THE DEVELOPMENT AND STANDARDIZATION OP SPEECH TEST MATERIAL IN ENGLISH FOR INDIANS

BY
REGISTER NO: 17

lDISSERTATION SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE
(SPEECH AND HEARING)
UNIVERSITY OF MYSORE
1972

C E R T I F I C A T E

This is to certify that the dissertation entitled "THE DEVELOPMENT AND STANDARDIZATION OF SPEECH TEST MATERIAL IN ENGLISH FOR INDIANS" is the bonafide work in part fulfillment for M.Sc. Speech and Hearing, carrying 100 marks, of the student with Register No.17.

(N.RATHNA)
Director-in-charge
All India Institute of Speech
and Hearing, Mysore.

C E R T I F I C A T E

This is to certify that this dissertation has been prepared under my supervision and guidance.

GUIDE.

D E C L A R A T I 0 N

This thesis is the result of my own study undertaken under the guidance of Dr. N.Rathna, and has not been submitted earlier at any University for my other diploma or degree.

DATE: SIGNATURE OF THE CANDIDATE.
MYSORE.

A C K N O W L E D G E M E N T S

I wish to thank all the Principals and the Headmasters of various Colleges and Schools in Mysore City and also all the subjects who have readily cooperated in carrying out this study. I acknowledge my indebtedness to my guide Dr. Rathna, N, from whom I have learned much, for his patient guidance throughout this study. My thanks are due to Mr. Vyasa Murthy, M.N., Mr. Bharat Raj, J. and Mr. Satyanarayana Murthy, S., for helping me at various stages in this study. Miss Nikkam, S. helped me with her valuable suggestions and I am thankful to her. Finally, thanks are due to staff members who helped me in this study.

TABLE OF CONTENTS

CHAPTER PAGE

LIST OF TABLES

LIST OF FIGURES

FIGURES PAGE

FIGURE PAGE

CHAPTER I

INTRODUCTION

Speech audiometry is an important element in the battery of audiometric tests. Speech audiometry has come into existence because of some inherent disadvantages in pure-tone audiometry. Though pure-tones are physically and mathematically simple and are easy to present, they are relatively uncommon and unimportant. Moreover, pure-tone audiometry does not provide information about the person's ability to hear above the threshold. On the other hand speech audiometry helps in earlier detection of slight losses otherwise overlooked and provides better documentation of initial or slight gains after therapy. It helps in a better assessment of differences among hearing aids., Also, in cases of high-frequency loss and non-organis losses speech audiometry yields better results than pure-tone audiometry. Moreover, it can be used to determine the patient's ability to perform at supra-threshold levels, and to determine his social adequacy index. The need for speech audiometry arises mainly because speech is by far the most important class of sounds one hears. Measurement of speech discrimination and speech reception threshold are:

> Useful in reading the qualitative estimate of the outcome of surgery, of potential for hearing aid use, of relative efficiency with different instruments, and of phonemic perception in everyday life.(Carhart,R., 1965, p.260)

For the reasons mentioned above pure-tone audiometry should be supplemented by speech audiometry,

Speech tests need to be standardized on the population to be tested. "Obtaining norms is one aspect of standardization" (Moskowitz, 1969). Standardization of speech material for obtaining speech reception threshold and discrimination scores will provide norms to which comparison can be made to assess amount of deviation,

Speech tests in Indian Languages (Hindi, Tamil, Telugu and Malayalam) are already available. Tests in other Indian languages are at present being made up. As an interim measure the standardized tests in English have been used with English knowing Indians. However, pilot studies (Nikam, 1968) have indicated that the available tests may not be wholly suitable to Indian populations because many words in the test are unfamiliar to us and this can affect performance. Here an attempt is made to modify the existing speech lists, to suit our conditions, The proposed study is "The Development and Standardization of Speech tests in English for an Indian Population".

Purpose of the study:

The purpose of the study were 1) to modify available English lists, 2) standardization to suit our conditions,

3) to help further research on these lines,4) to compare the results of these tests with those of speech audiometry tests already available and comparison with studies in Indian Languages. This test would provide an efficient interim measure for speech testing.

Brief plan of the study:

Test materials (monosyllabic and disyllabic words) from the speech tests that were already available in English were subjected to familiarity test on Indian population. The selected monosyllabic words were phonetically balanced. Test materials were presented at various intensities and the number of correct responses given by the subject were analysed. Articulation curves were plotted and Speech Reception Threshold and the level at which one hundred per cent of the monosyllabic words were correctly discriminated were obtained.

Limitations of the study:

1) The study was restricted to the Mysore Population.
2) Only school children and college going adults who knew English were included in the study.
3) Even though different lists were presented at different intensities to different ears of 56 subjects, the 'total' number of subjects would be

tantamount to testing about 7 subjects with seven different lists. The testing procedure was selected to adequately avoid the effect of practice Which it was felt that the earlier studies in India and abroad had not done. The tantamount number of seven compares favorably with the six subjects used by Hirish etal.

Definitions of the terms used:

Speech Audiometry: "The technique whereby standardized sample of a language are presented through a calibrated system in order to measure some aspects of hearing ability. The standardized materials can be presented from a recording or by monitored voice". (Carhart,R.,1951)

Hearing loss for speech: "is the difference in decibels between the speech levels at which the average normal ear and the defective ear, respectively reach the same intelligibility, often arbitrarily set at 50 per cent" (Hirsh, 1952).

Speech Reception Threshold:(SBT) "is a measure of the intensity of speech which enables a subject to correctly repeat 50 per cent of the speech materials that are presented to him" (O'Neill and Oyer, 1966).

Speech discrimination test; "is a hearing test used to determine the subject's ability to hear and to repeat correctly the American speech sounds represented in PB word lists" (Glorig, 1965).

Phonetically balanced list (PB list): "is a list of monosyllabic words that contain a distribution of speech sounds that approximates the distribution of the same sounds as they occur in conversational American English" (Hirsh, 1952).

Spondee word: "A spondee word contains two syllabies with equal stress on both" (Hirsh, 1952).

Discrimination loss: "is the difference between 100 per cent and the percentage of words of a PB list that a listener repeats correctly when the list is presented at an intensity that is so high that a further increase in intensity will not increase the articulation" (Hirsh, 1952).

Articulation Curve: "The articulation Curve depicts the changes in intelligibility or the correct recognition of words as related to the intensity level at which the words are presented" (O'Neill and Oyer, 1966).

***

CHAPTER II

REVIEW OF LITERATURE

A review of the developmental history of speech audiometry provides an insight into why certain procedures are followed in the development and standardization of the speech tests for English speaking Indians. The inherent advantages and disadvantages in the selection of various speech test materials, their methods of presentation (live-voice or recorded) and for whom they are intended (adults or children) account for the development of the majority of speech tests. Extensive use of the excellent review of the literature made by O'Neill and Oyer (1966) is made in this chapter.

History of Speech Test Materials

"It is of interest to note that in 1874 Wolf had suggested that the human voice was the 'most perfect conceivable measure of hearing'. He constructed a table of intensity values for the various sounds of the German language. The intensity, rather than being expressed in decibels, was expressed in paces or distance from the speaking source. The major testing materials were consonants, syllables and words. Later in 1890, Wolf recorded words on an Edison Wax Cylinder. He was able to present the words to the ear of the patient through

adjustable tubing which permitted control of the intensity of the recorded materials". (O'neill and Oyer, 1966,pp.76-77)

Nonsense syllables:

> More than sixty years ago, in 1910 the telephone industry became interested in the nature the stimuli being transmitted over its systems. This led to the beginning of a quantification of speech materials aa test items. However, these materials were not used to determine the threshold of speech, but were used instead as discrimination tests or measures of intelligibility of speakers using particular communication systems. The Bell Telephone Laboratories then began an analysis of the characteristics of isolated speech sounds (vowels and consonants). Campbell and Crandall developed the first articulation lists. These lists consisted of a series of unintelligible words made up of consonant - vowel - consonant, consonant - vowel, and vowel - consonant combinations. Each list consisted of 50 words with five of the above three categories and was employed in the testing of the efficiency of telephone circuits. The words were either spoken through a microphone or recorded on then were presented through a particular circuit. The resulting scores were based on the percentage of syllable groupings that were recognized by the listener. This score was referred to as the syllable - articulation score of the tested circuit.

The use of nonsense syllables in the study of intelligibility represents an analytic approach in which the interest is focussed on the intelligibility or repeatability of specific phonemic elements. The advantage of using monsense syllables lies in the fact that they are devoid of meaning and hence their intelligibility is in no way dependent upon the vocabulary of the listener.

It has been found in practice by Lafon, J.C., (1966) that nonsense syllables are by no means easy to use because the subject has an unconscious tendency to look for a meaning in the sound presented to him and to reproduce it as a known term. It was felt preferrable to choose words which had meaning. Therefore monosyllabic words have been used in some of the later tests that were developed.

Monosyllabic words:

Monosyllable words are less analytic waits of speech and are more easily repeated than nonsense syllables. Therefore many researchers have preferred to use monosyllabic words. There was also an attempt to balance the sounds in any one list according to their normal frequency of occurrence ia normal conversational English.

This has given these lists the name "Phonetically balanced lists" or PB lists;

> A test of discrimination for speech as opposed to a threshold test must consist of relatively non-redundant items. Otherwise, the multiplicity of clues available to the patient will obscure many of his inabilities to differentiate consonants and vowels accurately. It is for this reason that monosyllabic words have been selected in this study instead of conversational sentences or multisyllabic words such as spondees. (Carhart, R., 1965, p.253)

Monosyllabic words are efficiently unpredictable for clinical subjects so that individual speech elements must be perceived relatively independently. On the otherhand, "they are not as confusing as nonsense syllables, which are so abstract that they baffle many subjects". (Carhart, a., 1965, p.253):

> The shorter the word is, the more difficult it is to identify it out of content. Monosyllables are thus the best material for vocal audiometry, since they offer less scope for intelligent guess work than disyllabic words. (Lafon, J.C., 1966, p.86)

A word test was developed by Shea (1941) who used words based on the Yale Chart of Phonetic elements., Ninety-six words were presented in lists of three. Each word list was attenuated from a 30 dB level to -3 dB level. Thresholds were determined using phonograph dises:

> MacFarlan (1940), was one of the first investigators to use monosyllabic words in the development of a test of speech threshold. He developed a test which used the first five hundred monosyllabic words from the Thorndike lists and the first fifty monosyllabic words from the Gates list. In order to find the particular frequency of the hearing loss for these words, MacFarlan developed a novel testing scheme. The words were recorded on dises, and these recordings were presented from an inaudible to audible level. At the time where the subject was able to detect only one out of every five of the words, the record was speeded up. This supposedly caused the low frequencies to drop out. Then a comparison was made of the changes that occured in test scores from the first testing. Another modification of the teat consisted of a recording of fifty words, divided into five different time groupings. The interval between words decreased from ten seconds to two seconds. This provided a test of the subject's 'hearing skill'. (O'Neill and Oyer, 1966, pp.78-79)

At Harvard University Egan et al (1948) developed a series of tests that were to assist in the assessment of intelligibility. These lists were given the label of PB word lists. From an original sample of twelve hundred monosyllabic words, twenty lists of fifty words each were constructed. They are known as PAL PB-50 lists. The words, grouped on the basis of phonetic similarity of the first part of the word, were selected to confirm to the following criteria (a) monosyllabic structure, (b) equal average difficulty, (c) composition representative of English speech, and (d) words in common usage. These lists were judged to be of equal difficulty. PAL PB-50 lists were modified into CID W-22 lists and even these were further modified.

In 1952 the original Harvard lists were modified by Hirsh et al at the Central Institute of Deaf. The modifications were made because of deficiencies discovered in the first tests. The major deficiencies were differences between test lists and extensiveness of the PB vocabulary;

> The two types of PB tests (Harvard and CID) differ, with higher discrimination scores being obtained with the W-22 tests. This is especially true if the CID recordings of the early PB lists (Rush Hughes recording) are used. Live-voice presentation of the spondees will probably yield thresholds which are quite similar to those obtained with recorded spondees. However, because of differences between speakers, inherent speaker variability, and the non-absolute aspects of intelligibility lists it is best to use the recorded versions of the PB tests. (O'Neill and Oyer, 1966, pp.89-90)

> The values obtained by the CID group for Auditory test W-22 were reinvestigated by Corso who used 139 trained listeners in his study. The various PB lists were presented at a level of 78 dB re:0.0002 dyne/cm^2. The obtained mean discrimination loss was 2.32 per cent or a mean score of 97.68 per cent. These results were in close agreement with the original CID results, (O'Neill and Oyer, 1966, p.91)

The North-Western University Auditory tests No:4 and No:6 made use of consonant - Nucleus - Consonant mono-syllabic words and were phonetically balanced. Half word lists have been introduced in speech discrimination tests as they shorten the test administration time without appreciable reduction in the efficiency of the test.

Half-ward lists:

An important modification of these discrimination test using monosyllabic words,has been the use of half-word lists. Fifty word PB lists were found to be cumber-some by several audiologists and thus some consideration has been given to development of shorter lists to replace the fifty word lists. Several attempts (Bowling, 1959; Campanelli, 1962; Elpern, 1961; Resniok, 1962 and Shutts, 1968) to shorten the lists from fifty to twenty five words have been made in the past. However, all of them, with the exception of Shutts (1968) have used the same technique - split - half or odd even division of a standard scrambling. The results showed high reliability and stability when the scores on a whole list were compared with scores for twenty five words selected from the same presentation. Grubb (1963) Questioned the statistical techniques employed in the construction of half word lists. No consideration was given to the level of difficulty of the words and phonetic balance of the lists. Grubb contends that values obtained in part - whole correlations are usually high and should be interpreted cautiously. Shutts (1968) constructed half-word lists giving consideration to average difficulty, range of difficulty, phonetic balance and frequency of occurrence of phonetic elements. The resulting lists

correlated highly with full lists (0.86 to 0.92) and with each other (0.83 to 0.97).

Kenneth Berger (1971) found the evidence to be positive when he attempted to find whether the W-22 recordings can be

word lists are just as accurate when need as half - lists with a monitored live - voice presentation is less clear.

carhart (1965) observed that there is little to be gained clinically by using a hundred item teet so as to enhance the representativeness of the score. Some authors, notably Elpern (1961), have contended that there is no point in using a fifty item test because precision can be maintained with twenty five words.

