MY TEACHERS
AND
SUBJECTS

CERTIFICATE

This is to certify that the Dissertation entitled "Deep Test of Articulation in Bengal Picture Form" is the bonafide work in part fulfilment for the degree of M.Sc,, (Speech and Hearing) of the student with Register No.M890l.

Mysore.

May 1991

Director
All India Institute
of speech & Hearing
Mysore,

CERTIFICATE

This is to certify that this Dissertation entitled: "Deep Test of Articulation in Bengali - Picture Form" has been prepared under my supervision and guidance.

April 1991

Savithri S.R

Dr.S.R.Savithri
GUIDE

DECLARATION

I hereby declare that thia Dissertation entitled:"Deep Teat of Articulation in Bengali-Picture Form" is the result of my own study under the guidance of Dr.S.R.Savithri, Lecturer in Speech Sciences, All India Institute of Speech and Hearing, Mysore-6, and has not been submitted earlier at any university for any other Diploma or Degree.

Mysore. Register NoM8901

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INTRODUCTION

The purpose of speech is effective communication which in turn can be facilitated through precise articulation. Articulation is a means to intelligible speech.Articulation involves the complex configuration of the place and manner in which the sounds of speech are produced. However, this process involves a more complex mechanism that it seems. Numerous other factors like intact oral structure, coarticulation effect, psychological status, intelligence, rate and speed of movements, influence the articulatory process. The process, as earlier thought does not consist of fixed static, position of the organs of articulation but of a functional, dynamic action and movement of those organs. The actions though have a more or less uniform pattern do manifest variability in its formation. This variability arises due to factors such as phonetic context (which is one of the most significant factors); context-ideational content and emotional attitude.

Same string of utterances show variation in successive repetitions which is attributed to the dynamic nature of the contributing factors. Thus, every utterance or formation or sound production is a result of a combination of the activities of the articulatory organs and the factors in various permutations and combinations. The articulatory apparatus consists of the organs including lip, dental.

structures, tongue, velum, palate etc. However, articulation is not an isolatory process. It requires perfect coordination with the phonatory (larynx) and resonatory (pharynx) apparatus.

In short, the articulatory process exhibit both intra and inter subject variability. Thus, as Gray and Braden (1963) state the four essentials in sound formulation and thus in articulation are - correct formulation, adequate formulation, sufficient breath and sharp, clean movement.

Any deviation in these static and dynamic components leads to misarticulations. Misarticulations vary as the nature, degree and extent of variation of the gestures and movement of articulators. Articulators move out off their respective normal ranges which ensure precise production.

As evident from the complex process of articulation the task of tapping the actual source among the numerous static and dynamic components of articulation become formidable. Often the source is more than one and many a times the sources and its effects are interwoven. Hence, this requires a systematic organized format which would help the diagnostician in coming to a consensus regarding the articulatory process and its efficiency.

Thus, with these in mind numerous researchers (Templin and Darley, 1969; Fudala, 1970; Fisher and Longemann, 1971; Goldman and Fristoe, 1967; Pendergast, Dickey, Selmar and Soder, 1969; Van Riper and Erickson, 1973; Tasneem, Usha, 1986; Arun Banik, 1988; Padmaja, 1989) have put-forth formats or tests Which would aid in articulation assessment. The problem of identifying the articulatory process, considering its constituents and environments such as sound production in isolation or combination, in different phonetic environments, in different word phrase-sentence positions (ie initial, medial and final position) and whether the defect has an organic or functional base, have formed the stepping stones in constructing different kinds of tests of articulation. In this regard.screening test of articulation, diagnostic test of articulation, and deep test of articulation have been formulated. These three classes of tests have a hierarchical relation interms of complexity, components and detail, with the screening test the most brief and the deep test the most descriptive, the major aspects of deep test being analysis in all possible phonetic environment: analysis interms of distinctive features, inclusive of all the sounds or phoneme occuring in that language.

Articulation is language specific i.e. though the phonemes in different languages are similar, their functional dynamics

vary in each language; which calls for construction of tests specific to each language. In this regard deep tests of articulation are available in English (McDonald, 1964; both picture and sentence form), Kannada (Rohini, 1989 sentence form) and Malayalam (Maya, 1990, sentence form). The present study aims at constructing a picture deep test of articulation in Bengali.

REVIEW

Disturbance of speech sound production-misarticulations are the most common type of speech disorder. Atleast 80% of the case loads of speech pathologists is comprised of these children who might substitute one phoneme for another or omit or distort other sounds. They are handicapped because their speech deviates from the norms of our society that depends upon effective communication and demands it. The clinician, therefore, should have a thorough understanding of articulation, disorders of articulation, assessment of articulation disorders and finally planning therapy programmes for defective articulation cases.

The word 'diagnosis' (Greek) means to understand thoroughly. To obtain detail information we need to have systematic articulation testing programme. Articulation testing is a procedure, using which the phonemic ability of an individual in a given language is determined.

Articulation tests,

1. help in identifying clients with abnormal articulation,
2. help in describing the phonemic ability of an individual,
3. help in locating possible causative factors,
4. are useful in studying phonological development,
5. enable one to compare the effect of particular environment and kind of stimulation.

6. make it possible to follow developmental schedule,
7. help in deciding the necessity of therapy,
8. help in planning and evaluating therapy,
9. help in locating the phonemes that should be treated first in therapy,
10. help in predicting the improvement of therapy and
11. help in finding out the effectiveness of the therapy.

However, it is not possible to achieve all these goals by a single test. Different types of tests according to clinicians meeds are needed. Various types of articulation testa have been proposed.

1. Predictive screening test:

They mainly are responsible in helping the speech pathologist predict whether or not a client, having a particular speech defect, will out-grow his/her problem with age. It also helps in deciding whether speech therapy is required or not.

2. Screening test:

This is used to assess the general accuracy of the clients articulation. It can test only those sounds, and sound clusters which are associated with significant progress in the development of articulation. This has the particular function of sorting out children who are deviant in their

articulatory behaviour. The main advantage of this test is that, it can detect articulatory defect as quickly as possible in an individual or a group situation like in this class room.

However, these tests neither help in describing the nature of the problem nor in diagnosing a problem. As most of the screening tests use limited sounds, the child may consistently misarticulate those sounds which are not included in the test and thus remain undetected during testing. Some children may consistently make an error on particular sound which may be corrected by themselves later. Hence, selecting the child on the basis of screening test is of little use when he/she may improve by himself/herself. To avoid these limitations of screening test, diagnostic articulation tests have been developed.

3. Diagnostic articulation test;

It is a much more systematic test and it helps in the thorough examination of articulatory defect. The primary function of this type is not only to detect those children who need speech correction but to aid in the evaluation of children already known to be defective in articulation. It includes all the possible speech sounds in a language. Thus, it gives information regarding all the sounds the child misarticulates and also helps in finding out whether the

misarticulation occurs in initial, medial or final position. According to Templin and Darley (1960) "A diagnostic teat of articulation should provide detailed information about a child's ability to produce a wide range of speech sounds in a variety of positions and phonetic contexts". This thorough articulatory investigation serves the dual purpose of further understanding the nature and possible cause of the disorder and establishing a basis for planning an effective sequence of therapeutic steps. It also gives information regarding predicting the possible improvement when visual and auditory clues are given.

However, it also has some limitation. It does not test a particular phoneme in all the possible context and usually does not help to find out the key phoneme which will be easy for a clinician to start the therapy programme. To avoid these disadvantages deep tests of articulation are proposed.

4. Deep test:

Deep test of articulation is one of the diagnostic articulation test in which each sound is tested in all possible phonetic contexts. That is, a sound is deep tested in a variety of phonetic contexts, as the sound is followed and preceded by each of the other consonants.

Deep test represents a marked departure from conventional tests of articulation. It is based upon the premise that speech is a continuous process of movements of articulators rather than a series of static positions of the structures. The function of consonants whether occuring singly or in clusters, is either to release or arrest syllables. The movements of the articulators into and out of a given consonant affects the character of the consonant. In order to analyze the correctness of the phoneme, then, it has to be deep tested ie. it has to be tested in many contexts in which it occurs in running speech.

The need for testing, according to McDonald (1964a) is based on two premises (1) three position inventories are representative of the location of sounds in written words rather than in connected speech, and (2) articulation errors especially in children are highly variable and inconsistent.

The purposes of the deep test of articulation are:

1. to permit the evaluation of speech sounds as the audible end-products of a series of over-lapping, ballistic movements.
2. to provide a test long enough to permit observation of the degree of variablity present in the speakers production of the sound.

3. the sentences or picture cards of the deep test may be used following the administration of any of the conventional tests to give information on consistencies and inconsistencies of errors and to help search for key words and contexts. and
4. Deep test can be very useful in the exploration of phonetic environments in which consonant production may be correct.

However, deep testscan be

1. Extremely long and laborious,
2. It cannot 'deep test' more than two sounds at one meeting if they are evaluated in all phonetic contexts,
3. The results are not valid for children with certain types of speech problems.
4. The children who speak slowly and children with multiple articulation errors have difficulty blending the two separate words into the single word without pausing. Yet these children do not have difficulties in speaking when pauses are part of natural speaking situations. Children with neuromuscular disorders involving the articulators have trouble also in joining words without a pause, particularly when fricatives are blended together.
5. They are not able to make the articulatory adjustments necessary to produce all the "funny words" in the test.

6. The construction of "funny words" can provoke too much laughter and thusreduce motivation.
7. Some children may even resist saying the word because of these reactions and thus negative validity of any test results.
8. Many hours of listening to the responses of children to the test item would be necessary before concluding the findings to be valid.

Inspite of these limitations, the deep test of articulation has definite advantages over other diagnostic articulation test. This necessiates its inclusion in the assessment of an articulation disorder. At present two types of 'Deep test' of articulation are available (l) sentence form (2) picture form.

(1) Sentence_form:

Short simple sentences are employed in this test. Usually words in the sentences are selected from a primer, first, and second grade reading lists, and a few from third grade reading level, and are used to elicit meaningful connected speech. The test might be administered by having the child read the sentences, which are written at an easy reading level for the average third grade child. Children who cannot read might be asked to repeat the sentences. The length of utterance of

most sentences are 4 to 5 words, with a few containing 7 to 8 words.

(2) Picture_form:

In this test, pairs of pictures are named to make a "funny big words" out of the two little words. The pictures chosen are those which elicit the desired name from 80% of a large group of kindergarden children. Children are given names for other pictures in a demonstration procedure, and then are instructed to name the two pictures as a bisyllable. i.e. with no pause between the words. The test may be administered as either a spontaneous or imitative test. Although real words are used, the combination results in a nonsense bisyllable.

Its main advantage is that it can be used for younger children than the children used to test in sentence form. But it also has the disadvantages (l) As the child has to produce a nonsense bisyllabic word, if they are not familiar with those words, their productions may be erroneous. (2) These funny bisyllabic words may lead for the children to loose their interest. Screening deep test of articulation in English is also available.

Screening deep test of articulation (SDTA):

The SDTA employs pairs of pictures to elicit ten production of each of nine commonly misarticulated consonants

Administration time for beginning kindergarden children is about 10 minutes and about five minutes for older children. The advantage is that all the phonemes need not be tested. Further, it takes less time and indicates when further deep testing is needed.

The first deep teat of articulation was developed by Dorsay (1959). He provides a deep test of articulation of 50 item sentence for /r/. The 50 sentences present /r/ in a representative sample of the more than 2000 phonetic contexts,

McDonald (1964) constructed a deep test of articulation in English in both picture form and sentence form. This deep test of articulation has been universally accepted. He cited evidence indicating that phonemes not immediately adjacent to target sound have little influence on the correctness of articulation with which that sound is heard. While the coarticulatlon studies cited did not use correctness of articulation as a dependent variable, they suggest that phones in broad context might influence the production of a given sound as measured by an articulation test.

McDonald's deep test of articulation is constructed to elicit production of the tested sound as one of a series of phonemes. Three factors that influence how a sound is articulated in connected speech are manipulated in the tests.

The tested sounds occur:

1. in different syllable roles (release or arrest)
2. as different consonant type (single, abutting and compound)
3. in systematically varied phonetic contexts to require a diversity of coarticulatory movements.

Pictureform: In this test 13 consonants are tested in different contexts. There are two series of word lists. Two words are selected for each sound; one with initial and one with final position. In this,the child has to combine two meaningful words of both the sides and produce a 'funny big nonsense word'. For example, when the pictures are representing /cup/ and /bell/, they have to combine and produce a nonsense funny big word /cupbell/. The production of the target phoneme will be noted down in different contexts.

Sentence form: The sentence form has 13 consonants, words in the sentences are selected from a primer, first and second grade reading lists, and few from third grade reading level. Most of the sentence length is 4 to 5 words with a few containing 7 to 8 words. All the sentences are meaningful. Children are asked to read the sentences. If they are not able to read, they could be asked to repeat after the clinician.

The responses of each child are recorded in the scoring sheet. From these recordings, the examiner can find out the percentage of correct productions as well as thephonetic

contexts in which correct productions occur. The tests provide information for a distinctive feature analysis of articulation. They identify correct productions that are valuable starting points for therapy. A comparison of the number of correct responses can be used as an indicator of progress resulting from maturation of speech training.

In 1968, McDonald constructed another deep test for screening purpose. The screening deep test of articulation employs pairs of pictures to elicit ten production of each of nine commonly misarticulated consonants. It yields a score for each subject. This may be interpreted in terms of the percentage of phonetic contexts in which each tested consonant was articulated correctly. When these scores are plotted on the record form, a phonetic profile may be drawn for each subject tested. The profiles portray the pattern of a childs development of articulatory skill and has potential implication for prognosis, case selection, therapy and evaluation of therapy outcomes. The SDTA indicates when further deep testing is needed.

Zehel and Shelton (1972) modified McDonald's /s/ list. In broad context McDonald tests the /s/ sound in two series of items, designated as lists IA and IB. In list IA, the test word 'sun' is preceded by adjacent words in such a way that 19 different consonants and three vowels are used as they immediately precede the /s/. Each word pair is uttered

as a single word. In list IB the word 'house' is immediately followed by 24 words initiated with 20 different consonants and four vowels. Three lists of items which differ systematically from McDonald's items were designed for this study. They are termed lists 2,3, and 4 each list has A and B subsets. Within the 'A' list, as in McDonald's original list, the /s/ appears in the initial part of the second word in the word pair and the second word is common to all items. In the list B, /s/ appears in the final position of the first word in the word pair, and that word is common to all items. The second word is different for each item; for example 'house poke' or 'house book'.

