With love to my father
to whom I owe my education

C E R T I F I C A T E

This is to certify that the dissertation "Development of a Synthetic Speech Identification Test in Kannada Language" is the bonafide work in part fulfilment for the degree M.Sc. Speech and Hearing, carrying 100 marks, of the student with Register No. 18

(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.

(M.N. Vyasamurthy)
Guide.

Head of the Department of
Audiology
All India Institute of Speech
and Hearing,
Mysore-6.

D E C L A R A T I O N

This thesis is the result of my own study undertaken under the guidance of Mr. M.N. Vyasamurthy and has not been submitted earlier at any university for any other diploma or degree.

Mysore,
2nd May 1973 Reg No. 18

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

The experimenter expresses his gratitude and thanks to Mr. M.N. Vyasamurthy, Lecturer and Head of the Department of Audiology for his invaluable guidance, without which this study would not have been possible. He expresses his acknowledgment to Dr. N. Rathna, Professor and Director-in-charge for all his encouragement in making this study possible. He expresses hi3 thanks to Mr. S.S. Murthy, Lecturer in Electronics for his patient effort and help in the instrumentation part of the study. Ha thanks Miss. Alice Mathews for all her help in writing this thesis. He thanks Mr. G.R.Kumar, Mr. N.P. Natraj, Mr. Jayaram, Mr. Mallikarjuna and Miss. Maya Devi for their help at various stages of the study. Thanks are extended to all those friends who extended their help in the analysis and in the writing of the data. He is indebted to all those who co-operated as subjects for this study.

CONTENTS

LIST OF TABLES

LIST OF FIGURES AND GRAPHS

CHAPTER I

INTRODUCTION

Speech audiometry ia a basic tool of audiological evaluation. Pure tone audiometry alone does not provide any information about the person's ability to hear above the threshold and hence should be supplemented by speech audiometry. Speech signals are used to measure threshold, supra-threshold intelligibility, progress in lip reading, auditory training, success in otologic surgery and to aid diagnosis of peripheral and central auditory disorders.

Traditionally consonants, words (Mono and disyllabic), nonsense syllables, sentences and continuous discourses are used as materials for speech audiometry. In using these materials clinically, many disadvantages of each material have been noticed. The use of single words imposes severe limitations on one's capacity to manipulate the parameters of ongoing speech and its changing pattern overtime. The open end method, where the cast is free to respond, the population of all the responses possible are not specified and the subject's previous history and extent to which this affects the patient's responses are not controlled. Under the conditions of leas ideal system, it is sometimeAambiguous as to whose speech discrimination is tested; the case's or the clinician's. This can be overcome to some extent by using "written responses". This is also not used widely as it is time consuming and tedious. A better solution is to structure the test procedure in such a way that the case's response is a simple motor act (Jerger, J. et al 1968). In using nonsense syllables, it was found that the case looked for the meaning of the syllable and to reproduce it as a known term This makes the use of nonsense syllable difficult and limited.

In view of all these things, "National Research Council on Hearing and Bio-acoustics" (American) has suggested the use of sentences aa the material for speech audiometry with the contention that sentences are a valid indicator of every day speech. The sentences are more redundant and long lists of sentences are necessary as the same sentence cannot be used with the same case for the second time as it becomes easier for him to recognize the sentence just from a single key-word.

For the aforementioned disadvantages Jerger, J. et al in 1968 deviced synthetic speech Identification test (SSI) in which

A) The message set is closed

B) The scoring is unambiguous

C) Each word item is multi-word rather than single word. (Jerger, J, et al, 1968).

Speech test in Indian languages are already available (Hindi, Tamil, Telagu and Malayalam ... Kapur Y.P. 1971) For those languages in which tests are not available, standardized English and Indian English tests are made use of to test the English knowing people. Hence, with this it is very difficult to test those who know only the native language.

In Kannada language, the situation is quite different. There are no test materials so far developed and/or standardized for speech audiometry in Kannada language. Though not impossible it is a difficult task to construct Spondee Word Lists or PB lists in Kannada language as there are only a few monosyllabic words and a few disyllabic words with equal stress. No word in Kannada ends with a consonant. This makes balancing difficult. There is a great need for tests in this language to serve clinical purpose.

In this study, it is attempted to construct a Speech test keeping these factors controlled as far as possible. It is an attempt at "Development of a Synthetic Speech Identification Test in Kannada language".

Purpose of the study:

The purposes of the study are:

i) To develop synthetic speech material in Kannada;

ii) To establish procedures for testing;

iii) To find the performance of normals on this test;

and

iv) To find the performance pattern of clinical population on this test.

Implications:

There are no speech tests in Kannada language and therefore this will be an useful addition to the battery of teat available. It can be used with Kannada speakers who do not know English. It may be used with more validity than English tests with people who may know English but whose proficiency in Kannada is greater. The procedure followed here may be utilized in the building of similar test in other Indian languages.

Brief plan of the study:

Synthetic speech sentences were constructed in Kannada to be used as material for speech audiometry. Three lists of first order sentences and three lists of second order sentences were recorded on a magnetic tape. They were presented to 30 normal subjects with a competing speech message and their data were analysed. At different message competing ratios 5 normal subjects were tested. The presentation level was found by administering the teat at different intensities and analysing the responses.

One list of first order and second order sentences were selected arbitrarily from the above set and was recorded on a magnetic tape. It was presented to 30 normal subjects and 24 clinical subjects with a competing speech signal at varying MCR's and intensity levels. Their responses were recorded and analysed. MCR curve and PI function curve were drawn.

Hypotheses:

The following were the hypotheses made in this study;

1) Performance on SSI test depends upon the Message competition ratio and the level of presentation of the signal.

2) Normals obtain maximum score on SSI test

3) The performance of the conductive loss cases will be same as that of normals on SSI test.

4) The performances of S.N. loss cases of SSI teat will differ significantly from that of normal and each of the other clinical groups.

5) Mixed hearing loss cases will perform differently from the normals and each of the other clinical groups on SSI test.

6) High frequency loss cases will perform in the same way as the normals and differ significantly from S.N. and mixed loss cases.

Limits of the study:

The present study is restricted to

i) Those who are above the age of 12 years

ii) Those who can read and speak Kannada

iii) Those whose speech reception threshold do not exceed 65 dB SPL.

iv) The study is not coss validated with any other study in the language, as there are no other studies on speech audiometry in Kannada language.

Terminology:

The following were the terms used in this study:

Speech audiometry:

The technique whereby standardized samples of language are presented through a calibrated system in order to measure some aspect of hearing ability. The standardized material can be presented from a recording or monitoring voice (Carhart R. 1951).

Synthetic Speech Identification (SSI) Test:

A hearing test used to determine the subject's ability to hear and identify the given synthetic speech in the presence of a competing speech.

Competing speech:

A continuous message read from a book and presented all through the test along with synthetic speech sentences.

Message competing ratio (MCR):

The ratio of synthetic speech to the competing speech message.

Synthetic speech sentences:

Artificial or synthetic sentences, artificial as they are not real and/or synthetic as the sequences of words that comprise the sentences following specifiable rules of syntax. (Jerger and Speaks, 1968).

First order sentences:

The randomly selected words from most common word list of language are put together in the same order of aelection to form a seven word sentence of first order.

Second order sentence:

A sentence characterized by sequence of word pairs, the second word in the sentence depends upon the conditional probability of the first word in the sentences for its existence, the third word on the second and so on till the seventh word is reached.

Performance Intensity function:

The relation between the performance of the subject and the level of presentation of the signal.

CHAPTER II

REVIEW OF LITERATURE

Speech audiometry ia an indispensable part of battery of clinical audiometry. It evaluates the receptive communication function and not just the ability to distinguish sounds of certain frequency or intensity. A wide variety of speech materials have been used for speech audiometry to measure speech reception threshold and speech discrimination. As the present study deals with the measurement of hearing aspect of speech identification, the review is confined only to literature concerning the speech discrimination and speech identification aspect of hearing. This may help in better understanding of the advantages and disadvantages of certain materials used, the teat procedures and the further need for advancement of test materials.

The otologists were the first to make extensive use of speech materials in testing the hearing capacity of an individual (the voice and whisper test). But the intensities in these tests were not adequately controlled. The audiologist was first to quantify the speech material and to make it a routine part of hearing testing. Wolf in 1874 suggested that the human voice was "the most conceivable measure of hearing". He made use of consonants, syllables and words as test materials. He indicated intensity of the Material in paces or distances from the speaking source. In 1890, he was able to present words recorded on Edison wax cylinder, to the patient's ears through adjustable tubing. This permitted the control of intensity of recorded material (O'Neill, J.J. and Oyer, J.H., 1966; pp. 76-77)

In 1910, the Telephone Industries became interested in the nature of stimuli transmitted over its systems. This led to the beginning of quantification of speech materials as test items. These materials were used not as materials for the measurement of threshold of speech, but as measure of intelligibility of the speaker using particular communication systems. The Bell Telephone Laboratories analysed the characteristics of speech sounds (vowels and consonants). During this period Cambell and Crandall (1920) developed the 'Articulation List', which consisted of a series of unintelligible words made up of oonsonant-vowel-consonant (CVC), consonant-vowel (CV) and vowel-consonant (VC) combinations. Each list consisted of fifty words with five consonant-vowel (CV), and forty-consonant-vowel-consonant (CVC) and five vowel-consonant (VC) combinations. This was employed in testing the efficiency of telephone circuits. The words were either spoken through a microphone or recorded on disc and then were presented through a particular circuit. The resulting score; were based on the percentage syllable groups that were recognized by the listeners. This score was called the "Syllable Articulation score".

In this context it is important to note that the term articulation is used audiologically for the function of speech discrimination, but it has other connotations for individuals whose orientation is in the field of speech (Newby, 1970; pp. 114).

The use of nonsense syllable in the study of intelligibility is an analytical approach, in which the interest is focused on the intelligibility or repeatability of certain phonemic elements. The advantage in using nonsense syllables lies in the fact that they are devoid of meaning and hence the intelligibility is in no way dependent upon the vocabulary of the listener (Hirsh,1952).

It is difficult to use nonsense syllables, as the subject haa an unconscious tendency to look for a meaning in the sound presented to him and to reproduce it as a known term (Lafon, J.C., 1966). So words which have meaning were preferred and monosyllabic words have been used in some of the later tests, that were developed.

> "A test discrimination for speech, as opposed to the threshold 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". (Carhart, R., 1965; p. 253)

For this reason mono-syllabic words are preferred to conversational sentences or multisyllabic words such as spondeea. Monosyllabic words are sufficiently unpredictable and as such individual speech elements are perceived with relative independence. They are not so confusing as nonsense syllables which are so confusing as to baffle many subjects (Carhart, R., 1965; p. 253).

If the word is shorter it is more difficult to identify it from its content. Mono syllables are thus the best materials for speech audiometry since they offer less scope for intelligent gueas work than disyllabic words (Lofan, J.C. 1966; p. 86).

MacFarlan (1940) was first to construct mono-syllabic word lists. It was a test for children and consisted of mono-syllabic words selected from the Thondike and Gates Word List.

During the period of World War II, speech tests were developed for the evaluation of military communication systems and equipment. A major share of this work was done at the 'Psycho-acoustic Laboratory (PAL)" at Harvard University* Soon the PAL materials were in army and navy rehabilitation programmes at the end of World War II (Berger, W.K., 1971; p. 209).

Egan et al (1948) developed a series of tests to assist in the assessment of speech intelligibility. They were known as PAL-PB 50 word lists. From an original sample of twelve hundred mono-ayllabic words, twenty lists of fifty words each were constructed. The words were grouped on the basis of phonetical similarity of the first part of the word. They were selected to confirm the following criteria:

a) Mono-syllabic in structure,

b) Equal average difficulty,

c) Composition representative of English speech, and

d) Worda in common usage.

These lists were judged to be of equal difficulty. The speaker was Rush Hughes and he spoke the test item and number, at a set intensity by speaking this, a carrier phrase, on the V.U. meter; the key or the test word following the item number was spoken at an intensity in relation to the carrier phrase at which it might normally occur. The actual test mono-syllable did not at all occur at the same level, although it has long been known that small variations in intensity may cause rather a large variation in discrimination for speech (Berger, W.K., 1971; p.210) Low signal to noise ratio also appears to be critical in discrimination test variability.

In 19S2 original PAL lists were modified by Hirsh et al (1952) at the Central Institute for the deaf. The modifications were made because several difficulties have been reported, mostly with respect to clinical use. The vocabulary that was assembled for 20 PB lists of 50 words each in No. 14 (PAL) was too large for many clinical patients. Vocabulary appears to need reconstruction in dimension of familiarity (Hirsh, 1952). This modifi version is W-22 of CID. Familiar W-22 recordings with Hirsh as speaker were produced. The CID modifications included adding of more familiar words to those used in PAL-PB word list. The modified version W-22 consisted of 120 words from PAL-PB 50 and eighty new words. The two hundred words were divided into four basic lists (numbered 1-4) of fifty words each and these in turn were scrambled into aix orders in each

> "The two types of PB teats (PAL and CID) differ with higher discriminations scores being obtained with W-22 tests. This is especially true if the CID recordings of the early PB lists (Rush Hughes recordings) 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 difference between speakers, inherent speaker variability and the non-absolute aspects of intelligibility lists, it is best to use the recorded version of PB tests" (O'Neill and Oyer, 1966, pp. 89-90)

> "The values obtained by the CID group auditory were reinvestigated by Carso, J. (1957) who used 139 trained listeners in his study. The various PB lists were presented at a level of 78 dB (re 0.0002 dynes/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 original CID results". (O'Neill and Oyer, 1966; p. 91).

The PAL PB-50 lists, the W-22 lists, and to a large extent those test lists developed since, have paid some attention to familiarity or word difficulty. In these, the familiarity of vocabulary is typically based as a whole or in part on the vocabulary studies by Thomdike or by Dewey (1325), both of whom were concerned only with printed English. Word length and vocabulary in speech, however, may differ considerably from that of printed English. It is also likely that word familiarity changes with time. Thus even if Thomdike and Dewey lists were representative of English speech, which they are not, they would need revising to account for usage changes since their publications (Berger, W.K., 1971; p.210)

The phonetic balance like word familiarity, was based on relative frequency of appearance of various sounds as they occur in English. It should be noted that the balancing of words phonetically, within each word list has been concerned only with approximately the first two-thirds of each word. The initial consonant or consonant blend and following vowel or initial vowel, have been computed in phonetic balancing. The usefulness of phonetic balance in discrimination testing has not been demonstrated, regardless of its apparent logic. The balancing of vowels within any test, because of some difference in pronounciation will at best be approximate. It is necessary to investigate further the relevance of phonetic balance and if the concept is found to be useful, the balanoing should be done according to speech data rather than according to printed material. (Berger, W.K., 1971; pp. 210-211).

In spite of the popularity of W-22 tests, there have been numerous efforts to further refine or to replace the W-22 records and lists. An important modification of these discrimination tests has been the use of half-word lists. Several attempted (Bowling, 1959) Campaneli, 1962, Blpern, 1961, Resnick, 1962 and Shutts, 1968), to shorten these lists from 50 to 25 words. The results showed high reliability and stability, when the scores on a whole list were compared with scores of 25-words selected from the same list. Grubb (1963) questions the statistical techniques employed in the construction of half-word lists. No considera-tion was given to the level of difficulty, range of difficulty, phonetic-balance and frequency of occurrence of phonetic elements. The resulting lists correlated highly with full lists and with each other.

When 50 words are used, each word carries 2 per cent weight and with 25-word list each word carries 4 per cent weight. So the error score is doubled in half-word liat and the variability will be higher. There is nothing inherently correct in using any particular number of word items in a test. The question is whether the W-22 word list can be just accurate when half lists are used. The evidence tends to be positive. Whether the half list is as clear when the monitored live voice is used, is less clear. (Berger, W.K., 1971; p. 211).

Both in PAL-14 and W-22(CID) tests the linguistic back-ground of the subject is not controlled. This serious dis-advantage has been overcome by using multiple-choice word lists. Mono-syllabic word lists are used in multiple-choice test. It consists of groups of words of single syllable or more than one syllables of equal length and same syllable pattern.

Black, J.W. (1957) and Haagen (1963) have constructed multiple-choice test on the basis of the test constructed by Haagen (1947). It consisted of twenty four multiple-choice lists each consisting of twenty-four test items. They are forms

A and B (Black, J.W. and Haagen, 1963) and forma C and D (Black, J.W. 1957). They were constructed by:

1. selecting materials from a master population of words,

2. collecting the error responses for the words through written down tests;

3. assembling of trail form of multiple choice list and answer form and

4. assembling of test forms C and D and A and B.

The characteristics of the tests are listed below:

1. scoring error is less than 1 per cent by an experienced scorer.

2. specified responses are possible, which reduces the importance of linguistic sophistication among listeners in testing the intelligibility. It also makes possible the study of confusion characteristic among fixed population of word.

3. it changes the relative intelligibility value of words that it has as a write down item.

4. range of scores: It limits the range of scores and the useful range is 25-100 per cent.

5. The time spent in administering is shorter and the scoring is easier and accurate.

The limitation of this test lies in the rigidity of the answer forms. The item cannot be scrambled from one experimental session to another and presumably cannot be used repeatedly with the same panel of listeners.