In the present study twenty five word lists have been made use of as it was felt that by taking care of the level of difficulty of the words and by using recorded material these lists will be as accurate as the full lists.

Disyllabic words:

Disyllabic words are less analytic than the mono-syllabic words and provid additional cues for intelligibility. In order to repeat a monosyllabic word correctly one must hear each of the phonetic elements. A word of two syllables, however,can be distinguished from other two syllable words

not only on the basis of phonetic elements but also on the basis of stress pattern;

> With the advent of World War II, considerable research effort was directed toward the development of speech tests that could be employed in the evaluation of military communication equipment and systems. A major share of this work was carried out at Harvard University in the Psycho - Acoustic Laboratory.This led to the construction of speech reception tests based on the concept of a threshold of hearing speech. The first test developed was Auditory Test No:9. In its original form it consisted of two lists of 42 disyllabic words. The spondaic stress pattern was used because it led to a higher audibility score. The two lists were sorted into twelve equivalent lists by a scrambling of the original items. Each test was divided into seven groupings of six words each, and each grouping of words was presented in 4 dB steps covering 24 dB range. Standardization of the test indicated that the tests should differ no more than 2.8 dB upon retest. Another test developed concurrently was Auditory Test No;14 which used the same word lists as Auditory test No:9. The only difference between the two tests was that test No:14 did not have attenuation on the recordings. (O'Neill and Oyer, 1966, p.82-83)

Hudgins et al (1947) followed certain criteria in constructing these lists, a) the words used should be familiar to the listener, b) the test items should be dissimilar in phonetic construction, c) they should be normal representation of English speech sounds, and d) they should have similar audibility values:

> The modification of Harvard lists was done by Hirsh at Central Institute of Deaf. The recorded versions of these lists were referred to as W-1 (constant level spondees), W-2 (attenuated spondees). The original eighty-four words were tested for familiarity. Thirty-six words that were recognised most frequently were selected from the original list and recorded in six lists. Words that were too easy were reduced 2 dB; the more difficult words were increased 2 dB. Initial testing with the revised form indicated that the threshold for normal ears was in the vicinity of 14.2 dB re: 0.0002 microbar. Test W-2 used the same words but employed a 33 dB attenuation range with every three words being attenuated 3 dB. The threshold for this test was 17.7 dB. (O'Neill and Oyer 1966, p.87)

Differences between the test results obtained with the Harvard tests and the CID tests were that lower thresholds were obtained with the latter test. Thresholds for the original spondees were on the order of 22 dB while an average Speech Reception Threshold of 14 to 15 dB was obtained for the W-1 lists. Also, different thresholds were obtained when the attenuated recording (W-2) was used. The difference was on the order of 4 dB (18 dB as compared to 14 or 15 dB for the W-1 test). Also free-field presentation, through a loud speaker, of the spondee materials resulted in a speech reception threshold that was some 3 dB lower then when the materials were presented via earphone (monanral presentation).

A modification of these tests had been the use of words which have not been phonetically balanced.

Another approach to discrimination testing was the use of multiple choice words. In this procedure printed groups of phonetically similar words were shown to the listener but he hears and is to respond to only one word from each grouping. An advantage to this approach is that words of more than a single syllable may be used, so long as each grouping contains words of the same syllable length and stress patten:. Another advantage is that these tests were a closed-response set.

A multiple-choice word intelligibility test was developed by Black, J.W. (1963). Other tests developed in this category, with some modifications, are the Rhyme test 'by Fairbanks (1958), and the 'vocal communication Lab test' by Haagen (1946). The Rhyme test was designed to emphasize auditory - phonemic factors and to minimize linguistic factors. It somewhat resembles a multiple - choise word test, but instead it is of the completion type. The stimulus words in the Rhyme test were drawn from a vocabulary of 250 common monosyllables which consists of 50 sets of five rhyming words each. one word from each set was read to the subject. On his response sheet were given the fifty stems, with a space in front of each where the subject enters one letter to complete the spelling of the word he believes he heard.

As opposed to this there are some who are against the use of monosyllables and spondee words as test material. The use of single words, and especially single syllable words, imposes severe limitations on the capacity to manipulate a crucial parameter of ongoing speech, its changing pattern over time. In order to add this dimension to speech audiometry it is necessary to develop materials based on relatively longer samples of speech than words.

The National Research Council Committee on Hearing and Bio-Acoustics (CHABA for short) found the monosyllabic words not to be representative of everyday speech. It specified the use of sentence as the sample item to represent everyday speech,

Sentences:

The relation between word lists used in the measurement of intelligibility and the continuous flow of words encountered in conversation is not clear. Sentences are considered to be more valid indicators of intelligibility.

Sentences were used by the Bell Telephone Laboratories (Fletcher and Steinberg, 1929) in their early work. These early lists consisted of interrogative sentences that were not to be repeated by the observer but were rather to be

answered. These lists were not found so useful for the clinician because the test demanded not only that the observer hear the words of the sentence, but also that he provide answers to some fairly difficult questions. Simpler lists of sentences were constructed at the Psycho Acoustics Laboratory by Hudgins et al(Audltory test No:12). The questions were relatively simple and can be answered by a single word, This feature makes them useful when a written test for use in group testing is desired. If only one subject is being tested he may be allowed to repeat the sentence he hears in which there are five key words. A set of sentences bad been prepared at CID to represent everyday American speech. The sentences were spoken by ten untrained speakers and were recorded. Much effort was devoted to obtaining natural, spontaneous everyday inflection, tempo and emphasis, with a realistic range of individual variation. However, no 'test' had been developed

The disadvantages of sentence tests are that long lists are necessary because the same sentence cannot be used twice with one listener, and his memory makes it much easier for him to recognise a sentence again even from a single Key word. But threse tests have high face validity as samples of English speech.

To overcome the aforementioned disadvantages Jerger, J. and C. Speakes (1968) devised a Synthetic Sentence Identification (SSI) teet in which (a) the message met is closed (b) the scoring system is un-ambiguous, and (c) each test item is a multiword rather than a single word item.

"Hughson and Thompson (1942) sought to determine if SRT scores could be correlated with pure-tone losses. They employed sentence lists prepared by the Bell Telephone Laboratories. The lists were presented via monitored live voice, with the SET being established at the point where the subject could just repeat two-thirds of the sentence correctly. The pure-tone thresholds for 512, 1024 and 2048 OPS were averaged and multiplied by 0.8. A fair degree of correlation was found between the two measures". (O'Belli and Oyer, 1966, p.79)

Continuous discourse was considered to be even a more valid representation of speech.

Continuous discourse:

"Although difficult to Quantity with respect to the response of the observer, the most valid sample of English speech, is, of course, a whole paragraph, or several paragraphs of continuous discourse" (Hirah, 1952). The available material that is to uniformly monotonous and

uninteresting that a speaker can repeat the material with remarkably little variability in intensity. The listener (experimenter) hae hie own criteria of what is just intelligible. By adjusting the physical demensions of the stimulus intelligibility scores oan be obtained.

Falconer and Davis (1947) in a study performed at the CID, attempted to develop a more rapid means of determining the threshold for speech. The method employed a sample of connected discourse to which the subject listened and adjusted the level of the recorded speech to a point where he could just understand what was being said. The test was compared experimentally with Auditory Test No:9 and the threshold determinations were found to be nearly identical. The test was also reliable, as indicated by high retest correlation.

Speech Audiometry for Children

> The most exacting speech hearing tests have proved to be the nonsense syllable type comprising consonant - vowel - consonant, because in such tests it is almost essential to hear every sound in order to obtain maximum score.(Fletcher, 1929)

Monosyllabic words with adult vacabulary have been used in the construction of tests by Try and kerridge and by

Hudgins et al(1947) at Harvard and these were found to be easier than nonsense syllables. An even less discriminating test is that of disyllabic words. For subjects with normal vocabularies sentence tests are probably the easiest. Fletcher and Steinberg (1929) used lists of Questions to which the listener has to give answers. Hudgins et al(1947) developed easier tests by requiring the listener simply to repeat the Questions. Fry and Kerridge developed five sentence tests comprising statements rather than Questions.

Watson in 1953 constructed discrimination tests using monosyllabic words taken from the vocabulary of five year old children. He also modified the Fry and Kerridge lists of sentences. The tests of Watson were also found to be useful for children with impaired hearing. As these tests were also found to be difficult for more severely deaf children. Quick constructed a simplified multiple - choice type test which warn administered with listening plus lipreading.

Watson, Murray, Reed, Keaster (1947), Sortini and Flake (1953), Siegenthaler, Pearson and Lezak (1954), and others constructed apeech tests for young children in which the child has to point to a picture or an object after hearing the stimulus word. Before the test, the

objects or pictures are shown to the child to make sure that he recognizes them or knows their names.

It is relatively more difficult to administer speech audiometry to children. There are many children who cannot repeat spondee words or any speech stimuli. such instances it is not always easy to determine whether the lack of response is related to the linguistic handicap, loss of hearing or to other factors. The child with defective articulation also presents problems for the clinician. He must then determine whether the incorrect response is secondary to the child's inability to correctly reproduce what he heard or to an impairment in auditory perception.

A review of speech audiometry for children shows that the attempts at modification can be divided into two categories. One was to modify the testing procedures to make them more appropriate for children. In as much as many bearing impaired children cannot repeat spondee or monosyllabic words, tasks using 'non-verbal' responses (point to the picture or object) have been developed. A second attempt involved a modification of the test stimuli. New word lists were developed which contained only those words judged to be within the vocabulary of children.

Although point to the picture tests have been developed for use with children, only limited clinical and research data are available. So it is intended here to follow the second method of making speech audiometry more suitable for use with children by

Variables

There are several variables involved in speech audiometry. They can be broadly classified into the personnel, speaker ana listener and methods of test prementation.

Personnel:

The Qualities of the operator's voice are of direct influence, the sex, articulatory pronounciation, volume capacity, regional accent, variation of intensity being characteristics which with training can be improved and made constant if the same speaker is used all the time. In view of these variations it would appear preferrable to use tape or disc recordings so as to 'conserve' the phonetic material which then remains absolutely constant under these characteristics.

French and Steinberg (1947) used male and female speakers in their speech tests and noticed differences in

the listener's scores. They reported that men's voices are about one aotave lower in pitch than women's and the latter tend to be somewhat richer in high frequency sounds;

> It appears therefore that there are some physical differences inherent in male and female voices which justify the notion that the hypoacusic ear could hear and understand the two types of voices differently, (as quoted by Palmer, 1955, p.192)

If there is a real difference between the manner in which hypoacusio ears hear and understand the voices of men and women then therm would be a reason for re-evaluating the testing procedures used. However, Palmer (1955) made some systematic investigations of this problem and reported;

> Because no real differences were found for male and female voices in the intelligibility scores of hard of hearing individuals and because of the sensitivity of the threshold measures with PB words, it appears that little doubt can be cast upon the clinical technic of testing hypoaousic ears with male voice as stimuli. Whether the speaker is male or female the acoustic differences do not contribute importantly to the test score. If one speaker achieves a different score from another, the examiner should investigate other aspects especially the articulatory characteristics of the different speakers. (Palmer, 1955, p.195)

Phonetic balancing:

The matter of phonetic balancing is given importance in the discussion of speech audiometric tests. Phonetic balance was based on the relative frequency of appearance of various sounds as they occur in English. Each word

list is thus a sample of the language from which it is taken. Each list must then be given a phonetic composition corresponding to that of the language in question, statistical studies show the relative frequency of utilization of the various phonemes and the percentages thus obtained can be used as a guide to teh choice of the words for the lists, giving lists which are phonetically balanced with respect to normal speech. Relative frequency of occurrence of English speech sounds was studied by Whitney, W.D.(1874), Godfrey Dewey (1923), French,N.R. etal (1930), Travis, L.E. (1931), Voelker, C.H.(1935), Fry, D.R. (1947), Hayden, R.C. (1950), Carroll, J.B. (1952), Fowler, M. (1957), Fletcher (1955) and Lehiste and Peterson (1959). Some of these studies were based upon written material as their sources. Dewey's (1923) relative frequency of English speech sounds served as an external criterion when he compiled the original Harvard lists for those who modified these lists afterwords. It should be recognized that Dewey's work is poorly suited for this job of phonetic balancing because his source material was completely written, though the analysis was phonetic. A better choice would be relative frequency lists obtained using day to day speech or telephone conversation etc. In the present study the data obtained by Fletcher using telephone conversations was used.

Studies done by Carhart (1965) showed that differences in phonetic balance among lists are of only secondary influence as long as these are only moderate differences:

> In general as long as the test items are meaningful monosyllables for the patient and their phonetic distribution is appropriately diversified one 50-word compilation is relatively equivalent to another. (Carhart, 1965. p.254)

As it was felt that the use of the relative frequency of speech sounds in English spoken by Indians would be more meaningful in these tests, attempts were made to obtain this information. It was found that no such information is available. Ramakrishna,B.S.(1972) in a personnel communication expressed:

> I would think the spoken English of Indians varies so widely that typical samples of one geographical group in India may not be representative of another group any more than the samples of England of America. (Ramakrishna, B.S., 1972)

For this reason Fletcher's (1965) list of relative frequency of occurrence of English phonemes in telephone conversation was used in these tests.(As shown in Table I)

TABLE I

RELATIVE OCCURRENCE OF SPEECH SOUNDS IN TELEPHONE CONVERSATION
FLETCHER (1965)

Vowels	Frequency	Initial Consonants	Frequency	Final Consonants	Frequency
Pin	10.27	W	9.39	t	14.30
Pine	7.58	T	7.86	r	13.05
Pan	6.89	th(then)	6.72	n	12.52
Pen	6.60	Y	6.48	l	8.40
Pul	6.44	D	6.21	z	6.01
Pool	6.26	M	5.89	m	5.48
Pot	5.21	H	5.75	d	4.44
Pane	4.78	K	5.55	v	4.23
Pale	4.74	S	5.46	ng	3.57
Pawn	4.15	N	4.99	s	3.13
Pun	4.14	B	4.64	k	2.85
Pull	2.96	G(gun)	4.33	f	1.37
Purr	1.69	I	4.31	th(with)	1.25
Par	1.31	F	3.96	P	1.24
Pair	1.09	R	2.78	ch	.53
Purr	.80	P	2.54	b	.42
Pew	.26	th(thin)	2.02	g	.38
Poiee	.19	SH	1.74	sh	.32
		V	1.25	j	.14
Unaccented Vowels		J	.83	th (myth)	.04
Possible	5.52	CH	.55	zh (azure)	.01
About	5.33	Z	.34	h	-
differ	4.56	ZH	.02	w	-
Receive	3.78	NG	-	y	
Notion	2.65				
Wanted	1.83				
People	0.97				

Not all authorities agree upon the necessity for phonetic balance. Kenneth Berger (1971) argued well that any sizable sample from conversational vocabulary would be, by definition, a phonetically balanced sample of spoken English. It will now be necessary to investigate further the relevance of phonetic balance. Black and Heagen (196)) and Lafon, J.C. (1966) argue that one should no longer choose the words on the basis of a phonetic balancing of the word lists, but on the basis of the information they carry.

