# NEW THERAPY TECHNIQUE FOR THE VOICED AND VOICELESS DISTINCTION IN THE SPEECH OF THE HEARING IMPAIRED

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MAY 1991

**To**

**AMMA**

**APPA**

**& THAMBI**

## CERTIFICATE

This is to certify that the Dissertation entitled: NEW THERAPY TECHNIQUE FOR THE VOICED AND VOICELESS DISTINCTION IN THE SPEECH OF THE HEARING IMPAIRED is the bonafide work on part fulfilment for the Degree of Master of Science (Speech and Hearing) of the student with Register No.M-8919.

Mysore

May 1991

May 1991

Director
All India Institute of
Speech & Hearing
Mysore-6

**CERTIFICATE**

This is to certify that the Dissertation entitled: NEW THERAPY TECHNIQUE FOR THE VOICED AND VOICELESS DISTINCTION IN THE SPEECH OF THE HERRING IMPAIRED has been prepared under my supervision and guidance.

Mysore

May 1991

RAVI SHANKARA SHUKLA, S.

GUIDE.

## DECLARATION

I hereby declare that this Dissertation entitled: NEW THERAPY TECHNIQUE FOR THE VOICED AND VOICELESS DISTINCTION IN THE SPEECH OF THE HEARING IMPAIRED is the result of my own study under the guidance of Mr. Ravi Shankara Shukla,S, Lecturer in Speech Pathology, All India Institute of Speech and Hearing, Mysore, and has not been submitted earlier at any University for any other Diploma or Degree.

Mysore
May 1991

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## INTRODUCTION

Human speech is the product of several integrated physiological processes. One of these, articulation, denotes the molding of sounds into phonetic units. Other speech activities include: respiration, which provides the basic air stream; phonation, which is the production of vocal tones; and resonation, which is the modification of the acoustic parameters relative to their energy distribution. Speech, as distinguished from articulation, is more extensive and cannotes cognitive language. During the speech process, intellectual awareness and perception accompany the articulatory movements so that sound represent purposeful symbols of concept. By this learned activity, the individual interacts with his environment to suit his intrinsic and extrensic needs.

Speech is such a natural by product of maturation process that its development is usually taken for granted. The child whose hearing is normal imitates his environment and elaborates his speech patterns by perfecting the rhythm, stress and duration parameters of speech. These parameters contribute to the intelligibility of speech. Well articulated speech which lacks good rhythm and stress is relatively unintelligible.

On the other hand, deafness arrests the normal development of speech and language, since the primary receptive avenue is disrupted and sensory motor servomechanism is seriously altered. Consequently, speech development with the deaf does

not follow the normal sequential elaboration of the infant's reflective vocalizations into purposeful sounds and words. The complex compendium of neuromotor synergies is not programmed into normal emotion laden patterns of culture. A "deaf speecH"pattem evolves which is relatively unintelligible.

"The speech of the deaf differs from that of normals in all regards" (Black, 1971).

"In all studies of speech of the hearing impaired, attention is drawn to the fact that, to a greater or lesser degree, the hearing impaired individuals do not produce speech as well as those who hear" (Monsen, 1974).

Several researchers (Voelker, 1938; Hudgins and Numbers, 1942; Brone, 1966; Nober, 1969; Colton and Cooker, 1968; Markides, 1970; Smith, 1975; Geffner, 1980; and Ravishankar, 1985) have attempted to describe the characteristics of speech of the hearing impaired. The characteristics include articulation errors, high pitched voice, improper intonation, improper rhythm, slow rate and nasality.

Analysis of articulatory errors showed that of errors of omissions, substitution, distortion and additions. The most common error as far as the consonants are concerned is voiced-voiceless distinction.

Several investigators, (Mangan, 1961; Nober, 1967; Markides,

1970; Oiler et al, 1978; Levitt et al, 1980) found that prepondarence of substitutions of voiceless cognates for voiced cognates are high.

Monsen(1975, 1976, 1978) did a acoustical analysis of speech errors and reported that many of the deaf subjects did not produce a distinction between /p/ and /b/ in VOT (Voice Onset Time) values as these subjects had the average values for both phonemes being located within approximately 10msec of each other, where as normals had a clear distinction in VOT values.

Shukla(1987) did a similar analysis on the Kannada speaking hearing impaired subjects. He reported that in the majority of the hearing impaired subjects, the negative VOT (prevoicing or voicing lead) which was a characteristic feature of voiced sounds of normals was absent in the speech of the hearing impaired. Shukla, concluded that absence or inadequate negative VOT values in the speech of the hearing impaired is the acoustic reason for their underlying problem, that is, voiced and voiceless confusion.

Therefore, it was assumed that if the therapeutic procedure aimed at eliciting voicing lead for voiced sounds, it will solve the voiced and voiceless confusion of the hearing impaired speakers.

It was believed that a therapeutic procedure with a specific aim of teaching prevoicing in case of voiced sounds will be effluent because " The temporal nature of the voiced-voiceless contrast may be one of the reasons why it is difficult for deaf children to learn it without special training" (Gulian et al, 1983).

With this in mind, Shukla (1987) designed a new therapy technique, which uses and highlights VOT information through auditory, visual and tactile mode while teaching voiceless and voiced distinction. Shukla called the technique as "closed mouth voicing initiation technique".

Description of the technique.

I. Subjects will be instructed to place the articulators at the appropriate position for the production of stop consonants (b, $\underset{n}{d}$, d, g). Then the subjects are asked to initiate voicing and to release the articulators after some time in case of voiced sounds. This results in the production of the voiced consonants ( b, $\underset{n}{d}$, g, d). Tactile, visual and auditory clues are given so that subjects while initiating the voice, perceive the production of voice.

II. Then the subjects will be instructed to place the articulators for (p, t, $\underset{n}{t}$, k ) sounds. Then they are instructed to initiate voicing after they release their articulators.

This results in voiceless stops namely /p t̪ t k/.

III. Difference between Step I and II will be highlighted.

The present study aims at evaluating the efficacy of the therapy technique in the hearing impaired subjects, using a single subject design.

## REVIEW OF LITERATURE

A serious impairment in hearing hinders the normal development of speech. Hearing impairment at birth or soon after birth and during early childhood results in concomitant deficiency in comprehension and usage of speech.

Description of the speech of the hearing impaired individuals have, for the most part, been based on subjective evaluations. Studies of Hudgins and Numbers (1942), Smith (1975), Mangan(1961), Nober(1967), Markides(1970), Mc Garr (1978) and Geffner(1980), Ravishankar(1986), have described the speech of the hearing impaired individuals by using a normal listener as an analytical tool.

Speech characteristics which have been described as typical of hearing impaired individuals include misarticulations, nasality, high pitch, slow rate, faulty rhythm and faulty intonation patterns.