Fairbanks (1958) developed a rhyme test on the basis of the multiple choice test. It was designed to emphasize the auditory phonemic factors and to minimize the linguistic factors. It is similar to multiple-choice word test and is of a completion type. The stimulus word in rhyme test were drawn from a vocabular of 250 common monosyllables which consists of 50 sets of five rhyming words each. One word from each set is read to the subject He responds by completing the spelling of the word he believes as heard by him, in the space given in front of each of the fifty stems of the response sheet. House et al (1963, 1965) modified these lists. Kreul et al (1968) using three talkers at the speech to noise differential, recorded six lists of House et al's (1963, 1965) modified rhyme test and the copies of these recordings were sent to different laboratories for further validation studies. Here few words were changed, original list and consonant-vowel (CV) vowel-consonant (VC) and consonant-vowel-consonant (CVC) forms were maintained. The revised lists were recorded with noise flat between 200-500 Hz and sloped at 3 dB octave beyong 500 Hza, in order to find the discrimination ability of the subjects in every day listening conditions. Beyer M.R., Webster, J.C. and Dague, D.M. (1965) revalidated these lists developed by Kreual et al (1968) at San Diego State college. They studied 27 normals on the test and found scores to be 2-3 per cent lower than the scores of 75, 83 and 96 per cent found by Kreul et al (1968). Averaging for all levels talkers yielded no statistically significant difference among lists. However, there were differences between lists within levels.

The use of single words and especially single syllable words imposes severe limitations on the capacity to manipulate a crucial parameter of on going speech and its pattern over time. (Jerger, J. et al, 1965). In order to add this dimension to speech audiometry it is necessary to develop materials based on relatively longer speech than words.

The National Research Council on Hearing and Bioacoustics (CHABA) found monosyllabic words not representative of every day speech. It specified the use of sentences as a sample item to represent every day speech. Sentences are considered to be more valid indicator of intelligibility.

Fletcher (1929) constructed a series of tests for both articulation recognition and intelligibility. The results of these intelligibility tests were reported in terms of recognition of sentences. He developed a series of word lists, vowel and consonant lists that were designed to be the problem of untrained listeners. There were 49 such lists, each list consisted of 50 sentences of 4 or 5 critical words each. These early lists consisted of interrogative sentences which were to be answered by the listener rather than to be repeated. The test demanded the listener not only to hear words of the sentences but also to answer some of the fairly difficult questions. Simpler tests were constructed at PAL by Hudgins et al

(Auditory test No. 12(1947). The questions were relatively Simpler and could be answered by single words.

The disadvantages of the sentence tests are that, long lists are necessary because the same sentences cannot be used twice with the same listeners as it is very easy for him to recognize sentences from just a single key word. But these are tests of high face validity as they are samples of every day speech.

> "A reawakening of interest in sentence test is suggested by the writings and studies of Lehiste and Peterson (1959), Davis and Silverman (1960), Harris et al (1960) and Giolas (1966). Initial efforts to employ artificial sentences has been reported by Speaks, C and Jerger, J.(1965) and Speaks et al (1966)". (Berger, W.K., 1969; p. 247).

Berger, W.K. in 1969, developed "a speech discrimination task using multiple choice key word instances". They employed Black (1957) and Black and Haagan (1963) words of multiple choice tests for the construction of sentences. Each sentence consisted of groups of phonetically similar key words. The subject should cross out on the printed answer sheet the words which he believes as heard by him. Eight equal forms of the KSU test were developed With each form there are thirteen sentences which, from a discrimination stand point, become progressively more difficult. The scoring is based on difficulty of the item. The test is presented at 25 dB SL

Carhart studied the problems in the measurement of speech discrimination in 1965. He studied the problem concerning with

(1) materials to be used, (2) teat presentation, (3) equipment and (4) scoring. He reported that:

> "Clinicians must be clear as to the purpose for which he is measuring speech discrimination. He should choose both the test to use and the method for administering it so as to satisfy his purpose. Different criteria apply when a test is used in diagnosis of auditory pathology and in determination of site of lesion, than when it is used in estimating either the efficacy of the hearing in every day life or the potential value of rehabilitation procedures such as hearing aid. finally, the clinician must remember that the existing tests for speech discrimination are imperfectly standardized and lacks validation. They have qualitative usefulness to-day, but with appropriate revision can become much better tools".

Kreul, E.J. et al (1969) studied, changes in item and test difficulty of speech discrimination and intelligibility tests as a function of, carrier phrase, talker, utterance by the talker and level of accompanying noise. It was found that the test difficulty changes significantly with changes in talker and carrier phrase. The test difficulty was found not to alter significantly with reutterances of the same test materials by a given talker over two recording sessions. Finally, the rank order of the test item difficulty tends to persist with change in carrier phrase and as the level of the accompanying speech is varied. Tests ought not to be thought as lists of written words, but as recordings of these words. He reported that "speech intelligibility and discrimination tests should be and can be designed to meet the specific need of the user".

Speaks, C. and Jerger, J. (1965) described a method for measuring speech identification. The message set contains synthetic sentences constructed as approximation to 'real' sentences solely on the basis of conditional probability of word sequences. As Miller (1951) emphasizes

> "Dependencies among successive words reduce the number of possible sentences and so reduces the number of alternatives that can be represented. In a very real sense, therefore, contextual restrictions reduce the amount of information that can be conveyed by a sequence of 'n' symbols".

Each message length is close, of controlled length and controlled relative informational content. Here the procedure was correct 'identification' rather than correct 'repetition' of verbal material. The testing procedure is automated, permitting rapid data acquisition and storage. Thirty subjects have been tested in a variety of experimental conditions. The results show that as the amount of information in the artificial sentences decreases subjects performances improve. This relation exists both when message is low pass filtered and when it is interrupted periodically.

Speaks, C. et al (1966) described the performance-intensity functions of synthetic sentences to explain the following questions:

1. What is the nature of performance-intensity (PI)

function for synthetic sentences?

2. What is the effect of low-pass filtering on PI functions of synthetic sentences?

3. How are differences in relative informational content of message sets reflected in PI functions?

4. What strategies do listeners employ when identifying one synthetic sentence from known set of alternatives?

Four experienced listeners served as listeners.

PI functions were sigmoidal and relatively steep. The SPL corresponding to 50 per cent correct identification varied from approximately 16-20 dB, depending upon the strategies employed by the listeners in the identification task. Findings were as follows:

1. The PI functions are sigmoidal and steep.

2. The effect of low-pass filtering (cut-off frequency of 500 Hzs) was to make the identification task uniformly difficult with no appreciable effect on the shape of the function.

3. Performance was related to contextual constraints of the message sets.

4. The strategies employed by the listener were complex and apparently not restricted solely to single word recognition.

The function relating to performance to intensity for synthetic sentences presented in quiet is exceedingly steep. Two experiments were conducted to determine the degree to which the PI function could be flattened by adding a competing message at a selected message competition ratios. Data were obtained on five trained listeners in a criterion controlled experiment and on 23 subjects in a criterion free experiment. Addition of the competing message flattened the PI function substantially. The degree of flattening was related to the presentation level of message. (Speaks, C, 1967-a).

Speaks, C. (1967-b) studied the intelligibility of filtered synthetic sentences on three normal hearing listeners. PI functions for several low-pass and high-pass frequency bands were drawn. The data was analyzed to find the interaction of signal level and frequency range on performance. The intelligibility of synthetic sentences was found to be dependant upon low frequency energy. The important frequency for the identification of the material was approximately 725 Hz.

Speaks, C. and Jerger, J. (1967) conducted two experimeats to explore the applicability of statistical decision model on performance in a synthetic sentence identification task. It was found that:

1. Per cent correct response is in some measure dependant upon the criterion adopted by the observer.

2. Observers generate Response Operating Characteristic (ROC) curve consistent to theory of signal detectability and per-

formance index free of criterion can be derived.

3. Experiments incorporating sentence identification task could profit from a design that either yields a criterion free measure or strives to control criterion of observer in a consistent fashion.

Speaks, C. (1967, c.) compared the PI functions for synthetic sentences with that of spondiac words and PB monosyllabic words. Four trained listeners with normal hearing were tested. The functions for sentences were slightly steeper than the functioned for spondiac words and markedly steeper than the functions for PB words. The level corresponding to 50 per cent correct responses were 16.1 dB for sentences, 20.2 dB for spondiac words and 26.4 dB for PB words.

Speaks, C. and Herman, L.J. (1967) studied the effect of noise on synthetic sentence identification on seven subjects with normal hearing. It was found that addition of competing noise to the sentences has no appreciable effect on slope of PI function. The single element of commonality between competing noise and competing speech is that the presentation level can be varied over a fairly wide range without altering theperformance substantially, competing noise, however, does not overcome the critical dependency that characterizes the PI function in quiet.

In 1968 Jerger, J., Speaks, C. and Trammell, explained a new technique of speech audiometry using synthetic speech sentences. It employs a close message set of ten synthetic sentences. There are only ten possible responses which are exactly specified. Secondly, the scoring system is unambiguous. The patient's response is a button push that can be scored as either correct or incorrect by a machine without the need for human decision making process. Thirdly, each item test is a multiword rather than a single word. This has both theoretical and practical advantage. Theoretically, a sentence has a greater face validity than an idolated word as a unit of understanding. Since it is multiword form practically there is sufficient duration to permit the easy manipulation of various temporal parameters of the ongoing speech such as temporal interruptions and compressions. The same set of 10 sentences can be used over and over by recording in a new random order.

> "Although the SSI test procedures has many potential applications in the general area of speech perception its use in clinical evaluation of hearing impaired is especially fulfilled. In many patients, especially those with, conductive, flat cochlear, eigth nerve and CNS lesions, the SSI procedures led to the same results as the PB test. In other especially sloping cochlear disorders, the two sets of information seems complementary.
>
> We believe that the clinician with an investigative turn of mind may find SSI and interesting, provocative and possibly fruitful avenue to explore in evaluating complex problems of speech understanding faced by hearing impaired listeners." (Jerger, J. et al, 1968).

Dirks, D.D. and Bower, R.D. (1969) performed two experiments to determine the effect of semantic content or meaning of the synthetic material. The competing speech was reversed and reproduced in a backward mode to eliminate the effect of semantic content or meaning. No important difference were observed between the PI functions in forward or backward mode3. The results of the two additional experiments demonstrated the presence of plateau or notch in the slope of the PI function obtained in English or foreign language competing messages. This plateau effect occurred primarily when three experimental conditions were present.

1. the same speaker delivered both the primary and competing messages.

2. the relative intensity levels of both primary and competing messages were equal.

3. when the temporal pattern of the competition was similar to that of primary message. The semantic content of the competing message did not contribute to the plateau in the slope of the PI function. But the PI function plateau was primarily due to similarities.

> "The masking effect found in the sentence identification task when a single competing voice message is employed is apparently not altered by the disruptive features of semantic content or meaning of the competing message". (Dirks D.D. and Bower, R.D., 1969).

Trammel et al (1970) conducted another study which paralleled the study done by Dirks, D.D. and Bower, R.D. (1969)

but led to a quite different conclusions. They stated that the question whether the listeners are distracted when presented with a competing speech message depends probably on the experimenter and listener.

Speaka, C. et al (1970-a) compared the performance scores for PB word list and for synthetic speech sentences on sixty hearing impaired patients. Scores on two types of material showed direct relation to audiometric contour. Patients with relatively flat losses performed similarly with words and sentences. As the slope of the audiometric pattern increased, however, the discrepancy between the scores for words and for sentences also increased. Results were consistent with previous on the frequency regions important for understanding of the two types of test material.

Speaks, C. et al (1970-b) studied the relation between the hearing handicapped scale (HHS) scores and selected measures of both sensitivity and discrimination loss on sixty subjects (5 conductive, 6 mixed and 49 sensory-neural hearing loss oases). Correlation HHS with sensitivity indicies were moderately high (about 0.65) in contrast to the low correlation (about 0.35) with measures of discrimination. Use of new index that incorporates information about both sensitivity and discrimination yielded a correlation higher than the sensitivity measures alone.

In Danavox symposium on speech audiometry held at Odense-Denmark, following questions were discussed. The questions raise on SSI were

1. What actually SSI test measures? Does it measure intelligibility or subject's ability to recognize a sentence?

2. Why seven words in a sentence are used, when only one word can be picked up for correct identification?

In answer to the question 1, Jerger, J. states that

> "We are measuring all kinds of things depending upon the difficulty and that to me seems very similar to listening in the world. When the situation is easy we do not analyze the phonemes of the word, we listen for the whole message. We address our memory storage, which has a finite set of possible messages that might have been sent, pull one from that storage and an appropriate response. As the situation becomes difficult we rely on more and more clues. It is a principle of least effort one utilized as few or as many cues as are necessary in the situation. So we are measuring many things and I like that. I think we are moving closer in this way to realism.(Jerger, J 1972; pp. 230-231).

In answer to question 2, Jerger states that

> "We found that people vary their listening strategy depending upon how difficult the task is, if it is very easy then they look for the entire sentence, they do not look at isolated words, they do not analyze the sentence down into its structures. As a task is made more difficult the subject begins to look for other cues such as recognizing a single world}. Now if you continue to

make it more difficult we come to the point when you cannot hear any single word but you can pick out pairs and that is why we used third order approximation, we take advantage of syntax, that helps people to pick out little sequences. As you continue to make it more difficult you can take advantage of the just temporal pattern without identifying any actual words, what happens then is that the listener varies his strategy depending on the difficulty of the task." (Jerger, J. 1970; p. 230).

In the same symposium Carhart, R. (1970; p. 259) discusses the purpose of the speech audiometry.

".......... It is quite obvious that we cannot in any reasonable time explore a patient's hearing with all major examples of every day speech nor duplicate all possible listening situations. Therefore, what we must do is to decide in a few critical dimensions that characterize hearing for every day speech, we must then select the proper type of test material to explore effectively the patient's efficiency in each dimension. My own primary interest is in assessing the patient's communicational efficiency via speech audiometry rather than concentrating on application to medical diagnosis. I think immediately of three different dimensions of hearing for speech, about which I want to know when I assess communicational efficiency. I need to know these three things before I have any basis for judging what the patient's performance in everyday life is likely to be.

The first thing I want to know is, how much more intensity my patient requires to receive everyday material easily than a normal listener requires stated in clinical terms. I want a measurement of his speech reception threshold which should be viewed as his threshold for conversational speech. It is convenient to perform this measurement in the English language with spondees, since spondees behave like abbreviated equivalents of connected sentences. Digits can serve this same purpose in languages where spondees are uncommon. In either case the important thing is that we can choose easily standardized material which is not everyday's speech but with which we can measure the amount of hearing loss for everyday speech. The second dimension I must measure is the patient's ability to understand all phonetic elements precisely since this type of reception is required in many situations. For example, you expect a taxi-cab driver to have this kind of accuracy in discrimination when you ask him to take you to an unfamiliar address. If his phonemic discrimination is poor you may arrive at a very different destination than you expected. Because we all must make precise discrimination like this, it is important to have tests which tell us whether an individual has a discriminatory defect even though the speech he is hearing is loud enough for his ordinary everyday understanding and even though he is not in disruptive background sounds. Here as we are all aware of tests using either monosyllabic words or nonsense syllables can be particularly useful. In the third place, I want information on how well the patient can do when he is surrounded by disturbing competition. Many people spend a large fraction of their wakeing hours in noisy places and we must all meet this type of challenge quite often. Moreover a patient's performance against competitions cannot be estimated from testa given in quite thus we again find ourselves needing type of test adopted to the dimension of performance, we wish to measure. Since our test cannot sample all types of acoustic competition we must have a fairly simple set of materials which are representative in that they give us information on whether the person being tested can cope with competition normally or is unduly disrupted by it. A good method for getting this information is to test discrimination against either modulated noise or competing speech. My recent experience suggest that competing speech is the better background to use. But we must then take special precautions to develop a recorded task, that is carefully standardized."

In support of SSI test, Jerger, J. (1970; p. 233) comments:

"........... The use of all four traditional materials, nonsense syllables, monosyllabic PB words, rhyming consonants are based on the false assumption, namely, the critical listening ability for understanding speech is frequency or spectral discrimination. The key parameter for speech intelligibility is time, as speech intelligibility remains remarkably good in spite of extreme frequency and amplitude distortion, so long as time axis is preserved. .... I think that the traditional materials and techniques of speech audiometry have very little value. In order to pursue the problem we have tc devise entirely new approaches baaed on the manipulation of time, not frequency, as the critical parameter".

Speech Audiometric studies done in India:

(Swarnalatha, K.C. (1972) has reported the studies done in India. It has been made use of in this review.)

Development of spondees and phonetically balanced word lists in Hindi was done by Abrol, B.M. (1971). He analyzed eight hundred commonly used words of Hindi for syllabic constructions. The majority of the words were found to have a CVC structure. Then the frequency of initial and final consonants were rated on the basis of frequency counts for all consonants as done by Ghalage (1964). Similarly the frequency of the vowels were also computed. Finally the familiarity of words was rated, according to their frequency of occurrence. Two lists of fifty words each were prepared based upon the frequency counts and familiarity of the words. No word was common to both the lists. And also two lists of 33 spondee words each were prepared from most commonly used words 30 normal subjects with SRT ranging from 10 to 30 dB were studied, by presenting the material with a carrier phrase 'say the word' at 10 dB above the presentation level of the test word. Two seconds were given to the subject to respond. At 10 dB above SRT slightly more than half of the population repeated 90 per cent of words and at 30 dB above SRT all the subjects repeated all the words presented to them. So optimum for Hindi PB were tentatively kept at 20 dB above SRT. (Abrol, B.M., 1971; p. 17-18).