Lists 2A and 2B use the test words sun and house, as in McDonald's test. However, the adjacent words were altered. In each adjacent word for list 2A, the sound abutting the /s/ was the same as used by McDonald, but the preceeding consonant or consonant and vowel were altered. The alteration was intended to change the height and place of tongue for vowels, and the place but not the manner of articulation of consonants. Thus, where possible, high front vowels were changed to low back vowels and vice-versa. In each adjacent word for list 2B, the consonant abutting the /s/ was again the same as used by McDonald, but the following vowels or vowel and consonants

were altered in the manner described previously. Thus as an example McDonald's adjacent word bell in 'housebell' was altered to 'book'.

List 3A used the adjacent words cup, tub, kite and others, as in McDonald test, but the test word was altered in the manner previously described. Thus the word 'sun' was changed to 'seek'. List 3B used the adjacent words pipe, bell, tie and others as in McDonald's test but the test word 'house' was altered to 'face'.

Rockman and Elbert (1984) modified McDonald's /s/ list to use in their study on untrained acquisition of /s/ in a phonologically disordered child. Contexts in which /s/ was evoked imitatively were as follows:

Word initial (CV or CVC)	Word final (CVC)	Word medial-two morphemes CVC+ Inflection -ing; -ie; -er	Word medial-one morpheme (CVSVC)
Sell	race	racing	possum
Sit	miss	missing	wrestle
Soup	puss	pussy	lesson
Sun	mouse	mousee	muscle
Seam	ice	icicle	bicycle
Soap	toss	tossing	whistle
Sign	loosa,	loosser	listen
Seed	pass	passing	jancet
Saw	bus	hissing	lasso _
sad	yes	bossy	recipe

Rohini (1989) constructed a deep test of articulation in Kannada (sentence form). 13 consonants (are /g/ /d/ /d/, /e/ /j//n//s/ /s//h//y//r/ /l/ /v/) were tested in vowel, consonant and consonant cluster contexts. 3 to 4 words long meaningful simple sentences were used with few 7-word sentences. Totally 305 sentences were used to test all the 13 phonemes in possible phonetic contexts, including 108 sentences in cluster contexts. Rohinl (1989) tested 120 children in the age range of 5 to 9 years in both the sex. For response each child was required to repeat the sentences after the tester or read the sentences. Each correct articulation was given a score of one and the total correct response was computed. The results indicated a maximum correct score of 96.63% at 8 years to 9 years age Group and the articulatory proficiency increased with age. She found that /h/ and /s/ were the most difficult phoneme to articulate. Also, it was observed that the vowel environment was easier for children to articulate than the consonant environment. Among consonant, consonant cluster environment was the more difficult than single tons. 'T' test showed no significant different between males and females within the age group and also no significant different between the age groups, 5-6 years vs 6-7 years; 6-7 years vs 7-8 years; 7-8 years vs. 8-9 years in terms of articulatory skills at 0.05 confidence level.

Maya (1990) also developed a deep test of articulation (sentence form) in Malayalam. She used 8 key phonemes (/j/, /s/, /s/, /s/,/r/, /l/, /R/,/L/) which were most commonly misarticulated by the children. Simple meaningful sentences were used. The sentence length was 2-3 words. Those 8 target phonemes were tested in vowel, consonant and consonant-cluster environments. The test consists of 87 sentences including 27 sentences in which target phonemes were tested in cluster environment. 90 Malayalam speaking children in the age range of 5 years to 8 years (in both the sex) were tested. Each child was instructed to read or repeat the sentence which were read by the examiner and the responses were recorded. Each correct articulation was given a score of one and the total correct response was found out. She reported a maximum score of 95.86% at 7-8 years. 'T' test showed no significant different between males and females within the age group. However, there was an increase in the total score with the increase of age and /s/ and /s/ were the most difficult items to articulate in all the age groups. She also found that vowel environment was the easiest and conmonant-cluster environment was the most difficult. In her diagnostic picture articulation test she found that /s/ was acquired by Malayalam speaking children only by 5-5.6 years,/r/ by 4.6 to 5 years and /s/ by 4-4.6 years. She Opined that this could be the reason why children had difficulty in producing /s/ correctly in the deep test of articulation.

Several investigators have used the deep test of articulation to evaluate articulatory performance. Aungst and Prick (1964) in their study to investigate the hypothesis that consistency of articulation is more directly related to the ability to judge one's own speech productions as correct incorrect than to the ability to discriminate between paired auditory stimuli presented by another speaker, along with 3 new tests, used'deep test' of articulation for /r/ - additional test for discrimlnation constructed by Dorsay (1959) according to principles suggested by McDonald (1959).Correlation among the tests indicated that the ability to judge one's own speech production as measured by the deep test is significantly related to the consistency of articulation. Therefore, tests of this ability should prove to be valuable in diagnosis, therapy and research.

The negligible correlation between the traditional test and the deep test of articulation as reported by Aungit and FKick (1964), in their study does not necessarily indicate that 'external' or 'inter personal' discrimination ability is unimportant in the development of articulation ability. However, the findings of their study seem to indicate that the tranditional speech sound discrimination tests samples an ability which is well established by 8 years of age and is not related to articulation defects which persist after that age.

Templin (1957) in her normative study, in which she introduced the 50 item test, also used in the study (AungSt, Prick, 1964) stated "... it would seen that at 8 years of age, the ceiling in sound discriminationability, as measured by the deep test in being pushed.

Zehel, Shelton, Arndt, Wright, and Elbert, (1972) while studying the influence of broad production as measured by deep tests found that broad context had little influence on the articulation of /s/ phonemes.

McReynolds,Kohn and Williams (1975) in their study analyzed the discrimination and production performance of severely misarticulating children. Their performance on the McDonald deep test of articulation and minimal pairs discrimination test was compared to the performance of children without articulation errors. The normal children performed well in production and discrimination. However, the articulatory error children performed poorly on the production test but performed as well as the normal children on the discrimination test.

Sundstrom (1988) while describing the process of /s/ acquisition among young children who substituted an inter-dental fricative for /s/ made use of the deep test of articulation for /s/ and concluded that the deep test of

articulation seemed to be reliable indicator of whether or not /s/ would be acquired with in 5 consecutive months.

Martin (1989) conducted a comparative study of two deep tests of articulation where the articulatory responses of children with articulatory disorders under two stimulus conditions (l) the traditional two picture elicitation procedure for compound words (McDonald,1964) and (2) a single picture elicitation procedure modeled after Clark (1985) were compared. This investigation has provided evidence that an additional factor for consideration when assessing contextual influences is the type of elicitation of stimuli. The findings parallelled the discrepancies between articulation performance in response to single - word stimuli and connected speech samples, thus highlighting the importance and necessity of the deep test of articulation.

This review highlights the various deep tests of articulation and its importance. It is also evident that any discussion of articulation in teams of assessment, diagnosis or therapy should take into account the specific language.

India being a multilingual country people speak different languages and tests in various languages are required. In this context, the present study is planned to develop a deep test of articulation (picture form) in Bengali language.

METHODOLOGY

Material: In this deep test of articulation those key phonemes which are most frequently misarticulated by the children are selected. In Bengali.the phonemes which are most frequently miaarticulated (Arun Bank, 1988) include /k/, /g/, /t/, /d/, /d/, /e/, / j / , /s/, /r/, /L/ and /h/ (Table-1).

Phoneme	Phonetic description
k	velar, voiceless unaspirated plosive
g	velar voiced unaspirated plosive
t	retroflex voiceless unaspirated plosive
d	retroflex voiced unaspirated plosive
d	dental voiced unaspirated plosive
e	palatal voiceless affricate
j	palatal voiced affricate
s	dental voiceless fricative
r	retroflex voiced trill/flap
L	retroflex voiced lateral
h	glottal voiceless fricative

Table-1: Description of phonemes selected for the study.

These eleven phonemes were included in the present test. Simple meaningful and picturable words with these phonemes in initial and final position were selected as a means of eliciting a response from the children. Two such word

lists were prepared with 21 picturable words in the first list and'20 picturable words in the second list. (Table 1)

In Bengali, word ending with the phoneme /h/ are pronounced as a vowel ending.for example /deh/ is pronounced aa /deha/. Hence the phoneme /h/ could not be tested in word final position. In the second list of this test the sound /d/ has not been tested in the word final position because of the nonavailability of picturable, familiar word ending with /d/.

These words were selected from L.K.G. I, II and III standard books and pictures (simple line drawings) depicting these words formed the test material. Each phoneme was used in several phonetic contexts as depicted in Table-2. Eight simple words were selected and the pictures depicting these served as the demonstration items (Table-3). All the pictures of the test are in Appendix-3.

Subjects: Twenty Bengali speaking normal children (10 males and 10 females) each in the age range of 4-5, 5-6 and 6-7 years were selected for the study. They were selected on the criteria that they had normal speech and language as evaluated by a speech pathologist and had no history of any eardischarge. Their mother tongue was Bengali and all of them were from middle socio-economic status.

Key Phonemes / Context		t *	d	k	g	d	c	J	s	r	l	h
t	F	+	+	+	+	+	+	+	+	+	+	+
	P	+	+	+	+	+	+	+	+	+	+	-
d	F	+	+	+	+	+	+	+	+	+	+	+
	P	+	+	+	+	+	+	+	+	+	+	-
	F	+	+	+	+	+	+	+	+	+	+	+
k	P	+	+	+	+	+	+	+	+	+	+	-
	F	+	+	+	+	+	+	+	+	+	+	+
g	P	+	+	+	+	+	+	+	+	+	+	—
	F	+	+	+	+	+	+	+	+	+	+	+
d	P	+	+	+	+	+	+	+	+	+	+	-
	F	+	+	+	+	+	+	+	+	+	+	+
e	P	+	+	+	+	+	+	+	+	+	+	-
	F	+	+	+	+	+	+	+	+	+	+	+
j	P	+	+	+	+	+	+	+	+	+	+	-
	F	+	+	+	+	+	+	+	+	+	+	+
s	P	+	+	+	+	+	+	+	+	+	+	-
	F	+	+	+	+	+	+	+	+	+	+	+
r	P	+	+	+	+	+	+	+	+	+	+	-
L	F	+	+	+	+	+	+	+	+	+	+	+
	P	+	+	+	+	+	+	+	+	+	+	-
	F	—	—	—	-	—	—	—	-	—	-	—
h	P	+	+	+	+	+	+	+	+	+	+	—

Table-2: Phonetic contexts selectea for the study.

'+' - Indicate phonemes are tested in that context.

'-' - indicate phonemes are not tested in that context.

'P' - Indicates preceding and 'F' indicates followed by

For example /t/ in column.- tp^{+}/p_{+} in row indicates that /t/ is preceded by /t/ (P) and followed by /t/ and both phonetic contexts are used in the study.

Picture arrangement: All the pictures representing words with the key phoneme in final position were placed on the left side (Set-1) and those representing words with key phonemes in Initial position were placed on the light side (set-2) such that any picture on the left could be combined with that on the right. Thus, the first list had ten pictures on the left and eleven pictures on the right and the second list had nine pictures on the left and eleven pictures on the right. The pictures represented the following words in order (Table-3)

Administration: The children were seated comfortably and the test materials were placed such that he/she could see the pictures without any difficulty. Each child was tested individually in a quiet environment of the school in Tamluk, West Bengal.

Since the main aim of the deep test of articulation was to find out which articulatory patterns associated with different phonetic contexts result in the correct production of the phoneme being tested, it is imperative that the child produces the words as a continuous movement of articulators i.e. as a continuous syllable. For this purpose, the task of naming the pictures was demonstrated to the child. The first two pictures of the demonstration item /cup/ and /paṭaka/ were shown to them and was uttered as a single word

List-1		List-2	
Left stack (set-1)	Right stack (set-2)	Left stack (set-1)	Right stack (set-2)
1. ɪ̆ṭ	1. ṭebil	1a. Uṭ	1a. ṭupi
2. bleḍ	2. ḍim	2a -	2a. ḍab
3. mak	3. kɔla	3a. bhaluk	3a. kaṭhal
4. bɤg	4. gɔla	4a. morog	4a. goru
5. cad̆	5. dăt	5a. chad	5a. doṛi
6. camɔe	6. coɤh	6a. sŭe	6a. cɔsma
7. pĭaj	7. janala	7a. jahaj	7a. jɔl
8. bas	8. sap	8a. hăs	8a. surjɔ
9. kukur	9. rɔth	9a. mour	9a. raja
10. biṛal	10. lɔbka	10a. chagɔl	10a. lal
	11. hat		11a. hati

Demonstration items

kap	bɔl
ṭɔb	pɔtaka
sap	balti
ḍab	pata

Table-3: Words represented by pictures which were used for the picture deep test.

/cupptaka/. Following this the second picture pair (cup and ball) was presented which was again uttered as a single word /cupball/ by the tester. The children were asked not to produce those ' big funny word' which were used for demonstration.

Later, both sets of cards were turned over exposing the cards on the left and on the right. The children were then asked to say the 2 words together as a single unit. If necessary, they were instructed to repeat this until they were able to utter the two words without pause. For more practice the card on the right side was turned over with keeping the card on the left side constant. The children were then asked to articulate the two words in a single articulatory movement. They were made to practice this repeatedly. Once the experimenter ensured that the children did not interrupt his articulatory movements at the syllabic junction, testing in different phonetic contexts was began. A phoneme was tested at the word initial and final positions. A picture which ended with the target sound was selected for example when the sound /t/ had to be tested, the stack of pictures on the left side were turned over until the picture with /t/ in final position was exposed. The child was then asked to combine the word on the left and right and to say the two words ' t' and ' t̪ bil' without stopping in between as ' t̪t̪ebll'. His or her response i.e. the articulation of

/ţ/ when followed by the sound /ţ/ was recorded. Then the picture on the right ('ţebil') was turned over the expose the next 'dim' where in the child had to say ţdim and his/her response was recorded when /ţ/ was followed by the sound / /. The picture on the right was once again turned over and the whole procedure repeated until all the cards in the right stack had been tested.

After this, a picture with the next target phoneme to be tested was selected. For example, if /d/ was to be tested in word final position, then the picture of the left set was turned over until the picture with /d/ in final position was exposed. For example, set the picture on the left side to 'bled' and right side to 'ţębil'. Then the child had to produce two words 'bledţebil' without stopping in between and the response was recorded. Then the picture of the right (ţębil) was turned over to expose the next picture 'dim' where in the child had to say 'bleddim' and the response was recorded. The picture on the right was once again turned and the whole procedure was followed until all the cards in the right stack had been tested. Same procedure was followed until all the phonemes were tested in all the phonetic contexts. Thus, in list, list one each phoneme in the left stack was tested in 11 phonetic environments and each phoneme on the right stack was tested in 10 phonetic

environments. Hence, the tester elicited a total of 110 responses (10x11) for list 1. For the second list, a phoneme on the left stack was tested in 11 phonetic contexts and that on the right stack was tested in 9 phonetic environments. Thus, in the second list, a total of 99 responses (9x11), were elicited for each child. In total, for each child 209 responses were recorded and for 60 children 12540 responses were recorded.