Live or recorded voice

A major point of controversy has been whether material should be administered by monitored live-voice i.e. spoken by the tester at the time of the test, or from a pre-recording. Critics of live-voice procedure argue correctly that results obtained by different speakers oannot be compared unless the talkers have been demonstrated to be equivalent. The words have to be repeated each time the test is given. The studies of Brandy, W.T.(1966) on reliability of voice tests in speech discrimination show that acoustic wave forme of two or more talkers are so different as to cause variability in listener performance when the talkers present the same

word lists. And also, recorded presentations which are equivalent in acoustic output are found to provide more reliable observer performance than do live-voice presentations.

A great advantage of recorded speech is the high reliability of the results on the same ear from day to day and from clinic to clinic.

Some clinicians favor the live-voice technique because it permits a flexibility in the clinical procedure: they can wait between items.

> The use of recordings in the clinic is debatable, for it is too rigid. The impossibility of taking out a word whose meaning is unfamiliar to the patient, the difficulty of altering the recitation without modifying the characteristics of the phonetic material are added problems with recorded material. Moreover, every patient answers in his own time according to his temperament. Finally, the records take away the possibility of measuring 'hearing' plus lipreading, an essential factor in the evaluation of the social value of the patients understanding of speech, (Portman and Portman, 1961, p.87)

Even in recorded material the taped one is to be preferred to the disc recorded one because of the ease with which the tape can be stopped and started again. The present study utilized tape-recorded speech as stimuli.

Speech Audiometric Studies done in India

Research was done on 'Adaptation of speech test material in English to Indian conditions'by Nikam,S.(1968). The words from W-22 and the children's spondee list were combined avoiding repetitions. As a result eighty words were obtained and these were administered to seventy two undergraduates in Mysore for rating them as very familiar, familiar and not familiar. Out of eighty words, forty five words were rated as very familiar by seventy per cent of the subjects. These words were intended to be used with those cases with a minimum of high school education. Further research was not carried out.

Development of spondee and phonetically balanced word lists in Hindi was done by Abrol, B.M.(1971). He started with eight hundred commonly used words and analyzed them for syllabic constructions. A majority of the words were found to have a C-V-C structure. Then the frequency of initial and final consonants were rated on the basis of frequency counts for all consonants made by Ghatage (1964). Similarly the frequency of the vowels was also calculated. Finally, the familiarity of the words was rated, according to their occurrence, number of times. Two lists of fifty words each were prepared

based upon the frequency counts and the familiarity of the words. No word was common to both the lists. Also two lists, of 38 spondee words each, were prepared from

> In order to test the working, 30 normal persons, who had SRT ranging generally from 10 to 30 dB were administered words with the carrier phrase 'say the word', at 10 dB higher than the word itself. Different tests were used for each ear. The persons were required to repeat the words as soon as they heard. A time of 2 seconds was allowed for them to speak. At 10 dB above SKI, slightly more than half of 30 people repeated more than 90 per cent of the words._____At 30 dB above SRT all the persons could give one hundred per cent score. Considering all these, optimum for Hindi PB words were tentatively fixed 20 dB above SRT which is 10 dB less than that recommended for English PB words.(Abrol, B.M., 1971, pp.17-18)

Some of the limitations of Abrol's study were (1) practice effect was not taken care of and (2) SRT level is not mentioned (3) Articulation curves are not given.

'Development of Hearing and Speech test materials based on Indian languages' (Tamil, Telugu aid Malayalam) was done by Kapur, Y.P. (1971). Excepting for the nature of materials used in the construction of these tests and the methods of their selection, methodology for tests in all theme three languages warn similar. Speech audiometric tests

in the Malayalam language were developed ae follows. Disyllabic words which were very common were used in developing speech materials for both SET and PB word lists as very few monosyllabic words were available. Two hundred disyllabic words were found to be most familiar.

> Six subjects with normal otological findings and with normal pure-tone audiograms were taken for the study and were given the two hundred disyllabic words. The responses were written down. Each listener listened to the tape recordings of the familiar disyllabic words at +4, +2, 0, -2, -4 and -6 dB relative to their average pure-tone thresholds. The order in which the lists were given at different levels however was varied for each listener and each list according to random Latin Square design.
>
> In the analysis of data, an easy word was defined as missed once or never by all six listeners. The words that five of the six listeners missed were considered as difficult words. Words falling in both of these extreme categories were eliminated. This resulted in a list of thirty five familiar spondee words. (Kapur, Y.P., 1971, pp.3-4)

In the preparation of PB word lists, a two hundred familiar words list was administered to six subjects and those words which were not missed more than three times by each subject, were divided into three lists of thirty worde each. The articulation percentages for these six subjects were determined at each intensity through a range of 50 dB in steps of 5 dB.

Articulation Curves showed that the maximum score of 97 was obtained at 45 dB.

Some of the limitations of Kapur's (1971) study were that (1) Practice effect was not taken care of and (2) SRT level was not mentioned.

The development and standardization of speech test material in Kannada for Indians is under way at the All India Institute of Speech and Hearing, Mysore as a part of on SRS research project.

CHAPTER III

METHODOLOGY

Procedure:

The three tests which comprised the study were administered serially to individual subjects. They were to obtain pure-tone thresholds, speech reception thresholds and discrimination acorea. However, the speech reception threshold tests and speech discrimination tests were adminiatered randomly at varioua levels of intensity with respect to subjects. All tests were administered in acoustically treated rooms.

There were three aspects to this study:

1) Procedure for obtaining test materials
2) Procedure for obtaining Speech Reception threshold
3) Procedure for obtaining Discrimination Scores

Procedure for Obtaining Test Materials

Procedure for familiarity:

Materials: One of the first steps in the development of the speech reception threshold test and the speech discrimination test, for adults and children, was to have the words tested for familiarity using a normal population.

In the development of speech reception threshold teat for adults eighty four words from Psycho Acoustic Laboratories Auditory test NO:9 and No:14 were used. Fifty seven words of children's spondee list were used, for children.

For speech discrimination tests with adults, two hundred monosyllabic words of PAL and another two hundred monosyllabic words of CID Auditory test W-22 were combined and used after eliminating the common words in the two tests. For developing the children's speech discrimination test one hundred and fifty monosyllabic words of Kinder garten PB word lists developed by Haskins, H.L., (1949) were used.

Subjects: Two hundred college going graduate and post-graduate students were selected for the familiarity test. Their ages ranged from 16 to 25 years with a mean age of 20 years. Two hundred school going children were selected whose ages ranged from 7 to 15 years with a mean age of 12 years rated for familiarity the children's spondee and monosyllabic words. All were of normal intelligence and knew English. They were all studying in Mysore.

Procedure: The spondee and monosyllabic word lists both for children and for adults were cyclostyled. The proforma used for the familiarity test ia shown in Appendix 'A'. The subjects were supplied with the cycloatyled forms and the purpose of the test was explained to them. The subjects were asked to rate the words as 'familiar', 'not so familiar' and 'not familiar'. Examples for each category were given and the subjects were told that this was not a test of their language or intellectual abilities. The responses of all the subjects were evaluated by weighted scores. The words were arranged in the order of familiarity. One hundred and seventy five moat familiar words were selected. This list was used as a starting point for standardization of speech reception threshold tests. The final spondee lists for adults and children had fifty and twenty five words respectively. Monosyllabic word lists for both adults and children were finalized after phonetically balancing them. The final PB lists for adults and children had fifty words each (two lists of twenty five words in each list).

Phonetic balancing of the monosyllabic words:

All the monosyllabic words (both for adults and children) were written in the IPA (International Phonetic Alphabet). Fletcher's (1965) analysis of telephone

conversations and the frequency of occurrence of English phonemes as given by him were used. This was necessary because (a) no Indian data was available, (Tickoo, 1972, personal communication), (b) no data using conversation was available and (c) Hirsh et al (1952) had used data obtained from telephone conversations. A frequency count of all the phonemes (vowels and consonants) in the monosyllabic word lists was made on the basis of Fletcher's tables. Relative frequency of occurrence of English speech sounds in these lists were adjusted by selective elimination of a few words. These results are found to be in close correspondence with the frequency of occurrence given by Fletcher (1965).

Finally, there were four monosyllabic word lists which were phonetically balanced, two lists of equal familiarity for adults and two lists of equal familiarity for children. Equal familiarity in the two lists was ensured by selecting the monosyllabic words randomly from the original lists. The weighted scores of the selected words in each list were totalled and they were found to be equal in the two lists. All the test lists are given in the appendix 'C'.

Recording Procedure:

The lists were recorded in the sound treated room using a UHER variocord 263 tape recorder with four tracks and stereo/mono arrangement. Recording was done only in mono at three and three-fourth inches per second speed. While presenting the lists the volume control of the tape recorder was adjusted until the VU meter of the speech audiometer reads zero.

In the recording of test material a 21 year old female (the author) spoke the test items. In connected discourse her dialect may be described aa Indian English common to the southern regions of Mysore State. Prior to this activity, she had four years experience in the monitored live-voice technique of speech audiometry. Recording of the test materials was done in a sound-treated room. All the test items, both for adults and for children, were recorded proceeded by a carrier phrase 'say the word'. A time interval of five seconds was allowed for the subject to respond.

Equipment and Acoustic Environment:

A calibrated diagnostic speech audiometer which satisfies the ASA criteria of essential elements of speech audiometer (Madsen model OB 70) and UHER four track, mono/ stereo tape recorder were used for the study. The

audiometer was calibrated to ISO (1963) specifications using Bruel and Kjoer equipment (artificial ear - B & K type 4152, SPL meter - B & K type 2203, Octave filter B & K type 1613 and preamplifier B & K), in a sound treated room. Corrections were applied wherever necessary. A talk-back system was used for the subject's responses. The scale of hearing level attenuator of the audiometer extended from -10 to +100 dB in steps of 5 dB. By pushing a special button the range could be increased with +20 dB. One decibel vernier device made it possible to adjust values between two 5 dB steps.

The study was conducted in a sound treated environment, a two-room arrangement, of which one Berved as a control room and the other as a test area. The audiometric rooms were located in a area away from the noisy localities.

The noise levels in the test room were measured by B & K SPL meter type 2203 with an B & K Octave filter set - 1613, and were as follows:

TABLE II

SOUND PRESSURE LEVELS IN THE SOUND TREATED ROOM USING WEIGHTED SCALES

Sl.NO.	Scale	SPL Values re:2 0.0002 dyne/cm
1	C	37 dB
2	B	31 dB
3	A	24 dB

TABLE III

SOUND PRESSURE LEVELS IN THE SOUND TREATED ROOM AT VARIOUS FREQUENCIES (ISO 1963)

Sl.No.	Central frequency of the Octave band in HZ	SPL value in the test room in dB re: 0.0002 dyne/cm^2	ISO specifications, SPL values in audiometric rooms, re:0.0002 dyne/cm^2
1	125	25	31
2	250	22	25
3	500	22	26
4	1000	16	30
5	2000	16	38
6	4000	18	51
7	8000	20	51

Test Procedure

For standardization of speech testa with adults, fifty-six subjects whose ages ranged from 16 to 25 years, with a mean age of 20 years, were selected. Their education ranged from Pre-University Course and above. Fifty six school going children whose ages ranged between 7 and 15 years, with a mean age of 12 years, were selected for standardization of speech tests with children. They were normal in intelligence and hearing acuity. All the subjects knew English. The ratio of male to female subjects was 1:1, both for adults and children.

Before proceeding with the actual test all the subjects were given an otological examination and air-conduction pure-tone audiometric test for both ears. Hughson - Westlake was uaed in obtaining the thresholds. Only such of those persons who had no observable abnormalities were selected as subjects for the speech tests.

Procedure for obtaining Speech Reception Threshold

Speech Reception Thresholds were determined as follows. The acoustic conditions were the same as for pure-tone audiometry. The subjects were given the following instructions:

> You will hear a list of words through your earphones. These will consist of two syllable words such as foot-ball, playground. You must repeat into the microphone any word just as you hear it. If you are not sure, guess. Do you have any questions?

The instructions given by Glorig (1965) in the speech reception threshold tests were made use of extensively. The above instructions were common to adults and children.

There were two lists of twenty five words each, in the test of speech reception threshold for adults. Each subject was tested only at one intensity, pact in the right ear using the list I and then in the left ear using the list II at a different intensity. The intensities at which the lists were presented varied from Oto 35 dB at intervals of 5 dB (i.e. 0,5,10,15,20,25,30 and 35 dB) above pure-tone average of each subject. Instructions were given to every subject and then the test items were fed from the tape to him at a predetermined intensity level. A time gap of 5 seconds was given to the subject to respond. Responses were noted down.

In the case of children, as there was only one twenty five item spondee word list, the test was administered to the right ear only. Otherwise the procedure was

game as that for adults.

Procedure for obtaining discrimination score

The following instructions were given both to adults and children while obtaining discrimination

> You are going to hear a list of twenty five one syllabic words with which everybody is familiar. You are to repeat each word into the microphone as best as you can. If you are not sure, guess. Do you have any Questions? Glorig (1965).

For adults two phonetically balanced monosyllabic word lists of twenty five items each were used. Each subject was tested only at one intensity, once in the right ear using the list I and then in the left ear using the list II at a different intensity. The intensities at which the two lists were administered were 0,10,20,30,35,40,45 md 50 dB above the subjects PTA. Each subject was given instructions and then the test items were fed to him at a predetermined intensity level. Responses were noted down.

For children also there were two phonetically balanced monosyllabic lists of twenty five items each. The test procedure was similar to that for the adults.

Practice effect was controlled in obtaining SRT and discrimination scores by administering each list only once to each subject.