Some of the limitations of the Abrol's study are as follows:

1) Practice effect was not controlled.

2) SRT levels are not maintained

3) Articulation curves are not given.

Development of hearing and speech test materials based on Indian languages (Tamil, Telugu and Malayalam) was done by Kapur, Y.P. (1971). Except for the nature of the materials used in the construction of these tests and methods for the selection, methodology for tests in all these three languages were similar. Speech audiometric tests in Malayalam was done by selecting words which were very common, for both SRT 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 hearing and otological findings were selected for the study and were given the two hundred disyllabic words. The responses were written down. The recorded words were presented at threshold +4, +2, 0, -4 and - 6 dB relative to the pure tone average thresholds of the subject. A 35 familiar spondee words were selected after rating for familiarity. For PB the maximum score of 97 per cent was obtained at 45 dB.

Swarnalatha, K.C. (1972) developed speech test material in English for Indians.

Monosyllabic and disyllabic words from Raskins lists were administered to two hundred adulta and two hundred children for testing familiarity. The most familiar words were selected to form two lists of spondees of 25 words each and two monosyllabic word lists. The monosyllabic words were phonetically balanced using Fletcher's list 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 materials were tape recorded and fed through the speech channel. Fifty-six adults and fifty six children were used as subjects for standardization 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 an SRT of 9 dB (re: 10 dB PTA) and 100 per cent correct articulation was obtained at 42 dB (re: 10 dB PTA) for adults and 45 dB with children (re: 13 dB PTA).

In Kannada there are no materials developed so far. To serve the urgent clinical need in the language thepresent study is undertaken.

METHODOLOGY

In the present study "Development of a synthetic speech identification test in Kannada language", Mill's method of con-concomitant variation was used as the experimental method.

The study was carried out in three stages:

I. Construction of test material
II. Finding the test procedure
III. Collection of data.

The following possible variables were delineated and controlled as far as possible.

Independent variables:

i) Speech material

a) Familiarity of the material
b) Length of the sentences
c) Homogeneity of the sentences.

ii) Test environment

iii) Instruments

iv) Subjects

a) Hearing acuity of the subjects
b) Type of loss, if any, of the subjects.

v) Message competing ratio (MCR)

vi) Level of presentation.

Dependent variable:

Performance of the subjects on synthetic speech identification (SSI) test.

I. Construction of Test Material:

Synthetic speech sentences of first order and second order were constructed in order to control the subject's familiarity of the material used, the premorbid linguistic ability and its changing pattern over time. Since the material was synthetic, it was assumed to be the same in meaning for every subject. The length of the sentences were controlled as far as possible. The number of words in the sentences were controlled by taking seven words in each sentence. The freedom of choice for the subject to respond was controlled by using a closed set. The probability of each sentence to occur in any random order remained the same. To rule out the approximation to the sentence to a real sentence acting as a variable, two orders of approximations of sentence to a real sentence were constructed and studied on all the subjects.

Construction of synthetic sentences:

(a) First order sentence:

Words from the list of most commonly used words in Kannada language (computed by the Research Project using 20,000 words of language, Project No. SRS IND 38-68 New No. 19 -

P. 58134-F-01 report for the year 1970-71) were selected at random by

i) using a random table (Kandell, M.G.; Smith B.B. 1938)

and

ii) selecting the every 15th word from the list.

They were put together in the same order as they were selected to form a seven word sentence. Ten sentences by using random table and another ten sentences by using the second method (selecting every fifteenth word from the list) were constructed.

(b) <u>Second order sentences:</u>

One word from the above mentioned list was taken at random. This served as the first word of the sentence. This word was given to an individual 'A' and he was asked to construct a meaningful sentence using the given word in the initial position of that sentence. The word which immediately followed the given word, in the sentence given by the individual 'A', was taken as the second word of the synthetic sentence. This word was given to another individual 'B', who was not aware of the sentence constructed by 'A' and the reason for which the word was collected. He was asked to use the given word (word supplied by individual 'A') in the initial position and to construct a meaningful sentence. The word which immediately followed the given word was taken to be the third word of the synthetic sentence.

The third word was used to elicit the fourth word and so on till the seventh word was reached. In this way twenty synthetic speech sentences were constructed in which

a) separate individuals were used for seven separate words.

b) different groups of individuals were used for the construction of different sentences.

c) people were not aware of the uses to which these words were used. (Thus a curse word has also appeared in one of the sentences.)

These sentences follow the word pair rule where any word of the sentence was conditioned upon the conditional probability of the word that precedes it, for its existence in that sentence. Thus the second word depended on the first, the third on the second and so on till the seventh word was reached. This approximated a real sentence to some degree. The number of words in each sentence in both the orders were seven only.

(c) Tests for Homogeneity of sentences!

Sentences were tested for

i) Reading time

ii) Identification time

iii) Intelligibility at a set intensity level.

Five normal hearing subjects with normal otologic findings and who could read and speak Kannada were selected for the above mentioned tests.

i) Reading time teat:

The twenty sentences of both first and second orders were read by all the subjects, one after another. The time taken to read each sentence by each subject was noted down using a stop watch. Those sentences which took approximately the same time for reading by all the subjects were put together to form a set of ten sentences of first order and of second order each.

ii) Identification time test:

The sentences of first order and second order were written on separate sheets of paper arranging them on a serial number starting from one to ten respectively. The list was given to the subject and was asked to repeat the number of the sentence they heard after scanning the list. The sentences were presented randomly through an audiometer, one after another. Time taken to scan the list, to identify the sentence and to repeat the number of the sentence was recorded using a stop watch. Approximately same time was required to identify a sentence by all the subjects. This varied from 13 to 15 seconds.

iii) Intelligibility test:

Twenty sentences, ten sentences of first order and ten sentences of second order, were presented at random to the subjects, one after another, at a aet intensity level of 30 dB SPL. The results were analysed and found that all the subjects could repeat all the sentences at that level. So it was assumed that the task became too easy and as such a competing speech message was used to make the task difficult.

(d) <u>Competing speech message:</u>

It has been argued by several audiologists that under normal conversational situation a fluctuating complex noise will be present (or interferes with signal). So, it was assumed that a speech signal would be better than a noise spectrum for competing message. Hence a continuous speech message was selected from one of the books to make the test task as complicated and realistic as possible ('Nonda Jivi' - a Kannada translation of Victor Hugue's "Le Missarable). This wag selected as it has been considered by many individuals as an interesting novel. Here this waa assumed that this would equally interest all the subjects.

To control the method of presentation as a variable, recorded signals were used all through the experimentation. The speaker practiced the material to be recorded for several seaaiona before the final recording was done to avoid possible variations in recording. The speaker was a 24 year old male with an experience of five years in using live voice for speech audiometry in clinic. His dialect was same as the dialect of Kannada speakers in Southern region of Mysore State. The recorded material was presented to three normals who could read and speak

Kannada for judgment of errors, distortions and total intelligibility. Until the judges accepted the material as intelligible, recording was repeated. Thus possible errors and distortions were minimized in recording the material. The judges also judged whether both the signals were of same intensity or not. A stereo tape recorder was used for recording and reproducing the signal.

The synthetic speech sentences were recorded on the first channel of the tape recorder with a time interval of 15 seconds between sentences, 20 seconds between lists and 25 seconds between two lists to enable the subject to respond. The competing speech was recorded on the second channel of the tape recorder keeping the intensity constant by the use of VU meter. Both signals were judged to be of same intensity by all the three judges. The competing speech preceded and exceeded the synthetic speech by 30 meter readings in length.

Two recorded tapes were made in the above mentioned way. The first tape consisted of three random ordered lists of both first order sentences and second order sentence set each comprising ten sentences.

From the above three random lists of each order, one random list from first order and another random list from second order were selected arbitrarily and recorded on tape 2. The recording was done in the same sound treated audiometric room used for testing.

II. Finding the Test Procedure:

(a) Test room situation:

All the teats were conducted on a single sound treated audiometric room. The noise levels in the room were measured on five consecutive days. A sound pressure level (SPL) meter (B & K type 2203) with an octave filter (B & K type 1613) was used to measure the noise in the test room. The average SPL readings on all the five days were indicated in the table given below:

TABLE - 1

Average SPL in the sound treated room using weighted scale

Sl.No.	Scale	SPL values Ref 0.0002 dynes/cm^2	
1	A	24 dB	
2	B	34 dB	
3	C	36 dB	
Sl. No.	**Central frequency of octave band in H_z**	**SPL values in test room in dB. Ref.0.0002 dynes/cm^2**	**ISO specification for SPL values in audiometric rooms. Ref. 0.0002 dynes/cm^2**
1.	125	28	31
2.	250	22	25
3.	500	25	26
4.	1000	22	30
5.	2000	20	38
6.	4000	18	51
7.	8000	16	51

(b) Instruments:

The following instruments were used in the study:

i) Tape recorder

ii) Audiometer

iii) Monitoring set

iv) Push button switches and bulbs

The instruments were periodically checked and calibrated.

i) Tape recorder:

A aterco tape recorder (Uher variocord 263 stereo) with microphone (scennheiser type MD 722 LM) was used to record and reproduce the test signals.

ii) Audiometer:

An audiometer (Arphi model 700 MK) was used for the testing purpose with head set (TDH 39 with cushion LX 41 AR). Since there was no provision to feed the second tape signal in this audiometer it was modified suitably to inject tape-2 signal in place of noise on second channel.

The two outputs of the tape recorder were fed to the audiometer auch that the competing speech appeared on channel 1 and synthetic speech on channel 2. The audiometer was kept either in Langen left or right all through the experimentation to feed both the signals to the same ear. The output of the signals could be controlled separately by using alternators of channels

1 and 2. The function selector switch was placed at speech/masking position. A sterco pre-amplifier developed in the Electro Acoustic laboratory at All India Institute of Speech and Hearing, Mysore (Type EA 724) was used in between tape recorder and audiometer to boost the signal to the required level.

Calibration:

Audiometer was periodically calibrated for speech and pure tone using B and K equipment at the Electro-Acoustic laboratory of AIISH, Mysore.

A Block diagram showing the calibration unit is inserted. A 1000 CPS white noise tape was played on aforementioned tape recorder and the output signal was used as the standard signal for speech calibration of the audiometer.

Block Diagram - I

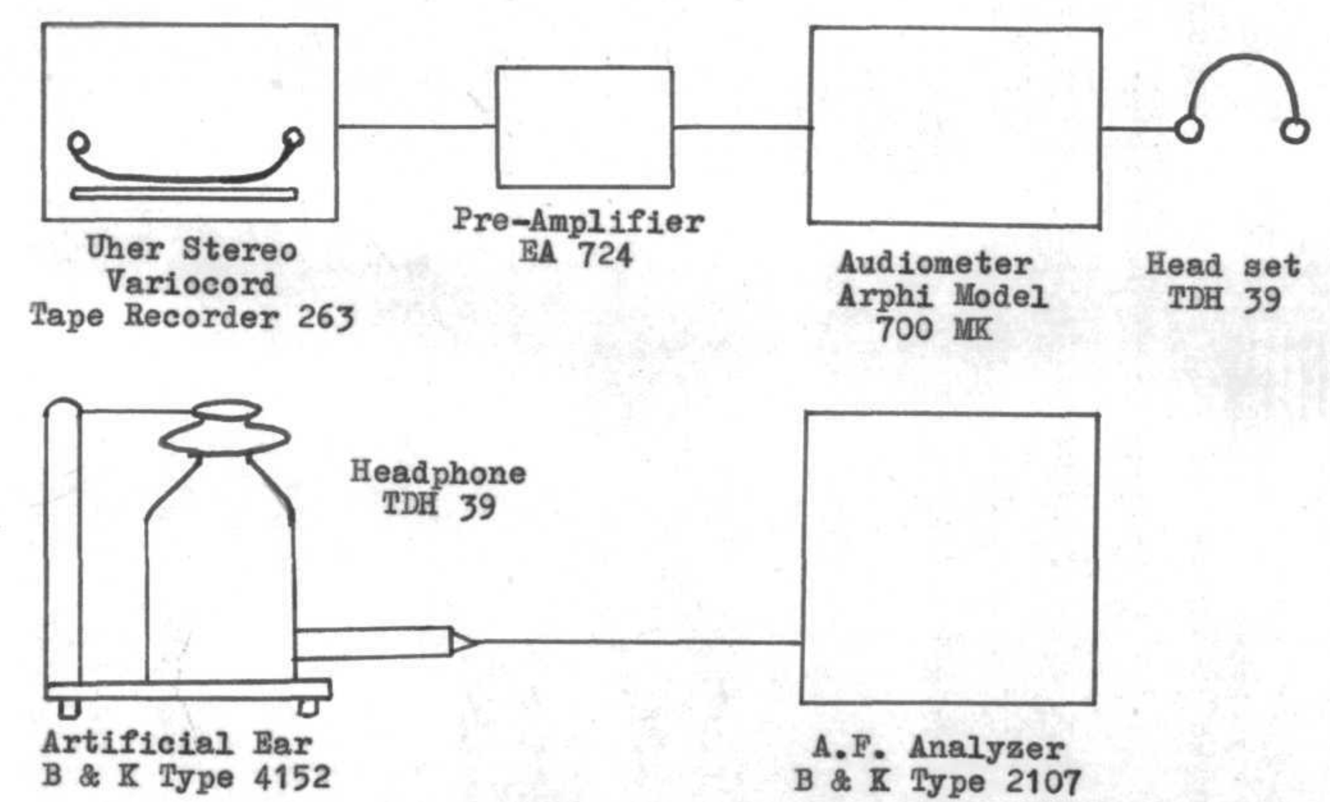
iii) Monitoring set:

To know which sentence was presented to the subject at any moment of time during experimentation, the experimenter was provided with a monitoring system using a separate amplifier (Arphi TA 25) and a head set (5l.PP.63l). Precaution was taken to see that the output of the head set did not exceed 30 dB at any time, to avoid interference of this signal with signal presented to the subject.

iv) Push button switch and bulbs:

To make the subject's response a motor act ten push button switches were connected to ten bulbs (6.3 volts) and all

BLOCK DIAGRAM I



Block diagram showing the equipment used for calibration of the audiometer.

the ten switches and bulbs corresponding to them were numbered in the same order from one to ten. All the switches were fixed at a convenient distance in front of the subject and were numbered such that they could be clearly identified. The ten bulbs were arranged in front of the experimenter such that they could be visualized with least difficulty during testing.

Block Diagram - II

c) Subjects:

All the subjects were selected on the following criteria:

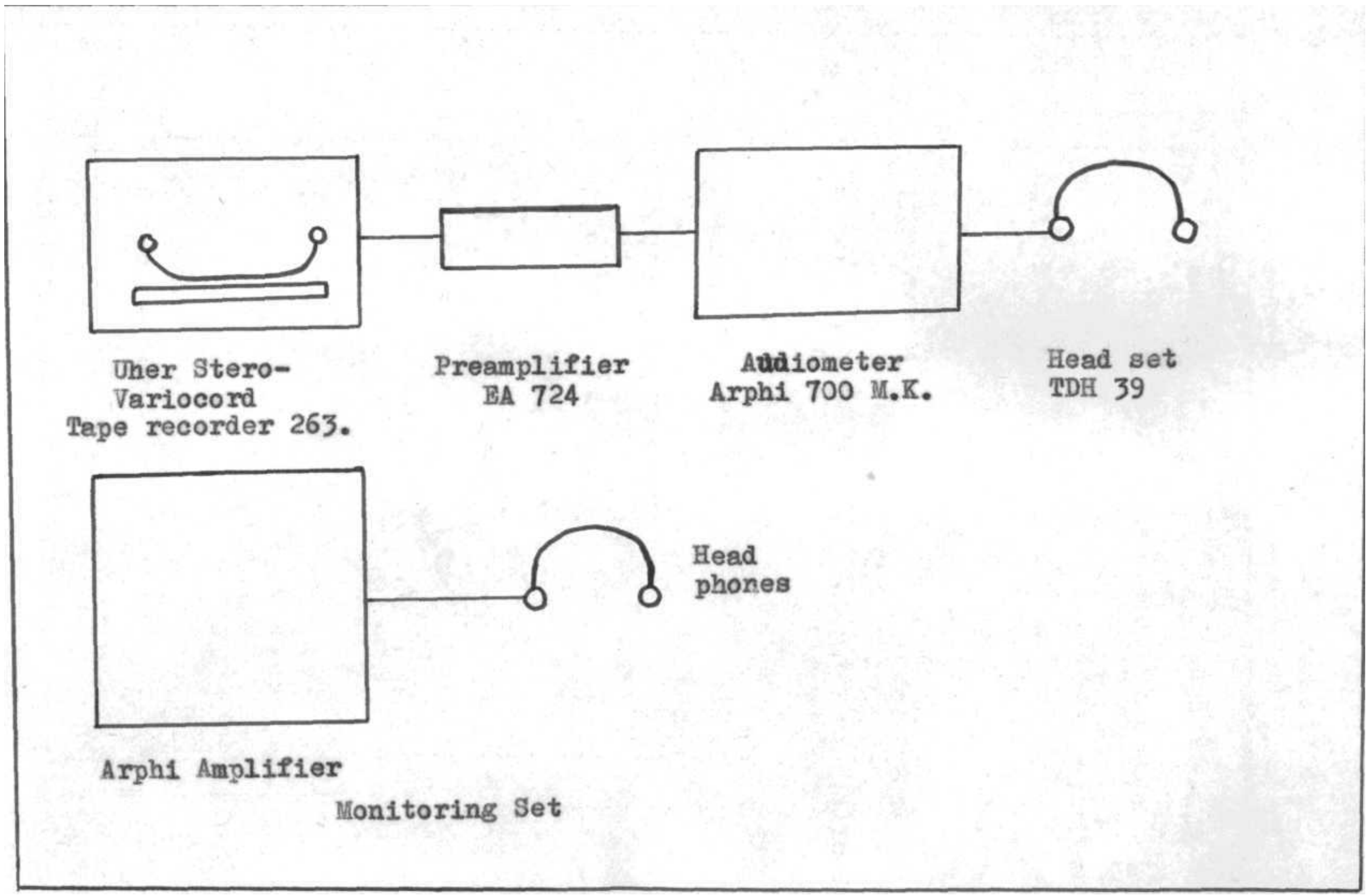
1) Audiogram configurations
2) Above the age of 12 years
3) Proficiency in speaking and reading Kannada
4) Speech reception threshold not more than 65 dB SPL.