During the testing, if the child failed to say the desired word, the examiner prompted the child by uttering the word.the testing was then continued and in the end the above mentioned picture or context was tested again, thus ensuring the elicitation of spontaneous responses rather than the imitative ones.

Instead of prompting a child on a particular phoneme, alternate pictures could be used from the second list. For example if the phoneme /g/ using /bæg/ or /gola/ in the first list had not been articulated correctly in the first deep testing in any of the context, the test was repeated using 'more g' or 'goru' from the second list.

Recording: Both testing of the sounds in different contexts and recording of the childs responses were carried out simultaneously. The examiner listened to the childs response and

marked it on the scoring sheet. Depending upon the childs response appropriate symbols were used to indicate whether he had articulated thetest sound correctly or incorrectly. For a correct response the symbol ' ' was used. Incase of an incorrect response appropriate symbols were used to indicate..

1) a substitution or addition (in which case the substituted or additional sound was noted down) or
2) an omission or distortion (which are indicated by 'OX' for omission and 'DX' for distortion).

The scoring sheet is given in Appendix-3.

The total number of correct response for each child was computed and the percentage of correct response was determined by the formula.

$$\% \text{ of correct response} = \frac{\text{No. of correct response}}{\text{Total no. of response}} \times 100$$

The % of correct responses of all the children in each age group were averaged and a 'T' test was administered to find out: the age and sex differences in the performance of children.

RESULTS AND DISCUSSION

The Bengali deep test of articulation was administered to 60 children in the age range of 4 to 7 years. They are devided into three age groups (4-5, 5-6 and 6-7 years). The test was scored on the basis of the frequency of correct responses. The data was statistically analyzed by obtaining the mean, percentage and variance. 'T' test was used to find out the significant difference between males and females in general and within the age groups and also between the age groups.

Results are discussed under the following headings:

1. Distribution of total score
2. Distribution of scores among subgroups
3. Item analysis
4. Order of difficulty of the items.

Distribution of total score: The mean score was 101.5, 103.5 and 107 respectively for the age groups of 4.5, 5-6 and 6-7 years for the first list, in which the total possible score was 110. In case of second list the mean score was 91.25, 93.95 and 96.65 respectively for the age groups of 4-5, 5-6 and 6-7 years, where total possible score was 99. Thus.it was observed that as the age increased the scores also increased suggesting the increasing capacity to articulate. Table 4 and 5 show the mean and percentage score for each age group.

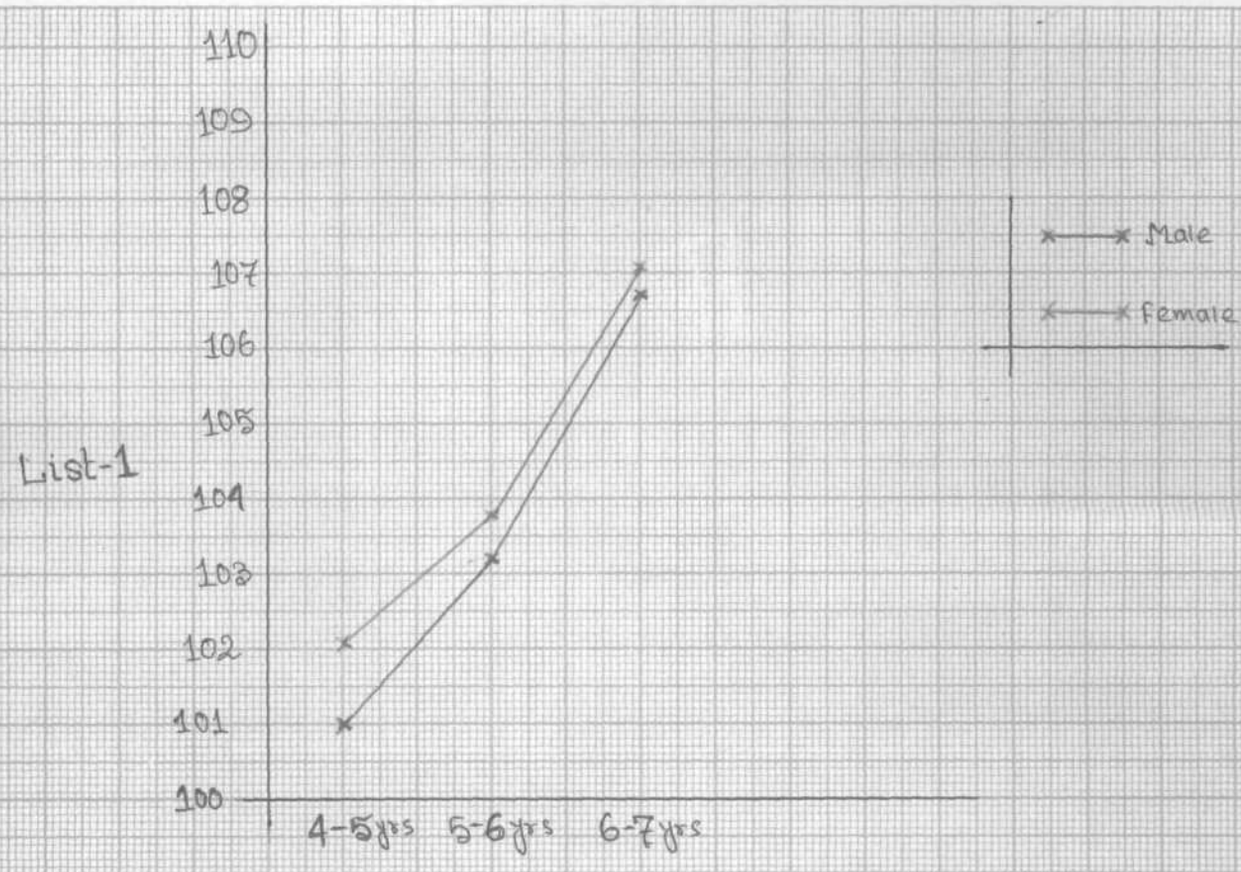
Age	Sex	Mean score		Average score	Average S&ore
		List-1	List-2	List-1	List-2
4-5	M	101	90.9	101.5	91.25
	P	102.1	91.6		
5-6	M	103.2	93.8	103.5	93.95
	F	103.8	94.1		
6-7	M	106.8	96.5	107	96.65
	F	107.1	96.8		

Table-4: Shows mean score for each age group.

Age	Sex	Percentage of score		Average percentage of score	
		List-1	List-2	List-1	List-2
4-5	M	91.8	91.8	92.3	92.15
	F	92.8	92.5		
5-6	M	93.8	94.7	94.1	94.9
	F	94.4	95.1		
6-7	M	97.1	97.5	97.25	97.65
	F	97.4	97.8		

Table-5: Shows percentage of score for each age group.

Figure-1 shows the mean score obtained by different age groups by males and females and Figure-2 depicts the mean score



Total Score obtained by different age groups by males and females

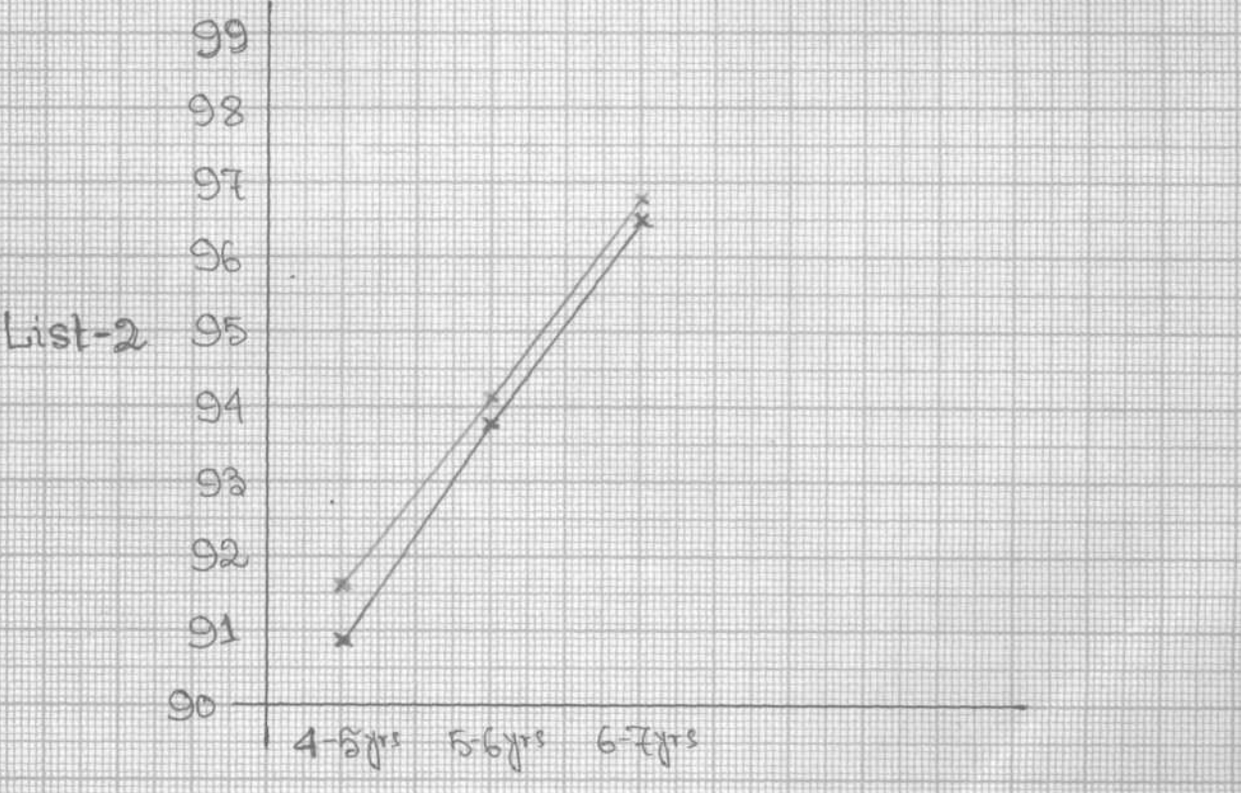
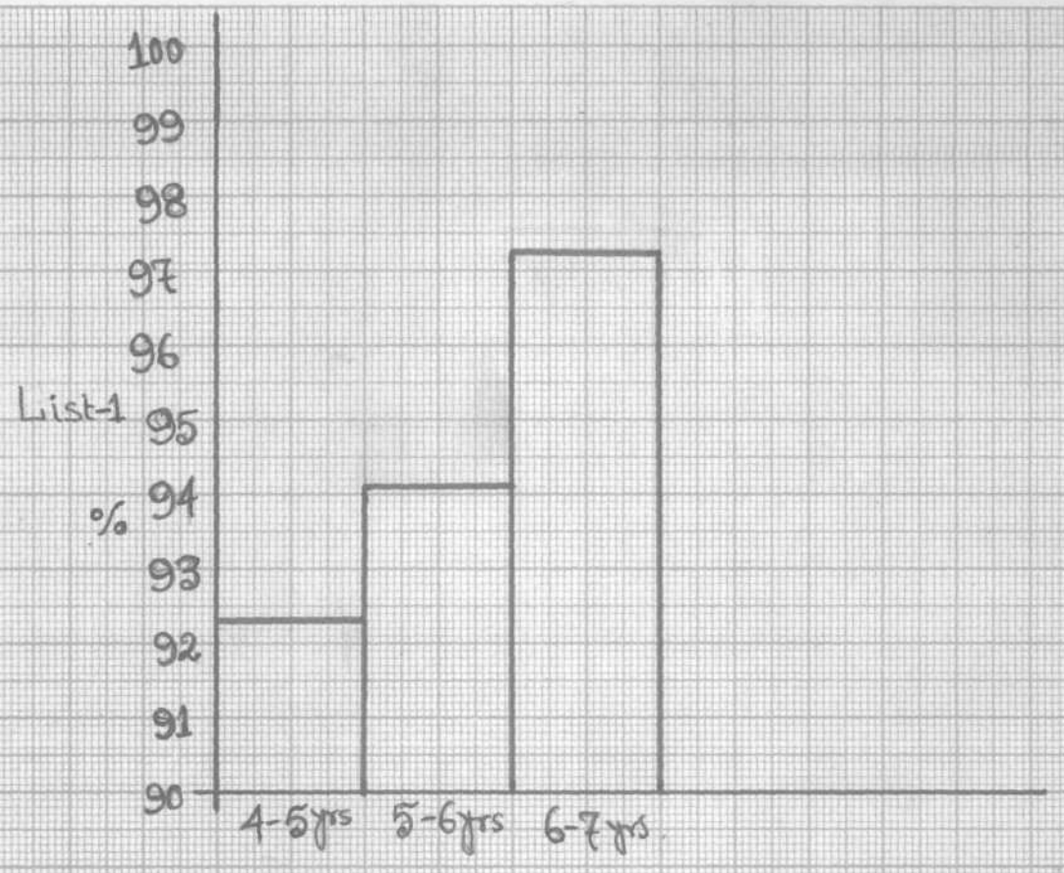


Fig-1



Total Score obtained by different age groups interms of percentage

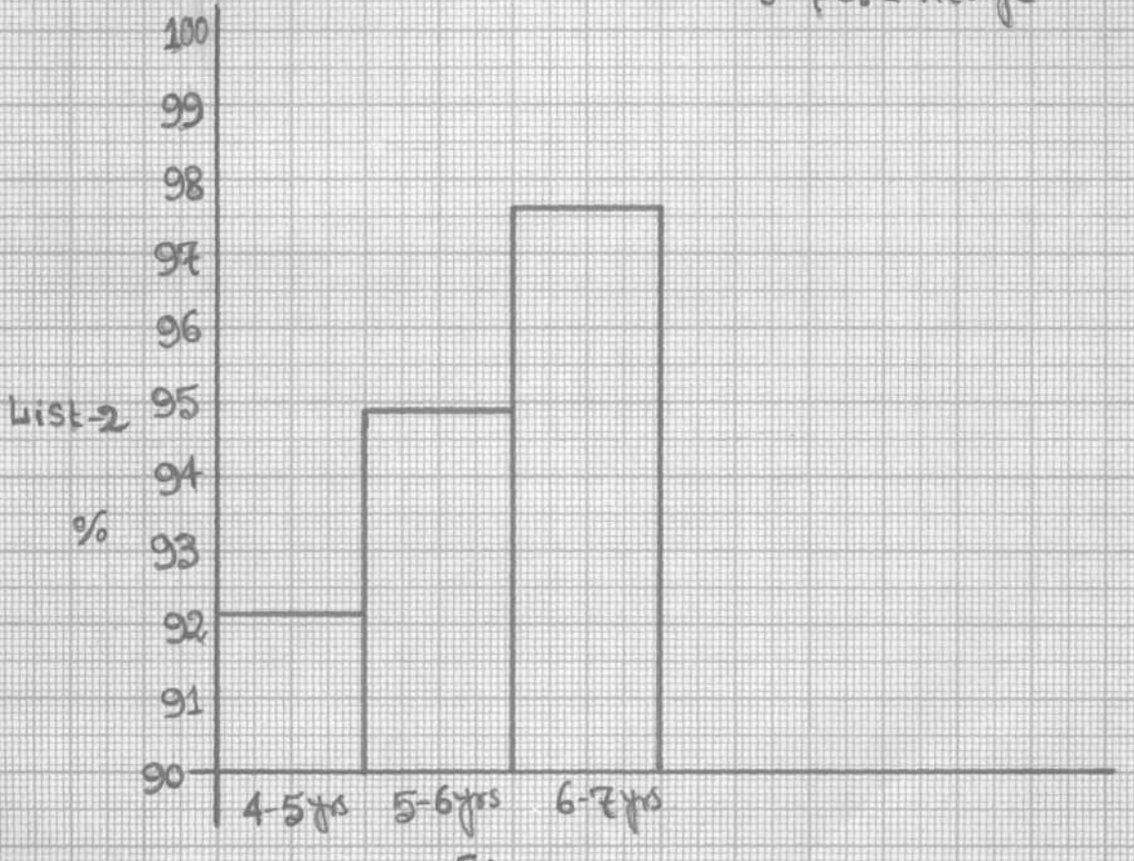


Fig-2

obtained by different age groups in terms of percentage. The findings of Wellman (1931), Poole (1934) and Templin (1957) indicated that 'phoneme' development is correlated with age and that some sounds are mastered, earlier than the others. The results of the present study confirms those of the above in that articulation scores and thus the articulation skill increased with age.