Articulation:

"Failure to develop certain sounds, failure to differentiate between others, substitution of one sound for another, use of the neutral vowel schwa /a/ as a general purpose vowel and other distortion of pronounciations of various sorts are all articulatory difficulties that are encountered in the speech of the deaf persons" (Nickerson, 1975).

**PRODUCTION OF VOWELS AND DIPHTHONGS**

Good vowel articulation is important in speech since they are the basic building blocks of words, they help in identifying adjacent consonants and carry the prosodic information (Monsen and Shaughnessy, 1978).

Monsen(1976c) has shown that the accurate control of vowel articulation by deaf speakers is highly correlated with the overall intelligibility of the speech they produce.

Hudgins & Numbers (1942) were among the first investigators to study systematically the production of vowels and diphthongs in the speech of the hearing impaired. They classified errors according to five major types. These include:

1) Substitution of one vowel for another
2) Neutralization of vowels
3) Diphtongization of vowels
4) Nasalization of vowels
5) Errors involving diphtongs: either the diphtong was split into two distinctive componant or final member of the diphthong was dropped.

Nober(1967) did a study on the articulation of 46 severe to profound hearing impaired children. His results revealed that clearly visible, lip rounded vowels are correctly articulated. The rank order of correct vowel production are :

/u/ 77% , /u/ 76% , /x/ 75% , and /i/ 59% . Similarly he ranked diphthongs in terms of correctness as (eɪ) 80%, (oʊ) 72%, (aɪ) 66%, and (ɔɪ) 62% and lowest (EI) 58%.

Carr(1963) studied the spontaneous speech sounds of 48 five year old deaf children, of whom 27 were boys and 21 were girls. Carr's results were similar to that of Nober, his results indicated that deaf children used front vowels more than back vowels. Carr related this fact to the speech development to that of hearing infants. He also found that there was no significant difference between boys and girls in the production of vowels.

Markides (197$) concluded that the deaf children mis-articulated nearly 56% of all vowels and diphthongs attempted. The vowel errors of children were grouped into four categories. They were vowel substitution, neutralization, prolongation and diphtongization. Results of this are in agreement with those of Hudgins and Number(1942), Nober(1967) and Carr(1963).

Smith(1975) found that the low central vowels were produced correctly most often and that there was a tendency for all vowels to drop to a more neutral position.

Levitt et.al.(1980) studied the articulatory errors in 77 deaf children and found that vowel substitution were typically towards a more central vowel. All the vowels were substituted by the vowel /ə/ fairly often and mid-central vowel /ʌ/ less

frequently. The most common substitution for diphthongs was one of its componants, or to a closely related vowel, Eg. /EI/ to /ɛ/ or /ai/ and /au/ to /a/. Occurence of diphthongization of vowels were found in all vowels except back vowels.

Geffner(1980) analysed the spontaneous speech production of sixtyfive deaf children aged from 6 years to 6.11 years. The results of the study showed that vowels with low tongue position were correct more often than those produced with mid or high tongue position. This finding is in agreement with earlier studies of Nober(1967) and Smith (1975).

In contrast. Stein's (1980) cineflourographic study of vowels produced by hearing impaired speakers showed fronting of back vowels.

With respect to errors of substitution, hearing impaired speakers often confuse the tense-lax distinction or substitute a vowel that is clearly related in articulatory position (smith, 1975) although there is evidence to the contrary (Hudgins & Numbers 1942; Markides, 1970).

**CONSONANT PRODUCTION**

Hudgins and Numbers (1942) and Nober (1967) reported that their subjects made twice as many consonant errors as vowel errors. Very recently, Geffner(1980) also found that the vowels

were produced correctly more often than consonants. Geffner (1980) attributed this fact to greater phonetic power and visibility of vowels and to high frequency componants and inherently weaker intensity of consonants. This is further substantiated by the fact that voiceless consonants more accurate than voiced consonants.

Ravishankar(1985) studied the articulatory errors of 30 conginital hearing impaired, of the age range 11 to 22 years. His results showed that error rate for consonants was 37.53% and for vowels 17.63%.

On the contrary, few investigators (Hutington et al.,1968? Jones, 1967) have claimed that as a rule,deaf speakers produce consonants more clearly than vowel sounds. These authors believe that this is because vowels do not have clearly defined place of articulation.

Hudgins & Numbers(1942) studied 142 subjects between the age range of 8 to 20 years, whose hearing loss ranged from moderate to profound. The most common error types observed were:

1. Confusion of voiced-voiceless distinction
2. Substitution of one consonant for another
3. Added nasality
4. Misarticulation of consonant blends
5. Misarticulation of abutting consonants
6. Omission of word-initial or word final consonants.

The articulatory errors of the hearing impaired children can be divided into substitutions, omissions and severe distortion of the intended phonemes, as well as additional adventitious phonemes or syllables.

**ERRORS IN PLACE OF ARTICULATION**

The common articulatory error in the speech of the hearing impaired involves the substitution of one phoneme for another; frequently substitution is to a phoneme with a similar place of articulation. There is a general agreement that phoneme produced in front of themouth are often produced correctly than are phonemes produced in the back of the mouth. This when one considers that the relative visibility of articulatory gestures should be important to hearing impaired persons from whom there is reduced auditory information.

Carr(1953) studied the spontaneous speech sounds of 5 year old deaf children. The total number of subjects investigated were 48, of whom 27 were boys and 21 were girls. Results indicated that deaf children tend to use front consonants.

Nober(1967) analysed, correctly articulated consonants according to place of articulation and then ranked them from highest to lowest scores, bilabials, 59% ? labiodentals, 48%? glottals, 34% ? linguadentals, 32% y lingua-alveolar, 23% ? linguapalatals, 18% and linguavelars, 12% .

Oller and Kelly(1974) studied the phonological substitution process of 6 year old child with moderately sensory neural hearing loss. Their results showed that the substitution of the consonants were shifted more towards forward place of articulation. Results of this study are in agreement with those of Nober(1967) and Carr(1953).

Levitt et al.,(1980) did a comprehensive study on segmental errors occuring in the speech of 77 deaf children. Their results revealed that the consonant substitution typically involved the same place of articulation, particularly for consonants typically produced at the front of the mouth.

Geffner(1980) studied the spontaneous speech of 65 deaf children, ranging in age from 6 to 6.11 years. Her results revealed that labiodental and bilabial consonants were produced correctly than velar consonants.

More errors of the alveolars and velar sounds in a deaf child could be for the following reasons:

The articulatory movements for both velar and alveolar sounds are visually obscure. Alveolar sounds are produced in the middle than in the back of the oral cavity. Because of this, precise positioning of the articulators is necessary in order to differentiate all sounds with medial place of articulation (Osberger & Mc Garr, 1982).

Consonants that are easy to be lip read are most often produced correctly (Ravishankar, 1985).