All the subjects were tested for

1) Wax and discharge from ear
2) Pure-tone audiogram
3) Speech reception threshold
4) Special test as needed.

An otolaryngologist of the Institute examined the cases for ear discharge and wax. In cases of discharge the subject was not tested till the ear became dry. The subjects with wax were tested only after the removal of wax.

BLOCK DIAGRAM - II



Block diagram showing the arrangement of instruments used in the study.

Hughson and Westlake ascending and descending method of pure tone audiometry was used for listing subject's pure-tone thresholds. They were tested from 250 to 8000 CPS on Air conduction and 250 to 4000 CPS on Bone conduction.

For speech reception thresholds, standardized spondee word lists in Indian English (Swarnalatha K.C., 1972) was used with English knowing subjects. With those subjects who knew only Kannada, digit repetition, repetition of some common words in Kannada, simple questioning and answering techniques were used.

Normals:

Thirty normal individuals (60 ears) ranging from 16 years to 30 years with a mean age of 20.66 years were selected for the study. They ranged in SRT from 5 to 15 dB with a mean SRT of 11,3 dB. Ten were females with an age range of 18 to 23 years and with a mean age of 20 years. Their SRT ranged from 10 to 15 dB with a mean SRT of 11.5 dB. Twenty were males with an age range of 16 to 30 years, with a mean age of 21 years. Their SRT ranged from 5 to 15 dB with a mean SRT of 11.2 dB.

Clinical population:

Twenty-four clinical subjects with different types of pathologies were studied. They ranged from 18 to 72 years of age with a mean age of 35.62 years, with an SRT range of 28 to 98 dB.

Sensori-Neural loss cases:

A total of ten (20 ears) sensori neural loss cases were studied. They ranged from 18 to 20 years and 20 to 60 dB SRT. Out of this, eight were males and two were females.

Conductive loss cases:

Six conductive loss cases (9 ears) ranging from 15 to 43 years and 20 to 63 dB SRI were tested. Out of this five were males and one was female.

Mixed hearing loss cases:

Three subjects (4 ears) with mixed loss, with an age range of 21 to 49 years and 18 to 60 dB SRT range were studied. This group consisted of one female and two males.

High frequency loss:

Five cases with this type of loss were studied.

d) Instructions:

Kannada

F ¥ÀAiÀÄ£ÀÄ MAzÀÄ ¨Áj N¢. FUÀ¤ªÀÄ MAzÀÄ Q«AiÀÄ°è MAzÀÄ GzÀÝÁzÀ ªÀÄvÀÄÛ AiÀÄ ªÁUÀÆ CAzÀgÉ ¥ÀæPÉªÀÄVAiÀÄ ªÀgÉÆÀ §gÀÄvÀÛzÉ. CzÉ Q«AiÀÄ°è D ªÀÄwÛ£À eÉvÉAiÀÄ°è F ªÁPÀåUÀ¼À §AzÀÄ §AzÀÄ ºÉÃUÀÄvÀÛªÉ. ¤ÃªÀÅ UÀªÀÄ£À«lÄÖ PÉý AiÀÄ ªÀÄ ªÁPÀå ¤ªÀÄUÉ PÉý¹vÀÄ JA§ÄzÀ£ÀÄß ¤ªÀÄUÉ PÉÆnÖgÀÄªÀ ¥ÀÄ¸ÀÛPÀzÀ°è UÀÄgÀÄw¹, D ªÁPÀåzÀ ¸ÀASÉåAiÀÄ ¹ZïÖ£ÀÄß MAzÀÄ PÀqÀ MwÛ »r¬Äj. MAzÀÄ ªÉÄÃ¯É ¤ÃªÀÅ AiÀÄ ªÀÄzÁzÀgÉ ªÁPÀåªÀ£ÀÄß UÀÄgÀÄw¸À¯É ºÉÃzÀgÉ£ÀÄßªÉÆÃ UÉÆvÁUÀÄªÀÅzÀ JAzÀÄ w½¹.

English

"There are some sentences written on this chart. Please read them once. Now you are going to hear a continuous speech in one of your ears. Along with it and amidst it you are going to hear these sentences presented one at a time to the same ear. please hear carefully and identify the sentence, which you heard, from the list given to you. Please press the switch that corresponds to the number of the sentence that you have identified and hold it for a while. If you miss any sentence, please let me know."

EXPERIMENT 1

Finding the level of the presentation of material.

The tape 1 comprising of three lists of random order from first order and three lists from the second order were presented to five normal subjects. The intensity was varied in 5 dB steps starting from the level of SRT with each random list till the maximum performance on SSI test was reached. Data was analyzed. This level varied from 35 dB SL to 45 dB SL and as such 40 dB SL was selected as the level of presentation for further experiments.

EXPERIMENT 2

Finding the message competing ratio for maximum performance.

Tape-1 which consisted of 6 random lists of first and second order sentences were presented to five normal individuals starting from the level of SRT varying the message competing ratio from zero to 45 dB at each level and responses were recorded. That is, both SSI and competing speech message were presented, first at the same level. Next the competing speech message was revised in 5 dB steps with each list and noting down the response till 45 dB above the level of SSI. In the above way, responses were recorded at each intensity used, varying the intensity in 5 dB steps, till 40 dB SL was reached and the data was analysed.

It was found that performance on SSI was maximum when message competing ratio was 0dB and the stimulus was presented at 40 dB 3L, Further tests were carried out at message competing ratio equal to 0 dB and presentation level at 40 dB SL.

Finding normative data for tape-1

Tape-1 was presented to each of the thirty normal subjects selected for the study at 40 dB SL and message competing ratio at 0 dB. The responses were noted down on a score sheet prepared for the same reason (Enclosed in Appendix-1) and data was analyzed.

III. Data Collection: Finding performance Dattem of normals and clinical population on SSI test:

Since tape-1 was very lengthy and time consuming one, tape-2, which consisted of one random list of first and second order each was used for data collection. Message competing ratio was 0 dB all through the experimentation.

EXPERIMENT 4

Finding normative data for tape-2

Tape-2 was presented to thirty normal subjects selected for the study, at 40 dB SL and message competing ratio was 0 dB. The responses were noted down in the score sheet-2 (Enclosed in Appendix-1) and data was analyzed.

EXPERIMENT 5

Finding pattern of responses by clinical groups on 'SSI' test

Twenty-four clinical subjects comprising conductive, sensori-neural, mixed and high frequency hearing loss cases were studied. They were presented with tape-2 at message competing ratio of 0 dB and at 40 dB SL. Their responses were recorded and analysed.

EXPERIMENT 6

Findidng the performance-Intensity function on clinical population:

Test was administered on five randomly selected clinical subjects representing each clinical type. They were presented with tape-1 starting from the level of SRT. The intensity was varied in 5 dB steps till 45 dB SL was reached. At every intensity level different random orders were used to rule out the practice effect. Responses were recorded at each level and analyzed.

EXPERIMENT 7

Ten subjects from normal group were subjected to retesting after a random selection. They were presented with tape-2 at 40 dB SL and 0 dB message competing ratio. Responses were recorded and analyzed. Teat-retest reliability was computed.

EXPERIMENT 8

A study was carried out to compare the results of PB tests and SSI test to check content validity of the SSI test in Kannada. The subjects who knew both Kannada and English were selected. the results were analyzed.

Brief plan for analysis of the data:

The data was arranged according to each group. Normals and each clinical group were compared to each other in performance using suitable statistical measures. The difference between groups were studied for statistical significance.

CHAPTER IV

RESULTS AND DISCUSSION

EXPERIMENTS 1 & 2

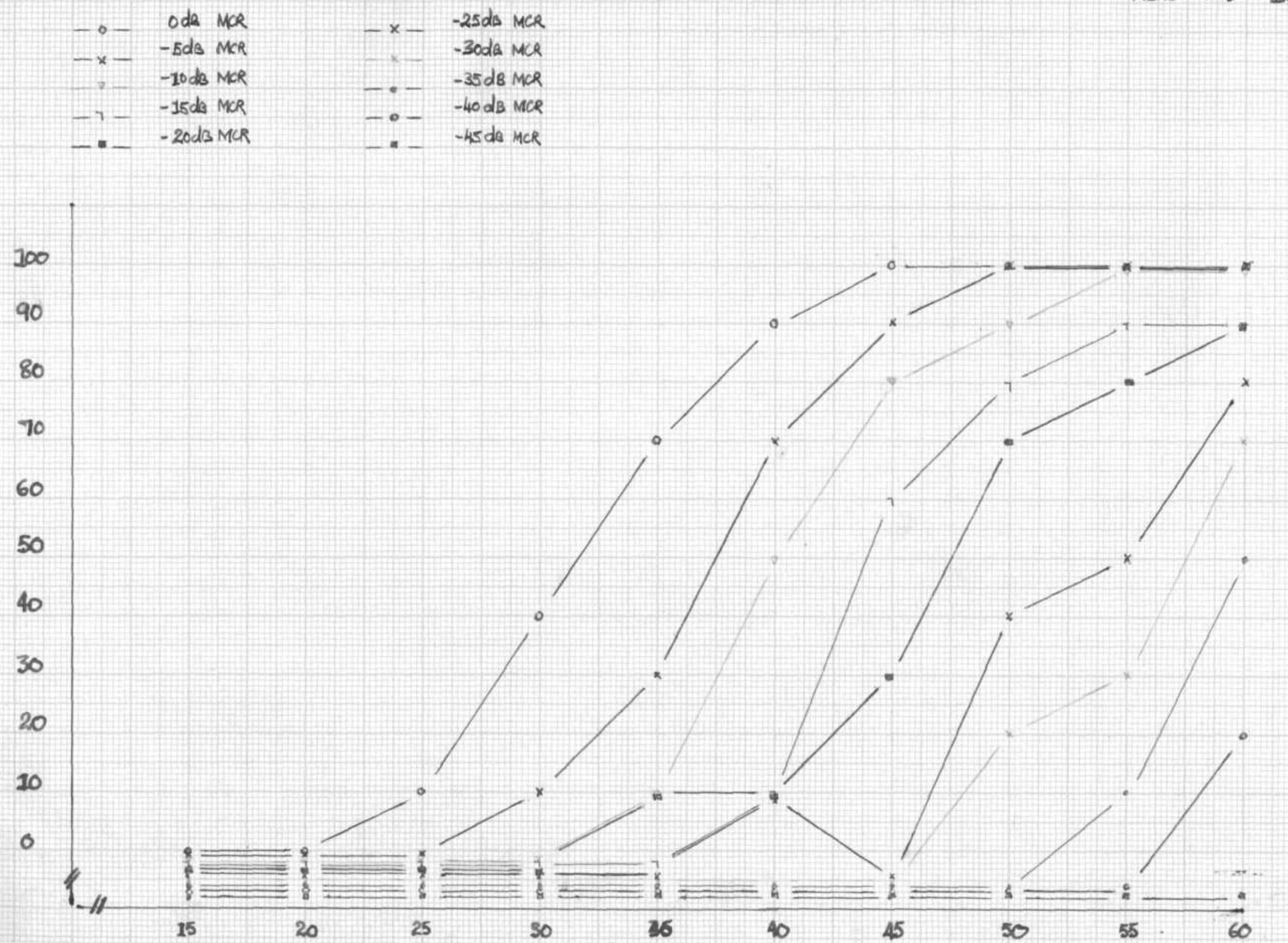
The results indicated in the Table-2 was obtained on normal hearing subjects. Table indicates the change in the performance as the intensity of the presentation of synthetic sentences was increased at different Message Competition Ratios (MCR).

TABLE - 2

Message Competition Ratio (MCR)

Intensity in SPL	0dB	-5dB	-10dB	-15dB	-20dB	-25dB	-30dB	-35dB	-40dB	-45dB
15	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
20	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
25	10%	0%	0%	0%	0%	0%	0%	0%	0%	0%
30	40%	10%	0%	0%	0%	0%	0%	0%	0%	0%
35	70%	30%	10%	0%	10%	0%	0%	0%	0%	0%
40	90%	70%	50%	10%	10%	10%	0%	0%	0%	0%
45	100%	90%	80%	60%	30%	0%	0%	0%	0%	0%
50	100%	100%	90%	80%	70%	40%	20%	0%	0%	0%
55	100%	100%	100%	90%	80%	50%	30%	10%	0%	0%
60	100%	100%	100%	90%	90%	80%	70%	50%	20%	0%

GRAPH - 1 SHOWING PERFORMANCE AT DIFFERENT MCRS AND INTENSITIES



It is clear from the Graph-1 and Table-2, that performance increases as the intensity level of presentation of sentences increases till 40 dB SPL, and remains constant thereafter at the level of zero dB MCR. From the level of 15 dB SPL to 25 dB SPL the performance is zero per cent for all MCR levels. As the MCR was varied in 5 dB steps from 0 dB MCR to -45 dB MCR the performance droped down. When MCR was OdB and the presentation level was above 45 dB SPL the performance was maximum.

When the stimulus was presented at -25 dB MCR and intensity level was 40 dB, the performance was 10%. As the intensity was raised to 45 dB SPL, the performance dropped to 0 per cent. This is either due to experimental error or due to an accidental response at 40 dB SPL.

Performance varies 'directly' with the level of presentation of the sentences and inversely with the Message Competition ratio (MCR).

Thus the hypothesis-1 is confirmed.

EXPERIMENT 3

TABLE-3

Showing the results of 30 normal individuals on SSI tape-1

Sl. No.	Age	Sex	Ear	P.T.A. in dB	PB Max.	SSI First Order			SSI Second Order		
						I List	II List	III List	IV List	V List	VI List
1	21	F	L	15	100	100	100	100	100	100	100
			R	15	100	100	100	100	90	100	100
2	19	F	L	15	100	100	90	100	100	100	100
			R	15	100	100	100	100	100	100	100
3	23	F	L	20	100	100	100	100	90	100	100
			R	15	100	100	100	100	100	100	100
4	19	M	L	5	92	100	100	100	100	100	100
			R	8	96	100	100	100	100	100	100
5	17	M	L	5	100	100	100	100	100	100	100
			R	5	92	100	100	100	100	100	100
6	18	M	L	10	100	90	100	90	100	100	100
			R	10	100	90	100	100	100	100	100
7	19	M	L	15	100	100	90	100	100	100	100
			R	15	96	100	100	100	100	100	100
8	19	F	L	10	96	100	100	100	100	100	90
			R	10	92	100	100	100	100	100	100
9	21	F	L	5	100	100	100	100	100	100	100
			R	10	100	100	100	100	100	100	100
10	24	M	L	15	100	100	100	100	100	100	100
			R	15	100	100	100	100	100	100	100

Sl. No.	Age	Sex	Ear	P.T.A. in dB	PB Max	SSI First Order I List	II List	III List	SSI Second Order IV List	V List	VI List
11	21	F	L	10	100	100	100	100	100	100	100
			R	10	100	100	100	100	100	100	100
12	20	M	L	20	100	100	90	100	90	100	100
			R	20	100	100	100	100	100	100	100
13	28	F	L	10	100	100	100	100	90	100	100
			R	10	100	100	100	100	90	100	100
14	20	M	L	10	95	100	100	90	100	100	100
			R	15	100	100	100	100	100	100	100
15	20	F	L	10	96	100	100	100	100	100	100
			R	10	92	100	100	100	100	100	100
16	21	M	L	10	98	100	100	100	100	100	100
			R	10	96	100	100	100	100	100	100
17	39	M	L	20	90	100	90	90	100	100	100
			R	20	88	100	100	90	90	100	100
18	21	M	L	10	96	100	100	100	100	100	100
			R	10	98	100	100	100	100	100	100
19	18	M	L	5	100	100	100	100	100	100	100
			R	10	100	100	100	100	100	100	100
20	21	M	L	10	98	100	100	90	100	100	90
			R	10	100	100	100	100	100	100	100

Sl. No.	Age	Sex	Ear	P.T.A. in dB	PB Max	SSI First Order I List	SSI First Order II List	SSI First Order III List	SSI Second Order IV List	SSI Second Order V List	SSI Second Order VI List
21	14	M	L	15	90	90	100	100	100	100	100
			R	15	92	100	100	100	100	100	100
22	23	M	L	15	100	100	100	100	100	100	100
			R	15	100	100	100	100	100	100	100
23	22	M	L	10	98	100	100	100	100	100	100
			R	10	100	100	100	100	100	100	100
24	19	M	L	10	96	100	100	100	100	100	100
			R	10	92	100	100	100	100	100	100
25	23	M	L	5	96	100	90	100	100	100	100
			R	10	98	100	100	100	100	100	100
26	26	M	L	10	100	100	100	100	100	100	100
			R	10	100	100	100	100	100	100	100
27	18	M	L	15	98	90	100	100	100	100	100
			R	10	100	100	100	100	100	100	100
28	23	M	L	10	100	100	100	100	100	100	100
			R	10	100	100	100	100	100	100	100
29	23	M	L	10	100	100	90	90	100	100	100
			R	10	100	100	100	100	100	100	100
30	30	M	L	18	98	100	100	100	90	100	100
			R	15	96	100	100	100	100	100	100

The results obtained on 30 normal hearing individuals on tape-1 for SSI First order and on SSI Second order, presented with the competing speech message at 0 dB MCR and 40 dB SL, are computed in Table-3. It is evident from the Table that most of the subjects obtained maximum that is either 90% or 100% scores on SSI First and Second orders. All the six lists (3 lists from first order and 3 lists from Second order) were presented to each of the 30 subjects. Since fatigue may act as a variable when 6 lists are used, and also it is time consuming, a second tape (tape-2) was prepared. It was used for further experimentations. It may be noted that any list out of the 6 lists of tape-I may be used for evaluation purposes.