On 'T' test it was found that there was no significant difference between males and females in terms of articulatory skills (confidence level 0.05) within the age group. Roe and Milisen (1942) and Winitz (1959a) reported no significant difference between articulatory skills of males and females.. Perkins (1977) and Winitz (1969) stated that sex is a minor variable in the development of articulatory skills. Perkins stated that the results were conflicting, differences reported were small and they were virtually nonexistent in well controlled studies. Rohini (1989), Maya (1990) also found no significant difference between the performance of males and females within the age groups.

Between the groups there was significant difference, with low scores in the younger age groups and high scores in the elder age groups. This contradicts the results of Rohini(1989) who found no significant difference between the age groups. Also, no significant difference was found between the two lists on 'T' test at 0.05 level.

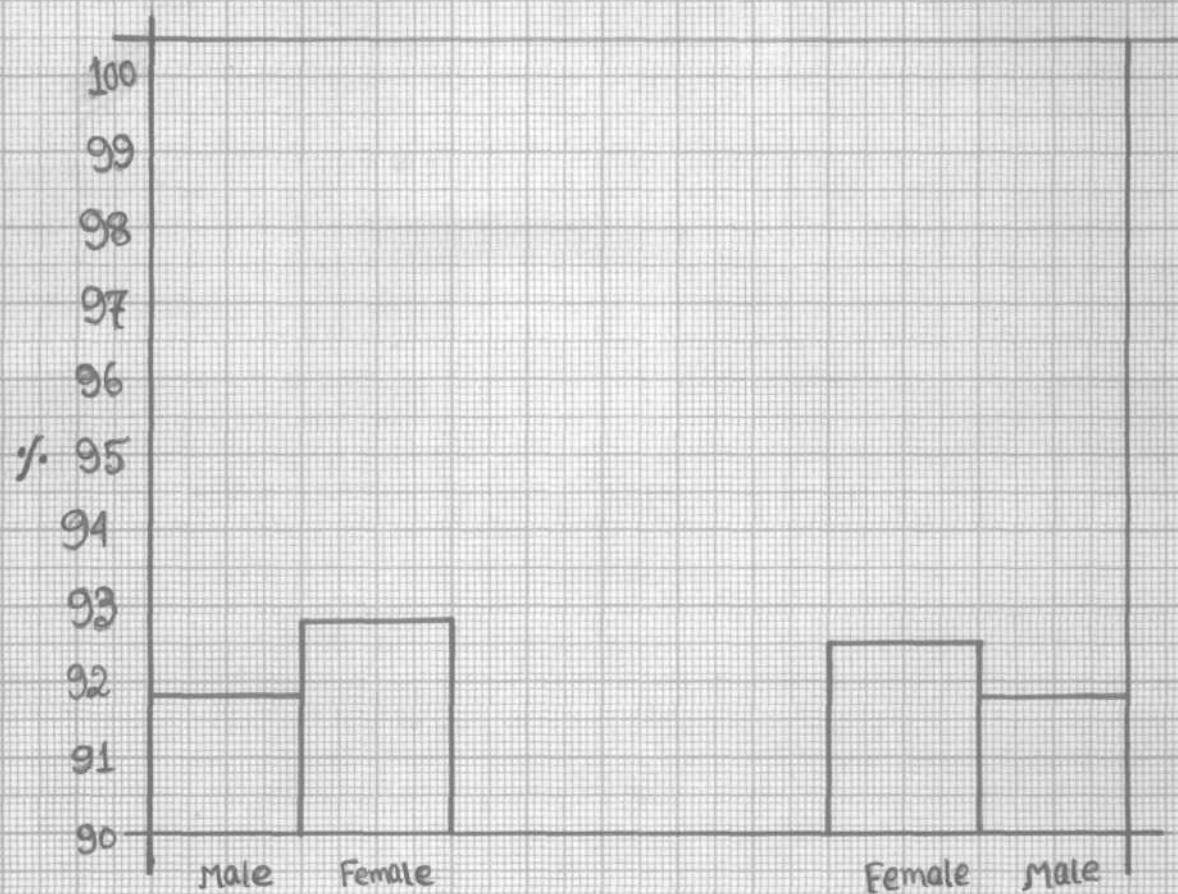
Overall it was observed that, females scored better than males though it is not significant and subjects scored better in second list than in the first list except in 4-5 years age group,

2. Distribution of scores among sub-groups:

2.1 4 to 5 years: The children in this age group obtained a mean score of 101.5 out of a total score of 110, with a percentage of 92.3 in list 1. Within this group, males obtained a mean score of 101 as against the females scores of 102.1 with a percentage of 91.8 and 92.8 respectively.

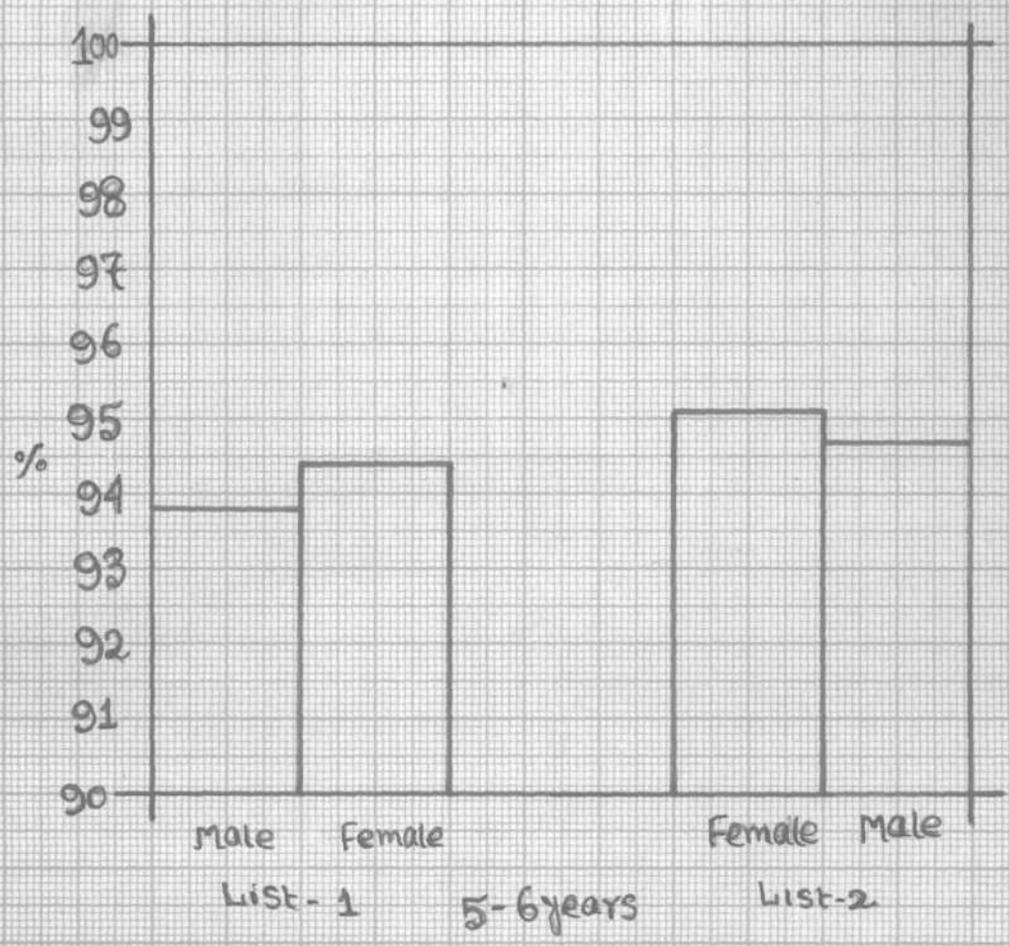
In the second list, they obtained a total mean score of 91.25 with 92.15 percentage. Within the group males obtained a score of 90.9 with 91.8 percent. Whereas,females obtained a score of 91.6 with a percentage of 92.5. Figure 3 shows a comparison of percentage score between males and females and list one and list two. The phonetic environments which were uttered incorrectly by these children are aalisted in table 6a for list one and table 6b for list two.

2.2: 5 to 6 years: The children in this age group obtained a score of 103.5 with a percentage of 94.1 in list one. Within the group, males obtained a score of 103.2 with 93.8 percent; where as females obtained a score of 103.8 with 94.4 percent (Fig.4).



Mean Percentage of Score

Fig:- 3



Mean Percentage ob Score

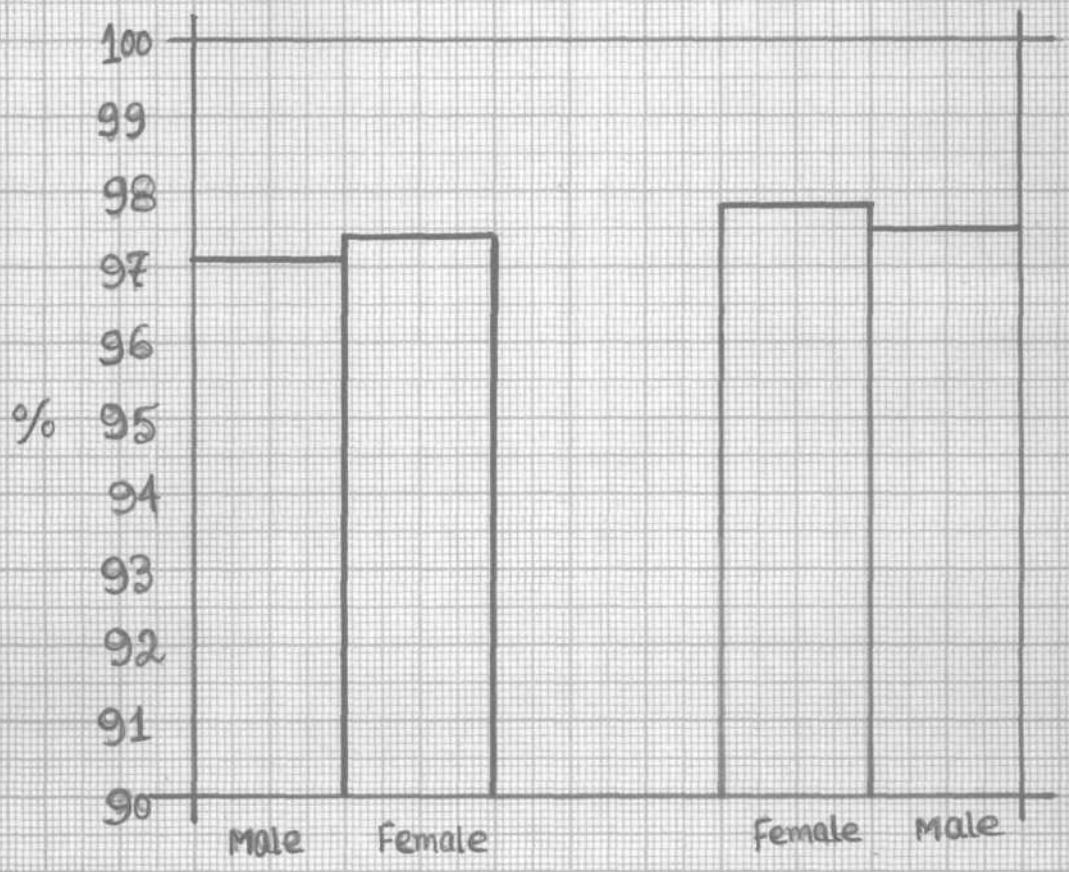
Fig:-4

In the second list, the children obtained a score of 93.95 with a 94.9 percent. Males obtained a score of 93.8 with a percentage of 94.7 and females obtained 94.1 with 95.1 percent (Figure 4). The phonetic environments which were uttered incorrectly by these children are enlisted in table 7a for list one and table 7b for list two.

2.3: 6 to 7 years: The children in this age group obtained a score of 107 with a percentage of 97.25 in list one. Within this group, males obtained a score of 106.8 with 97.1 percent as against females scores of 107.1 with a percentage of 97.4 (Figure 5).

In the second list, these children obtained a score of 96.65 with 97.65 percent. With in this age group males scored 96.5, with a percentage of 97.5 and females obtained a score of 96.8 with a percentage of 97.8 (Figure 5). The phonetic environments which were misarticulated by these children are enlisted in table 8a for list one and table 8b for list two.

In general,the scores increased linearly from 4 to 7 years and females performed better than males though not significantly. It was observed that the children tested in this study did not obtain the maximum score even at the age of 6-7 years. While the maximum possible score was 110



Mean percentage of score

Fig-5

for first list and 99 for the second list, the maximum score obtained by the children participated in this study was 107 in the first list and 96.6 in the second list. On the basis of the results the cut off scores for different age groups would be 101.5 (4-5 years); 103.5 (5-6 years); 107 (6-7 years) for first list and 91.25 (4-5 years); 93.95 (5-6 years); and 96.65 (6-7 years) for the second list. The results suggest that the test need to be administered for higher age groups to know about the age of acquisition of all phonemes in all the phonetic environment of Bengali.