Recording of responses:

A talk-back system was used for the subject's responses. The number of correct responses given by each subject, for each list, were noted down. These were then converted into percentage of correct responses at each intensity level for further analysis.

Plan of Analysis:

The familiarity ratings of the monosyllabic and disyllabic words given by the adults and children were analyzed for selecting the most familiar words. Then the test words were divided into half word lists randomly. The selected monosyllabic words were phonetically balanced. The familiarity scores of the words in each half list (25 words) were totalled to make certain whether or not the two lists are equivalent in level of difficulty.

The mean and the standard deviation values of the percentage of correct responses were calculated for each list. Articulation curves were plotted and from the graphs the SRT and the intensity levels at which one hundred per cent discrimination score were given were

determined. A few subjects, adults and children from the original sample, were randomly selected and they were retested to find out the test - retest reliability.

CHAPTER IV

ANALYSIS AND RESULTS

Analysis:

For the analysis of the familiarity of the monosyllabic and disyllabic words, scores of +3, +1 and -1 were given to each word on the basis of whether it is 'familiar', 'not so familiar', or 'not familiar'. The ratings made by the subjects were quantified using the above scores. Words necessary for forming the test lists were selected from among the most familiar words. In dividing the familiar words into two 25 word lists all the words were numbered and 25 words for each list were selected randomly.

For phonetically balancing the monosyllabic word lists the words were written in IPA and a frequency count of all the phonemes were made in each 25 word list. These frequencies were compared with the frequency count made by Fletcher (1965) using Telephone conversations, and with the frequency count given by Hirsh et al(1952) using W-22 lists. This comparison is given in Appendix 'B'. By selective inclusion and exclusion of some familiar words* the frequency count of the phonemes in the present study were found to be approximately the same as given by Fletcher (1965) and

Hirsh (1952). To make sure that the two lists were of equal difficulty weighted scores of all the words in each list were totalled. The total scores in the two lists were found to be approximately the same. Table IV shows the total scores when the two equivalent lists were compared in the case of adults and children.

TABLE IV

COMPARISON OF THE WEIGHTED SCORES IN THE TWO HALF WORD LISTS

S1. No.	List No.	Weighted Score totals		
		Adults		Children's monosyllabic word list
		Monosyllabic word lists	Disyllabic word lists	
1.	I	8968	7068	9249
2.	II	8974	7085	9240

P.S: In the case of children only one disyllabic word list was developed and hence no comparison could be made with a second list.

The percentage of correct responses, their means and standard deviations at various intensity levels were obtained both in the ease of adults and children. The tables V and VI show the percentage of articulations obtained using adult's spondee word lists I and II. Discrimination scores obtained using PB word lists I and II in the case of adults, are represented in tables VII and VIII.

Table IX shows the percentage of articulation scores obtained using the spondee word list of children at various intensity levels. The discrimination scores obtained using children's PB word lists I and II at various intensity levels are shown in table. X and XI.

TABLE V

PERCENTAGE OP CORRECT RESPONSES, THEIR MEANS AND S.Ds OBTAINED USING ADULT'S SPONDEE WORDS LIST I AT VARIOUS INTENSITY LEVELS

Sl. No.	Intensity in dB re: PTA(10dB)	Percentage of correct responses							Mean	S.D
		A	B	C	D	E	F	G		
1	0	0	12	0	16	8	0	4	6	6.0
2	5	48	44	40	36	24	28	44	38	8.2
3	10	60	48	56	48	52	48	52	52	4.3
4	15	80	88	76	80	68	84	64	77	7.9
5	20	80	84	100	88	96	88	92	90	6.4
6	25	92	84	88	100	100	96	92	93	5.6
7	30	96	92	100	100	100	100	96	98	2.9
8	35	96	100	100	100	100	96	100	99	1.8

TABLE VI

PERCENTAGE OF CORRECT RESPONSES, THEIR MEANS AND S.Ds OBTAINED USING ADULT'S SPONDEE WORDS LIST II AT VARIOUS INTENSITY LEVELS

Sl. No.	Intensity in dB re: PTA(10dB)	Percentage of correct responses							Mean	S.D.
		A	B	C	D	E	F	G		
1	0	12	4	8	0	12	12	8	8	4.3
2	5	40	44	28	40	36	48	32	38	6.4
3	10	52	56	48	44	44	56	50	50	4.7
4	15	68	84	80	92	92	80	64	80	10.0
5	20	92	100	80	92	88	96	92	91	5.8
6	25	88	100	100	96	96	92	88	94	5.2
7	30	96	92	100	92	100	96	96	96	3.0
8	35	94	96	100	96	100	100	96	98	2,4

TABLE VII

PERCENTAGE OF CORRECT RESPONSES, THEIR MEANS AND S.DS OBTAINED USING ADULT'S PB-WORD LIST I AT VARIOUS INTENSITY LEVELS.

Sl. No.	Intensity in dB re: PTA(IOdB)	Percentage of correct responses							Mean	S.D.
		A	B	C	D	E	P	G		
1	0	20	16	20	16	12	16	12	14	3.6
2	10	40	32	28	52	36	48	36	39	7.5
3	20	76	76	56	60	80	76	76	71	8.7
4	30	92	84	96	76	88	88	80	86	6.4
5	35	96	92	84	92	96	96	92	93	4.0
6	40	100	96	100	100	100	96	100	99	1.13
7	45	100	100	100	100	100	100	100	100	0.0
8	50	100	100	100	100	100	100	100	100	0.0

TABLE VIII

PERCENTAGE OF GRRECT RESPONSES, THEIR MEANS AND S.Ds OBTAINED USING ADULT'S PB-WORDS LIST II AT VARIOUS INTENSITY LEVELS

Sl. No.	Intensity in dB re: PTA(10dB)	Percentage of correct responses							Mean	S.D.
		A	B	C	D	E	F	G		
1	0	20	12	20	16	8	16	12	15	4.1
2	10	40	32	28	52	40	48	28	38	8.8
3	20	76	60	64	60	76	72	68	70	6.7
4	30	92	88	96	80	84	60	84	85	7.8
5	35	84	92	88	96	96	92	96	92	4.3
6	40	100	100	100	100	96	100	100	99	1.4
7	45	100	100	100	100	100	100	100	100	0.0
8	50	100	100	100	100	100	100	100	100	0.0

TABLE IX

PERCENTAGE OF CORRECT RESPONSES, THEIR MEANS AND S.Ds OBTAINED USING CHILDREN'S SPONDEE WORDS LIST AT VARIOUS INTENSITIES

Sl. No.	Intensity in dB re; PTA(13dB)	Percentage of correct responses							Mean	S.D.
		A	B	C	D	E	P	G		
1	0	12	18	0	4	8	0	8	6	4.2
2	5	40	32	44	28	48	40	44	40	6.6
3	10	56	52	60	48	52	60	44	53	5.6
4	15	92	88	72	84	88	76	76	82	7.1
5	20	88	92	100	96	96	80	84	91	6.6
6	25	96	100	100	96	92	92	96	96	3.0
7	30	100	96	96	100	100	100	100	99	1.8
8	35	100	100	96	100	96	100	100	99	1.8

TABLE X

PERCENTAGE OF CORRECT RESPONSES, THEIR MEANS AND S.Ds OBTAINED USING CHILDREN'S PB-WORDS LIST I AT VARIOUS INTENSITY LEVELS

Sl. No.	Intensity in dB re: PTA(13dB)	Percentage of correct responses							Mean	S.D.
		A	B	C	D	E	F	G		
1	0	4	4	12	8	4	4	12	6	3.6
2	10	24	32	40	32	42	28	24	32	6.6
3	20	44	44	60	48	60	48	52	51	6.3
4	30	72	68	80	72	76	88	88	78	7.4
5	35	92	80	88	84	88	80	80	85	4.5
6	40	96	100	96	88	88	92	96	94	4.2
7	45	100	100	100	100	100	100	100	100	0.0
8	50	100	100	100	100	100	100	100	100	0.0

TABLE XI

PERCENTAGE OF CORRECT RESPONSES, THEIR MEANS AND S.Ds OBTAINED USING CHILDREN'S PB-WORD LIST II AT VARIOUS INTENSITY LEVELS

Sl. No.	Intensity in dB re; PTA(13dB)	Percentage of correct responses							Mean	S.D.
		A	B	C	D	E	F	G		
1	0	12	4	8	12	4	4	4	7	3.5
2	10	32	32	28	20	36	40	28	31	5.9
3	20	52	44	52	40	64	48	56	51	7.3
4	30	68	84	76	72	76	72	80	76	5.0
5	35	92	82	84	88	84	84	92	87	3.5
6	40	96	100	96	92	96	100	92	96	3.0
7	45	100	100	100	100	100	100	100	100	0.0
8	50	100	100	100	100	100	100	100	100	0.0

A comparison of the standard deviations obtained by Tillman and Carhart (1966) with N.U. Auditory Test No:6 (Phonetically balanced CNC monosyllabic words), for subjects with normal hearing, was made with the standard deviations obtained in this study using phonetically balanced monosyllabic word lists I and II for adults and children. These values are shown in table XII.

The figures 1 and 2 graphically represent the articulation gain functions of spondee word lists I and II when used with adults. Mean articulation scores plotted against intensity (re:PTA, 10dB) using monosyllabic word lists I and II with adults are shown in figures 4 and 5. Figures 3 and 6 show a comparison of the articulation scores obtained with adults using monosyllabic word lists

Pigure 7 shows the articulation curve obtained using spondee word list with children. PB word lists I and II were used with children in obtaining artuclatlon curves shown in figures 8 and 9. Figure 10 compares the per cent of articulations obtained using monosyllabic lists I and II with children.

A comparison of articulation curves obtained by Hirsh etal (1952) using W-1 and W-22 lists is made with the articulation curves obtained in the present study with adults and the values are shown in figures 11 and 12.

TABLE XII

STANDARD DEVIATIONS OBTAINED BY TILLMAN AND CARHART (1966) USING CNC WORDS ARE COMPARED WITH THE STANDARD DEVIATIONS OBTAINED IN THE PRESENT STUDY USING MONOSYLLABIC WORDS

Sl. No.	Level of presentation of test words re:PTA*	Standard Deviations obtained in the present study				Sensation level of presentation re: 21. 9 dB SPL	Standard deviation reported by Tillman & Carhart (1966)			
		Adults		Children			List I	List II	List II	List IV
		List I	List II	List I	List II					
1	0	3.6	4.1	3.6	3.5	-4	8.2	9.8	5.9	7.7
2	10	7.5	8.8	6.6	5.9	0	14.1	16.1	10.8	15.3
3	20	8.7	6.7	6.3	7.3	8	14.3	12.1	9.4	10.6
4	30	6.4	7.8	7.4	5.0	16	10.6	7.2	5.3	6.1
5	35	4.0	4.3	4.5	3.5	24	5.2	2.8	8.1	2.8
6	40	1.8	1.4	4.2	3.0	32	3.8	1.5	1.0	2.4
7	45	0.0	0.0	0.0	0.0	-	-	-	-	-
8	50	0.0	0.0	0.0	0.0	-	-	-	-	-

* Mean PTA of adults is 10 dB and of children is 13 dB.

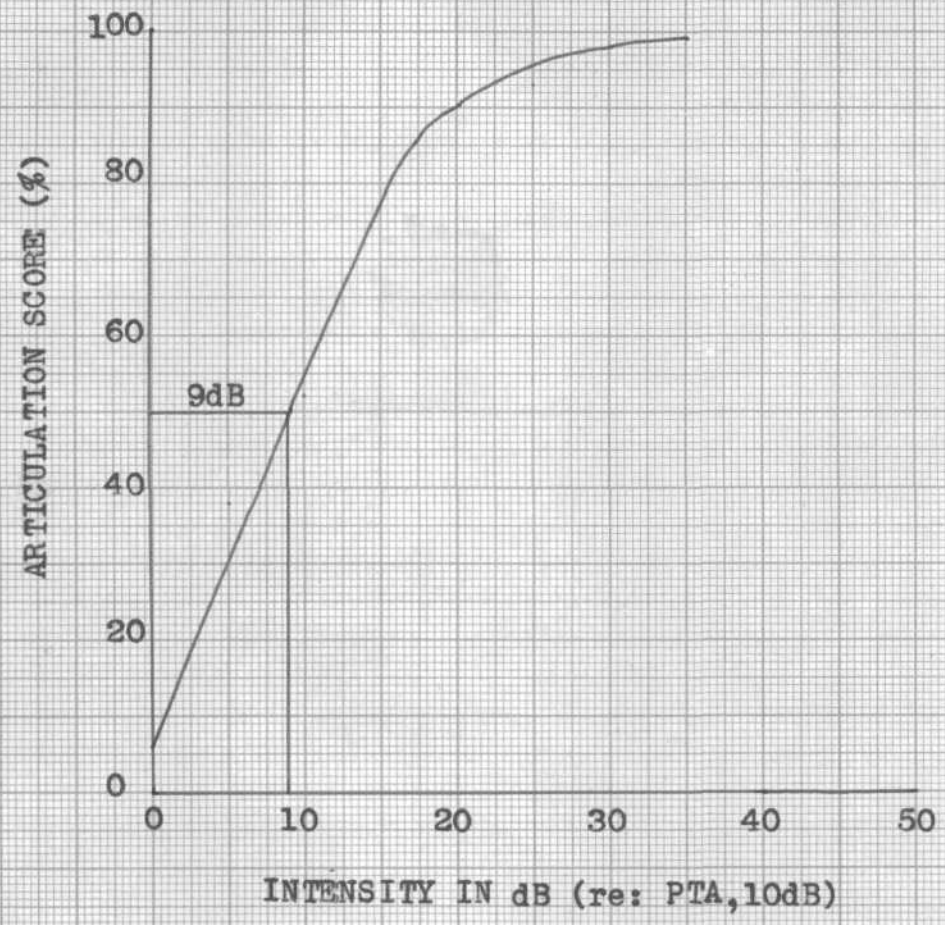

FIGURE I : GRAPH SHOWING MEAN ARTICULATION SCORES AT DIFFERENT INTENSITY LEVELS (re:PTA, 10dB) OBTAINED WITH ADULTS USING SPONDEE WORD LIST I.