In any event, a consistant finding in terms of articulation errors according to the place of articulation is that hearing impaired children correctly produce the highly visible phonemes more often than the phonemes which are least visible.

Huntington(1968)made EMG measurement from oral articulators of two normal subjects and two deaf adults. His results showed that deaf were more likely to produce a consonant correctly if they had a visual model to follow (i.e. more visible sounds /b, m, w/). But he suggested that visibility was not a very crucial factor determining why bilabials sounds were more often correct than other consonants. He proposed that tongue movements are harder than lip movements and therefore, lingua-alveolars, lingua dentals and lingua velars would be hard to produce. This interpretation also is in consistant with the observation cited above, (Nober,1967) that the frequency of correct production of glottal consonants is greater than that of the lingua dentals, lingua alveolars, lingua palatals and lingua velars.

**MANNER OF ARTICULATION**

A common observation that arises from an analysis of consonant errors according to the manner of articulation is that the hearing impaired speakers tend to position their

articulators fairly accurately, especially for those place of articulation that are highly visible, but fail to co-ordinate properly the movements of articulators (Hutington et al., 1968; Levitt et al., 1976).

According to Hudgins and Numbers (1942), the common error involving manner of articulation is nasal-oral substitution. They found that non-nasal phonemes are often nasalized and nasal continuents were often produced as stops.

Nober(1967) reported that in terms of correctness of production, glides,39% , were most often correct, followed by stops,30%; nasals, 28% ; and fricatives, 26% .

Oiler and Kelly(1974) studied the phonological substitution process of 6 year old moderately severe hearing loss and found that substitution were similar to the substitution of younger normal children. They found similar results as that of Nober(1967), liquid consonants were substituted by glides and rounded vowels and final fricative consonants were devoiced.

Smith(1975) found that hearing Impaired were most often in error in producing the following: palatal plosives, fricatives, affricates and nasals. Glottals were frequently substituted for stops and fricatives. The affricates were never substituted by other consonants but by one of their componants, usually the plosives consonants. However, bilabial plosives, the glides and fricatives /f/ and /x/ were often

produced correctly.

Similarly Levitt et al.,(1980) did a study on segmental errors of 77 deaf children and found that nasals were frequently substituted by voiced plosives with the same place of production? the inverse substitution was also fairly common, but comparatively less frequent; frequent substitution of the glottal stops for many of the consonants produced in the centre as well as the back of the oral cavity. The fricatives were also substituted, but not from, the plosives. The afficates were never substituted by other consonants, but tend to be substituted by one of their componants, the plosive componants being substituted more often, occasionally with a voiced - voiceless problem. These consonantal errors are due to the errors in timing or control of articulators.

Geffner(1980) studied spontaneous speech production of 65 deaf children, ranging in age from 6.0 to 6.11 years. Her results revealed that laterals and glide phonemes were elicited more accurately than the affricates.

**TYPE OF MISARTTCULATION**

By far the single most frequently reported error in the speech production of severely and profoundly hearing impaired is omission of a phoneme .(Hudgins & Numbers, 1942; Markides, 1970? Smith, 1975). The omission of consonants may occur in word initial and or in the word final position of words.

Hudgins & Numbers(1942) reported that omission of initial consonants was more common than the omission of final consonants. The consonants that are most frequently omitted from the initial position of word included /h, 1, r, y, th, s/. Patterns of eeror of the final consonants are: dropping of consonants, releasing of consonants into following syllable, or incomplete production whereby the phoneme loses its dynamic properties and merely becomes passive gestures. Among the final consonants that are frequently omitted were /l,s,z,d,g,k/.

Markides(1970) reported that deaf children misarticulated nearly 72% of all consonants attempted, whilst the partially hearing children misarticulated a little over 26%. The study also showed that in deaf individuals omissions were more than substitution and distortions. Among the partially hearing individuals substitutions were more than omissions and distortion.

Analysis of the position of errors showed that the final consonant errors were more numerous than errors involving the initial and medial positions, which is contrary to findings of Hudgins & Numbers(1942).

Smith(1975) found the omission of consonants to be the commonest error in the speech of hearing impaired individuals. In her study, an analysis of position of errors indicated that there was no differences in mean proportion of errors in

initial and medial position, however, there was a marked increase of errors in the final position.

Levitt et al.,(1980) studied the segmental errors of 77 deaf children. Their results indicated that, for consonants, most common error was that of omission. Consonant produced near the front of the mouth (Eg. /p,b,f,v,m/) were substantially less prone to omissions than consonants produced in the center or back of the oral cavity.

Geffner(1980), in her study of the spontaneous production of phonemes in 65 year old hearing impaired children, found omissions to be more frequent problem (91%) followed by substitution (7%), distortion (1%) and finally addition (0.1%).

Analysis of the frequency of omission errors in all position revealed that velar consonants, which are not visible were omitted in greater proportion than visible front consonants, vowels were omitted less often than consonants in general. Among consonants those with features of sonorance and frication were omitted more frequently.

Ravlshankar(1985) found that the errors in initial position were more frequent than the errors in medial position. This result in contrary to results of several investigators (Nober, 1967; Markides, 1970; Smith, 1975). Ravishankar suggested that this could be due to the non-occurance of consonants in the final position in Kannada.

Consonant cluster errors has an important and deleterious effect on speech intelligibility. Hudgins & Numbers(1942), in their study, these error involved two forms: (1) One or more componants of clusters were dropped and (2) an adventitious phoneme, usually the /ə/. was added between the elements. Later error may be particularly determental to the time or rate and rhythm of speech.

Brannon(1964) tested the speech production and spoken language of 20 deaf children. He tested these children on the Templin Darley Screening Test of Articulation and found that misarticulation of consonant blends to be an important error.

Smith(1975) studied the residual hearing and speech production in deaf children. She tested /p, t, k/ and /s/ in blends for older children only and found omission of one element or the other of the blend to occur frequently.

Similarly, Oiler, Jenson, and Lafayette(1978) noted that their 6 year old deaf subject s tend to reduce words to the CV level, thereby omitting clusters or final consonants.

Ravishankar(1985) analysis of errors in the blends revealed that substitution errors were most frequent, followed by omission of a componant in the blend. This was followed by the addition of a vowel in between the componants of the blend.

Complete omissions, unidentifiable substitutions and distortion were the other types of errors shown by the subjects.

An error considered especially typical of deaf speakers is the " Surd-Sonant " or the substitution of sounds which have same place of articulation but differ in voiced-voiceless feature. Thus the voiceless stop consonant /p/ may be heard as its voiced stop consonant cognate /b/ or the vice-versa.

The causes of this substitution error putforth by Calvert (1962) are:

(1) Inadequate coordination of voicing and articulation.

(2) Inappropriate force of articulation causing duration distortion of consonants.