The results of the study conducted by Rohini (1989) revealed that the maximum scores obtained were 93.98 percent for males and 92.37 percent for females in 5-6 years and 94.06 percent for males; 94.38 percent for females in 6-7 years age group; 94.6 percent for males and 93.79 percent for females in 7-8 years age group and 96.63 percent for males and 95.78 percent for females in 8 to 9 years of age. Maya (1990) reported the maximum score obtained by different age groups as 85.8% in 5-6 years of age; 93.33 in 6-7 years of age and 95.86 for 7-8 years.of age group. The results of the present study agree with that of Rohini (1989) and Maya (1990) in that the mean percent of scores increase with age. However, it does not agree in that, the percent

scores obtained in this study was high. This may be because of the difference in the material used. While Rohini and Maya used sentences, the present test used words (pictures) which are more simpler for the children and thus their performance is enhanced.

Table 6 to 8 represents the number of substitutions, omissions and distortion for each phoneme tested in various phonetic environment. Columns represent the substituted/ distorted/omitted phoneme and the key phoneme and the Rows represent the phonetic environments. For example t/d in the column and /l/ F_ in the row indicates that /t/ is substituted for /d/ when key phoneme is preceded (P) by /l/ and followed (F) by /ɪ/. 'DX' stands for distortion and 'OX' for omission.

Different types of errors / Context		ṭ/ḍ	t/d	k/g	n/d	ḍ/ḍ	ṭ/ṭ	l/r	n/l	r̥/r	t/c	ḍ/l	cox	ḍox	lox	ḍox	cox	t/ḍ	c/j	jDX
ṭ	F																			
	P	6	3	6							1									
ḍ	F							4		3										
	P											1								
k	F								1											
	P	5	4	5		1													2	
g	F																			
	P																			
d	F					3														
	P																	2		
c	F																			1
	P	2	4	2															3	
j	F									3										
	P																			
s	F						1													
	P	3	1	3																
r	F													2						1
	P				1									1	1	1	1			
l	F							5		3										
	P												1							
h	F																			
	P	2																		1

4-5 years Male : List-1

Table-6a: Shows different types of errorsin different context.

Total number of errors- 90.

LIST-2

Different types of Error / Context		k/g	t/d	t/ṭ	t/ḍ	l/r	s/j	d/ḍ	r/ṛ	ṭ/x	r/x	c/x	s/x
ṭ	F				1								
	P	4	6				1						
ḍ	F												
	P										2		
k	F							1					
	P	6	5				2						
g	F					2							
	P												
d	F			2	1								1
	P												
c	F										4		
	P	3	3				3			1			
J	F					4			3		1	1	
	P												
s	F												
	P	2	4				5						
r	F												
	P			3						1		2	
l	F				1	5			1				
	P												
h	F												
	P			1									

4-5 years - Male

Table-6b: Shows different types of errors in different context

Total number of errors - 81

Different types of errors / context		t/d	t/d	k/g	t/d	t/t	c/j	d/j	th/s	l/r	r/r	g/k	jax	cax	lox
t	F				1										
	P	6	2	4			2								
d	F												4		
	P														
k	F			1				1							1
	P	3	4	5			1								
g	F											1			
	P														
d	F														
	P				1	2									
c	F					1									
	P	3	2	1			3								
j	F					2				3	3	1			
	P										2				
s	F														
	P	3	1	2											
r	F														
	P					1			1					2	
l	F										4				
	P									4					
h	F														
	P	1													

4-5 years Female
List-1

Table-6a: shows different types of errors in different context.

Total number of errors - 79

List-2

Different types of error / Context		t/d	k/g	t/ṭ	d/ḍ	d/ṭ	c/j	s/j	s/c	l/r	r/r	th/s	cØx	tØx	rØx	jØx
t	F															
	P	7	4				1									
ḍ	F															
	P															
k	F	1		1												
	P	3	6				2									
g	F															
	P															
d	F				1										4	
	P			2												
c	F															
	P	2	3				4					1				
j	F			1						4	3					
	P															
s	F															
	P	3	2				2	2								
r	F								1							
	P			1		1							2	1		2
ḥ	F				1					5	2		1			
	P															
h	F															
	P															

4-5 years Female

Table-6b: Shows different types of errors in different context.

Total number of errors- 74

Different types of error / Context		t/ḍ	t/d	k/g	c/j	ṇ/d	t/ṭ	l/r	ṛ/r	n/l	cox	dDx
ṭ	F											1
	P	6	3	3	2	3						
ḍ	F											
	P											
k	F									1		
	P	5	1	5	1							
g	F								3			
	P											
d	F											
	P						3		2			
c	F							1				
	P	3	1	1	4							
J	F							2				
	P								2			
s	F											
	P	4		2								
r	F											
	P										2	
l	F							5				1
	P											
h	F											
	P	1										

5-6 years Male

List 1

Table-7a: Shows different types of errors in different context

Total number of errors- 68

Different types of error / Contexts		t/d	k/g	t/j	ṭ/d	ṛ/r	s/j	d/ḍ	t/ṭ	l/r	COx	jDx	rox
ṭ	F												
	P	5	3		1								
ḍ	F												
	P											2	
k	F												
	P	2	5										
g	F												
	P												
d	F							2					
	P			1					1				
c	F									1			
	P	3	1			1	1						2
j	F					3				2			1
	P												
s	F												
	P	1	1				3						
r	F											2	
	P										1		
l	F									4			
	P					1							
h	F												
	P	1	1										

5-6 years Male

List 2

Table-7a: Shows different types of errors in different context.

Total number of errors-52

Different types of error / Context		t/d	k/g	t/d	c/j	t/d	s/j	s/c	c/x	l/r	r/r	g/k	t/t	s/x
t	F													
	P	5	3	2		2								
d	F									1	1			
	P													
k	F													1
	P	2	6	3										
g	F											2		
	P													
d	F													
	P												2	
c	F									1				
	P	3	1	2	2									
j	F									2				2
	P										3			
s	F													
	P	2	2	1			3							
r	F								1					
	P							1						
l	F									5				
	P													
h	F													
	P	1												

5-6 years Female

List 1

Table-7a: Shows different types of errorsin different context.

Total number of errors- 62

Different types of error / Context		t/d	k/g	c/j	s/j	t/ṭ	g/k	d/ḍ	l/r	ṛ/r	sox	cox
ṭ	F											
	P	3	2									
ḍ	F											
	P											
k	F											
	P	4	5									
g	F						1					
	P											
d	F							2				
	P					3						
c	F									1		
	P	2	1	3					1			
J	F								1	3		
	P									1		
s	F											
	P	2	1		2							1
ṣ	F							1				
	P											1
l	F								4			
	P								2		1	
h	F											
	P	1										

5-6 years Female

List-2

Table-7b; Show different types of errors in different context.

Total number of errors- 49

Different types of error / Context		t/d	k/g	t/d	s/j	r/r	l/r	dDx
t	F							
	P	4	2	2				
d	F					1		
	P							
k	F							
	P	2	3	2				
g	F							
	P							1
d	F							
	P							
c	F							
	P	2	1	1				
j	F					1		
	P							
s	F							
	P	1	2		2			
r	F							
	P							1
l	F						3	
	P							
h	F							
	P	1						

6-7 years Male

List 1

Table-8a: Shows different types of errors in different context.

Total number of errors- 32

Different types of error / Context		t/d	k/g	c/j	l/r	r/r	d/d	dx
t	F							
	P	3	2					
d	F							
	P					1		
k	F							
	P	2	2					
g	F							
	P							
d	F						1	
	P							
c	F							
	P	1	2	1		1		
j	F					2		
	P							
s	F							
	P	1	1					
r	F							1
	P							
l	F				2			
	P				1			
h	F							
	P	1						

6-7 years Male

List-2

Table-8: Shows different types of errors in different context.

Total number of errors- 25

Different types of error / context.		t/ḍ	t/d	k/g	l/r	ṛ/r	c/j	t/ṭ	cox
t	F								
	P	4	2	2					
ḍ	F				1				
	P								
k	F								
	P	1	1	4					
g	F								
	P								
d	F								
	P							1	
c	F								
	P	2	1	1			2		
j	F					2			
	P								
s	F								
	P	1		1					
r	F								
	P								1
l	F				2				
	P								
h	F								
	P								

6-7 years Female

List 1

Table-8a: Shows different types of errors in different context

Total number of errors- 29.

Different types of error / Context		t/d	k/g	l/r	r/r	s/j	th/s	d/d	rDx
t	F								
	P	2	2						
d	F								
	P								
k	F								
	P	3	1						
g	F								
	P								
d	F							1	
	P								
c	F								
	P	1	1						
j	F				2				1
	P								
s	F								
	P	1	1			3			
r	F								
	P						1		
l	F			2					
	P								
h	F								
	P								

6-7 years Female
List 2

Table-8b: Shows different types of errors in different context.

Total number of errors:- 22

3. Item analysis: An item analysis was carried out on the 6,600 responses (in the first list) and 5940 responses (of the second list) of the 60 children to the 11 items to obtained the information on the item correct or wrong and to list the item in the order of difficulty. Table 6(a & b), 7, (a & b), and 8 (a & b) depict the different types of incorrect articulation at different age groups for both the lists. It also shows how many children have incorrectly articulated for each age group and in each sex for both the lists.

Percentage of the correct responses were calculated for each target phoneme which is shown in table 9(a & b). It shows that as the age increases the correct responses for each key phoneme also increases in both the sex. In general. Table 9 shows that /d/ is the most difficult item in the first list for all the age groups, where as /r/ is the most difficult item in the second list for both the sex. However /r/ is the second or the third most difficult item for all the age groups for both the sex. This could be due to fact that in the first list /d/ phoneme was tested in a cluster word i.e. 'bled'. Rohini (1989) stated that /h/ is the most difficult phoneme in Kannada; Maya (1990) stated that the /š/ and /s/ were the most difficult phoneme in Malayalam to articulate correctly in different phonetic

environment. The results of the present study does not concur with those of Rohini (1989) and Maya (1990).

Table 9 shows the percentage of correct response for each key phonemes. The columns indicate the percentage of score for each key phoneme and the rows indicate the age range.

Age	Sex	t	d.	k	g	d	c	j	s	r	l	h
List-1												
4-5	M	99.1	74.5	100	85.5	88.2	97.3	92.7	100	83.6	97.3	100
	F	94.5	84.5	98.2	88.2	91.8	98.2	90	99.1	85.5	99.1	100
5-6	M	97.3	82.7	100	90	90.9	98.2	93.6	100	86.4	99.1	100
	F	98.2	88.2	98.2	89.1	90.9	98.2	95.5	100	85.5	100	100
6-7	M	100	89.1	100	92.7	95.5	100	98.2	100	95.5	100	100
	F	99.1	92.7	100	92.7	96.4	99.1	98.2	100	95.5	100	100
List-2												
4-5	M	92.9	95.9	100	84.8	81.8	97	88.9	99	77.8	100	100
	F	92.9	98	100	84.8	83.8	98	86.9	99	81.8	100	100
5-6	M	99	98	100	88.9	86.9	99	90.9	100	84.8	100	100
	F	97	97	99	90.9	87.9	98	94.9	99	86.9	100	100
6-7	M	100	99	100	92.9	90.9	100	99	100	92.9	100	100
	F	100	99	100	94.9	92.9	100	97	99	94.9	100	100

Table-9: Shows percentage of correct responses for each phonemes

4. Order of difficulty of the items: The item /d/ (retroflex voiced stop) and /r/ (retroflex voiced trill) were found to be the most difficult in the first list. In the second list /r/ and /d/ (dental voiced stop) were found to be the most difficult. The order of difficulty of phonemes as indicated by the item analysis was as follows:

4 to 5 years: For males.the order of difficulty of items from easy to difficult was /k/, /g/,/s/,/ṭ/, /l/, /c/, /j/, /d/, /g/, /r/, /d./. The females it was /h/, /s/, /l/, /k/, /c/, /ṭ/, /d/, /j/, /g/, /r/ and /d./ in the first list.

In the second list the order of difficulty of the phonemes for males was /k/, /h/,/1/, /s/, /c/, /d/, /t/, /j/, /g/, /d/ and /r/. For female it was /k/, /h/, /l/, /s/, /d./, /c/, /ṭ/, /j/, /g/, /d/ and /r/.

Within these phonemes the order of difficulty of phonetic environments for each phoneme in males and females for both the lists were as in Table 10 (a&b).

5-6 years: The order of difficulty of the phonemes for males was /k/ /s/ /h/ /l/ /c/ /t/ /j/ /d/ /g/ /r/ and /d./for females it was /l/ /s/ /h/ /k/ /ṭ/ /c/ /j/ /d/ /g/ /d./ and /r/ in the first list.

In the second list the order of difficulty for males was /k/ /s/ /l/ /h/ /ṭ/ /c/ /d./ /j/ /g/ /d/ and /r/. For

females it was /l/ /h/ /k/ /s/ /c/ /ṭ/ /d./ / j / /g/ /d/ and /r/. The order of difficulty, of phonetic environment for these phonemes were as in Table 11 (a & b).

6 to 7 years: The order of difficulty of phonemes for this age groups was as follows. For males /k/ /l/ /h/ /s/ /ṭ/ /c/ / j / /d/ /r/ /g/ and /d./. For females /k/ /l/ /h/ /s/ /ṭ/ /c/ / j / /d/ /r/ /d./ and /g/ in the first list.

In the second list the order of difficulty was as follows:
for males /k/ /l/ /h/ /s/ /c/ /ṭ/ /d./ / j / /g/ /r/ and /d/.
for females /k/ /l/ /h/ /ṭ/ /c/ /s/ /d./ / j / /g/ /r/ and /d/.
The difficulty of phonetic environment for these phonemes are ordered in table 12 (a & b).

In general voiced consonant environment was the easiest and the voiceless consonant environment was the most difficult. Among the voiceless consonants, the retroflex plosive /t/ environment was the most difficult in both the lists followed by the trill and fricative environments. It was noticed that in the first list, /d/ was not uttered properly when it proceeded /t/. This could be due to two reasons (i) in the first list /d/ is preceded by a cluster ie /ble/ and (ii) a change in the voicing dimension has to be performed

which is difficult. Among the phonemes /g/ /d/ /d./ and /r/ were the most difficult to produce. However, no particular pattern in the order of difficulty was found.

In Kannada, Rohini (1989) reported that /h/ and the fricatives were the most difficult and that the vowel environment was found to be easiest context to produce the item correctly. In Malayalam, Maya (1990) reported that /s/ (voiceless palatal fricative was the most difficult item and that the vowel environment was the easiest. The results of the present study partly agree with that of Rohini (1989) and Maya (1990) in that the trill environment was one of the most difficult. As the present study focussed on only consonant environments it cannot be compared for a vowel environment reported in Kannada and Malayalam.

Table 10 to 12 represents the order of difficulty of the phonetic environments. For example k-g^2 represents that two responses of /k/ were erroneous in the phonetic environment of /g/. g-indicates that /g/ is preceding the key phoneme and -g indicates that /g/ is following the key phoneme 'M' represents males and 'F' represents females.

