsig PC, Madison C L. A study of phonological processes exhibited by 3, 4, and 5 year-old children. J of Language, Speech, and Hearing Services in Schools 1986; 17: 107-14. http://dx.doi.org/10.1044/0161-1461.1702.107

[37] Ingram D. Phonological disability in children. 2nd ed. San Diego: Singular Publishing Group; 1989.

[38] Locke JL. Phonological acquisition and change. New York: Academic Press; 1983.

[39] McCormack PF, Knighton T. Gender differences in the speech patterns of two and a half year old children. In: McCormack P, Russell A, Eds. Speech Science and Technology: Sixth Australian International Conference Adelaide: Australian Speech Science and Technology Association 1996; pp. 337–41.

[40] McLeod S. Children's acquisition of consonant clusters [PhD thesis]. Australia: The University of Sydney; 1999.

[41] Roberts JE, Burchinal M, Footo MM. Phonological process decline from 2;6 to 8 years. Journal of Communication Disorders 1990; 23: 205–17. http://dx.doi.org/10.1016/0021-9924(90)90023-R

[42] Watson MM, Scukanec GP. Phonological changes in the speech of two-year-olds: A longitudinal investigation. J of Infant-Toddler Intervention 1997; 7: 67–77.

[43] Sunil TJ. Development of phonological processes in 3-4 year old Kannada speaking children [Master thesis]. India: University of Mangalore; 1998.

[44] Bortolini U, Leonard LB (1991). The speech of phonologically disordered children acquiring Italian. J of Clinical Linguistics and Phonetics 1991; 5: 1-12. http://dx.doi.org/10.3109/02699209108985499

[45] McLeod S, van Doorn J, Reed VA. Normal acquisition of consonant clusters. American Journal of Speech-Language Pathology 2001; 10: 99-110. http://dx.doi.org/10.1044/1058-0360(2001/011)

[46] Lowe RJ. Phonology: assessment and intervention application in speech pathology. Baltimore: Williams & Wilkins; 1994.

[47] Stockman IJ, Stephenson LW. Children's articulation of medial consonant clusters: implications for syllabification. J of Language and Speech.1981; 24: 185-204.

[48] Singh S, Frank, DC. A distinctive feature analysis of the consonantal substitution pattern. J of Language and Speech 1972; 15: 209-18.

[49] Rahul B. Study of phonological processes of 2-3 years old Hindi speaking normal children [Master thesis]. India: University of Mysore; 2006.

[50] Sreedevi, N. Study of phonological process in normal Kannada speaking children: 1.6-2 years. Interdisciplinary Journal of Linguistics 2008; 1: 103-10.

[51] Shriberg LD, Kwiatkowski J, Best S, Hengst J, & Terselic-Weber B. Characteristics of children with phonological disorders of unknown origin. J of Speech and Hearing Disorders 1986; 5: 140-60. http://dx.doi.org/10.1044/jshd.5102.140

[52] Grunwell, P. Clinical phonology. 2nd ed. Baltimore: Williams and Wilkins; 1987.

[53] Hodson B, Paden E. Targeting intelligible speech. San Diago: College Hill Press; 1983.

[54] Otomo K, Stoel-Gammon C. The acquisition of unrounded vowels in English. J of Speech and Hearing Research 1992; 35: 604-16. http://dx.doi.org/10.1044/jshr.3503.604

[55] Stoel-Gammon C, Pollock KE. Vowel development and disorders. In Ball MJ, Perkins M R, Muller N, Howard S, Eds. The handbook of clinical linguistics. Malden MA: Blackwell Publishing 2008; pp. 525-47. http://dx.doi.org/10.1002/9781444301007.ch33

[56] Smit AB. Phonologic error distribution in the Iowa- Nebraska articulation norm project: Consonant singletons. J of Speech and Hearing Research 1993; 36: 533-47. http://dx.doi.org/10.1044/jshr.3603.533

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