EXPERIMENT 4

TABLE 4

Showing the performance of normals on SSI tape-2

Sl. No.	Age	Sex	Ear	P.T.A.	Level of presentation of the material	PB Max	SSI-I	SSI-II
1	23	F	L	15 dB	55 dB	96%	100%	100%
			R	15	55 dB	98%	100%	100%
2	23	M	L	10	50	92	100	100
			R	10	50	90	100	100
3	16	M	L	10	50	98	100	100
			R	10	50	100	100	100

Sl. No.	Age	Sex	Ear	P.T.A.	Level of presentation of the material	PB Max	SSI-I	SSI-II
4	21	F	L	10	50	100	100	100
			R	10	50	100	100	100
5	18	F	L	10	50	100	100	100
			R	10	50	100	100	100
6	18	M	L	15	55	96	100	100
			R	15	55	92	100	100
7	20	M	L	15	55	100	100	100
			R	15	55	100	100	100
8	19	M	L	15	55	100	100	100
			R	15	55	95	100	90
9	19	M	L	5	45	92	100	100
			R	8	50	96	100	100
10	17	F	L	10	50	96	90	100
			R	10	50	94	100	100
11	19	M	L	15	55	100	90	100
			R	15	55	96	90	100
12	22	M	L	15	55	96	100	100
			R	15	55	98	100	100

Sl. No.	Age	Sex	Ear	P.T.A.	Level of presentation of the material	PB Max	SSI-I	SSI-II
13	20	M	L	15	55	92	100	100
			R	15	55	96	100	100
14	17½	M	L	5	45	95	90	100
			R	5	45	100	100	100
15	22	F	L	10	50	100	100	100
			R	10	50	100	100	100
16	18½	M	L	5	45	92	100	100
			R	5	45	100	100	100
17	18½	F	L	10	50	100	100	100
			R	10	50	100	100	100
18	18½	F	L	10	50	100	100	100
			R	10	50	100	100	100
19	21	F	L	15	55	100	100	100
			R	15	155	100	100	100
20	21	F	L	10	50	96	100	100
			R	10	50	92	100	100
21	18	F	L	10	50	100	90	100
			R	10	50	100	90	100

Sl. No.	Age	Sex	Ear	P.T.A.	Level of presentation of the material	PB Max	SSI-I	SSI-II
22	17½	M	L	10	50	100	100	90
			R	10	50	100	100	90
23	30	M	L	15	55	100	100	100
			R	15	55	98	100	100
24	21	M	L	10	50	100	100	100
			R	15	55	100	100	100
25	18	M	L	15	55	100	100	100
			R	15	55	100	100	100
26	20	M	L	15	55	100	100	100
			R	15	55	100	100	100
27	19	M	L	15	55	92	100	90
			R	15	55	96	100	100
28	23	M	L	15	55	96	100	90
			R	15	55	98	100	100
29	18	M	L	15	55	98	90	100
			R	15	55	94	100	100
30	24	M	L	15	55	100	100	100
			R	15	55	100	100	100

The results of Experiment 4 are given in Table-4. It is the performance of 30 normal hearing subjects on tape-2 presented at 0 dB MCR and 40 dB SL. Out of the 60 ears tested 11 ears' performance score was 90% and the reat 39 ears' performance score was 100%. This suggests that normal subject obtain maximum performance scores on this test. Thus it supports the hypotheais-2.

Table-4 also indicates the PB scores obtained by the same subjects. It is seen that performance in SSI is greater than or equal to PB scores in most of the cases. To find statistical significance of difference between PB scores and SSI scores of normal subjects "Wilcoxon matched pair sign rank test" was applied. At both the levels of significance; 0.05 level and 0.01 level the Ho - Null hypothesis was confirmed - There exists no difference between the performances of normal subjects on PB and SSI tests, as the obtained value of 'T' was 52.5 much above the given value of the table - the table values are 21 at 0.05 level and 13 at 0.01 level (Table-G - Sidney Siegal, 1956-P- 83).

Thus the hypothesis No.2 is confirmed.

EXPERIMENT 5

TABLE 5

Showing the performance scores of conductive hearing loss group on SSI - First Order and Second Order test

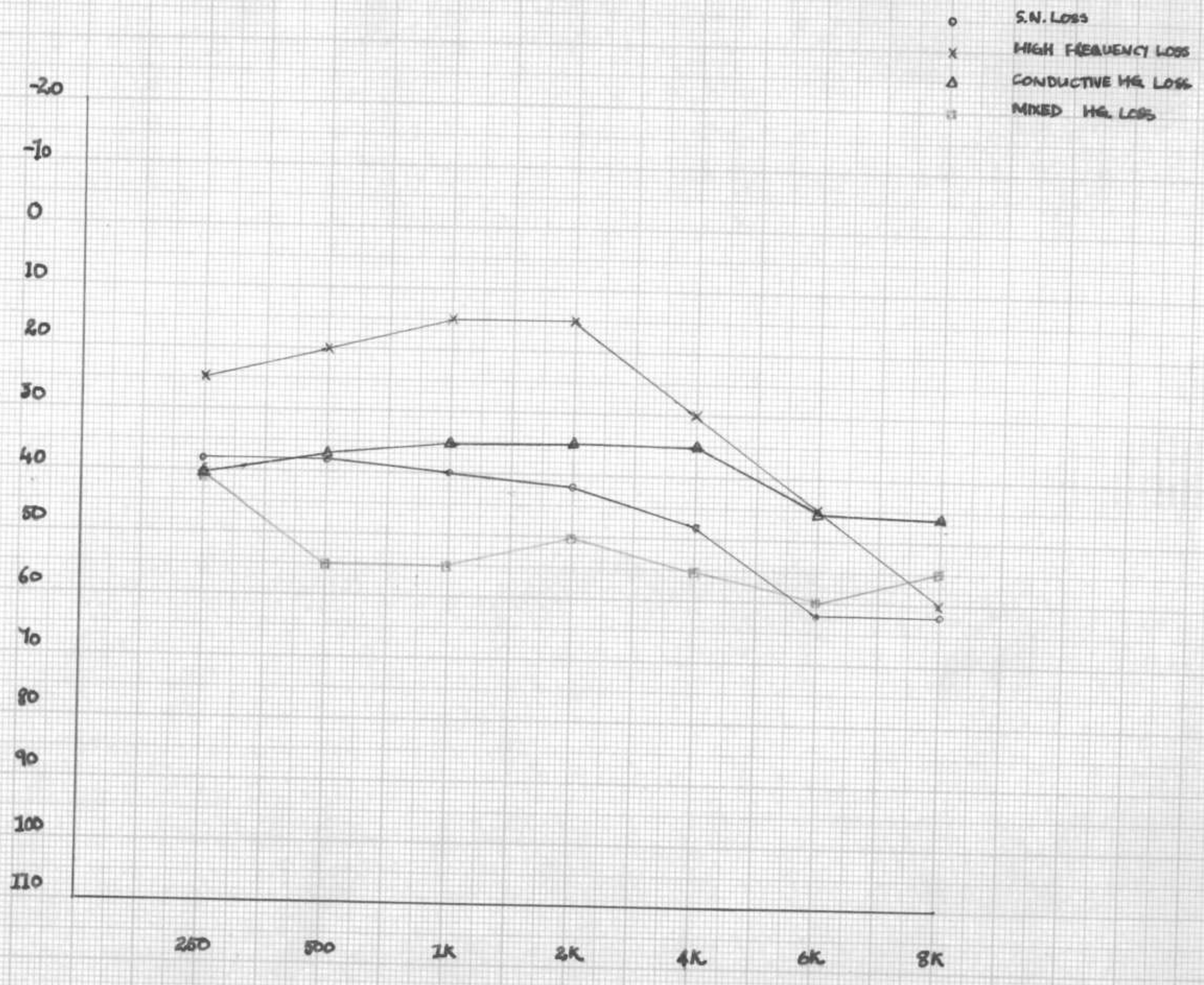
Sl. No.	Age in Years	Sex	Ear	P.T.A. in dB	P.L. in dB	PBM in %	SSI First Order	SSI Second Order.
1	19	M	L	98	-	0	0	0
			R	58	100	95	80	80
2	43	M	L	10	50	100	100	100
			R	65	100	95	100	100
3	42	M	L	35	75	100	100	100
			R	35	75	90	100	90
4	24	M	L	18	60	-	90	100
			R	48	90	-	100	100
5	31	M	L	33	75	100	100	100
			R	53	95	100	100	100
6	21	F	L	42	85	-	80	80
			R	23	65	-	80	90
7	24	M	L	92	-	-	-	-
			R	58	100	100	100	90
8	22	M	L	10	50	98	100	100
			R	30	70	96	100	100

In this experiment, data was obtained on 24 clinical subjects. They were arranged according to the pathology and the audiogram pattern. Tables 5, 7, 9 and 11 indicate the performance of pathological cases: Conductive hearing loss, mixed hearing loss, sensori neural hearing loss and high frequency hearing loss respectively. Tables 13, 15 and 17 indicate the performance of those belonging to groups of flat curves, gradually sloping curves and sloping curves respectively. Graphs 2 and 3 represent the average audiograms of each of the clinical groups.

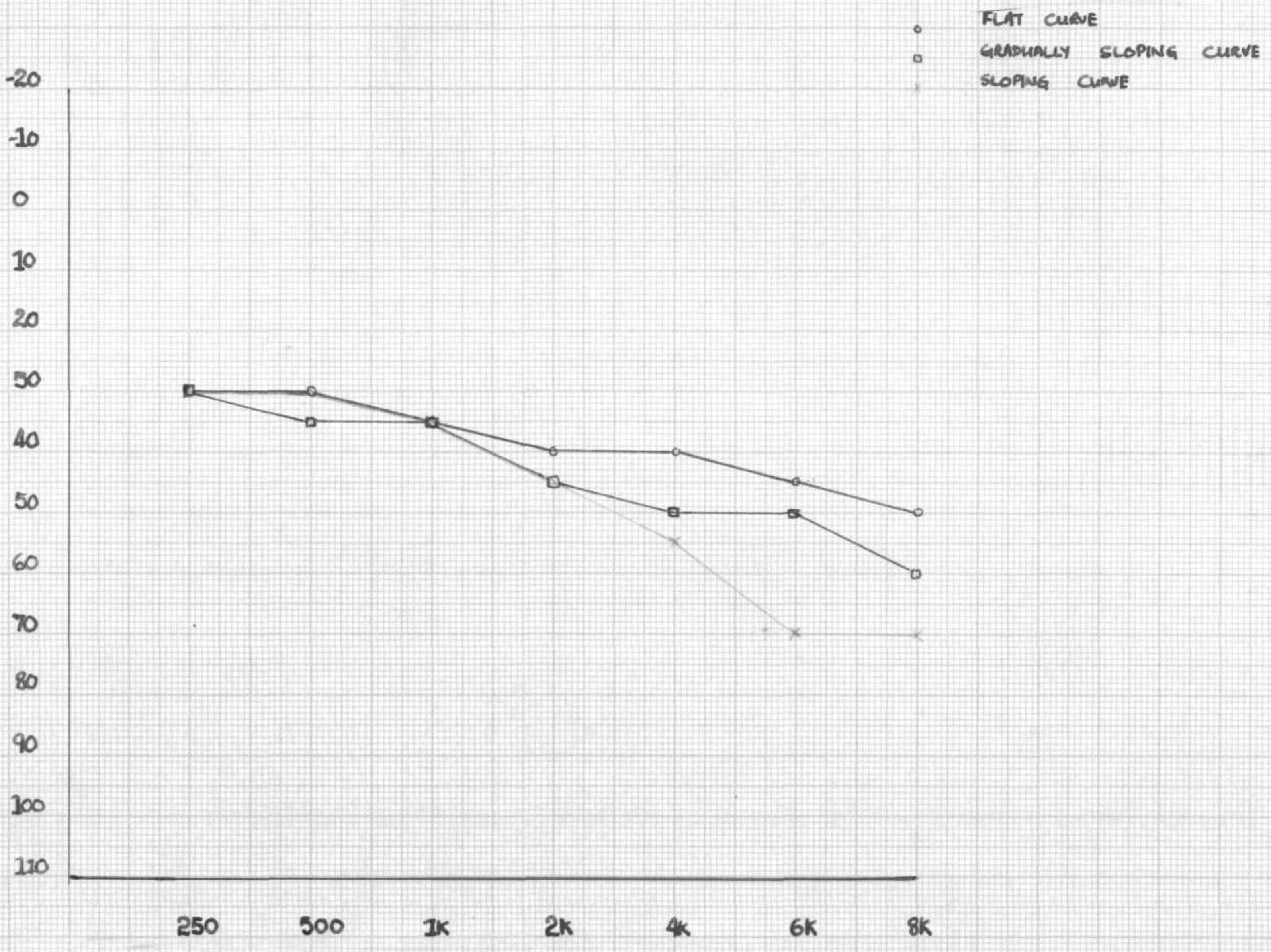
Table-5 indicates the results on SSI First order and SSI Second order on 14 conductive loss ears. The performance ranged from 30 to 100 percent. To find whether there was any difference between performance on SSI First order and II Order 'Wilooxon matched pair signed rank test' (WMPSR) was tried. It was not applicable, as the N was less than 4. From the Table-5 it is evident that not much difference is apparent. To find the difference between PB scores and SSI First order and Second order scores 'WMPSR' test was employed. The results of the analysis rejects the null hypothesis in favour of alternative hypothesis. Thus there exists a difference between the performance scores of PB and performance scores of SSI First order. Regarding the difference in performance of PB on SSI Second order, No inference could be drawn of statistical significance of difference as N was small.

The performance of this group of subjects was compared with the performance of the following groups of subjects on SSI

GRAPH - 2 AVERAGE AUDIOGRAM FOR S.N., CONDUCTIVE, MIXED AND HIGH FREQUENCY LOSS



GRAPH-3 AVERAGE AUDIOGRAM FOR FLAT, GRADUALLY SLOPING AND SLOPING CURVES



First order and Second order: (1) Normals, (2) Mixed loss cases (3) S.N. loss cases, (4) High frequency loss cases, (5) Casea with flat curve, (6) Cases with gradually sloping curve and (6) cases with sloping curve.

To find whether or not there exists differences between these groups in performance on SSI First order and II Orders and to find out whether the samples in each group are drawn from the same population 'Mann Whitney 'U' test' was employed, as generally employed parametric tests are not applicable in this analysis for the following reasons:

a) Here the groups were not matched to one another;

b) The total number of subjects in each group are different

c) The scores obtained do not come under normal distribution and are discrete rather than continuous.

TABLE 6

Showing the result of analysis of the scores of conductive loss compared with other groups

Sl. No.	Groups	Order of sentences	U'Scores	U Scores	Z Scores	Value of Z in A table	Interpretation
	Conductive group Vs. Normal	SSI - I	531.5	225.5	-2.684	0.0037	Ho is rejected at both the levels
		SSI - II	503	368.5	0.71082	0.2389	Ho is accepted at 0.05 & 0.01 levels
	Conductive loss Group Vs Mixed loss group	SSI - I	124.5	49	0	0.5000	Ho is accepted at both 0.05 & 0.01 level
		SSI - II	77	48	-4.238	0.0003	Ho is rejected at both the levels
	Conductive loss Group Vs Sensori Neural loss group	SSI - I	340	111	-1.139	0.1292	Ho is accepted at both the levels.
		SSI - II	328	118	-0.1338	0.4483	Ho is accepted at both the levels.
	Conductive loss Group Vs. High frequency loss group	SSI - I	38.5	17.5	-1.116	0.1230	Ho is accepted.
		SSI - II	30	26	-0.04963	0.4840	Ho is rejected
	Conductive loss Group Vs. Flat Curve group	SSI - I	209	190	-4.149	0.0003	Ho is rejected
		SSI - II	182	28	-4.906	0.0003	Ho is rejected
	Conductive loss Group Vs. Gradually sloping curve group	SSI - I	86	59.5	0.2530	0.4103	Ho is accepted
		SSI - II	76	71	-0.3998	0.3998	Ho is accepted
	Conductive loss Group Vs. Sloping curve group	SSI - I	205.5	4.5	-4.312	0.00003	Ho is rejected
		SSI - II	185.5	15.0	-3.481	0.0003	Ho is rejected

Ho is the null hypothesis.