Phoneme	Sex	Order	Phonetic environment
k	M	0	Nil
	F	1	g^1-, j^1-
h	M	0	Nil
	F	0	Nil
s	M	0	Nil
	F	1	-r^1
t̤	M	1	s-^{1}
	F	1	c^1-, -r^1
		2	-d^2, j^2-
l	M	1	k-^{1}, -d^1, r^1-
	F	1	k^1-
c	M	1	-t^1, -l^1
	F	1	-r^2
j	M	1	c^1-, r^1-, -h^1
		2	-k^2
		3	-c^3
	F	1	-k^1, k^1-
		2	-t^2
		3	-c^3
		4	d^4-

Phoneme	Sex	Order	Phonetic environment
d	M	1	$-s^1$, $-r^1$
		2	$-\dot{t}^3$
		3	$-k^4$, $-c^4$
	F	1	$-s^1$
		2	$-\dot{t}^2$, $-c^2$
		3	$-k^4$
g	M	1	$-c^2$
		2	$-s^3$
		3	$-k^5$
		4	$-\dot{t}^6$
g	F	1	k^1-, $-c^1$
		2	$-s^2$
		3	$-\dot{t}^4$
		4	$-k^5$
r	M	1	j^3-
		2	$\dot{d}^6-$
		3	l^8-
	F	1	$-j^2$
		2	$-l^4$, l^4-
		3	$-j^6-$

Phoneme	Sex	Order	Phonetic environment
ḍ	M	1	$-c^2$, $-h^2$, r^2-, $-d^2$
		2	$-s^3$, d^3-, $-r^3$
		3	$-ṭ^6$, $-k^6$
	F	1	$-d^1$, $-h^1$, $ṭ^1-$
		2	$-k^3$, $-s^3$, $-c^3$
		3	$-ṭ^6$

Table-l0a: Order of difficulty and items on list 1 (4-5 years).

Phoneme	Sex	Order	Phonetic context
k	M	o	Nil
	F	0	Nil
h	M	0	Nil
	F	o	Nil
l	M	o	Nil
	F	o	Nil
s	M	1	d^1-
	F	1	-c^1
c	M	1	j^1 -
		2	-r^2
	P	1	r^1-, l^1-
	M	1	$ţ^1$ —, d^1 —, L^1 —, k^1 —
	F	1	d^1 -, L^1 —
ţ	M	1	-c^1
		2	d^2-
		3	-r^4
	F	1	k^1-, j^1-
		2	-d^2
		3	-r^3

Phoneme	Sex	Order	Phonetic contexts
j	M	1	-ţ[1]
		2	-k[2]
		3	-c[3]
		4	-s[5]
	F	1	-ţ[1]
		2	-k[2],-r[2]
		3	-c[4],-s[4]
g	M	1	-s[2]
		2	-c[3]
		3	-ţ[4]
		4	-k[6]
	F	1	-s[2]
		2	-c[3]
		3	-ţ[4]
		4	-k[6]
d M		1	-c[3]
		2	-s[4]
		3	-k[5]
		4	-t[6]
	F	1	k[1]-
		2	-c[2]
		3	-k[3] -s[3]
		4	-ţ[7]

Phoneme	Sex	Order	Phonetic contexts
r	M	1	g^{2}-, -d^{2}
		2	c^{4}-
		3	L^{6}-
		4	J^{8}-
	F	1	d^{4}-
		2	J^{7}-, L^{7}-

Table-l0b: Order of item difficulty in list 2 (4-5 years)

Phoneme	Sex	Order	Phonetic environment
k	M	0	Nil
	F	1	9[2]-
s	M	0	Nil
	P	O	Nil
h	M	O	Nil
	F	O	Nil
L	M	1	k-[1]
	F	O	Nil
C	M	1	-r[2]
	F	1	-r[1], r[1]-
t	M	1	_d[3]
	F	1	-d[2]
j	M	1	-k[1]
		2	-ʧ[2]
		3	-c[4]
	F	1	-c[2]
		2	-s[3]

Phoneme	Sex	Order	Phonetic environment
g	M	1	-c[1]
		2	-s[2]
		3	-ṭ[3]
		4	-k[5]
	F	1	-c[1]
		2	-s[2]
		3	-ṭ[3]
		4	-k[6]
r	M	1	e[1]-
		2	-j[2], j[2]-, -d[2]
		3	g[3]-
		4	L-[5]
	F	1	c[1]-, k[1]-
		2	ḍ[2]-
		3	-j[3]
		4	j[4]-
		5	L-[5]
d	M	1	-k[1], -c[1], ṭ[1]-, l[1]-
		2	-ṭ[6]
	F	1	-s[1]
		2	-c[2]
		3	-k[3]
		4	-ṭ[4]

Phoneme	Sex	Order	Phonetic environment
d	M	1	-h[1]
		2	-c[3]
		3	-s[4]
		1	-k[5]
		5	-t[6]
	F	t	-h[1]
		2	-k[2],-s[2]
		3	-c[3]
		4	3-t[5]

Table lla: Order of the difficulty of the items on list 1 (5-6 years).

Phoneme	Sex	Order	Phonetic environment
k	M	o	Nil
	F	1	g^1-
s	M	o	Nil
	F	1	-1^1
L	M	o	Nil
	F	o	Nil
h	M	o	Nil
	F	o	Nil
t	M	1	-d^1
	F	1	-d^1
c	M	1	-r^1
	F	1	-s^1, -r^1
d	M	1	d^2-
	F	1	d^2-
j	M	1	-d^1, -c^1
		2	-d^2, -r^2
		3	-s^3
	F	1	-s^2
		2	-c^3

Phoneme	Sex	Order	Phonetic environment
g	M	1	-c[1], -s[1], -h[1]
		2	-t3
		3	-k[5]
	F	1	-s[1] , -c[1]
		2	-t[2]
		3	-k[5]
d	M	1	-s[1] , -h[1]
		2	-k[2]
		3	-c[3]
		4	-t[6]
d	F	1	-h[1]
		2	-c[2], -s[2]
		3	-t[3]
		4	-k[4]
r	M	1	-c[1], 1[1]-
		2	
		3	-L[4]
		4	-J[6]
		1	-c[1], -J[1], c[1]-
		2	-L[2]
		3	-J[4]-, L[4]-

Table l1b: Order of item difficulty on list 2 (5-6 years)

Phoneme	Sex	Order	Phonetic environment
k	M	o	Nil
	F	e	Nil
t	M	o	Nil
	F	o	Nil
h	M	o	Nil
	F	o	Nil
	M	o	Nil
	F	o	Nil
t	M	o	Nil
	F	1	-d^1
c	M	o	Nil
	F	1	-r^1
j	M		-S^2
	F	1	-c^2
d	M	1	-c^1
		2	-k^2, -t^2
	F	1	-k^1,-c^1
		2	-t^2

Phoneme	Sex	Order	Phonetic environmer
r	M	1	d[1], j[1]
		2	1[3]
	F	1	- d[1]
		2	-1[2]-, j[2]-
g	M	1	-c[1]
		2	-t[2], -s[2]
		3	-k[3]
	F	1	-c[1], -s[1]
		2	-t[2]
		3	-k[4]
d	M	1	-s[1], -h[1,] - g[1], -r[1]
		2	-t[2]
		3	-t[4]
	F	1	-k[1], -s[1]
		2	-c[2]
		3	-t[4]

Table-12: Order of item difficulty on List 1 (6-7 years)

Phoneme	Sex	Order	Phonetic environment
k	M	o	Nil
	F	o	Nil
L	M	o	Nil
	F	o	Nil
h	M	o	Nil
	F	o	Nil
s	M	o	Nil
	F	1	$-r^1$
c	M	o	Nil
	F	o	Nil
t	M	o	Nil
	F	o	Nil
d	M	^{1}	d^1-
	F	1	d^1-
J	M	1	$-c^1$
	F	1	Nil

Phoneme	Sex	Order	Phonetic environment
g	M	1	-s[1]
		2	-t[2], -k[2], -c[2]
	F	1	-k[1], -c[1], -s[1]
		2	-t[2]
r	M	1	-L[1], -d[1], .-c[1]
		2	L[2]-, j[2]-
	F	1	L[2]-
		2	j[3]-
d	M	1	-c[1], -s[1], -h[1], r[1]-
		2	-k[2]
		3	-t[3]
	F	1	-c[1], -s[1]
		2	-t[2]
		3	-k[3]

Table 12b: Order of item difficulty on list 2 (6-7 years)

To summarize the results indicated the following;

i) Articulatory performance of children improved with age.

ii) Females performed better than males* though not significantly.

iii) The item /r/ was the most difficult to articulate in general. However, on the first list /d/ was the most difficult phoneme.

iv) Voiceless consonant, trill and fricative environments were the most difficult and voiced consonant environment was the earliest.

Age		4-5	5-6	6-7
Cut off score	List-1	101.5	103.5	107
	List-2	91.25	93.95	96.65

Table-13: Shows cut off scores.

On the basis of the results of this study, cut off score (Table-13) are provided which could be of use in diagnosis.

SUMMARY AND CONCLUSIONS

The deep test of articulation is a diagnostic articulation test which tests the phonemes in all possible position and in all possible phonetic contexts. At present deep tests of articulation areavailable only in Kannada (Rohini, 1989) and Malayalam (Maya, 1990) among the Indian languages. India being a multilingual country,it is necessary to have articulation tests in different languages. In this context, the present study aimed to develop deep test of articulation in Bengali language. For this 11 key phonemes were selected /ṭ/ /d/ /k/ /g/ /d/ /c/ / j / /s/ /r/ /l/ and /h/ based articulation test in Bengali developed by Arun Bank (1988). Meaningful picturable easy words were prepared with these phonemes in initial and final positions. These phonemes were tested in various consonant environments. The test material consists of two lists. First list comprised of 21 picturable words and 20 picturable words were there in second list. Each list consists of two sets of word list. Word with target phonemes in the final position were placed on the left hand side and the words with target phoneme in initial position were placed on the right hand side.

The subjects considered for the study included 10 male and 10 female Bengali speaking children each in the

age ranges of 4-5, 5-6 and 6-7 years. The subjects selected did not have any speech problem and did not report of any hearing problem and were from middle socio-economic status.

The children were instructed to produce a big funny word by combining left side one word from the left slack and one word from the right slack. They were instructed not pause between the two words. They were asked to produce the big funny words by seeing the picture or reading the words which were written below the pictures. When they were unable to produce the sounds properly in the first instance they were given a second trial or they were asked to repeat after the tester.

After two to three trials or even after repetition, if the children were unable to produce the target phoneme then it was considered as an error. In this manner, from the list one 110 responses were elicited and 99 responses were elicited from list 2. Each correct articulation of the subject was given a score of one and the toal scare of each subject was grouped and statistically analyzed. On 'T' test, it was found that there was no significant difference between males and females as well as between the first list and the second list. However, there was significant difference between the different age groups, in terms of articulatory skill (at 0.05 level). The results

indicate that the articulation skill increased with age. On the item analysis, it was observed that /r/ and /d./ were the most difficult. Also the voiceless stop consonants environment were the most difficult followed by trill and fricatives. The voiced consonant environment was the easiest.

On the basis of the results,cut off scores have been provided below which could be used in diagnosis.

Age		4-5	5-6	6-7
Cut off score	List-1	101.5	103.5	107
	List-2	93.25	93.95	96.65

Table-14: Shows cut off score.

The present test helps in evaluating articulation in detail, with which the phonetic environment in which the key phoneme is articulated correctly can be located. A therapy programme can be made on the basis of these easy-difficult phonetic environment. It also can aid in research to find out the coarticulatory effects of the preceding and the following sounds.

However, the test-retest-reliability and the validity of the test should be assessed on a large population and norms are to be developed to identify children who are at risk for failure to develop mature articulation.

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APPENDIX-1

PRACTICAL GUIDE FOR ABMINISTRATION AND ASSESSMENT

The Bengali deep test of articulation includes 21 pictures in list one and 20 pictures in list two for testing. Of the 21 pictures in list 1, 10 are on the left slack and ll are on the right slack. In list 2, 9 pictures are on the left slack and 11 are on the right slack. Each of 11 consonants are tested in various phonetic contexts. The test consonants included are /t/ /d/ /k/ /g/ /d/ /c/ / j / /s/ /r/ /l/ and /h/. Initially the Bengali diagnostic articulation test (Arun Banik, 1988) should be administered. The key phonemes which are misarticulated as assessed from the diagnostic test should be deep tested.After deciding which sound should be deep tested; the tester should turn to the appropriate picture in the booklet and should place the pictures in a place so that the client can see it easily.

The client should be instructed to see the pictures on the left and the right slack or to read the word which are written below the pictures. They should be instructed to produce a big funny word by combining the words on the left and the right slack to make one word. They should not give pause between the two words. If they are unable to produce the big funny word after visualizing the pictures.

they should be asked to repeat after the tester. Before starting the actual test the tester should demonstrate the client how to produce the big funny word by combining the words from each side. Eight pictures are provided for this purpose. When the client understands the instruction the tester should start the actual testing.

After instruction and demonstration, the tester should select a particular picture with a key phoneme which he is going to test. Initially the tester should start with the picture which tests the key phoneme in the final position and set the picture on the left slack. Then he should keep the first picture on the right slack and show these two pictures to the client and ask them to produce the big 'funny word'. After obtaining the first response he should keep the left side picture constant and turn over the picture of the right slack and ask the client to produce it together. The procedure should be continued till the right side pictures get over.

After testing the target phoneme in the final position, the tester should turn over the right side, till the picture card exposes the target phoneme in the initial position and the should set the left side picture from the beginning. He should ask the client to produce both

the words together. After obtaining the first response the tester should keep the right side picture constant and turn-over the left side picture and ask the client to produce the big funny word. The test should be continued till the left side pictures get over.

If the tester wants to test all the phonemes in all the possible contexts, then, instead of testing both the side words in all the possible combination, it is better to test one side. Words in all the possible combination where in one can test two phonemes from a single response ie one phoneme in the final position and an other in the initial position. The tester should be ready to listen carefully and administration time could be saved by this. The response of the client should be noted down in the scoring sheet.

Apart from prompting a child on a particular phoneme, alternate pictures could be used from the second list for example, if the phoneme /g/ using 'big', or 'gala' in the first list had not been articulated correctly in the first deep testing in any of the context, then the test should be repeated using 'morag' or 'goru' from the second list or list 2 also can be used as test material.