(3) Distortion of duration of vowels preceeding consonants.

Mangan(1961) evaluated the speech production ability of 21 deaf and 9 hard of hearing children. The test material was reading a list of familiar phone tically balanced words. The commonest error reported was that of devoking of the final voiced consonant.

Nober(1967) analysed the production of phonemes by 46 severely and profoundly hearing impaired children. He ranked

voiced-voiceless cognates in accordance to the order of correct production: voiceless consonant(31%) and voiced(23%). His results also indicated that voiced stop cognates are substituted by their corresponding voiceless stop cognates. According to Nober, the reason for the substitution of voiceless for voiced is that voiced sounds are harder to produce.

Markides(1970) tested 83 hard of hearing and deaf children of the age range of 7-9years, using an articulation test consisting of 24 pictorially presented monosyllabic words. The test results showed that when voiced stops were intended, the voiceless cognates was frequently substituted.

Oiler, Jensen and Lafayette(1978)studied the phonological process of 6 year old, hearing impaired subjects. Their results revealed that subjects omitted final voiced consonants, devoiced them, or added a / ə / after them. They claimed that this avoidance of final voiced consonants was in keeping with a phonological process used by younger normal-hearing children.

Levitt et al., (1980) studied the segmental errors of 77 deaf children and found that in consonant substitutions, voiced voiceless confusion were extremely frequent, the preponderence of substitutions being towards the voiced cognate. These errors are due to inappropriate voicing or lack of voicing.

Ravishankar(1985) on the contrary to above findings, Carr(1953) investigated the spontaneous speech sounds of 5 year old deaf-born children. His results revealed that young deaf children tend to produce more voiced sound than voiceless sound in spontaneous speech. This result is contrary to Mangan(1961), Nober(1967), Markides(1970), Oiler et al., (1978) and Levitt et al.,(1980) and Ravishankar(1985).

Ravishankar(1985) reported that voicing errors in the form of substitution of a voiceless cognate for its voiced counterpart were most frequent. The average voiceless/voiced errors is 61.31% and voiced/voiceless is 0.82%.

These errors may be due to the problem in co-articulation resulting in the failure to make the necessary VOT adjustment for making the voicing contrast.

Heider et al.,(1941) studied the spontaneous vocalization of hard-of-hearing and deaf children of the age range 3 years, 10 months to 6 years 10 months. They reported greater tendency to use voiced sounds than their voiceless cognates.

Millin(1971) studied the speech of severely hearing impaired individuals and found that voiced plosives are produced more correctly than voiceless plosives. This prepondarence of voiced plosives over voiceless one is attributed to the manifestation of the problem of continuous phonation seen in severely hearing impaired individuals.

Smith(1972) studied 40 deaf children, these children were asked to read 20 specially designed sentences which incorporated all of the most frequently used phonemes of English. Her test results showed tendency of greater proportion of voiced sounds for their voiceless cognates as opposed to voiceless for voiced cognates.

Geffner(1980) studied the spontaneous speech of 65 deaf children of the age range 6 years to 6.11 years. Her results revealed that voicing feature dif€erred minimally with a greater proportion correct for voiced (25%) when compared to voiceless consonants which is of (22%).

Mousen(1983) reported that hearing impaired children make frequent errors when they try to produce the voiced and voiceless stop consonants. His results also indicated that voiced-voiceless distinction between stops is collapsed into a single phoneme that is produced for both voiced and voiceless stops and also phonemes are produced as voiceless aspirated sound in final position.

**THERAPY TECHNIQUES TO IMPROVE VOICED-VOICELESS DISTINCTION IN HEARING IMPAIRED**

While the articulation abilities of hearing impaired children have been described in greater detail by various investigators (Hudgins & Numbers, 1942; Mangan,1961; Nober, 1967; Markides, 1970;Smith, 1975; Mc Garr, 1978? and

Geffner, 1980), there are only a few experimental attempts to train these children to improve their articulation.

Variability in training methodology for voiced-voiceless distinction in hearing impaired, is apparent in emphirical studies to date. The variability in training methodology is in terms of training stimuli, task and response mode. The use of meaningful Vs non-meaningful material as stimuli for speech training is apparently one of the major difference, among the methodologies employed to train the articulatory behaviours of severely hearing impaired children.

Bennett(1974, 1978); Monsen and Shaughnessry(1978) used meaningful word as stimuli for speech training. Wing and Maretic(1971), and Stark (1971, 1977) used non-meaningful syllable as stimuli. Novelli-Olmsted(1979) and Solomon(1981) trained with syllable, than words and phrases. Abraham and Weiner(1985)investigated the relative merits of using Meaning Vs non-meaningful stimuli with hearing impaired children. They found syllable practice was significantly more effective than meaningful word practice for the aquisition of normal phonemes by normal hearing adults listener under conditions of simulated hearing loss.

Ling and Maretic(1971) used frequency transposition in teaching of the deaf. In their study, conventional (linear) amplification supplimented with frequency transposition was

compared with conventional amplification. Speech training to 10 severely deaf children,aged 7-11 years for 10 hours in the articulation of 64 consonant vowel syllables was given. Their results indicated that children improved in their articulation of consonant vowel syllables.

Stark(1972) used real-time spectral displays in teaching /ba/ and /pa/ to deaf children. Results indicated that children learnt /ba/ and /pa/.

However, children's ability to generalize from training materials to other context on which they had received no training, were not examined.

Bennett(1978) used distinctive feature approach for the voiced-voiceless training of profoundly hearing-impaired children. Distinctive feature training was given to three profoundly hearing impaired children of age range of 9 to 12 years. Pretesting involved an indepth assessment of spontaneous and invitative responses of phonemes /b, p, d, t, g, k, k & m/ in the initial, medial and final position of words. Training was given for 3 days a week, each session lasted approximately 15 minutes and consisted of 100-175 trials. Results indicated there was a significant difference between the pre and post therapy in the performance of the deaf children in all the three positions.

Metz et al.,(1980) also used distinctive feature approach for the remediation of voicing errors produced by 8 hearing impaired adults. The results indicate that production of the (+voice) feature was mastered by all subjects in the phonetic context, but generalization of the (+voice) feature usage rule was not achieved by the subjects.

Abraham and Weiner(1985) investigated the efficacy of speech training using meaningful versus non-meaningful verbal stimuli with 10 severely and profoundly hearing impaired children. Results indicated that both syllable and word training improved, imitative production of target phonemes in trained content.

Mc Reynolds & Jetzke(1986) studied the articulation generalization of voiced-voiceless sounds of 8 hearing impaired children. Results showed that 6 of the 8 children generalized both the voiced and voiceless target to 50% or more of the target sound probe items. Results also indicated that more generalization occured to the voiceless cognates from voiced target sound training than occured to voiced cognates from voiceless target sound training.