By the results of the analysis given in Table 6, it is observed that there is no difference between the performances of normals and conductive loss cases on SSI Second order test. This supports the hypothesis No. 3, whereas, the performance on SSI First order is found to differ between conductive loss subjects and normal subjects significantly. This refutes the hypothesis No. 3. Thus it seems reasonable to assume that SSI Second order test is probably more valid test than SSI First order teat.

Further, when the performance of conductive loss cases are compared with that of mixed loss cases on SSI First and SSI Second order, significant difference between these two groups was observed on SSI Second order teat but not on SSI First order test. This supports the previous assumption. This discrepancy between SSI First order and Second order may be attributed to the fact that SSI Second order sentences approximate the real sentence to a greater degree than the First order sentences. Thus the hypothesis No. 5 is supported in case of SSI Second order and refuted with regard to First order sentences.

The comparison between the performance of conductive loss cases and the performances of sensori neural loss cases on SSI First and Second orders shows no significant difference between the two. It is of interest to note that conductive and normals did not differ on SSI Second (Table 6) and also that the sensori neural loss cases differed from normal (Table 10) but not with conductives. The reason as to how there did not exist a difference between the performances of conductive loss cases and sensory neural loss cases, when no significant difference between conductive and normals,

and significant difference between normals and aenaory neural loss cases, existed, is not explainable with the available data and may be attributed to experimental error.

When the performances of conductive loss cases was compared with that of high frequency loss cases, it was observed that the groups did not differ significantly on SSI First and SSI Second orders at both the levels of significance. Thus the hypothesis No. 6 is supported.

When the performance of conductive loss cases was compared with performances of cases with sloping curve, it was observed that the groups differed significantly at both the levels of significance.

When the performance of conductive loss cases was compared with that of the gradually sloping curve group, no significant difference was observed on SSI First and Second orders. The comparison of performance of flat curve group and of conductive loss group showed significant difference between the two on SSI First and Second orders at both the levels of significance. The comparison of performance of the conductive loss cases with that of sloping curve group and flat curve group probably is fallacious as the classification depending upon the pattern of the audiogram may not be justifiable.

TABLE 8

Results of the analysis of Mixed toss group compared with the data of other groups

sl.No.	Groups	Order of Sentence	U' Scores	U Score	Z Score	Value of Z in A Table	Interpretation
1	Mixed loss group Vs Normal group	SSI - I	348.5	22.5	-6.3142	0.0000	Ho is rejected
		SSI - 11	281.1	177.5	-0.6662	0.2546	Ho accepted at both levels.
2	Mixed loss group Vs Sensory neural loss group	SSI - I	132	15.5	-3.380	0.0007	Ho rejected at both levels
		SSI - II	137.5	15.5	-3.380	0. 0007	Ho rejected at both levels
3	Mixed loss group Vs High frequency loss group	SSI - I	21.5	16.5	-0.4724	0.3192	Ho accepted
		SSI - II	21	17	-0.5669	0.2877	Ho accepted
4	Mixed loss group Vs Flat curve group	SSI - I	78	74.5	-5.960	0.0000	H.O. rejected
		SSI - II	84	63.5	-1.678	0.0475	Ho rejected at 0.05 level and accepted at 0.01 level.
5	Mixed loss group Vs. Gradually sloping curve group	SSI - I	37.5	34.5	-0.3177	0.3783	Ho accepted at both levels.
		SSI - II	32	32	-0.2660	0.4013	Ho accepted at both levels.
6	Mixed loss group Vs. Sloping curve group	SSI - I	110	15	-2.626	0.0044	Ho rejected at 0.05 level and accepted at 0.01 level.
		SSI - II	99	6	-3.241	0.0007	Ho rejected at both levels

TABLE 7

Showing the performance scores of mixed loss group on SSI First and Second orders.

31. No.	Age	Sex	Ear	P.T.A. in dB	PL in dB	PB Max. in %	SSI First Order	SSI Second Order
1	30	F	L	60	100	85	80	80
			R	53	95	84	70	100
2	56	M	L	30	70	88	70	90
			R	45	85	72	70	100
3	44	M	L	13	55	—	100	100
			R	20	60	—	90	90
4	20	M	L	—	—	—	—	—
			R	40	80	90	100	100

Table No. 7 indicates the results obtained by mixed loss cases on SSI First order and II Order. The performance ranged from 70 to 100 per cent. The difference between the performances among PB, SSI First order and SSI Second order could not be computed as the N was small and 'Wilcoxon methhed pair signed rank test' was not applicable. Hence, no inferences could be drawn. However, there seems to be no difference among them as observable from Table 7.

To find out whether there is any difference in performance of this group with regard to the other groups M.W.U test waa employed for the reasons as mentioned before.

TABLE 8
Resalts of the analysis of data of Mixed loss group compared with the data of other groups

Sl. No.	Groups	Order of Sentence	U' Score	U Score	Z Score	Value of Z in A Table	Interpretation
1	Mixed loss group Vs Normal group	SSI - I	348.5	22.5	-6.3142	0.0000	Ho is rejected
		SSI - II	281.1	177.5	-0.6662	0.2546	Ho accepted at both levels.
2	Mixed loss group Vs Sensory neural loss group	SSI - I	132	15.5	-3.380	0.0007	Ho rejected at both levels
		SSI - II	137.5	15.5	-3.380	0.0007	Ho rejected at both levels
3	Mixed loss group Vs High frequency loss group	SSI - I	21.5	16.5	-0.4724	0.3192	Ho accepted
		SSI - II	21	17	-0.5669	0.2877	Ho accepted
4	Mixed loss group Vs Flat curve group	SSI - I	78	74.5	-5.960	0.0000	H.O. rejected
		SSI - II	84	63.5	-1.678	0.0475	Ho rejected at 0.05 level and accepted at 0.01 level.
5	Mixed loss group Vs. Gradually sloping curve group	SSI - I	37.5	34.5	-0.3177	0.3783	Ho accepted at both levels.
		SSI - II	32	32	-0.2660	0.4013	Ho accepted at both levels.
6	Mixed loss group Vs. Sloping curve group	SSI - I	110	15	-2.626	0.0044	Ho rejected at 0.05 level and accepted at 0.01 level.
		SSI - II	99	6	-3.241	0.0007	Ho rejected at both levels

When the mixed loss cases are compared with normals there exiata a significant difference with regard to SSI First order but not SSI Second order sentences. This discrepancy may be due to the small sample of the group. When the performance of mixed loss cases are compared with the performance of high frequency loss group there exists no significant difference between the two groups on both SSI First order and Second orders at both the levels of significance.

When the performance of mixed loss cases was compared with that of sloping curve group, on SSI Second order, it was found that they differed significantly at both the levels of significance, whereas on SSI First order the difference existed at 0.05 level but not at 0.01 level. This means that 95% of the time SSI First order yields difference in performance among mixed loss cases and sloping curve group.

The comparison of performance of mixed loss cases with regard to the performances of gradually sloping curve showed no significant difference at both the levels of significance on both SSI First and Second orders.

When the performance of mixed loss cases are compared with the performance of flat curve group on SSI First order, there exists a difference between the two groups at both the levels of significance. On SSI Second order, the difference existed at 0.05 level but not at 0.01 level.

Table 9

Showing the performance scores of sensory neural hearing loss group on SSI First and Second order tests

Sl. No.	Age	Sex	Ear	P.T.A. in dB	PL in dB	PB Max in %	SSI First order score in %	SSI Second order score in percentage.
1	18	M	L	40	80	--	40	40
			R	40	90	--	50	60
2	65	M	L	28	70	--	40	80
			R	17	60	--	40	40
3	68	M	L	60	100	--	30	50
			R	44	85	--	60	50
4	72	M	L	38	80	84	60	80
			R	32	75	88	60	60
5	37	F	L	65	100	--	30	50
			R	60	100	--	50	50
6	19	M	L	38	80	--	70	70
			R	10	50	--	100	90
7	58	M	L	25	65	85	70	90
			R	20	60	88	70	70
8	47	M	L	34	75	60	60	50
			R	25	65	72	65	50
9	33	F	L	57	100	--	50	40
			R	52	95	--	50	50

Sl. No.	Age	Sex	ear	P.T.A. in dB	PL in dB	PB Max in %	SSI First order score in %	SSI Second order acore in percentage
10	48	M	L	39	80	–	70	70
			R	39	80	–	70	60

Table 9 indicates the results obtained on 19 ears with sensory neural loss on SSI First and Second orders presented at zero dB MCR and 40 dB SL. The performance ranged from 30 to 80 per cent.

When the performance of sensory neural loss cases on PB teat waa compared with that of SSI it was found that there existed no difference between the two, with regard to SSI First order, whereas on SSI Second order there existed a significant difference at both the levels.

When the difference between performances of SN loss cases with regard to SSI First order and II order were computed by using 'Wilcoxon matched pair signed rank test' it was found that there was no difference between the two performances at both the levels of significance.

To find whether or not the performance of the subjects with SN loss of hearing differ from that of other clinical groups M.W.U. test was employed and the results of the analysis are given in the Table 10.

TABLE 10

Results of analysis of data obtained by Sensory neural loss of hearing subjects compared *3^)§ other groups ^

Sl. No.	Groups	Order of Sentence	U' Scores	U Scores	Z Scores	Value of Z as in Table A	Interpretation
1	Sensory neural Vs Normal	SSI-I	1156.5	33.5	-6.295	0.0000	Ho is rejected at both the levels
		SSI-II	1204.8	33.5	-6.295	0.0000	Ho is rejected at both the levels
2	Sensory neural Vs High frequency	SSI-I	111	7	-2.557	0.0054	Ho is rejected at 0.05 level
		SSI-II	82	1	-3.021	0.0013	Ho is rejected at both levels
3	Sensory neural Vs Flat curve group	SSI-I	334.5	85.5	-3.247	0.0007	Ho is rejected at both levels
		SSI-II	341.5	85.5	-3.247	0.0007	Ho is rejected at both levels
	Sensory neural Vs Gradually sloping Curve group	SSI-I	41	39	-2.404	0.0082	Ho is rejected at both levels
		SSI-II	181	39	-2.404	0.0082	Ho is rejected at both levels
	Sensory neural Vs. Slope curve	SSI-I	208	132.5	-0.7671	0.2236	Ho is accepted.
		SSI-II	172.5	117.5	-1.098	0.1379	Ho is accepted.

Ho is null hypothesis.

It was found that the performance of normals and SN loss caaea differed significantly at both the levels. This supporta the first part of the hypothesis No. 4- SN loss cases will differ significantly from normals on 3SI test. When the performance of 3N loss group is compared with the performance of mixed loss group it is observed that they differ significantly at both the levels of significance supporting the hypothesis No. 5.

When the performance of SN loss group is compared with that of high frequency loss group, it was observed that there existed significant difference between the two - supporting the hypothesis No. 6.

When the performance of SN loss group is compared with that of sloping curve group, no significant difference was observed, whereas with gradually sloping curve group and the flat curve group the performance of SN loss group differed significantly at both the levels of significance.

TABLE 11

Showing the performance of High frequency loss group on SSI First and Second orders

SI.	Age	Sex	Ear	P.T.A. in dB	PL in dB	PB Max	SSI-I	SSI-II
1	31	M	L	13	55	100	90	90
			R	18	60	100	90	100
2	25	M	L	10	50	75	100	100
			R	20	70	90	90	100

Table 11 indicates the performance scores obtained by 4 ears with high frequency hearing loss on SSI First and Second order sentences presented at 40 dB SL with a competing speech message at M.C.R. of OdB. 3 ears secured performance score of 90 per cent and the remaining one 100 per cent on SSI First order and 3 ears secured 100 per cent performance score and one 90 per cent performance score on SSI Second order. No statistical test could be applied as the N was very small. However, no observable difference was noticed among PB, SSI-I and SSI-II order scores from Table 11.

The differences studied on MannWhitney U test between the performances of High frequency loss group and other groups. The results of the analysis are given in Table It was found that normals differed with regard to SSI First order from the performance of Hg frequency Hg. loss group at both the levels and showed no difference with regard to SSI Second order at both the levels supporting the hypothesis - 6.

TABLE 12

Results of the analysis data obtained on comparison of scores of High frequency hearing loss group with other groups.

Sl. No.	Groups	Order of sentences	U' Scores	U Scores	Z Scores	Value of Z as in Table A	Interpretation
1.	High frequency group Vs. Normal group	SSI-I	390.5	219.5	-2.764	0.0029	Ho is rejected at both levels.
		SSI-II	738	170	-1.389	0.0838	Ho accepted at both levels
2.	High frequency group Vs. Flat Curve group	SSI-I	50.5	19.5	-1.668	0.0485	Ho is rejected at 0.05 level and accepted at 0.016 level.
		SSI-II	43.5	39.5	-0.18533	0.4286	Ho is accepted at both levels
3.	High frequency group Vs. Gradually sloping Curve group	SSI-I	18.5	7.5	-1.620	0.0526	Ho accepted at both levels
		SSI-II	15.5	10.5	-1.157	0.0582	Ho accepted at both levels
4.	High frequency Group Vs. Sloping curve group	SSI-I	53.5	4.5	-2.55	0.0054	Ho rejected
		SSI-II	70.5	8.5	-2.50	0.0062	Ho rejected.

Ho is null hypothesis.

Table 12 indicates that subjects with sloping curve differ significantly in performance from the High frequency loss group on both SSI First and Second order at both the levels of significance. The subjects of the gradually sloping curve group show no difference in performance from that of the subjects from high frequency hearing loss group. Subjects with flat frequency curve show no differences with regard to the performance on SSI Second order sentences from that of High frequency loss at both the levels but on SSI First order they differ at 0.05 level and not at 0.01 level.

TABLE 13

Shows the performance score of the subjects with flat curve on SSI First and Second order

Sl. No.	Age	Sex	Ear	P.T.A. in dB	PL in dB	P.B.M. in %	SSI-I	SSI-II
1	31	M	L	33	75	100	100	100
			R	53	95	100	100	100
2	43	M	L	35	75	100	100	100
			R	35	75	90	100	90
3	56	M	L	30	70	88	70	90
			R	45	85	72	70	100
4	49	M	L	18	60	--	100	100
			R	13	55	--	90	90
5	33	F	L	57	100	--	50	40
			R	52	95	--	50	50

Sl. No.	Age	Sex	Ear	P.T.A. in dB	PL in dB	P.B.M. in %	SSI-I	SSI-II
6	18	M	L	40	80	--	40	40
			R	48	90	--	50	60
7.	42	M	L	35	73	100	100	100
			R	35	73	90	90	100
8	24	M	L	92	--	--	--	--
			R	58	100	100	90	100
9	19	M	L	38	80	--	70	70
			R	10	50	--	100	90
10	24	M	L	18	60	--	90	100
			R	48	90	--	100	100
11	30	F	L	60	100	85	80	80
			R	53	95	84	70	100

Table 13 ahows the results obtained on the performanc of flat frequency loss group on SSI First order and SSI Second order. The performance ranged from 40 to 100 per cent on SSI First and Second order sentences. To find the differences in performance among PB, SSI First and SSI Second order 'Wilcoxon Matched Pair Signed Rank Test' was applied. It was found that there existed no difference between the performances on SSI First and Second order at both the levels of significance. When the performance on pB was compared to the performance on

SSI First order there was no significant difference between the two at both the levels whereas the performance on SSI Second order performance on PB test were comparedno inference could be drawn as N was small.

TABLE 14

Results of the analysis of the data obtained by subjects with Flat curve compared with regard to other groups

Sl. No.	Groups	Order of sentences	U'Scores	U Scores	Z Scores	Value of Z as given in Table A	Interpretation
1.	Flat curve group	SSI - I	963	365	-2.856	0.0022	Ho rejected at both levels
	Vs						
	Normal group	SSI - II	925.5	412.5	-2.350	0.0094	Ho rejected at both levels
2.	Flat curve group	SSI - I	95.5	93.5	-6.987	0.0000	Ho rejected at both levels
	Vs						
	Gradually sloping Curve group	SSI - II:	106	83	-3.292	0.0007	Ho rejected at both levels
3	Flat curve group	SSI - I	245.5	43	-7.348	0.0000	Ho rejected at both levels
	Vs.						
	Slope curve group	SSI - II	251	75	-5.295	0.0000	Ho rejected at both levels.

The performance of Flat curve group is compared with other groups on SSI First and Second order. The results are indicated in Table 14. The analysis of the results on Man Whitney U test indicate that the performance of Flat curve group differ significantly with regard to normals, gradually sloping curve group and sloping curve group of subjects on SSI First and Second orders at 0.05 and 0.01 levels.