(iv)

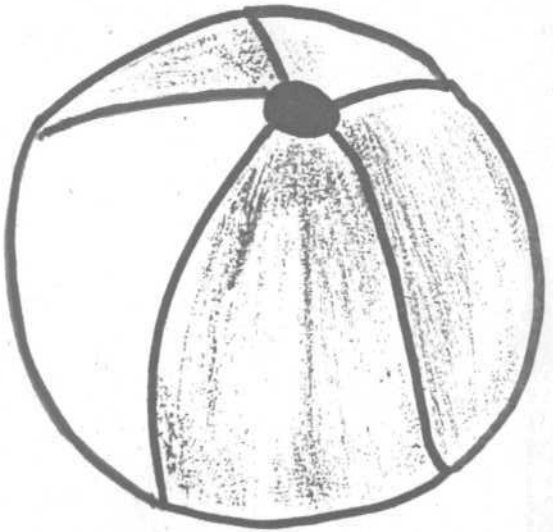
In the same manner all the key phonemes which are misarticulated by the client should be deep tested and the responses should be recorded on the scoring sheet, which can later be compared with the cut off scores provided.

APPENDIX II

PICTURES ARRANGEMENTS

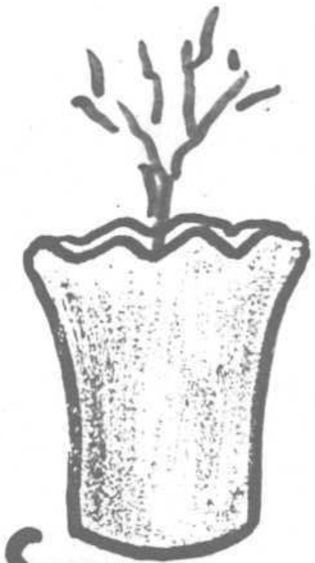
কাপ

[kap]

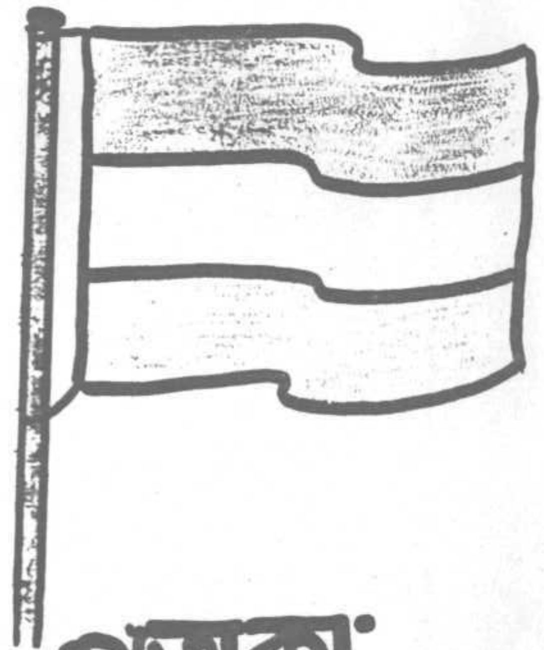


বল

[bɔl]



টব
[ṭɔb]



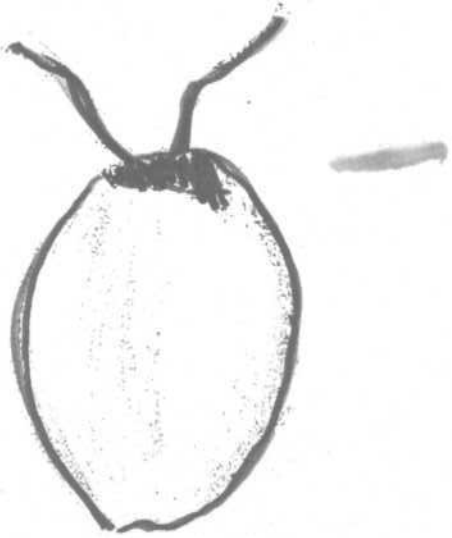
পতাকা
[pɔtaka]

সাপ

[saɸ] /s/

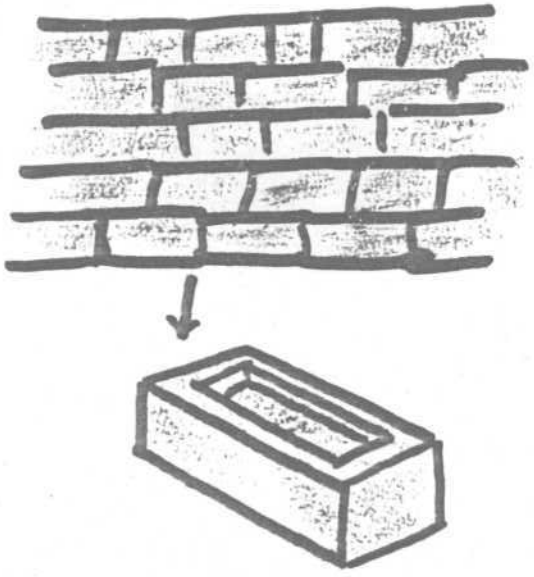
বালতি

[ɓalti]

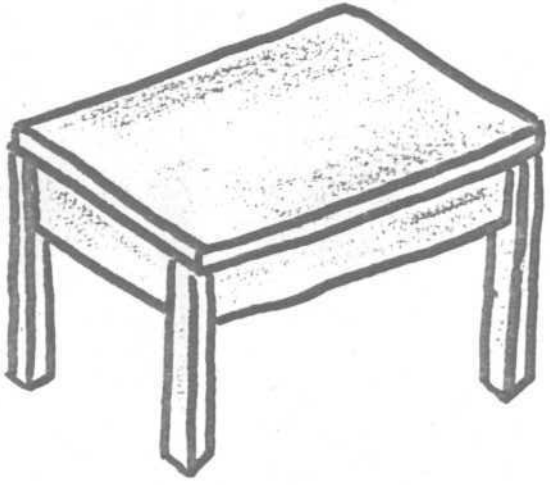


ডাব
[dab]/ɖ/

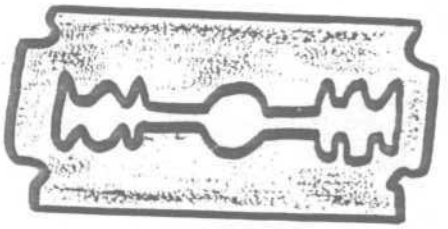
পাতা
[pata]



1. ইট
[iṭ] /ṭ/



টেবিল
1. [ṭebil] /ṭ/

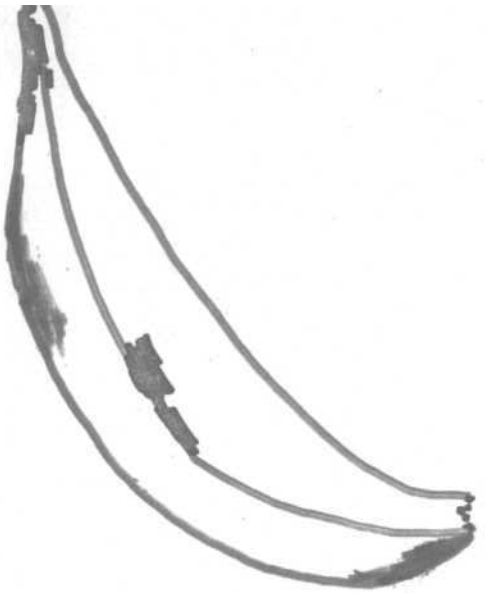


2. ব্লেড [bleḍ] /ḍ/

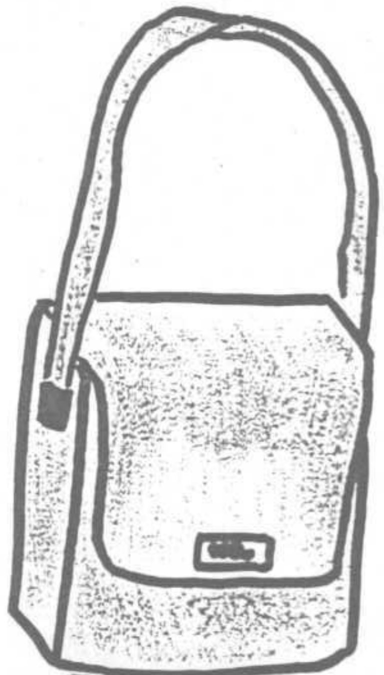
2. ডিম [ḍim] /ḍ/

নাক

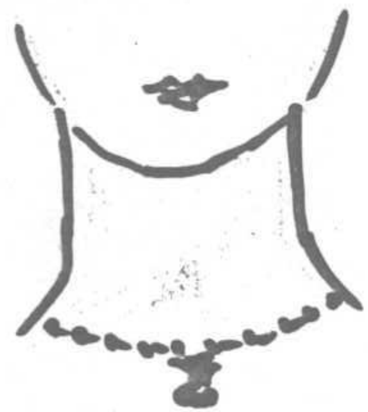
ঽ. [nak] /k/



ঽ. কলা /k/
[kola]



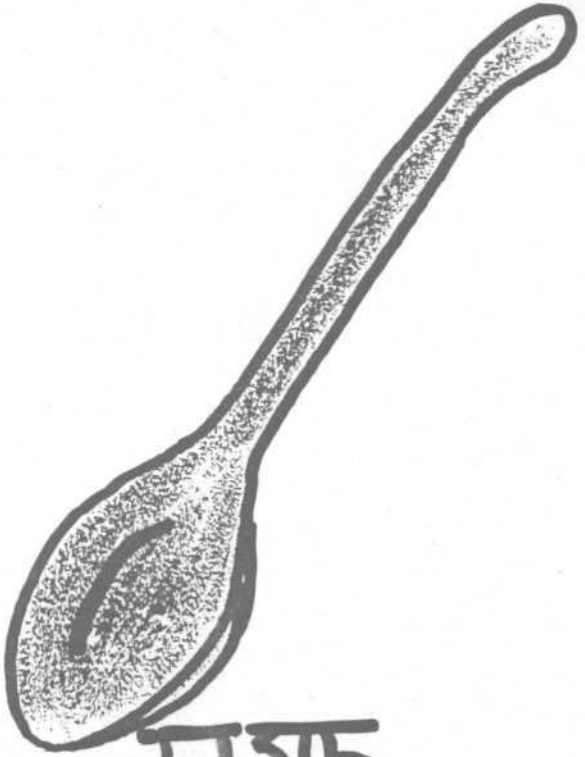
4. ব্যাগ
[bæg] /g/



4. গলা
[gɔla] /g/

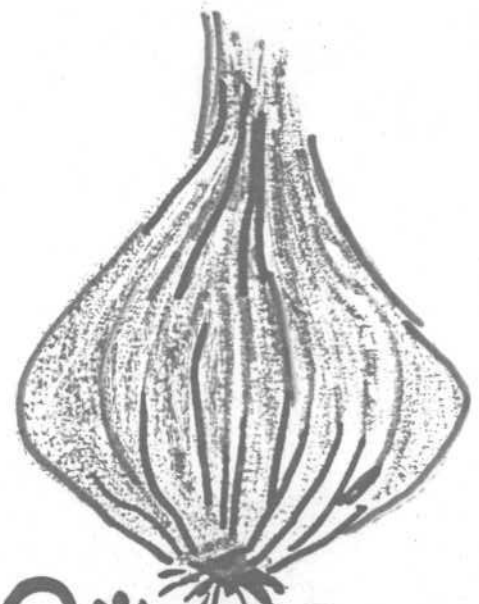
চাঁদ
চ. [চাঁদ]/চাঁদ/

পাতা
প. [পাতা]/পাতা/



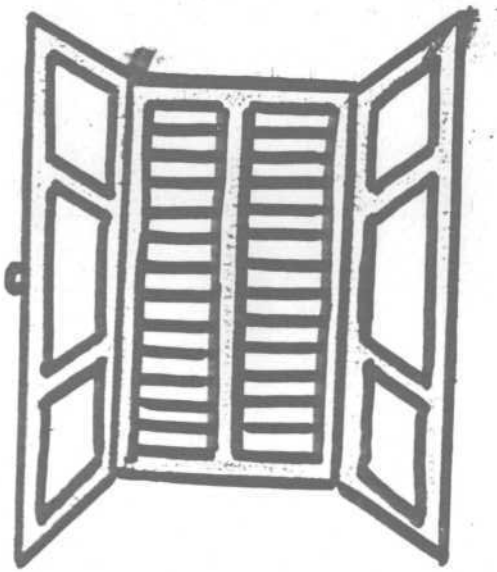
চামচ
ড. [camɔc]/c/

চোখ
ড. [coxʰ]/c/



পিঁয়াজ

ব. [piaj] /j/

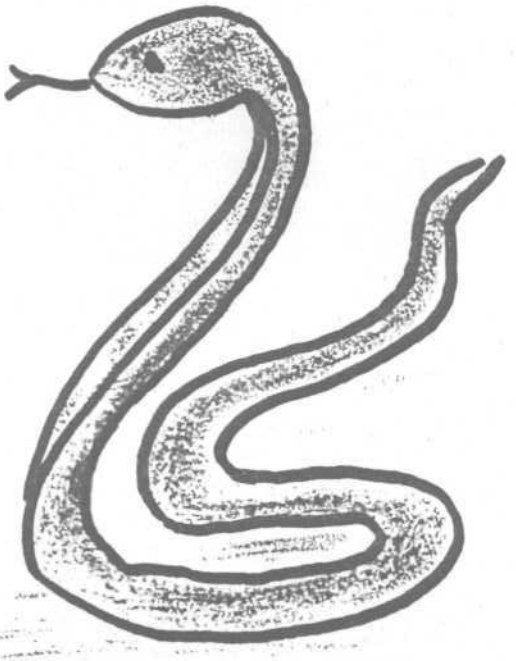


জানালা

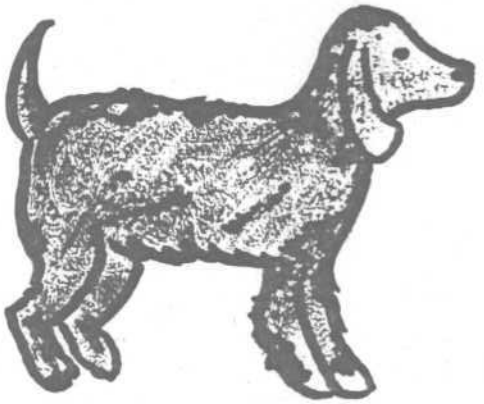
ব. [janala] /j/

বাস

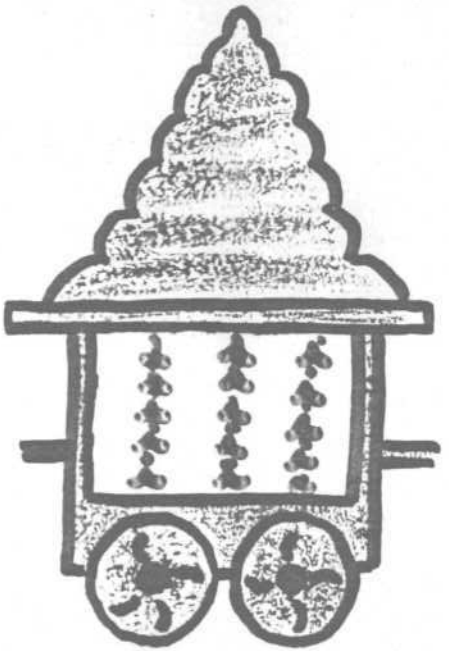
৪. [bas] /s/



৪. সাপ /s/
[saɸ]