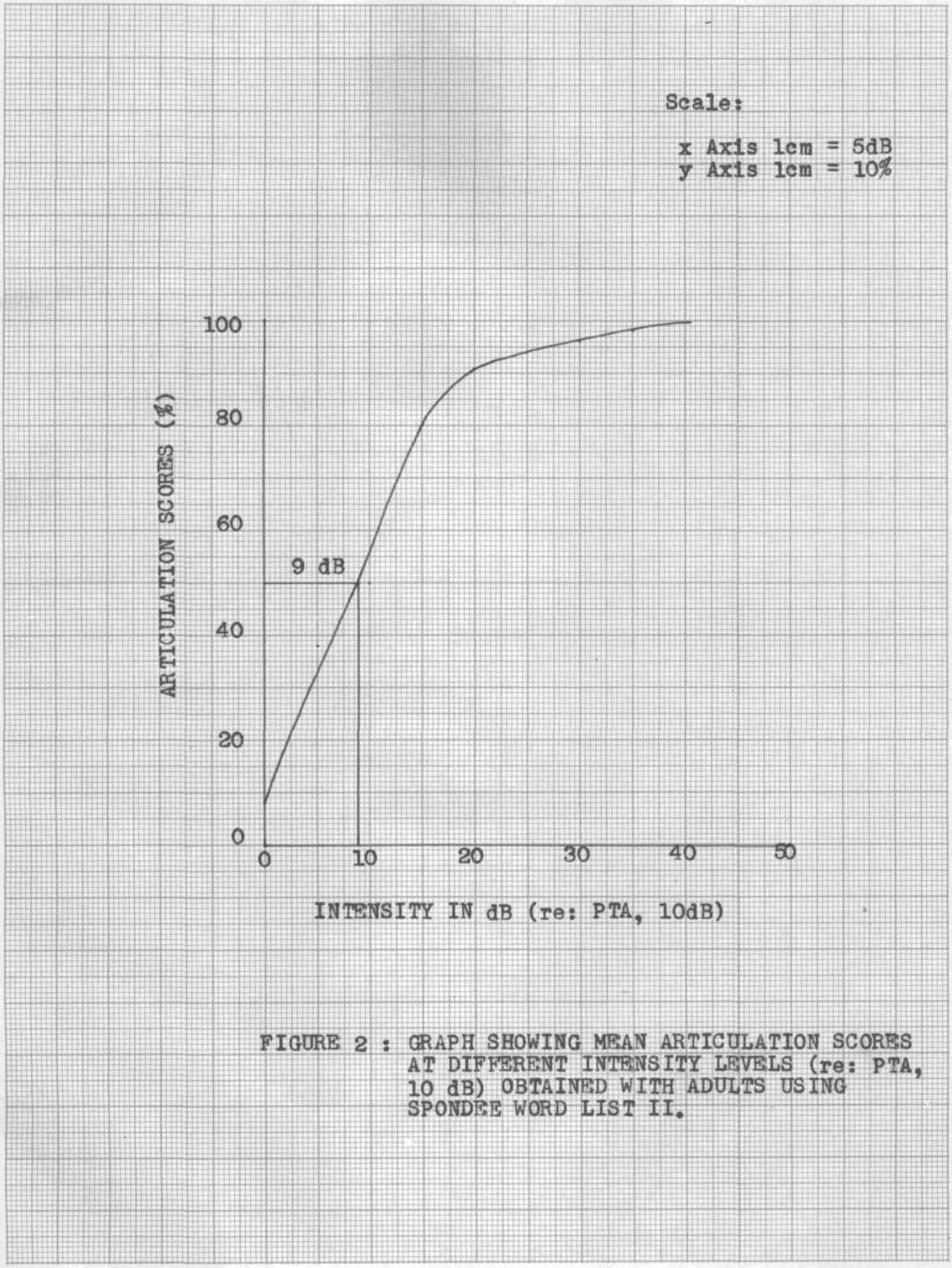

FIGURE 2 : GRAPH SHOWING MEAN ARTICULATION SCORES AT DIFFERENT INTENSITY LEVELS (re: PTA, 10 dB) OBTAINED WITH ADULTS USING SPONDEE WORD LIST II.

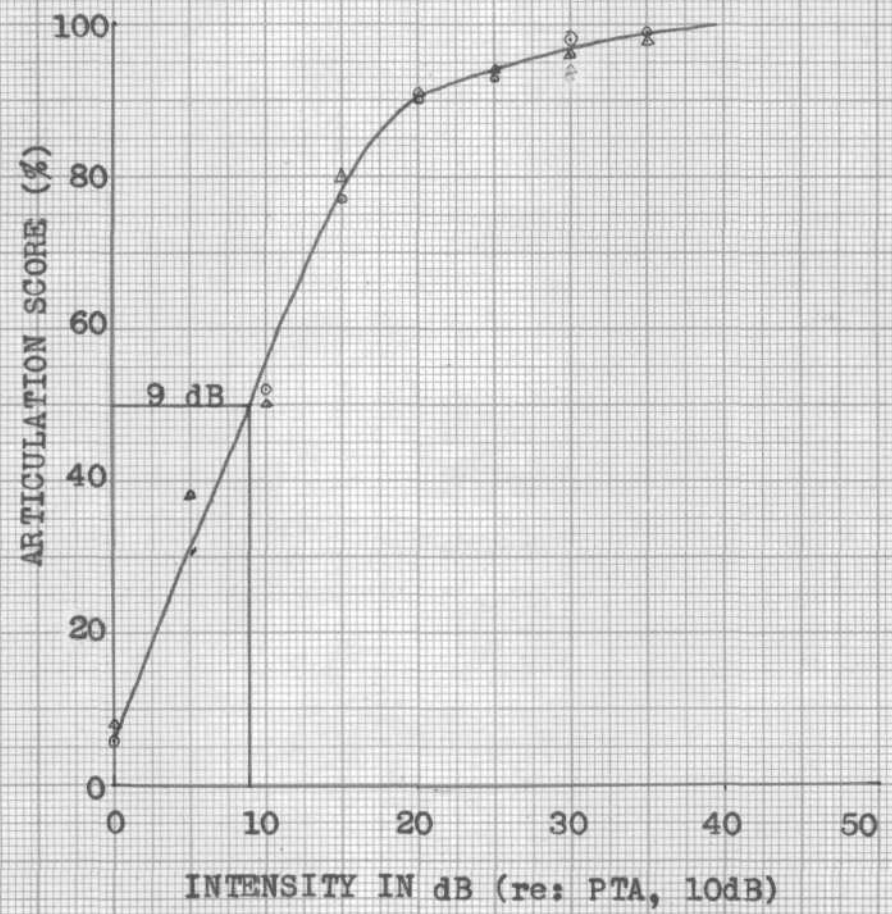

FIGURE 3 : GRAPH SHOWING COMPARISON OF MEAN ARTICULATION SCORES OBTAINED WITH ADULTS AT DIFFERENT INTENSITY LEVELS (re:PTA,10dB) USING SPONDEE WORD LISTS I AND II.

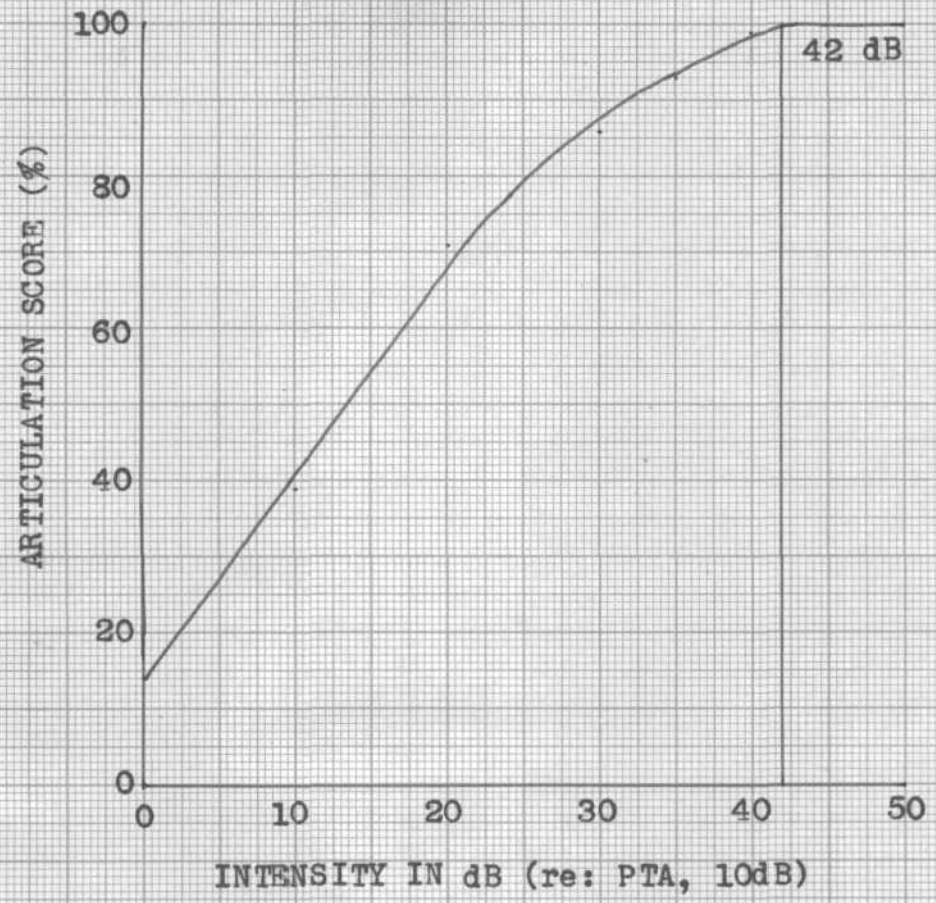

FIGURE 4 : GRAPH SHOWING MEAN ARTICULATION SCORES OBTAINED WITH ADULTS AT DIFFERENT INTENSITY LEVELS (re: PTA,10dB) USING PHONETICALLY BALANCED MONOSYLLABIC WORD LIST I.

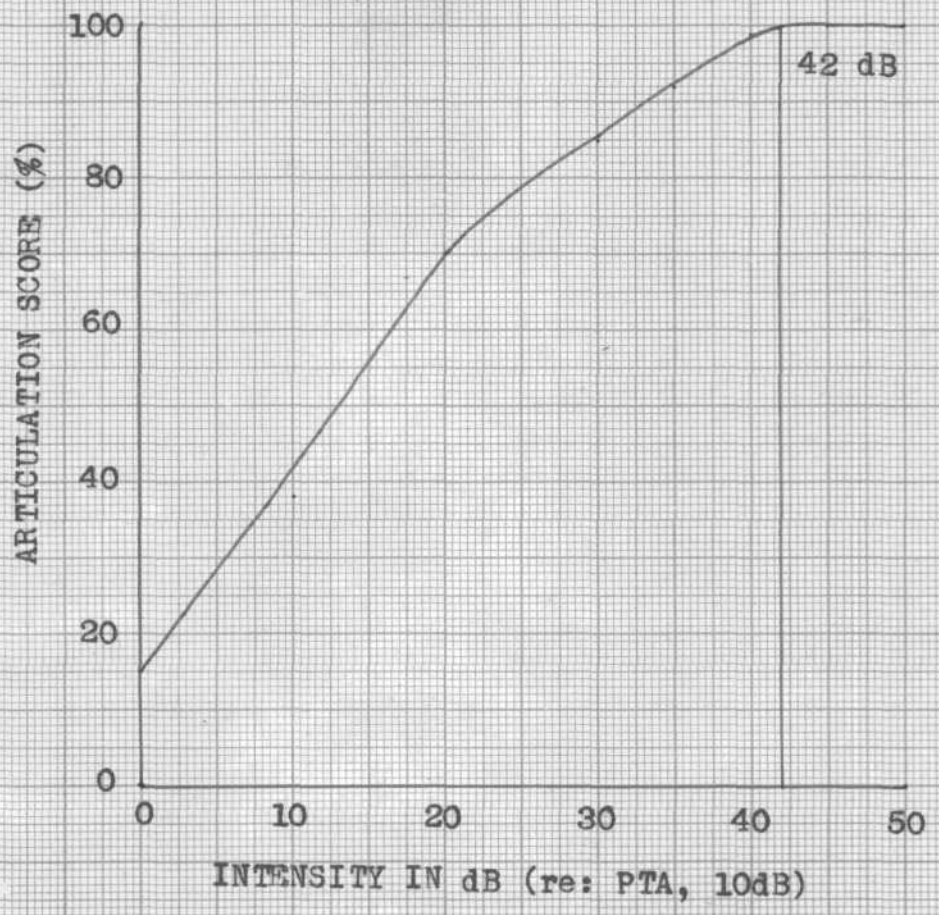

FIGURE 5 : GRAPH SHOWING MEAN ARTICULATION SCORES OBTAINED WITH ADULTS AT DIFFERENT INTENSITY LEVELS (re: PTA, 10dB) USING PHONETICALLY BALANCED MONOSYLLABIC WORD LIST II.