Perigoe and Ling(1986) studied the generalization of speech skills in 12 profoundly hearing impaired children. Subjects were given phonetic and phonologic speech training for 15 minutes daily for 40 sessions. Results indicated that

of significant improvement in speech ability after intensive training.

Monsen(1975, 1976a) measured spectrographically the VOT of word initial stop consonant (/p/, /t/, /k/) and (/b/, /d/, /g/) in the speech of thirty seven deaf and six normally hearing adolescents. In 11 of the deaf children, VOT values for voiceless stop consonants were similar to those in the normal hearing i.e. these individuals could produce all the stops in a manner similar to normals. The remaining deaf individuals deviated systematically from the normal in their failure to produce a distinction between the voiced and voiceless stop at a given place of articulation. Those who failed to produce "voiced-voiceless distinction" tended to produce /p-b/ and /t-d/ as unaspirated stops, and to produce either aspirated or unaspirated stops, and to produce either aspirated or unaspirated stops for /k-g/. He concluded that "while the speech production of a deaf child may deviate from normal, it is by no means phonetically or phonologically inconsistent in itself".

Gilbert and Cambell(1978), in their study, observed differences in VOT, though the stop consonants produced by both the normally hearing and hearing impaired individuals were perceived as being produced correctly.

VOT values for hearing impaired speakers were shorter than those values for normally hearing speakers. Gilbert and Cambell(1978) have given two explanations for the short VOT values observed in the speech of the hearing impaired.

(1) Gilbert(1975) reported that airflow during the production of stop consonants was less for hearing impaired subjects than for normally hearing subjects. Short VOT values observed possibly is due to this reduce intraoral pressure during the production of stop consonants.

(2) And the other explanation for the short VOT values obtained for voiceless stops may be inability of hearing impaired individual to co-ordinate the phonation and articulatory mechanism.

Another difference was that the hearing impaired speakers exhibited fewer negative VOT values for the pre-vocalic *oiced componants, than did the normally hearing subjects. According to Gilbert and Cambell(1978) the reduced number of negative VOT values obtained from hearing impaired speakers indicated that they did not make as great a distinction in the production of stop consonant cognates. Because, Lisker and Abrahamson (1967) indicated that the percentage of negative VOT values for the voiced stop consonants increased as the need for the greater cognate distinction increased.

Shukla(1987) did a similar study having 30 hearing impaired and 30 normally hearing individuals. His results revealed that both normally hearing and hearing impaired speakers had positive VOT values for voiceless stops. However, VOT values for the hearing impaired speakers were shorter. His results also indicated that normally hearing speakers showed negative VOT values for voiced stops, while in a majority of the hearing impaired speakers, negative VOTs were absent. He conducted that absence of negative VOT (pre-voicing) is the acoustic reason for the "surd-sonant" problem in the speech of the hearing impaired.

## METHODOLOGY

Voiced-voiceless distinction is the commonest problem in speech of the hearing impaired. Inspite of conserted efforts by the Speech Pathologist, to overcome the problem, it persists. The aim of the study is to evaluate the efficacy of a recent therapy technique " closed mouth voicing initiation technique " to overcome the voiced-voiceless distinction problem in the speech of the hearing impaired, using a single subject design.

**Subjects:** Five hearing impaired children were selected as subjects. The age range of the subjects was between lOyears 3 months to 13 years 7 months. All the subjects selected for the study had been enrolled as cases at All India Institute of Speech and Hearing, Mysore-6.

All the subjects had to satisfy the following condition before they were included as subjects for the study.

1. should have voiced-voiceless distinction problem.
2. should have congenital moderate to severe sensory neural hearing loss.
3. should have normal intelligence.
4. should have ability to read simple syllabic words of the Kannada.
5. should have no other handicap except the hearing loss.

TABLE-1 : Shows age, degree of hearing loss at each frequency from 250 to 8KHz and the PTA for all the five subjects selected for the study.

| Subject | Age | | 250Hz | 5OOHz | 1KHz | 2KHz | 4KHz | 8KHz | PTA |
|---|---|---|---|---|---|---|---|---|---|
| Subject-l | 11 years | Rt. | 60 | 75 | 90 | 100 | 100 | NR | 88.33 |
| | 6 months | Lt. | 70 | 90 | 95 | 90 | 110 | NR | 91.66 |
| Subject-2 | 13 years | Rt. | 90 | 90 | 105 | NR | NR | NR | 96.0 |
| | 7 months | Lt. | 90 | 100 | NR | NR | NR | NR | 100.0 |
| Subject-3 | 12 years | Rt. | 80 | 90 | 100 | 85 | 95 | 85 | 91.66 |
| | | Lt. | 05 | 85 | 80 | 90 | 100 | NR | 85.0 |
| Subject-4 | 10 years | Rt. | 75 | 85 | 90 | 80 | 85 | 90 | 85.0 |
| | 3 months | Lt. | 70 | 70 | 75 | 70 | 75 | 90 | 71.6 |
| Subject-5 | 11 years | Rt. | 60 | 70 | 70 | 75 | 75 | 75 | 71.6 |
| | 2 months | Lt. | 60 | 65 | 70 | 80 | 80 | 80 | 71.6 |

**TEST MATERIAL:**

The test material used for the study consisted 36 bisyllabic meaningful words. 18 words consisted of voiceless stop consonants (p, ṭ, X, t ) and remaining 18 words consisted voiced stop consonants (b, ḍ, g, d ) in initial and medial positions. The word list is given in Table-2. Three randam-ized lists of same 36 bisyllabic words were prepared for the three trials of recording.

TABLE-2 WORD LIST - KANNADA

| | |
|---|---|
| ಪೂಲ | ಪಾಪಿ |
| ತಾಳ | ತಾತಾ |
| ಕಾಳ | ತಾಕಿ |
| ದಾಳ | ದಾದಾ |
| ಬಾಲ | ಬಾಬಿ |
| ಗಾಳ | ತಾಗಿ |
| ಪಾಪ | ಬಾಬು |
| ಟಿತ | ಬೆತಿ |
| ಯಾಕ | ದಾಸು |
| ಟಿದ | ಬೆದಿ |
| ಯಾಗ | ನಾಕು |
| ಬಾಬು | ಗಡಿ |
| ಪಾಳು | ದಾಯಿ |
| ಡಡ | ತಾಯಿ |
| ಗರ | ಕಡಿ |
| ತಡ | ಬಾವು |
| ಕರ | ಪಾವು |
| ಬಾಳು | ಪಾವು |

**Recording:**

Each subject was seated in a chair comfortably in a quite environment. Prior to actual recording of speech material, each subject was given simultaneously signed and spoken instructions. Then each subject was given an opportunity to practice the test materials. The flash cards of the 36 bisyllabic words were prepared to elicit the response and to record the response with appropriate inter word gap.