TABLE 15

Showing the performance scores of subjects with gradually sloping curve on SSI First and Second order.

Sl. No.	Age	Sex	Bar	P.T.A. in dB	Presentation level in dB	PB Max in %	SSI First in %	SSI Second in %
1	25	M	L	to	50	75	100	100
			R	20	70	90	90	90
2	20	M	L	—	—	—		
			R	40	80	90	100	100
3	37	F	L	65	100	—	30	50
			R	60	100	—	50	50
4	31	M	L	33	75	100	100	100
			R	53	95	100	100	100
5	22	M	L	10	50	98	100	100
			R	30	70	96	100	100

Table 15 indicates the results obtained on SSI First and Second order by the subjects of gradually sloping curve group. The performance ranged from 30 to 100 par cent. No statistical test could be applied to find the difference in performance among PB, SSI First order and SSI Second order as the N was small.

TABLE 16

Results of the analysis of data obtained on comparison of gradually sloping curve with other group.

Sl. No.	Groups	Order of sentences	U'Score	U Score	Z Score	Z Value as given in Table-A	Interpretation
1.	Gradually sloping curve group Vs Normal	SSI- I	399	173	-1.729	0.0427	Ho is accepted at 0.05 level and rejected at 0.01 level.
		SSI-II	335.5	234.5	-8.108	0.0000	Ho is rejected at both levels.
2.	Gradually sloping Curve Vs.	SSI-I	94	21	4.804	0.0003	Ho is rejected at both levels
		SSI-II	106	23	7.335	0.0000	Ho rejected at both levels

Table 16 indicates the analysis of the results obtained on comparison of performance of gradually sloping curve group with normals and sloping curve group. Normals on comparison with performance of the gradually sloping curve group of subjects on SSI First order and Second order indicated difference at 0.01 and 0.05 levels. Gradually sloping curve group of subjects differed significantly from sloping curve group of subjects in performance on SSI First and Second orders at both the levels.

TABLE 17

Knowing the performance of sloping curve group on SSI First and Second order tests.

Sl. No.	Age	Sex	Ear	P.T.A. in dB	PL in dB	P.B.M. in %	SSI-I	SSI-II
1	49	M	L	34	75	60	60	50
			R	25	65	72	65	50
2	48	M	L	39	80	75	70	70
			R	39	80	80	65	60
3	58	M	L	25	65	85	70	90
			R	20	60	80	70	70
4	65	M	L	28	70		40	80
			R	17	60		40	40
5	68	M	L	60	100		30	50
			R	44	85		60	50

SI. No.	Age	Sex	Ear	P.T.A. in 43	PL in dB	P.B.M. in %	SSI-I	SSI-11
6	12	M	L	38	80	84	60	80
			R	32	75	88	60	60
7	19	M	L	58	100	95	80	80
8	21	F	L	23	65	—	80	90

Table t7 indicates the results obtained by the sloping curve group on SSI First and Second order. The performance ranged from 30 to 90 per cent. By applying W.M.P.S.R. test it was found that there is no significant difference between the performances on SSI First and Second order sentences by this group of subjects. When the differences among PB, SSI First order and SSI Second order were computed, it was observed that there existed a significant difference in the performance on PB and SSI First order and no difference on SSI Second and PB scores at both the levels of significance.

TABLE 18

Results of analysis of the data obtained on comparison of sloping curve group with normals:

Group	Order of Sentence	U' Scores	U Scores	Z Scores	Z value in Table A	Interpretation
Sloping curve group Vs. Normal} group	SSI- I	900	246	-1.377	0.08533	Ho accepted at both levels
	SSI-II	935	234	-2.862	0.0021	Ho rejected at both level.

Table 18 indicates that subjects belonging to the sloping curve group differ significantly from the normals in performance on SSI Second order sentences but show no difference on SSI First order at both the levels.

EXPERIMENT 6

To compare the synthetic sentence identification material with the conventional PB word lists in the assessment of discrimination loss in hearing impaired patients, PI functions for PB words and for synthetic sentences are drawn. The following cases were tested for this purpose:

(1) A case of mild SN loss in left ear

(2) A case with bilateral flat sensory neural loss. Right ear was tested,

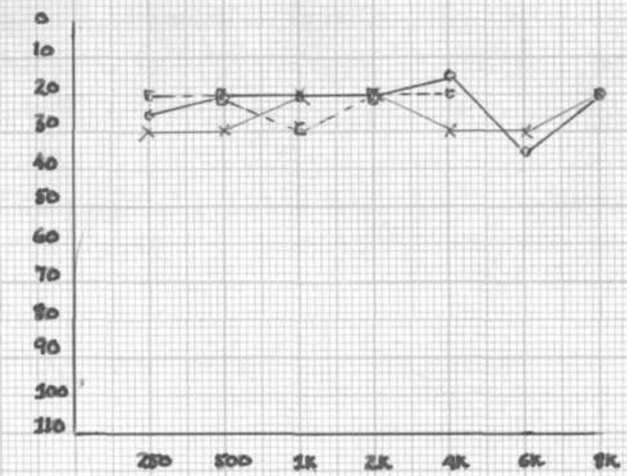
(3) A case with gradual sloping curve with S.N. loss. Right ear,

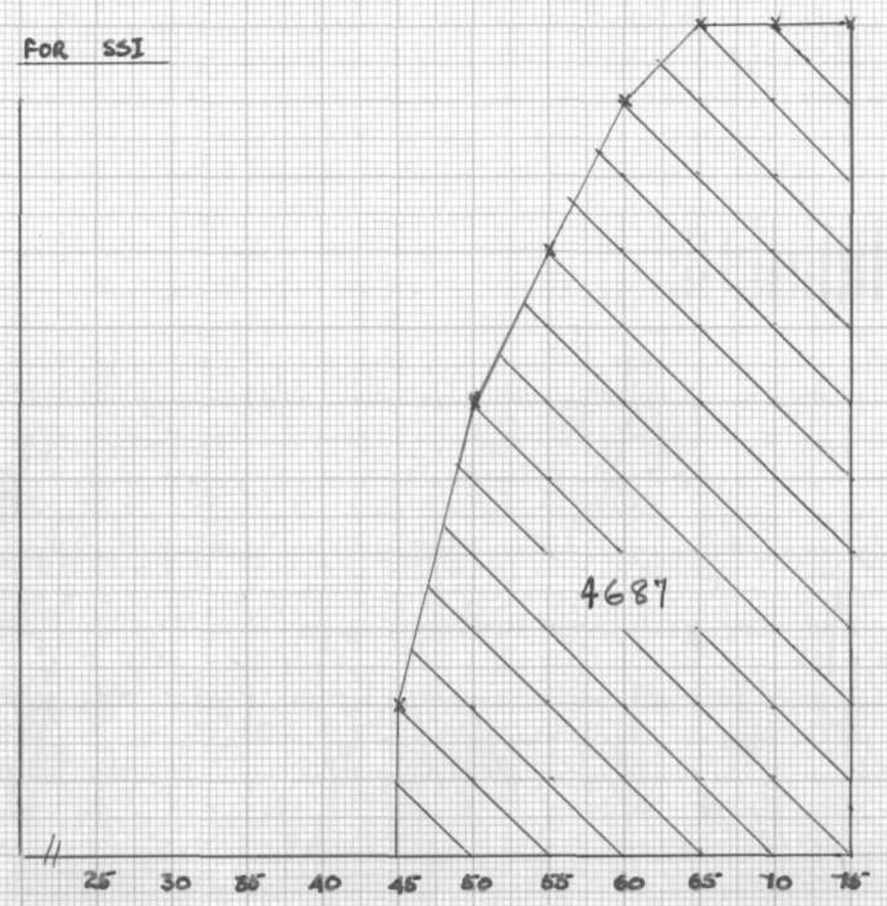
(4) A case with bilateral sensory neural loss with severe slope. Right ear was tested.

The audiograms of the above cases are presented in the graphs 4, 5, 6 and 7 respectively.

Graph 4 shows the PI function for PB and SSI. The number of squares under each of the PI function curve was summed up to represent the areas of the curves. On PB discrimination test the area is 5651 and on SSI the area is 4687. The areas show a sizable discrepancy. This may be due to the difference

GRAPH-[redacted] 4 PI FUNCTION CURVE FOR A FLAT CURVE





in language as PB words were in English and SSI was in Kannada.

Graph 5 shows a sizable discrepancy between the areas of PB and SSI. Again this discrepancy may be attributed to differences in the languages of the two tests. The areas being 6060 for SSI test and 2959 for PB.

Graph 6 and 7 also show sizable difference in the areas. In all the graphs except for No. 4 (Flat curve) the PB area is larger than the SSI area.

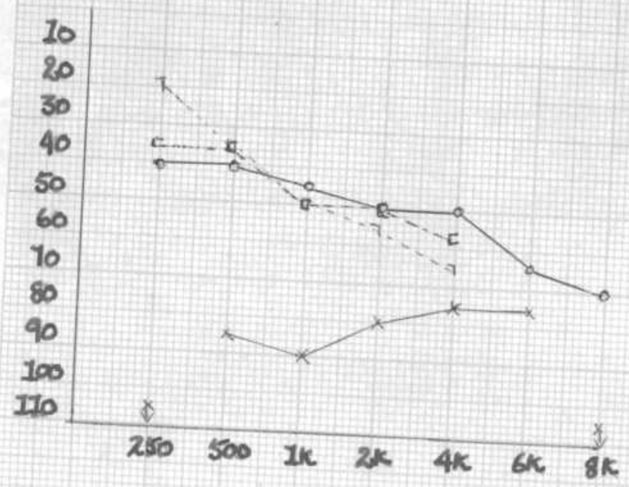
EXPERIMENT 7

To find test retest reliability, the test was re-administered on 10 randomly selected subjects after a week of the prior testing. The results of the two tests were subjected to rank correlation test. It was found that the reliability was high as the correlation values were 0.56, 0.76

EXPERIMENT 8

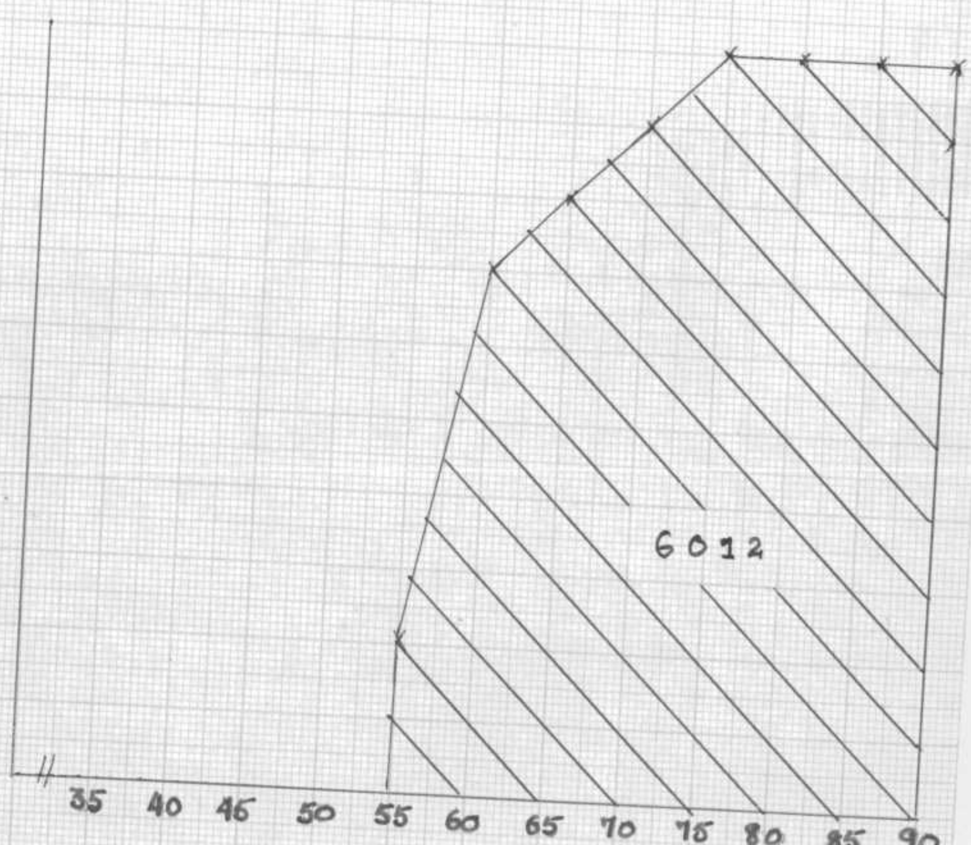
To find the content validity of the test, the performances on SSI were compared with the performances on PB words. They were compared with regard to normals and each of the clinical group. The statistical significance of the difference between the two sets has been computed using Wilcoxon matched pair signed rank teat. The Table 19 in the next page indicates the results of analysis.