9. কুকুর /r/
[kukur]



9. রথ /r/
[rɔtʰ]

বিড়াল

10. [biral]/l/

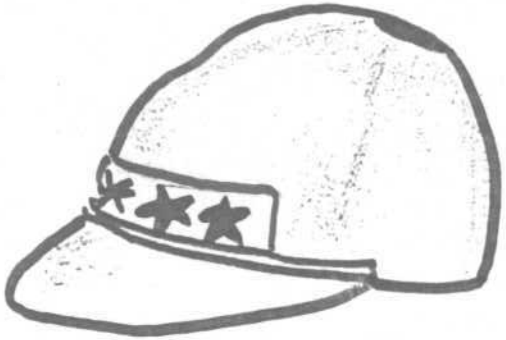
লঙ্কা

10. [lɔŋka]/l/

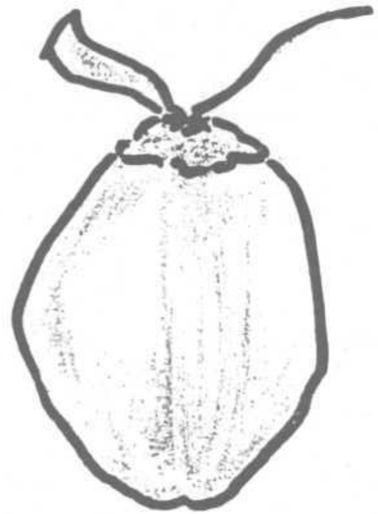
11. হাত [h] ।

[haṭ]

ऊट
1.a [uṭ] /ṭ/



टोपी
1.a [ṭupi] /ṭ/

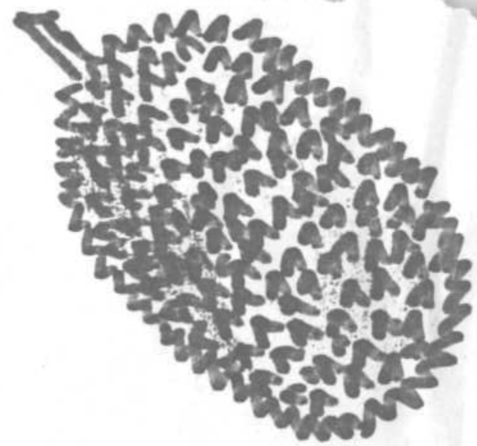


ডাব

2a.[d ab] /d/

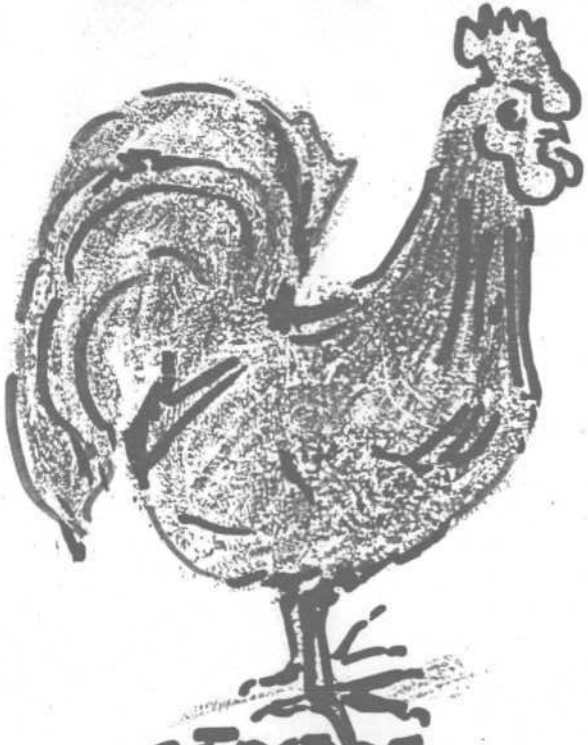
ভল্লুক

3.a.[bhalux]/k/



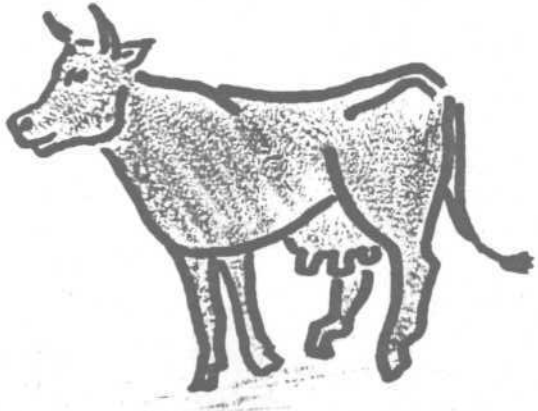
কাঁঠাল

3a.[kãṭhal]/k/



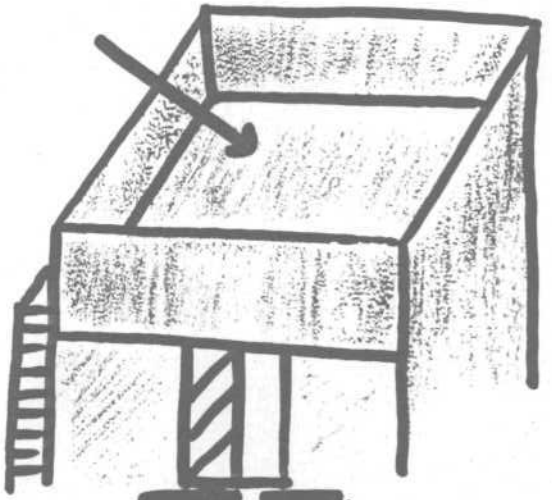
মোরগ

4a. [morog] /ম/



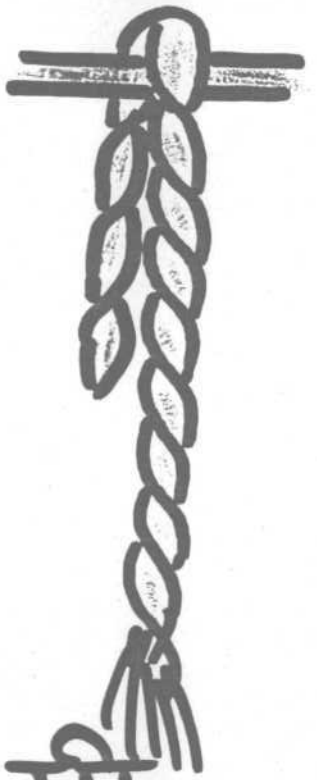
গরু

4a. [gɔru] /গ/



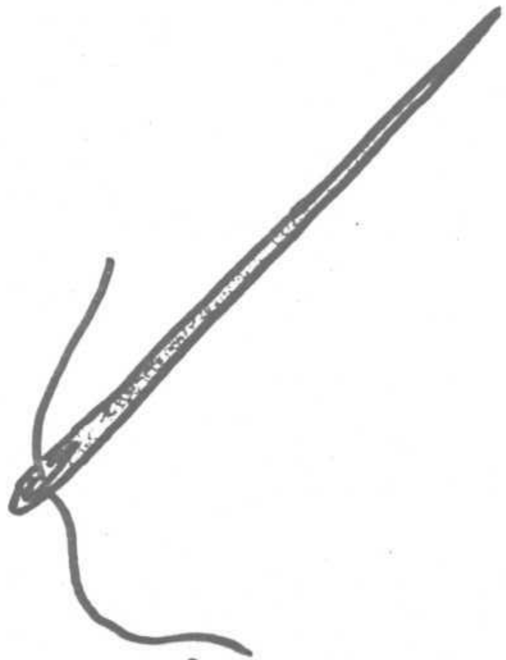
ছাদ

5 a. [c^had] /d/



দড়ি

5.a [doɾi] /d/

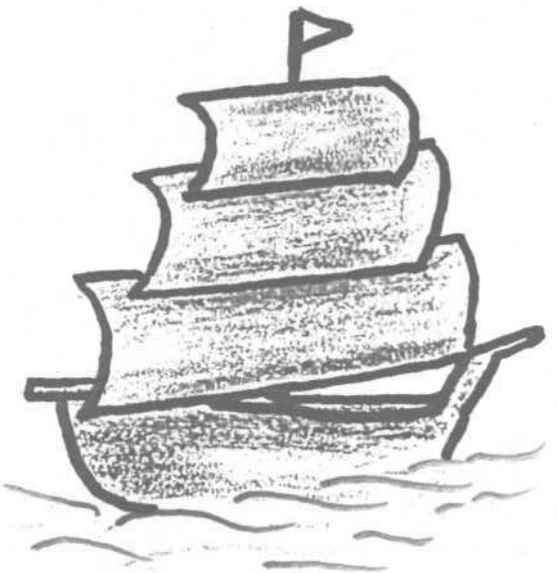


সুঁচ

6a.[sũc] /c/

চশমা

6a.[cɔʃma]/c/

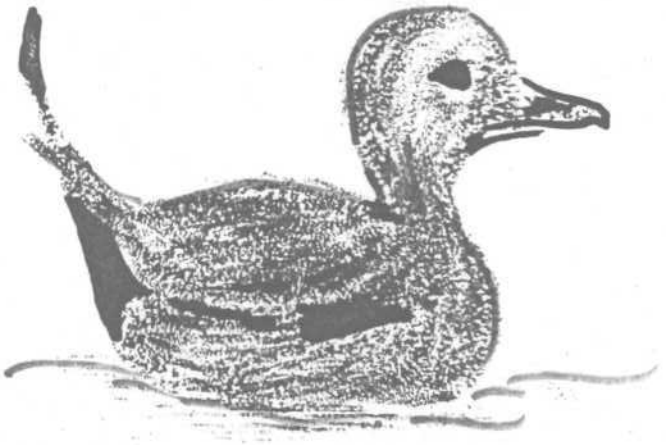


জাহাজ

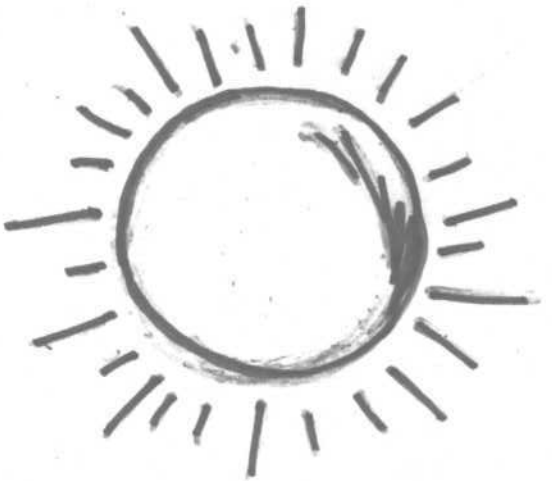
ʒa.[jahaj]/j/

জল

ʒa[jɔl]/j/



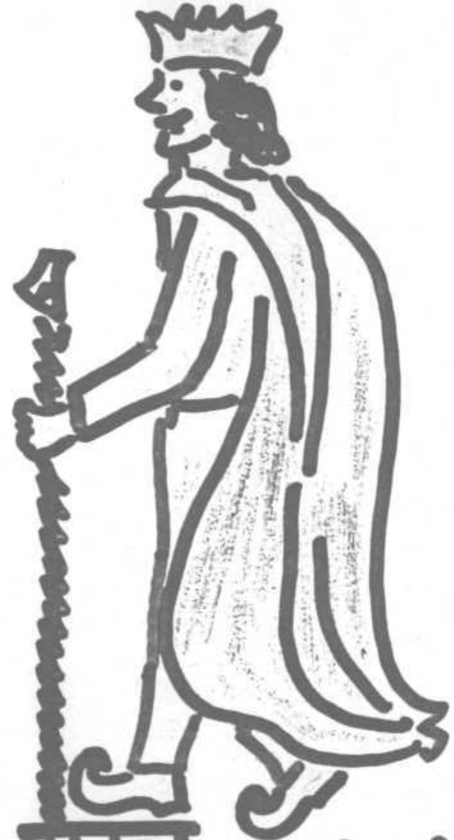
৪৪. হাঁস
[hãs] /s/



৪৫. সূর্য
[surjo] /s/

ময়ূর

৯.৫.[mour]/র/



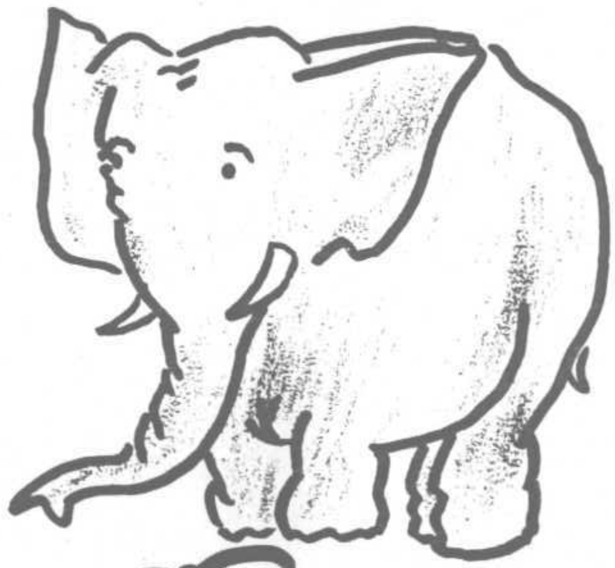
৯.৫. রাজা [raja] /র/

ছাগল

10.a[cʰagɔl]/l/

লাল

10.a[lal]/l/



হাতি

11.a.[hati] /h/

APPENDIX 3

Case Name: Case No.

Age: Sex LIST 1

Key phoneme Context.		ʈ	d.	k	g	d	c	J	s	r	l	h
ʈ	F											
	P											
d.	F											
	P											
k	F											
	P											
g	F											
	P											
d	F											
	P											
c	F											
	P											
J	F											
	P											
	F											
s	P											
	F											
r	P											
L	F											
	P											
h	F											
	P											

Marking: 'DX' for distortion
'OX' for omission
Note down substituted or added phoneme.

LIST-2

Key Phoneme / Context		ṭ	d	k	g	ḍ	c	j	s	r	l	h
ṭ	F											
	P											
d	F											
	P											
k	F											
	P											
g	F											
	P											
ḍ	F											
	p											
c	p											
j	F											
	P											
ś	F											
	P											
r	F											
	P											
l	F											
	P											
h	F											
	p											