Recording was done using AHUJA Deck Tape Recorder and a Meltrak C-90 audio cassette. Microphone was placed at a distance of 10-12 inches from the child at the level of the mouth. While recording care was taken that Vu meter needle does not overshoot the red region and undershoot below the yellow region.

Before the recording, each subject was instructed as follows: " Now I will show you some picture card. YOu have to read or identify what is written on the card and say it loudly after carefully looking at them".

For every subject, the list was presented three times, a gap of 10 to 15 seconds was given between the two flash card. The same procedure was used for both pre and post therapy recording.

**Therapy Procedure:**

The children were seen Individually by the experimenter 3 days a week. Each training session lasted approximately 15 to 20 minutes.

Training was individualized, depending on each child's performance on the pretest and throughout the training sequence. The training sequence was as follows:

1. Discrimination training between voiced and voiceless stops was given to the child (both intra and interpersonal discrimination training).

2. Each subject was asked to assume the articulatory position for production of stop sounds (p, t, t, k or b, d, d, g ).

3. While each subject maintained the articulators in that position, he/she was instructed to initiate voicing (closed mouth voicing) and to maintain voicing for some time. Enough practice of this exercise was given to each subject.

4. Once the subject mastered the closed mouth voicing, each subject was instructed to close the articulators, initiate voicing and the releasing of articulators after maintaining the voicing for some time. This resulted in the production of voiced sound.

5. For the production of voiceless sound, the subjects were asked to initiate voicing after they released the articulators.

The above procedure was repeated for all the stop cognates, however therapy procedure was started with front stop cognate i.e. p/b. During the course of therapy, precaution was taken that the subjects enrolled in the present study did not have speech therapy for the voiced-voiceless distinction problem.

Appropriate reinforcement and tactile, auditory and visual feedback were given throughout the training programme.

Analysis:

Both the pretherapy and post therapy recorded speech material were assessed by three experienced listeners (judges). A total of 30 lists obtained from all the subjects were randomized and re-recorded to rule out order effect.[5 Subjects X 3 lists X 2(pre-and post therapy)]

Then list were played for all the three judges separately. They were requested to write down what they perceived from the recorded sample.

When the judge correctly identified the whole word, it was considered as correct response. The number of correct response were converted into percentages.

The pre and post therapy performance of each subject is assessed in terms of :

1. Percentage of word intelligibility.
2. Percentage of voiceless to voiced substitutions.

## RESULTS AND DISCUSSION

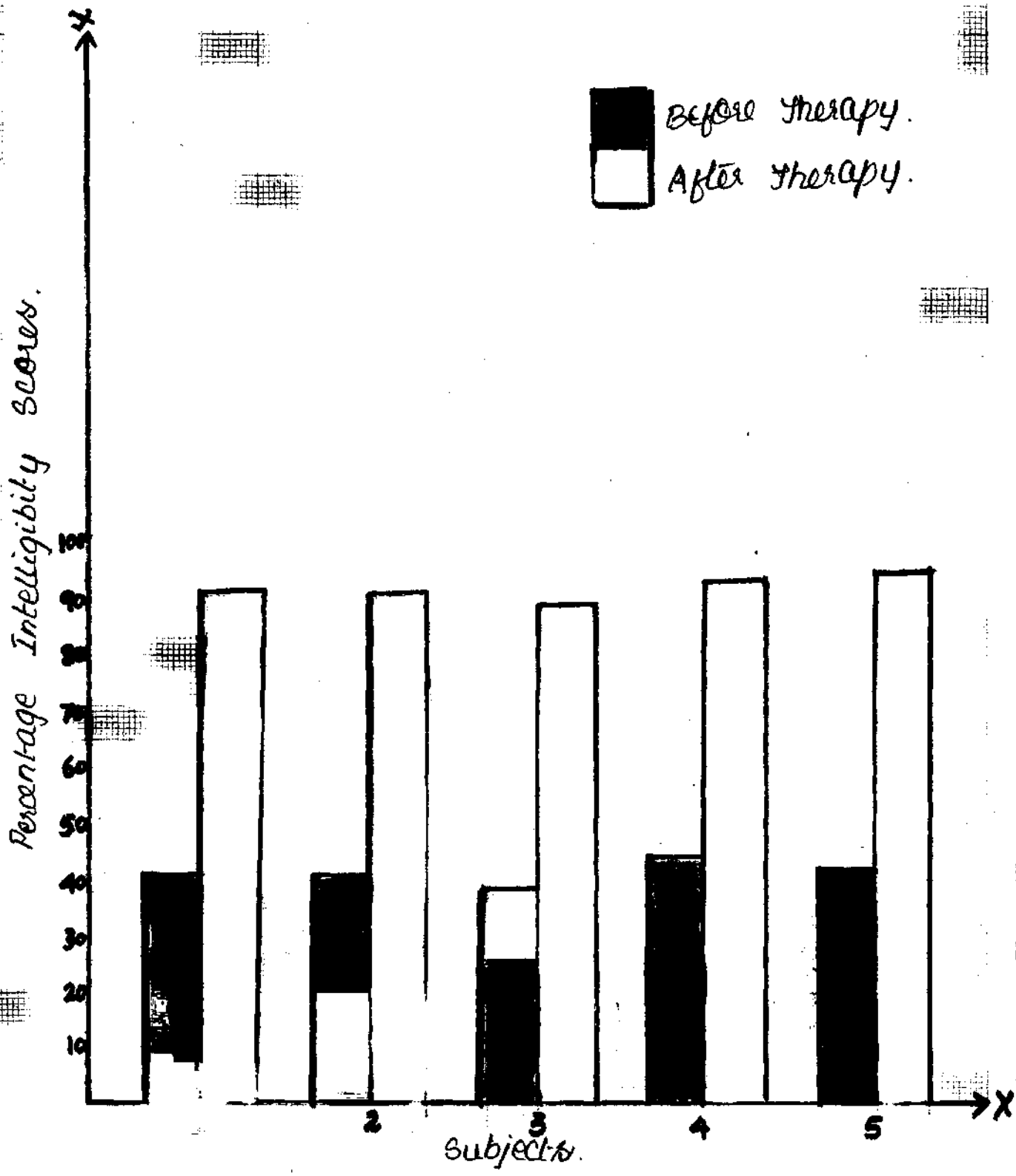
The aim of the study was to evaluate effect of " closed mouth voice initiation technique " to overcome voiced-voiceless distinction problem of the hearing impaired subjects. The study included 5 hearing impaired subjects. All of them underwent therapy of about 10 to 15 sessions, each session being 15 to 20 minutes of duration. The efficacy of the treatment procedure was assessed by measuring pre and post word intelligibility and in terms of percentage of substitution errors before and after therapy.