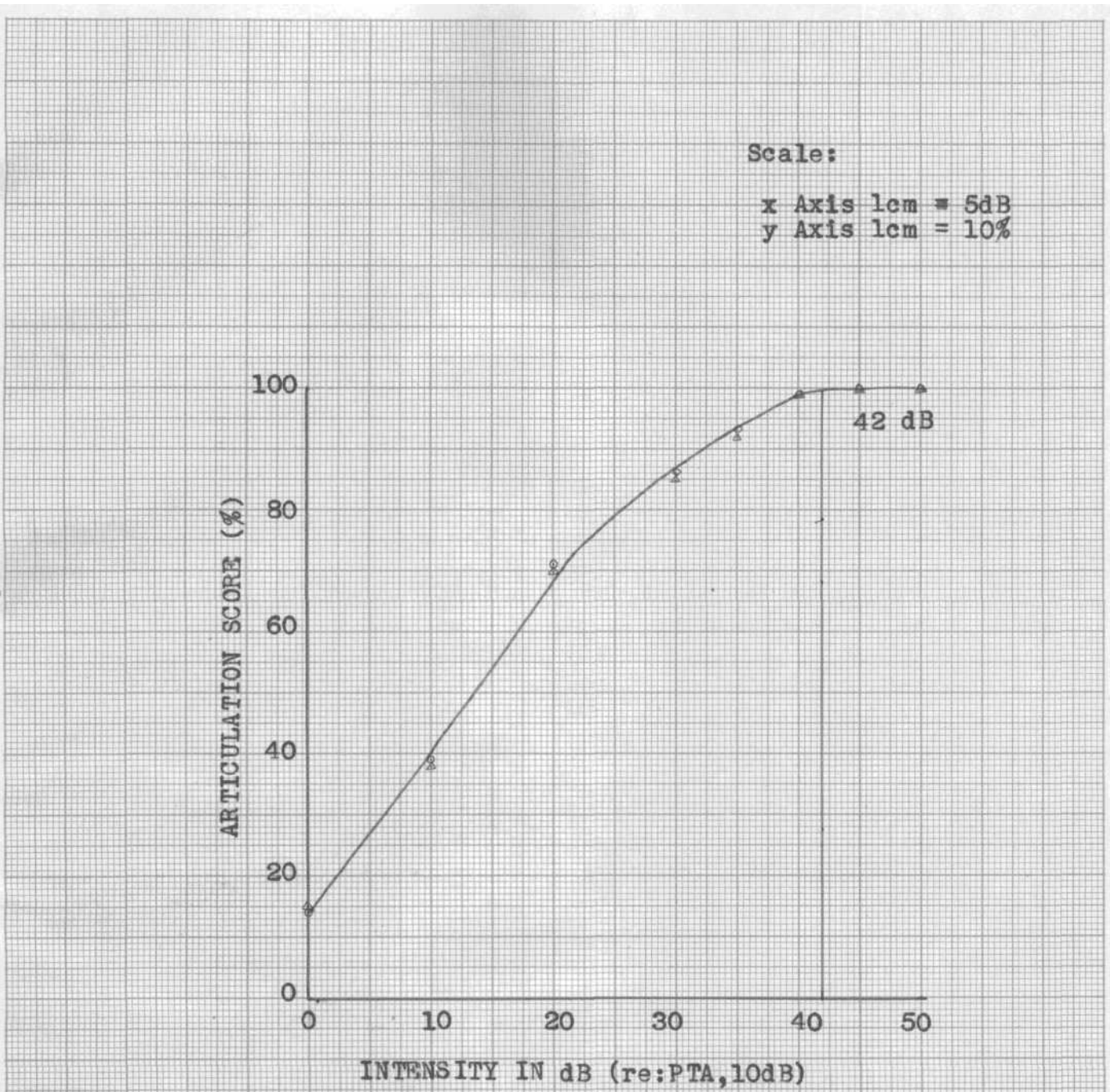

FIGURE 6 : GRAPH SHOWING COMPARISON OF MEAN ARTICULATION SCORES OBTAINED WITH ADULTS AT DIFFERENT INTENSITY LEVELS (re: PTA,10dB) USING PHONETICALLY BALANCED MONOSYLLABIC WORD LISTS I AND II.

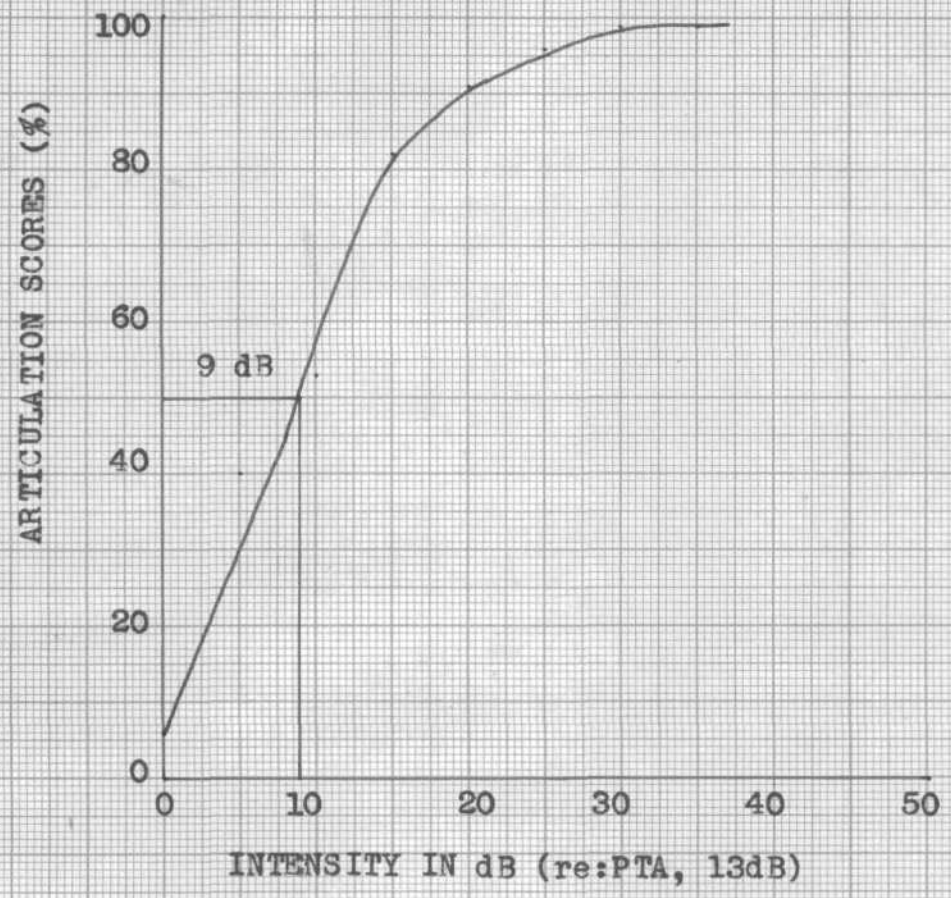

FIGURE 7 : GRAPH SHOWING MEAN ARTICULATION SCORES OBTAINED WITH CHILDREN AT DIFFERENT INTENSITY LEVELS (re: PTA, 13dB) USING SPONDEE WORD LIST

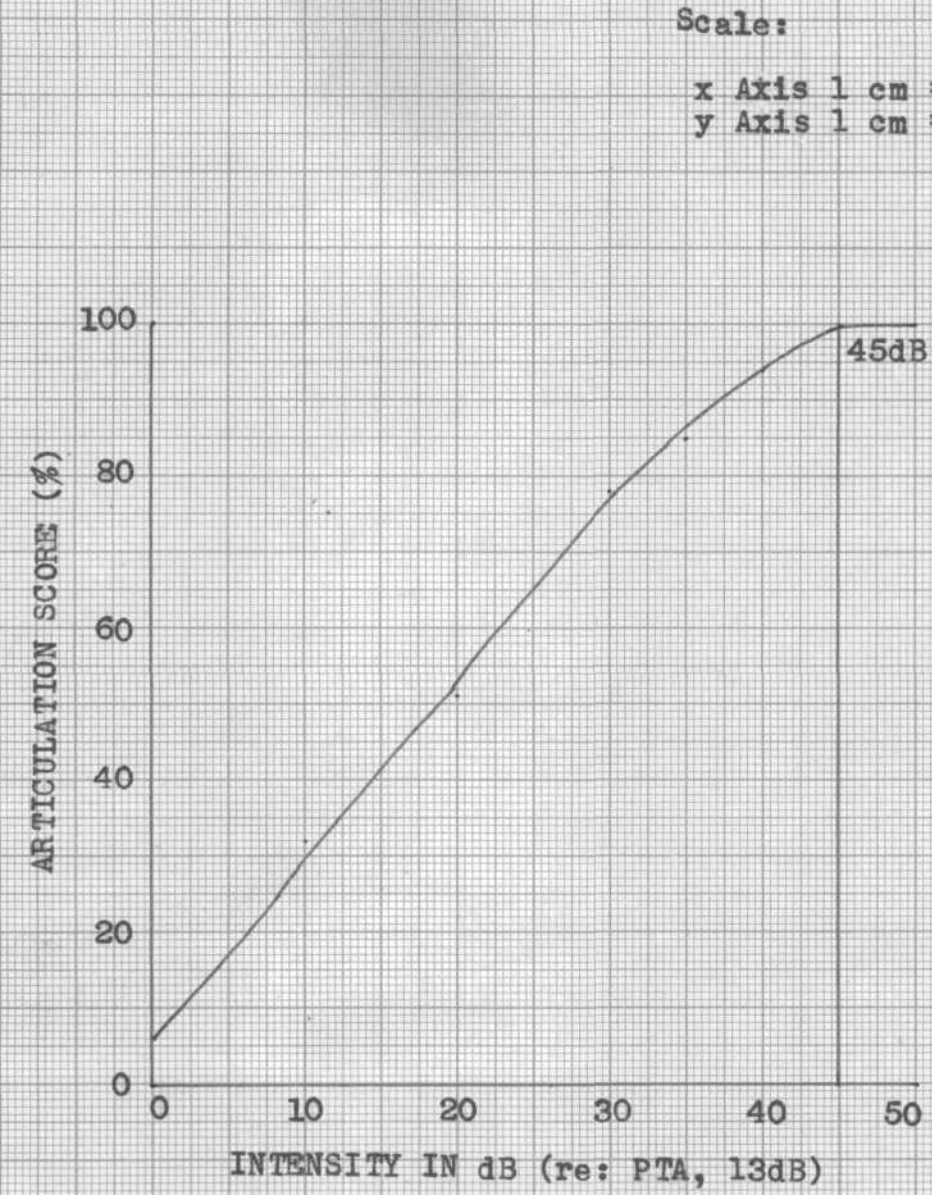

FIGURE 8 : GRAPH SHOWING MEAN ARTICULATION SCORES OBTAINED WITH CHILDREN AT DIFFERENT INTENSITY LEVELS (re: PTA,13dB) USING PHONETICALLY BALANCED MONOSYLLABIC WORD LIST I.

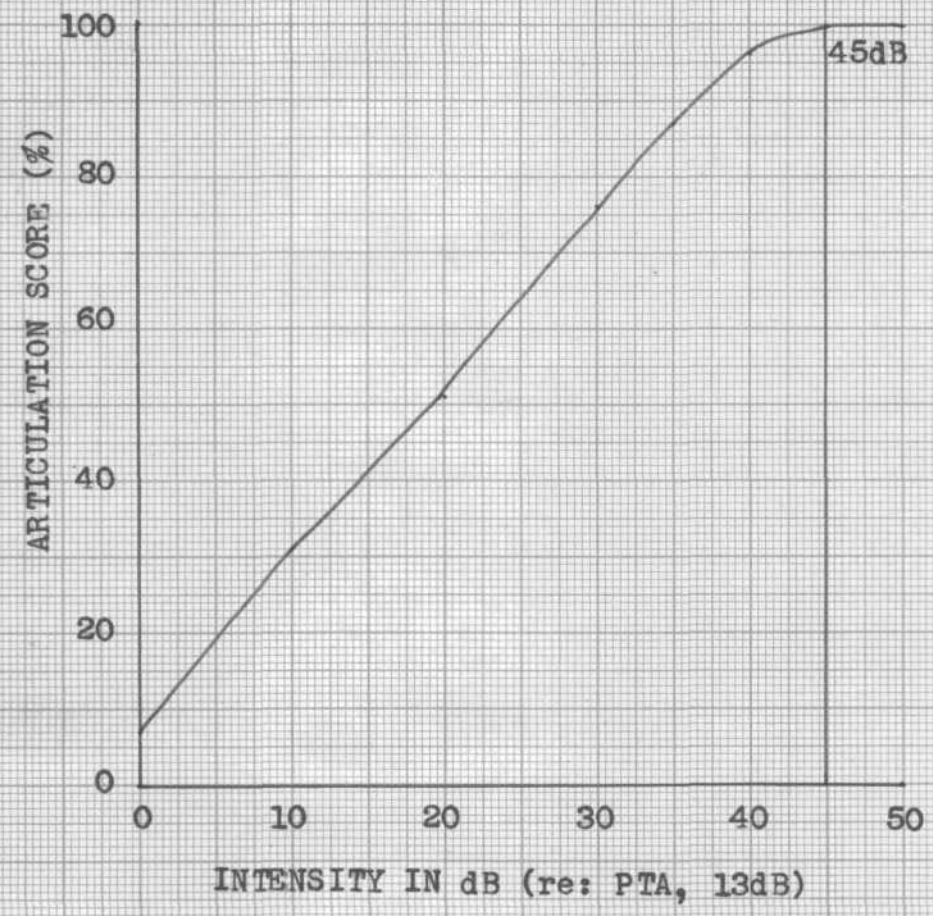

FIGURE 9 : GRAPH SHOWING MEAN ARTICULATION SCORES OBTAINED WITH CHILDREN AT DIFFERENT INTENSITY LEVELS (re: PTA, 13dB) USING PHONETICALLY BALANCED MONOSYLLABIC WORD LIST II.

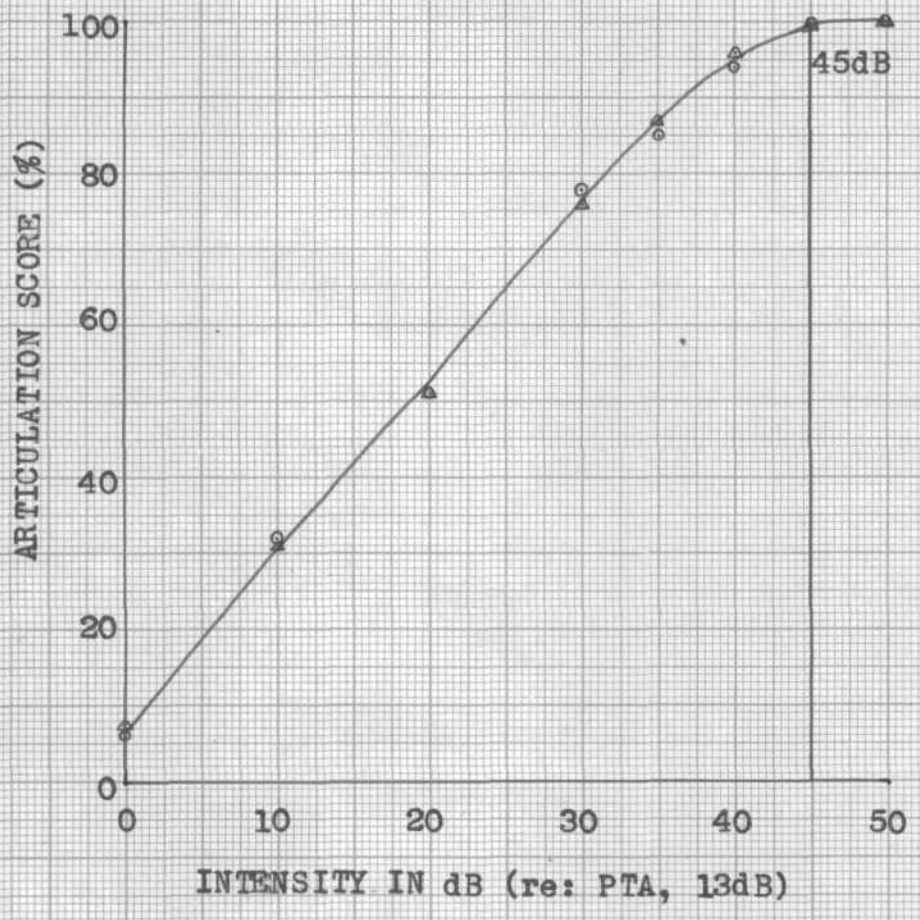

FIGURE 10 : GRAPH SHOWING COMPARISON OF MEAN ARTICULATION SCORES OBTAINED WITH CHILDREN AT DIFFERENT INTENSITY LEVELS (re:PTA,13dB) USING PHONETICALLY BALANCED MONOSYLLABIC WORD LISTS I AND II.