Table-2 shows the correlation coefficients of perceptual analysis done independently by the three judges for both pre and post therapy.

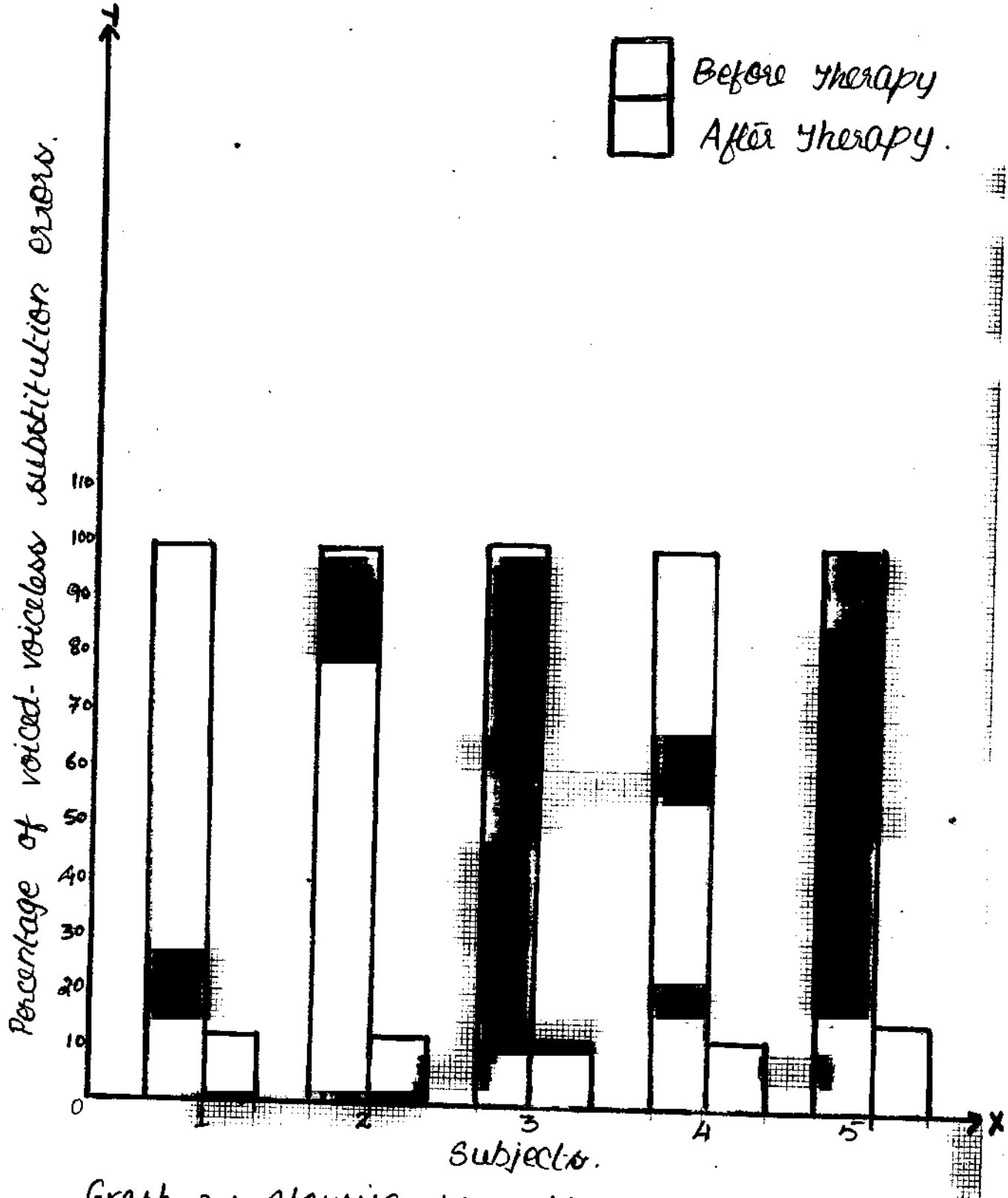
Table-3 showing the correlation co-efficients among judges for pre therapy and post therapy judgements.

| | $J_1$ & $J_2$ | $J_1$ & $J_2$ | $J_1$ & $J_2$ |
|---|---|---|---|
| Pre therapy | .875 | .982 | .975 |
| Post therapy | .89 | .95 | .67 |

It may be observed from the table that there is a high correlation among the judges for both pre-therapy and post-therapy judgements revealing a high degree of interjudge reliability. Therefore judgement from all the three judges was averaged.




Graph 1:- Showing percentage intelligibility scores before and after therapy.




Graph 2 :- Showing percentage of voiced-voiceless substitutions error before and after therapy.

Since it was a single subject design, results of each subject has been presented individually both interms of pre and post therapy word intelligibility and percentage of substitutional errors.before and after therapy.

**SUBJECT-1**

Aswin was a male and was about 11 years 6 months old having hearing loss of PTA 88.33dB in right ear and 91.66dB in the left ear.

Table-4: Showing word intelligibility and percentage of subs-aitution errors before and after therapy for Subject-1.

| | Pre therapy score | Post therapy score |
|---|---|---|
| % word intelligibility scores | 40.33% | 92.19% |
| % voiced - voiceless substitution errors | 99.38% | 13.88% |

Number of sessions: 10

From the table it may be observed that Aswin had substituted voiceless stops (p, t, ʈ, k ) for all the voiced stops (b, d, ɖ, g ). Post therapeutically Aswin improved signfi - cantly by bringing errors just to 14% from 99%. Word intelligibility also improved from 40% (pre therapy) to 92% (post therapy).

**SUBJECT–2**

Prashanth was a male and was about 13 years 7 months old having hearing loss of PTA 96 dB in right ear and l00dB in the left ear.

Table-5: Showing word intelligibility and percentage of substitution errors before and after therapy for subject-2.

| | Pre therapy score | Post therapy score |
|---|---|---|
| % word intelligibility scores | 40.66% | 90.34% |
| % voiced - voiceless substitution errors | 98.77% | 12.77% |

Number of sessions: 12

From the table it may be observed that Prashanth had substituted voicelss stops (p, t, ṭ, k ) for all the voiced stops (b, d, ḍ, g ). Post therapeutically Prashanth improved significantly bringing errors just to 12.77% from 98.77%. Word intelligiblity has improved from 40.66% (pretherapy) to 90.34% (post therapy).

**SUBJECT–3**

This subject Prema was a female and was about 12 years old having hearing loss of PTA 91.66dB in right ear and 85dB in left ear.