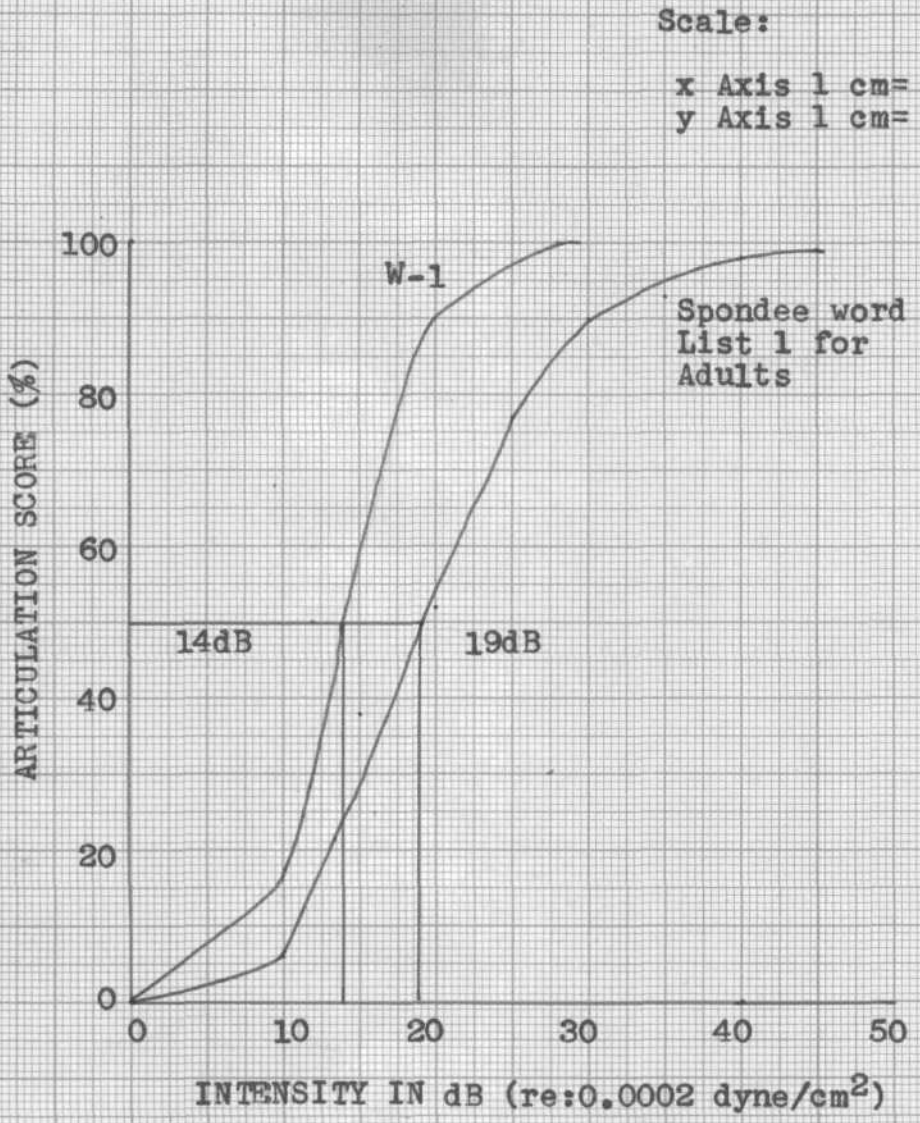

FIGURE II : GRAPH SHOWING COMPARISON OF THE MEAN ARTICULATION SCORES OBTAINED IN THE PRESENT STUDY WITH ADULTS USING SPONDEE WORDS WITH THE MEAN ARTICULATION SCORES OBTAINED BY HIRSH et al (1952) USING W-1 LIST.

NOTE: W-2 LIST USED BY HIRSH et al(1952) RESULTED IN A SRT OF 18dB WHEREAS W-1 RESULTED IN A SRT OF 14dB.

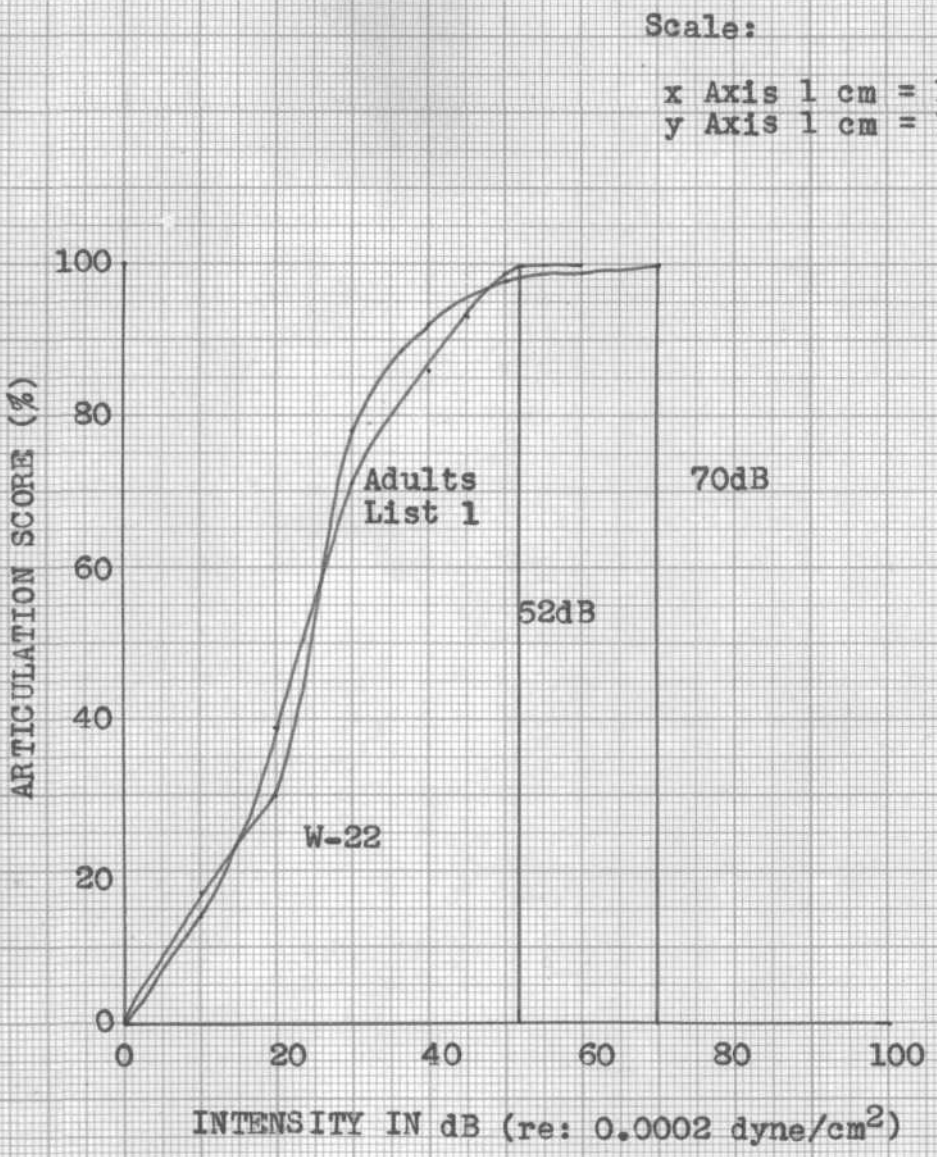

FIGURE 12 : GRAPH SHOWING COMPARISON OF THE MEAN ARTICULATION SCORES OBTAINED IN THE PRESENT STUDY WITH ADULTS USING MONOSYLLABIC WORDS WITH THE MEAN ARTICULATION SCORES OBTAINED BY HIRSH et al (1952) USING W-22 LIST.

NOTE: ONE HUNDRED PERCENT DISCRIMINATION WAS OBTAINED AT 52dB (re:0.0002 dyne/cm^2) IN THE PRESENT STUDY AND AT 70dB (re: 0.0002 dyne/cm^2) WITH W-22 LIST.

Test retest reliability of the lists was verified in the following way - the lists were administered to a few randomly selected subjects from the original sample (both adults and children) for a second time one week after the first test, with the same lists and at the same intensity levels. The results were compared with the results obtained during the first test, No significant differences were found between the two lists.

The value of speech reception threshold obtained using adult subjects was 9 dB (re: PTA., 10dB) i.e. the mean zero SRT for adults was 19 dB (re: 0.0002 dyne/cm^2). The SRT obtained by Hirsh etal (1952) using W-2 1ist was 18 dB. American Standards Association for speech audiometry specified that zero hearing level for speech audiometry was a sound pressure level of 22 dB (rex 0.0002 dyne/cm^2) with allowable limits for calibration being + 4 dB.

The one hundred per cent discrimination score was obtained at 42 dB (re: PTA., 10 dB) when monosyllabic word lists were used with adults. This compares favourably with the score of 32 dB above mean SRT of 21.9 dB (re;0.0002 dyne/cm^2) obtained by Tillman and Carhart (1966). Hirsh etal (1952) using CID PB word list W-22 obtained one hundred per cent discrimination at 70 dB SPL (re:0.0002 dyne/cm^2).

Abrol (1971) obtained one hundred articulation score using Hindi 2B words at 30 dB SET. Kapur (1971) using Malayalam words obtained one hundred per cent discrimination at 45 dB (relative intensity) and at 44 dB (relative intensity) using Tamil words.

In the case of children in the present study the SRT was obtained at 9 dB (re: PTA., 13 dB) i.e. Mean zero SRT was 22 dB (re: 0.0002 dyne/cm^2). Maximum discrimination of one hundred per cent discrimination was obtained at 45 dB (re: PTA., 13 dB). In the present study the intensity levels at which one hundred per cent articulation was given as 42 dB with respect to PTA.

In the clinical situation the speech discrimination test with adults has to be administered at 33 dB above SRT and with children at 36 dB above SRT.

The present study resulted in standardized speech lists which are equal in difficulty and which are valid and have a significant test - retest reliability.

***

CHAPTER V

SUMMARY AND RECOMMENDATIONS

Summary

Speech test materials in English were found to be not suitable for English speaking Indians as all the words were not familiar to them. This unfamillarity could affect the performance and the scores of the Individuals. The aim of the study was to standardize English speech materials to suit our conditions. Monosyllabic and disyllabic words from PAL lists and the monosyllabic words from Haskin's lists were administered to two hundred adults end two hundred children for familiarity testing. The most familiar words were selected to form two spondee lists of twenty five words for adults and one spondee word list of twenty five words for children, and two monosyllabic word lists both for adults and children. The monosyllabic words were phonetically balanced using Fletcher's lists of frequency of occurrence of phonemes in telephone conversations. This resulted in two PB monosyllabic word lists for adults and two for children. All the test material were tape-recorded and fed through the speech channal. Fifty six adults and fifty six

children comprised the subjects used in the standardisation of the speech lists. These lists were presented to the subjects at various intensities and articulation curves were plotted in each case. Adults and children obtained SRT of 9 dB (re: PTA 10 dB). One hundred per cent correct articulation was obtained at 42 dB (re: PTA., 10 dB) in the case of adults and 45 dB (re: PTA., 13 dB) in the case of children. In the clinical situation, the speech discrimination test has to be administered at 33 dB above SRT with adults and 36 dB above SRT with children. The present study resulted in standardized speech lists which are equal in difficulty and are valid and have a significant test - reteet reliability. Thesis lists can be used in diagnosing children and adults.

Recommendations for further research

Further research on these lines is to be done in the following-way:

1) Preparation of speech audiometric lists in Indian language.
2) Modification of the lists used in the present study with phonetic balancing as per the frequency of occurrence of sounds in Indian conversational English, and
3) Further standardization tests of these lists with other population in India.

B I B L I O G R A P H Y

B I B L I O G R A P H Y

ABROL, B.M. (1971) Establishment of a Pilot Rehabilitation Unit In Audiology and speech Pathology in India., Final report. New Delhl:A.I.I.M.H.

BERGER, KENNETH (1971) Speech Audiometry in Audiological Assessment (Ed) Rose, D.E., Englewood Cliffe: Prentice-Hall.

BEYER, M.R. ET AL(1969) Revalidation of the Clinical Test Version of the Modified Rhyme Tests. J.Speech Hearing Dis., 12, 374-378.

BLACK, J.W. AND C.H. HAAGEN (1963) Multiple-choice Intelligibility tests, forms A and B. J.Speech Beaming Pis.. 28,77-86.

BLACK, J.W.(1968) Responses to Multiple-choice Intelligibility Tests. J.Speech Hearing Res., 11, 453-466.

BOWLING, L. AND B. ELPERN (1961) Relative Intelligibility of Items on C.I.D. Audiotory Test W-1. J.Speech Hearing Res., 4, 152-157.

BRANDY, W.T.(1966) Reliability of voice tests of Speech Discrimination. J.Speech Hearing Res., 9, 461-465.

BROOKS AND GOETZINGER (1967) Vocabulary variables and Language skills in the PB Discrimination of children dsh Abstracts., 7.

CAMPBELL, (1954) Form end Style In Thesis Writing Boston; Houghton Mifflin.

CAMPBELL, R.A. (1965) Discrimination Test word difficulty. J.Speech Hearing Die. 8, 13-22.

CARHART,R (1946) Speech Reception in Relation to Pattern of Pure-tone Loss. J.Speech Hearing Die., 11, 97-108.

CARHART,R (1965) Problems in the Measurement of Speech Discrimination, Arch Otolaryng. 82, 253-260.