Table-6: Showing word intelligibility and percentage of substitution errors before and after therapy for Subject-3.

| | Pre therapy score | Post therapy score |
|---|---|---|
| % word intelligibility scores | 37.91 | 87.56 |
| % voiced - voiceless substitution errors | 100.0 | 12.77 |

Number of sessions: 15

From the table it may be observed that Prema had substituted voiceless stops (p,t,ʈ,k) for all the voiced stops (b, d, ɖ, g). Post therapeutically Prema improved significantly bringing errors just to 12.77% from 100%.Word intelligibility has improved from 37.91% to 87.56%.

**SUBJECT—4**

This subject Muralidhar was a male and was about 10 years 3 months old, having hearing loss of PTA 85dB in right ear and 71.6dB in left ear.

Table-7: Showing word intelligibility and percentage of substitution errors before and after therapy for subject-4.

| | Pre therapy score | Post therapy score |
|---|---|---|
| % word intelligibility scores | 41.28 | 90.25 |
| % voiced-voiceless substitution errors. | 98.38 | 12.20 |

Number of sessions: 12

From the table it may be observed that Muralidhar has substituted voiceless stops (p, t, ʈ, k) for all the voiced stops (b, d, ɖ, g). Post therapeutieally Muralidhar improved significantly by bringing errors just to 12.2% from 98.38%. word intelligibility also improved from 41.28% (pre therapy) to 90.25% (Post therapy).

SUBJECT-5

This subject Gururaj was male and was about 11 years 2 months old, having hearing loss of PTA 71.6 dBHL for both ears.

Table-8: Showing word intelligibility and percentage of substitution errors before and after therapy for subject-5.

| | Pre therapy score | Post therapy score |
|---|---|---|
| % word intelligibility score | 44.15 | 87.56 |
| % Voiced-Voiceless substitution errors | 100.0 | 14.05 |

Number of sessions: 12

From the table it may be observed that Gururaj had substituted voiceless stops (p, t, ʈ, k) for all the voiced stops (b, d, ɖ, g). Post therapeutically Gururaj improved significantly by bringing errors just to 14.05% from 100%.

Word intelligibility has improved from 44115% to 87.56% .

Table-9: shows the percent of correct responses for the voiced stop sounds averaged for initial and medial position before and after therapy for all the five subjects.

| | SUBJECT-l | | SUBJECT-2 | | SUBJECT-3 | | SUBJECT-4 | | SUBJECT-5 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Pre | Post | Pre | Post | Pre | Post | Pre | Post | Pre | Post |
| b | 0 | 98 | 6 | 100 | 6 | 94 | 0 | 98 | 0 | 97 |
| d | 0 | 100 | 0 | 100 | 0 | 100 | 0 | 100 | 3 | 100 |
| d | 0 | 100 | 3 | 98 | 3 | 96 | 0 | 98 | 0 | 98 |
| g | 0 | 100 | 0 | 100 | 0 | 100 | 0 | 100 | 0 | 100 |

From the Table-9 it may be observed that all the five subjects articulated voiced sounds almost every time they required to, and occasionally they made an error. This occasional error of the voiced stop sounds probably suggest that these children needed stabilization.

It is worth noticing that all the five hearing impaired children just needed 10 to 15 sessions of therapy, duration of which was 15 to 20 minutes to overcome their problems. Therefore we can conclude that the technique is effective even in terms of time of required to overcome the problems.

## SUMMARY AND CONCLUSIONS

Several researchers (Veoller, 1938; Hudgins and Numbers, 1942; Boone, 1966; Nober,1967; Colton and Cooker, 1968? Markides, 1970; Smith, 1975; Geffner, 1980; Ravishankar,1985) have attempted to describe the characteristics of speech of the hearing impaired. The characteristics include articulation errors, high pitched noice, improper intonation, improper rhythm, slow rate and nasality.

Analysis of articulatory errors showed that of errors of omissions, substitution distortion and additions. The most common error as far the consonants are concerned is voiced voiceless distinction.

Several investigators (Mangan, 1961; Nober, 1967; Markides, 1970; Oiler, et al., 1978; Levitt et al., 1970) found that preponderence of substitution of voiceless cognates for voiced cognates is high.

Monsen(1975, 1976, 1978) studied the VOT values of the deaf subjects and found that they did not have clear cut distinction in VOT values for voiced and voiceless when compared to normals.

Shukla (1987) reported that negative VOT (prevoicing or voicing lead) which is a characteristic feature of voiced sound in normals who use the Kannada as their language, was absent in

the speech of the hearing impaired and concluded that absence of negative VOT value is the acoustic reason for voiced-voiceless confusion in hearing impaired.

Based on this, Shukla(1987) designed a new therapy technique "closed mouth voicing initiation technique" to teach voiced-voiceless distinction among the hearing impaired. This technique mainly involves the placement of articulators at an appropriate position for the production of stop consonants (b, d, d, g) and voicing is initiated before the release of the articulation. This results in the production of voiced stop consonants.

The present study was aimed to study the efficacy of the therapy technique using a single subject design. Five hearing impaired subjects of the age range 10 years 3 months to 13 years 7 months with substitution errors of voiceless for voiced were taken as asubjects.

Therapy was given individually to each subjects for 15 to 20 minutes a session and three sessions a week, till the experimenter felt that the children have achieved the distinction.

Each subject was asked to read out word list consisting of 36 bisyllabic meaningful words. Among which 18 words consists of voiceless sounds (p, t, $\underset{n}{t}$, k ) and 18 words consists of voiced sound (b, d, $\underset{n}{d}$, g ) in both initial and medial position.

Pre thereapy and Post therapy recorded word list of each subjects were perceptually analysed in terms of:

1. Percentage of word intelligibility before and after therapy.

2. Percentage of substitution errors before and after therapy.

Results indicated that:

1. All the five subjects showed significant increase in percentage of word intelligibility score after the therapy.

2. All the five subjects showed decrease in the percentage of substitution errors after the therapy.

The above results indicate that the therapy technique "closed mouth voicing initiation technique" was effective in achieving the voiced-voiceless distinction among the hard of hearing children.

**CONCLUSION:**

Development of efficient training procedures for teaching speech to hearing impaired is essential.

The results of the study showed that the training procedure was causal for improvement of correct articulation of voiced stops. The major implication of this study is that articulation training for the correction of voiced-voiceless distinction for hearing impaired can be accomplished by basing training on

"closed mouth voice initiation technique". Even the profoundly hearing impaired children are capable of using this technique to learn voiced stops across positional and phonemic boundaries.

However, further investigation across subjects, setups, experiment is needed to strengthen the claim. The claim can be further strengthened by doing acoustical analysis of the speech of the hearing impaired before and after therapy.

The results of the study demonstrate that the therapy technique developed out of a acoustic analysis of the speech of the hearing impaired provides an efficient and a scientific approach in overcoming the speech problems of the hearing impaired. The research effort in future should concentrate in identifying "acoustical reasons" for the other deviation observed in the speech of the hearing impaired, so that newer or more scientific therapy technique can be developed.

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