CHAIKLIN, J.B. (1959) The Relation among Three Selected Auditory Speech Thresholds. J.Speech Hearing Res., 2, 237-243.

OHAIKLIN, J.B. AND I.M. YENTRY (1964) Spondee threshold measurement: A Comparison of 2 - and 5 dB method*. J.Speech Hearing Die.. 29, 47-59.

CRESTON (1965) Speech Audiometry: Taped vs Live voice.

DOYNE, M.P. AND M.D. STEER (1951) Studies in Speech Reception Testing. J.Speech Hearing Dis., 16, 132-138.

EWING A.M. G. AND IRENE BRING (1937) The Handicap of Deafness. London; Longmans, Greene and Co.,

FALCONER,G (1948) The Reliability and Validity of Monitered connected Discourse as a test of threshold Intelligibility. J.Speech Hearing Die.. 13, 369-371.

FARRIMOND,T (1962) Factors influencing Auditory Perception of Pure-tonee and Speech. J.Speech Hearing Res., 5, 194-204.

FLETCHER, H. (1965) Speech. Hearing and Communication. New York: Van Nostrand.

GIOLAS, T.G. AND A. EPSTEIN (1963) Comparative Intelligibility of word Lists and Continuous Discourse. J.Speech Hearing Res., 6, 349-358.

GLORIG, ARAM (1965) Audiometry: Principles and Practices. Baltimore: Williams and Wilkins.

GRUBB, P. (1963a) A phonemic Analysis of Half-list speech Discrimination Tests. J,Speech Hearing Res., 6, 271-275.

GRUBB, P. (1963b) Some considerations in the use of half list Speech Discrimination Tests. J.Speech Hearing Res., 6, 294-297,

HIRSH, I.J. (1947) Clinical Application of two Harvard Auditory Tests. J.Speech Hearing Dis., 12, 151-158.

HIRSH, I.J. (1952) The Measurement of Hearing. New York: McGraw-Hill.

HIRSH ET Al(1952) Development of Materials for Speech Audiometry. J.Speech Hearing Dis., 17, 321-337.

INDUSTRIAL NOISE (1967) U.S.Department of Health, Education and Welfare Report.

JERGER,J., ET AI,(1959) Some Relations between Normal Hearing for Pure-tones and for Speech. J.Speech Hearing Res., 2, 126-140.

JERGER,J.(1968) A New Approach to Speech Audiometry. J.Speech Hearing Research., 33, 318-328.

KAPUR,Y.P. (1971) Development of Hearing and Speech Test Materials Based on Indian Languages. A Report.

KELLEY, N.H. (1937) A Comparative Study of the Response of Normal and Pathological ears to Speech Sounds. J.Expt. Psychol., 31, 342-352.

KOPRA, L.L. AND D. BLOSSER (1968) Comparison of Fair Banks Rhyme Test and CID Auditory Teat W-22 in Normal and Hearing Impaired listeners. J.Speech Hearing Res.. 11, 735-739.

KREUL, E,J, ET AL (1968) A proposed test of Speech Discrimination. J. Speech Hearing Res., 11, 536-552.

LAPON, J.C. (1966) Auditory basis of Phonetics in Manual of Phonetics (Ed) Malmberg., Amsterdam. North-Holland.

LOYRINIC, J.H. ET AL (1968) A Comparative Evaluation of Five Speech Discrimination Measures. J.Speech Hearing Res.. 11, 372-381.

MILLER, G.A. ET AL (1951) The Intelligibility of Speech as a function of the context of the Test Materials. J.Expt. Psychol., 41, 329-335.

NEWBY, HAYES.A. (1965) Audiology. London; Vision.

O'NEILL, J.J. AND OYER, H.J. (1966) Applied Audiometry. New York: Dodd, Mead and Co,,

OWENS, E. (1961) Intelligibility of words varying in familiarity. J.Speech Hearing Res., 4, 113-129.

PALMER, J. (1955) The effect of Speaker Differences on the Intelligibility of Phonetically balanced word lists. J.Speech Hearing Dis., 20, 192-195.

PETERSON,G.E. AND I. LEHISTE (1962) Revised CNC lists for Auditory Tests. J.Speech Hearing Dis., 27, 62-70.

PORTMAN AND PORTMAN (1961) Clinical Audiometry. Springfield: Thomas.

RAMAKRISHNA, B.S. (1972) Personal Communication.

RESNICK (1963) Reliability of the 25 word PB lists. dsh Abstracts.3.

ROSE, DARRELL.E. (1971) Audiological Assessment. Englewood Cliffs: Prentice-Hall.

ROSENZWIG, M.R. AND L. POSTMAN (1964) Intelligibility as a function of frequency of usage. J.Expt. Psychol.. 54, 412-422.

SCHUTLTZ, M.C. (1964) Word familiarity Influences in speech discrimination. J.Speech Hearing Res., 7, 395-400.

SIEGENTHALER,B. (1949) A Study of the Relationship between measured Hearing loss and intelligibility of selected words. J.Speech Hearing Dis., 14, 111-118.

SILVERMAN, S.R. AND I.J. HIRSH (1965) Problems related to the use of Speech in Clinical Audiometry. Ann. Otol. Rhinol. Laryngol, 64, 1234-1245.

SHUTTS ET AL (1964) Derivation of 25 word PB Lists. J.Speech Hearing Dis.. 29, 442-447.

SPEAKS, C. AND J. JERGER (1965) Method for Measurement of Speech Identification. J.Speech Hearing Res., 8, 185-194.

SPEAKS, C. (1967) Intelligibility of Filtered Synthetic Sentences. J.Speech Hearing Res., 10,289-298.

STARK, EARL, W. (1968) Speech Audiometry with Children. MAICO Audiological library Series, VII, 7, 21-24.

STEER,M.D. ET AL (1951) Studies in Speech Perception Testing. J.Speech Hearing Pis.. 16, 132-138.

TIKKOO (1972) Personal Communication.

TILLMAN, T.W. AND J. JERGER (1959) Some Factors affecting the spondee threshold in normal hearing subjects. J.Speech Hearing Res.. 2, 141-146.

HUMAN, T.W. AND R. CARHART (1966) An expanded test for Speech Discrimination utilizing CNC mono-syllabic words: N.U. Auditory test No;6. USAF School of Aerospace Medicine Report,

TOBIAS, J.V. (1964) On Phonemic Analysis of Speech Discrimination Tests. J.Speech Hearing Res., 7, 98-100.

VRA REPORT (1968) From A.I.T.S.H. - VRA Reports No;4.

WEINHOUSE (1963) Discrimination Scores for two lists of PB words, dsh Abstracts,3.

A P P E N D I X

APPENDIX 'A'

PROFORMA USED IN RATING THE
FAMILIARITY OF TEST WORDS

Sex: Age: Education:

School/College: Date:

SL.No.	Word	Familiar	Not so familiar	Not familiar	Score

Please put a tick mark in the appropriate column.

APPENDIX 'B'

FREQUENCY OF OCCURRENCE OF PHONEMES IN THE MONOSYLLABIC LISTS IN THE PRESENT STUDY, IN THE W-22 LISTS AS GIVEN BY HIRSH (1952) AND IN TELEPHONE CONVERSATIONS AS GIVEN BY FLETCHER (1965)

1 Vowels

Sl. No.	Phoneme	Frequency of Occurrence of Phonemes in the Present Study				Fletcher's (1965)	Hirsh's (1952)
		Adult's List I	Adult's List II	Children's List I	Children's List II	List*	List**
1	Pin	3	3	2	4	2.6	3
2	Pine	2	2	2	3	2.0	1.0
3	Pan	2	3	2	3	1.7	2.5
4	Pen	3	4	2	1	1.7	2.4
5	Peel	1	1	1	1	1.6	2.5
6	Pool	2	2	3	1	1.6	1.5
7	Pot	1	1	1	1	1.3	1.0
8	Pane	1	2	3	3	1.2	2.5
9	Pole	2	1	2	1	1.2	1.5
10	Pawn	-	-	2	1	1.0	0.0
11	Pun	2	2	1	2	1.0	2.0
12	Pull	-	1	-	-	0.7	1.0
13	pout	-	-	1	1	0.42	0.5
14	Par	2	1	2	1	0.04	2.0
15	Pair	-	1	1	-	0.3	0.0
16	Purr	-	-	-	-	0.02	0.25
17	Pew	-	-	-	-	0.07	0.5
18	Poise	1	-	-	-	0.05	0.25
19	Possible	-	-	-	-	1.38	-
20	about	-	1	-	-	1.3	-
21	differ	3	-	1	2	1.1	-
22	receive	-	-	-	-	0.92	-
23	notion	-	-	-	-	0.6	-
24	wanted	-	-	-	-	0.46	-
25	people	-	-	-	-	0.24	

2 Consonants in Initial Position

Sl.' No.'	Phoneme in the final Posi-tion	Frequency of Occurrence of Phonemes in the Present study				Flet-cher's (1953)	Hirsh's (1952)
		Adult's List I	Adult's list II	Child-ren's List I	Child-ren's List II	List*	list**
1	W	2	2	2	1	2.3	2.0
2	T	2	1			2.0	2.0
3	th(then)	2	1	2	1	1.7	1.0
4	Y	2	3	1	1	1.6	1.0
5	D	2	1		1	1.5	1.5
6	M	2	2	2	2	1.5	1.0
7	H	2	2	1	1	1.4	1.5
8	K	1	1	1	2	1.4	1.5
9	S	1	2	1	2	1.4	1.5
10	N	1	-	1	2	1.2	1.5
11	B	1	1	1	1	1.2	1.0
12	G(gun)	1	1	1	1	1.1	0.5
13	L	1	1	1	1	1.1	1.0
14	F	1	2	1	1	1.0	0.5
15	R	1	1	1	1	0.8	1.0
16	P	1	-	-		0.6	0.5
17	th(thin)	-	-	-	-	0.5	0.5
18	SH	-	1	-	1	0.4	0.5
19	V	-	-	-	-	0.3	-
20	J	-	-	-	-	0.2	
21	CH	-	1	-	1	0.1	0.5
22	Z	-	-	-	-	0.1	
23	ZH	-	-	-	-	0.05	0.5
24	NG	-	-	-	-	-	-

3 Consonants in Final Position

Sl. No.	Phoneme in Initial Position	Frequency of Occurrence of Phonemes in the Prestnt study				Fletcher's (1953)	Hirsh's (1952)
		Adult's list I	Adult's List II	Children's list I	Children's List II	List*	List**
1	t	4	4	4	2	3.6	3.5
2	r	3	4	3		3.3	3.5
3	n	3	5	3	3	3.1	3.5
4	l	2	2	2	2	2.1	2.0
5	z	1	1	2	2	1.5	2.0
6	m	1	1	1	-	1.4	1.5
7	d	1	2	2	2	1.1	1.5
8	v	2	-	1	-	1.1	1.5
9	ng	1	1	-	1	0.9	0.5
10	s	-	-	-	1	0.8	1.5
11	k	0	1	1	1	0.7	0.5
12	f	1	-	1	1	0.34	0.5
13	th(with)	1	-	-	1	0.31	0.5
14	p	-	-	-	1	0.31	0.5
15	ch	-	-	-	-	0.13	-
16	b	-	-	-	-	0.1	-
17	g	-	-	-	-	0.1	-
18	sh	-	-	1	-	0.08	-
19	j	-	-	-	-	0.033	
20	th(myth)	-	-	-	-	0.01	-
21	zh(azure)		-		-	-	-
22	h	-	-	-	-	-	-
23	w	-	-	-	-	-	-
24	y	-	-	-	-	-	-

* The values given by Fletcher were divided by four since the frequency count was made in twenty five word lists in the present study and the values in earliar study were given in percentages.

** In the case of Hirsh's list as the frequencies of vowels were expressed in percentages they were divided by four. Consonants were given in 50-word lists and hence they were divided by two. This was done because the present study empoyed only 25 word lists.

APPENDIX 'B'

Spondee list I (adults)

1. Sunset
2. playground
3. workshop
4. birthday
5. outside
6. starlight
7. whitewash
8. blackboard
9. housework
10. although
11. farewell
12. daybreak
13. mushroom
14. northwest
15. playmate
16. doorstep
17. earthquake
18. lifeboat
19. sundown
20. stairway
21. armchair
22. hardware
23. outlaw
24. cargo
25. doormat

Spondee list II (adults)

1. Therefore
2. toothbrush
3. backbone
4. blackout
5. schoolboy
6. grandson
7. airplane
8. railroad
9. platform
10. eyebrow
11. woodwork
12. headlight
13. midway
14. beehive
15. pancake
16. cowboy
17. watchword
18. padlock
19. shipwreck
20. cardrum
21. coughdrop
22. yardstick
23. cupcake.
24. cookbook
25. horseshoe

PB list I (adults)

1. ran
2. ten
3. what
4. kite
5. start
6. does
7. her
8. give
9. near
10. poor
11. with
12. young
13. leave
14. fate
15. two
16. bill
17. oil
18. then
19. then
20. arm
21. hand
22. though
23. year
24. move
25. my

PB List II (adults)

1. yard
2. hunt
3. lie
4. there
5. earn
6. you
7. chair
8. send
9. true
10. than
11. him
12. skin
13. fire
14. flat
15. well
16. king
17. book
18. may
19. dull
20. got
21. show
22. rat
23. men
24. when
25. else

Spondee Met (children)

1. birthday
2. busstop
3. football
4. playground
5. bedroom
6. blackboard
7. outside
8. sunshine
9. icecream
10. toothbrush
11. birdnest
12. sunset
13. rainbow
14. toyshop
15. hairbrush
16. daylight
17. shoelace
18. airplane
19. cowboy
20. ashtray
21. playmate
22. dollhouse
23. schoolroom
24. bathtub
25. doorbell

PB List I (children)

1. room
2. true
3. need
4. take
5. sell
6. most
7. bath
8. knife
9. you
10. dish
11. hurt
12. loud
13. ways
14. wait
15. then
16. own
17. give
18. air
19. fall
20. that
21. or
22. on
23. my
24. are
25. as

PB List II (children)

1. great
2. white
3. sun
4. shop
5. mouth
6. did
7. all
8. smile
9. hit
10. cat
11. ran
12. those
13. bread
14. choose
15. may
16. tree
17. nute
18. pink
19. laugh
20. fire
21. near
22. where
23. king
24. waste
25. than