GRAPH- [redacted] 5 PI FUNCTION CURVE WITH FLAT CURVE OF S.N. LOSS

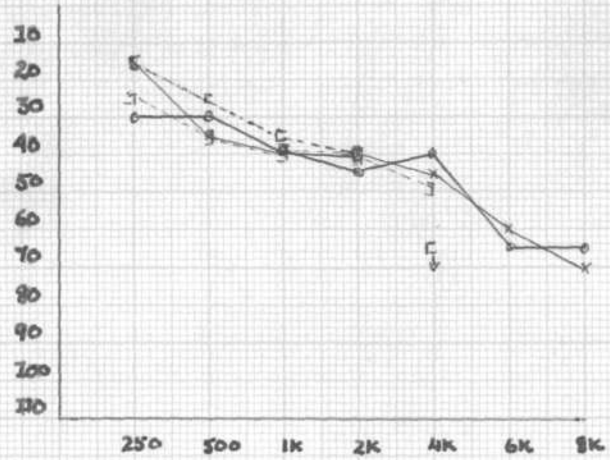


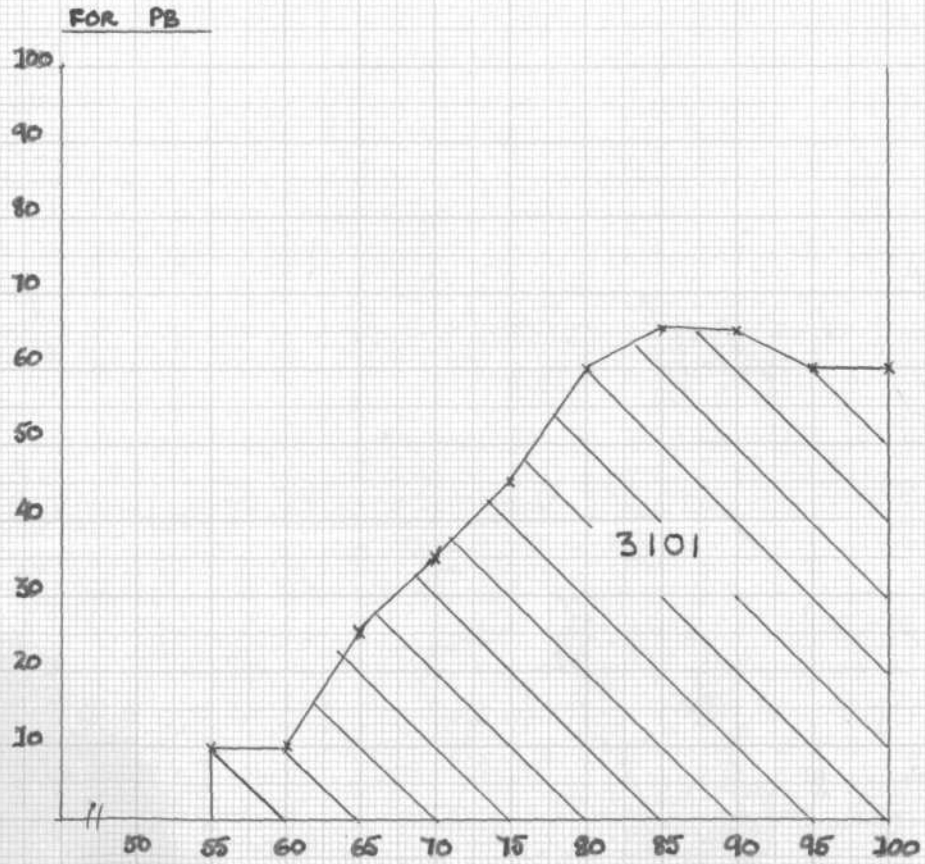
FOR PB

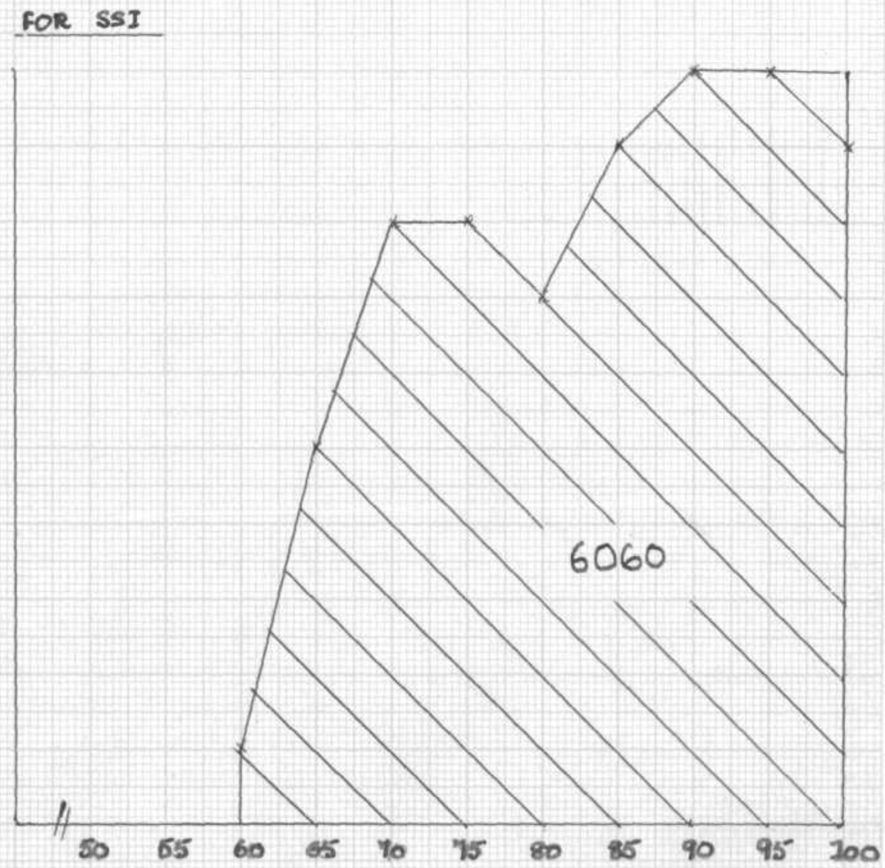
FOR SSI



GRAPH - 6   PI FUNCTION FOR S.N. LOSS CASE OF GRADUALLY SLOPING CURVE







GRAPH 7 PI FUNCTION CURVE FOR A SLOPING CURVE

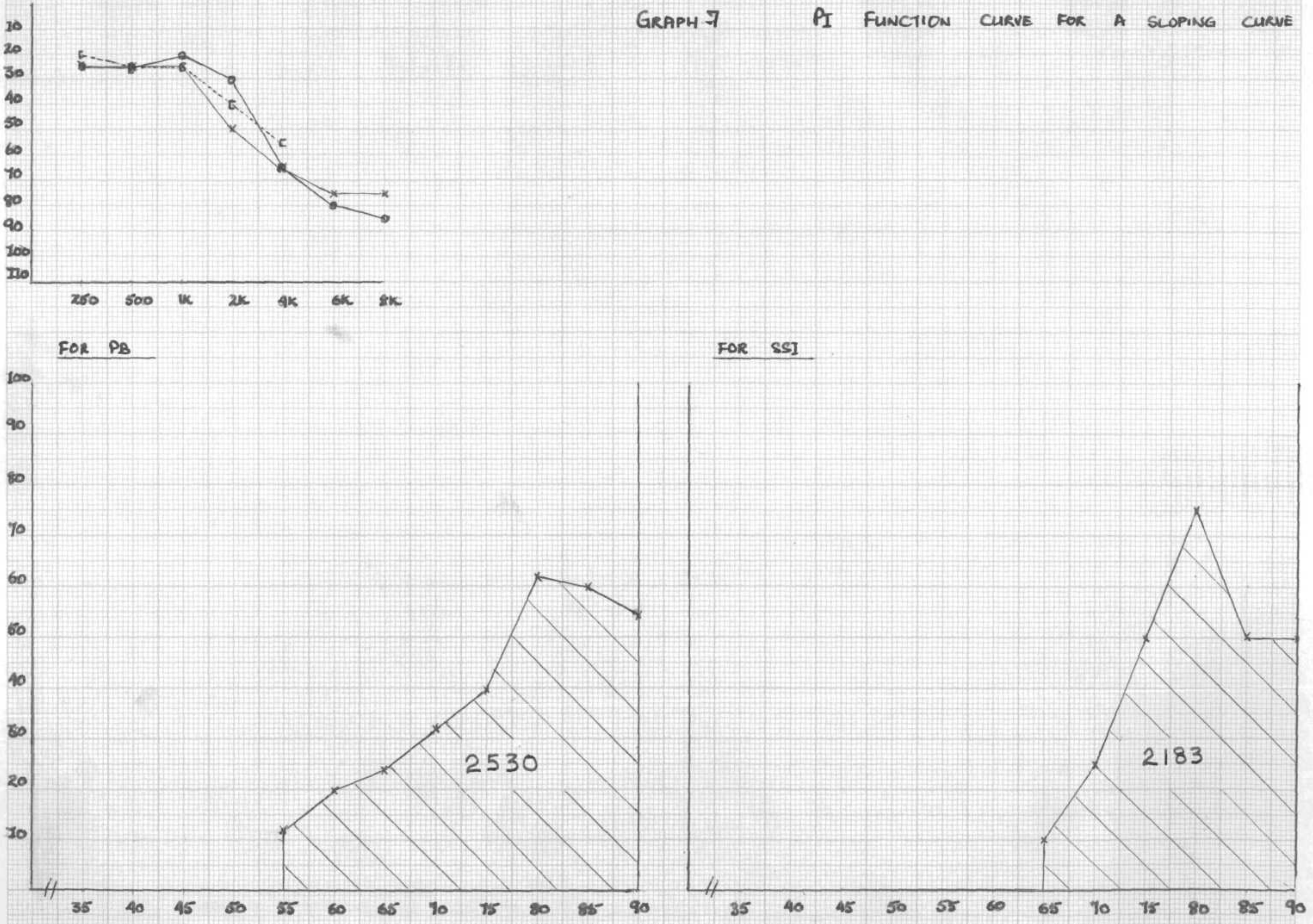


Table 19

Sl. No.	Groups	Significance of difference
1.	Normals	Significant
2.	Conductive loss	Significant
3.	Sensory neural loss	Insignificant
4.	Mixed loss	No inference could be drawn
5.	High frequency loss	-do-
6.	Flat curve	Insignificant
7.	Gradually sloping curve	Insignificant
8.	Sloping curve	Insignificant.

From the above data no valid conclusions can be drawn probably due to the difference in the languages. Probably the attempt of establishing validity by comparing the performance on SSI test with the performance on PB list may not be justifiable. Yet this has been done as there is no alternative.

CHAPTER V

SUMMARY AND CONCLUSIONS

Speech audiometry is an invaluable tool for diagnostic purposes. Traditionally monosyllabic words (PB words) and spondee words were used as materials for speech audiometry. Certain shortcomings have been noticed in traditional speech audiometry. To overcome these shortcomings Jerger et al (1968) have developed a new approach to speech audiometry. In Kannada language there are no standardized speech materials developed so far. It is difficult to construct PB and spondee word lists in Kannada as there are a few monosyllables and a few equally stressed disyllabic words. For this reason, in this study, an attempt is made to construct a synthetic speech identification tests in Kannada on the basis of "A New Approach to Speech Audiometry". (Jerger J. 1968)

Synthetic sentences were constructed using most commonly used words in Kannada language. Ten first order sentences and ten second order sentences were constructed. To make the task more difficult these sentences were recorded with a continuous competing speech message. First, 3 lists of First order and 3 lists of Second order sentences were presented to 30 normal hearing subjects for getting performance pattern and to find the presentation level and MCR level at which performance is maximum.

As this was very lengthy and time consuming and also as fatigue might have affected the performance of the subjects a second tape was prepared. It consisted of 1 list of First order sentences, another list of Second order sentences on one track and competing speech on the other track. Thia tape-2 was presented to 30 normal hearing subjects for competing normative data. Next it was administered to 8 conductive hearing loss cases, 4 mixed loss cases, 10 sensory neural cases and 2 high frequency hearing loss cases to study their performance on this test. The obtained data was subjected to statistical analysis (MannWhittney - U. test-Siegal's 1956; pp. 166-27) for finding the statistical significance of differences among the groups. PB word test was administered to all those cases and normal who know English and Kannada languages. The data obtained on this test were compared with that of SSI test by applying Wilcoxon paired sign rank test.

To compare the performance of 4 subjects of different audiogram patterns in terms of area, PI function curves are drawn for PB and SSI scores obtained at different intensity levels. The reliability of the test was computed by analysing the data obtained on two different days for the same test on ten randomly selected subjects.

Conclusions:

The following inferences can be drawn from this study.

1. The performance on the SSI test varies directly with the level of presentation and inversely with MCR.

2. Normals obtain maximum performance scores on SSI test at 40 dB SL and at 0 dB MCR level.

3. There was no significant difference between normals and conductive loss groups on SSI Second order sentences than SSI First

orders

4. Sensorineural hearing loss group showed significant difference in performance with regard to normals and other clinical groups except conductive loss group on SSI Second order. The discrepancy with regard to conductive loss group could not be explained with the help of the available data and may be due to an experimental error.

5. Mixed loss group showed significant difference in performance with normals and other clinical groups on SSI Second order except for gradually sloping curve.

6. High frequency loss group differed significantly in performance from clinical groups except in gradual sloping curve from normal group.

7. It is observed that classifying patients solely on the basis of the pattern of audiogram seems to be fallacious.

8+ Comparison of the performances on PB word lists and SSI lists did not yield any valid conclusions as comparison of SSI test in Kannada with English PB test may not be appropriate.

9. SSI First order test seems to be not as valid as SSI Second order test as the former shows many discrepancies in the results. This can be explained on the basis of the nature of the Second order sentences.

10. SSI Second order test appears to be a valid clinical tool

and may be used as a test for speech discrimination especially with subjects who know Kannada only.

Limitations:

1. The study is not conducted on a large populations and may require further standardization.

2. The test cannot be used with illiterates and children.

3. The morphological aspects of Kannada language are not fully controlled in this study.

Further recommendations:

1. Construction and standardization of materials by taking the root of words and by considering the preceding words instead of the following words and finding the difference, if any, between this and the present test.

2. Comparison of English S3I with Kannada SSI to study the differences.

3. Finding binaural effect by using competing speech in place of noise as in Feldman's experiments (Beltone Translations).

4. Evaluating the efficacy of hearing aids using SSI test.

5. Finding the improvement in auditory training.

6. Developing SSI test in other languages.

APPENDIX I

APPENDIX

Audio frequency analyzer B & K type 2107 (used for calibration)

Tpe 2107 ia an a.c. operated audio-frequency analyzer of the constant percentage band width type.

It has been designed especially as a narrow band sound and vibration analyzer, but may be used for any kind of frequency analysis and distribution measurement within the specified frequency range.

This instrument is used with artificial ear type 4152 and artificial mastoid type 4130 for a.c. and b.c. calibration.

Artificial ear - type 4152 - A.E. type 4152 is designed to enable acoustical measurements on ear-phones to be carried out under well-defined acoustical conditions (I.S.O. specifications), It consists basically of a replaceable acoustical couple and two sockets for the mounting of a condensor microphone cartridge type 4132 and a cathode follower amplifier type 2163, connected to the A.F. analyzer type 2107. A spring arrangement is provided to fulfill certain standard requirements regarding the force applied to the object under measurement. To enable acoustical testa, to be made on head phones used in audio-meters, a six centimeter cube acoustical coupler is provided in this type.

The artificial ear satisfies the I.S.O. specifications (I.S.O./T.C. 43).

APPENDIX II

CHAPTER-1

1 §AzÀÄ CªÀgÀÄ ªÀÄ£ÀÄÀ CªÀ£ÀÄ EzÀÄ FUÀ¸À®

2 §AzÀÄ vÀÃÉ£ÉÃqÀÄ ºÉÃUÀÄ ¢£À£ÀÄÀÉM¼ÀÉ

3. JµÀÄ vÀ¤ÀÄ F H I CªÀ£ÀÄ ¤£Àª ÃÉ¯É

4 ¨ÃÉPÀÄ PÀqÀÄ vÀ¤ÀÄ ¥ÀqÀÄ ºÉgÀÉF ¤£À

5 ªÀzÀÄª É¹PÀÄ M¼ÀÉPÉ¢£À«µÀiÀÄ §gÀĪ À

6 ¹PÀÄ JA§ »AzÉJAzÀCªÀgÀÄ v£ÀÀ»ÃUÉ

7 EªÀgÀÄ vÀÃÉD ¥ÀqÀÄ PÀ½vÀÄ ²Ã PÁtÄ

8 ¨ÃÉPÀÄ ªÃÉ¯ÉªÉz®Ä vÉÉÀÄ ¤£À²Ã §UÉ

9 PÀ½vÀÄ vÉÉÀÄ CªÀgÀÄ AiÀÄPÉCªÀgÀÄ M¼ÀÉ E£ÀÄ

10 PÁAiÀð PÀqÀÄ F ºÉUÉ§gÀĪ ÀºÉ¼ÀÄ EzÀÄ

CHAPTER-2

1 ¸À ªÄºÁzÉªÀF ºÀqÀUÀgÀ §º¼ÀÀJ£ÀªÁzÀªÉªÀqÀªÁzÀªÉ

2 AiÀªÀÀÀ ©¹ ©¹ PÁ¦ü¥Àr ªÀqÀªÁzÀªÉPÀ¸À

3 ¥ÉÀÁUÀÁd ¸ÀÀºÉÃzÀCAiÉÃ £ÀÀ¥À§º¼ÀÀZÉÁVzÉvÀ ¨Á

4 ¯ÉÃ I §º¼ÀÀUÁ½ vÀ¥ÁV E® vÀÉE® vÀÉÄ®zÀ½ÀUÉ

5 ¸ÀÀd §ºÀ¨ÉUÀ§¤Ã §¤Ã M¼ÀÉ£ÀÀ ªÀÀÀ

6 £ÀÉÀÉAqÀ ºÉÃUÀ ¨ÉªÁ¹ð §qÉÀÉKPÉÃ EµÉ vÀÉÁ

7 PÀzÀÄ vÀ ¨Á ZÉÁV PÀ¸ÀE® E®ªÉ E® £ÀÀ

8 gÁUÀºÁqÀvÃAiÉ CAvÀªÀvÉJ°UÉ¨ÉPÁzÀÀ PÁ¸À

9 §AUÁgÀ£ÀÀÉ§AUÁgÀÀªÀ£ÀµÀÁV ºÀnzÉ vÀÀÁV KPÉ

10 ©ÃUÀJ°UÉºÉÃVzÉCªÀÀ §gÀÁ£É¨Ér ¨ÉU½ÀÉgÀ

ALL INDIA INSTITUTE OF SPEECH & HEARING: MYSORE 6

Synthetic Speech Identification Test Score Sheet-1.

Name Age: Yrs. Sex:M/F

List-1-Order of presentation: 2 5 8 9 6 4 1 3 10 7

1 §AzÀÄ vÀÄÉ£ÉÃqÀÄ ºÉÃUÀÄ ¢£À£ÀÄÛÉM¼ÀUÉ
2 ªÀÄzÀĪÉ¹PÀÄ M¼ÀUÉPÉ¢£À«µÀAiÀÄ §gÀĪÀ
3 ¨ÉÃPÀÄ ªÉÃ¯ÉªÉzÀÄ vÉÆÉÃÀÄ ¤£À²Ã §UÉ
4 PÀ½vÀÄ vÉÆÉÃÀÄ CªÀgÀÄ AiÀÄPÉCªÀgÀÄ M¼ÀUÉE£ÀÄ
5 ¹PÀÄ JA§ »AzÉJAzÀCªÀgÀÄ v£ÀÀ»ÃUÉ
6 ¨ÉÃPÀÄ PÀqÀÄ vÀÄÀÄ ¥ÀqÀÄ ºÉgÀÄÉF ¤£À
7 §AzÀÄ CªÀgÀÄ ªÀÄ£À¸ÀÄ Cª£ÀÄ EzÀÄ FUÀ¸À®
8 JµÀÄ vÀÄÀÄ F H Ì Cª£ÀÄ ¤£ÀªÉÃ¯É
9 PÁAiÀÕ PÀqÀÄ F ºÉÃUÉ§gÀĪÀºÉ¼ÀÄ EzÀÄ
10 EªÀgÀÄ vÀÄÉD ¥ÀqÀÄ PÀ½vÀÄ ²Ã PÁtÄ

No. of correct Identification: Percentage

No. List 2- Order of Persentation- 6 1 3 10 4 2 9 7 5 8

1 ¹PÀÄ JA§ »AzÉJAzÀCªÀgÀÄ v£ÀÀ»ÃUÉ
2 §AzÀÄ CªÀgÀÄ ªÀÄ£À¸ÀÄ Cª£ÀÄ EzÀÄ FUÀ¸À®
3 JµÀÄ vÀÄÀÄ F H Ì Cª£ÀÄ ¤£ÀªÉÃ¯É
4 PÁAiÀÕ PÀqÀÄ F ºÉÃUÉ§gÀĪÀºÉ¼ÀÄ EzÀÄ
5 ¨ÉÃPÀÄ PÀqÀÄ vÀÄÀÄ ¥ÀqÀÄ ºÉgÀÄÉF ¤£À
6 §AzÀÄ vÀÄÉ£ÉÃqÀÄ ºÉÃUÀÄ ¢£À£ÀÄÛÉM¼ÀUÉ
7 PÀ½vÀÄ vÉÆÉÃÀÄ CªÀgÀÄ AiÀÄPÉCªÀgÀÄ M¼ÀUÉE£ÀÄ
8 EªÀgÀÄ vÀÄÉD ¥ÀqÀÄ PÀ½vÀÄ ²Ã PÁtÄ
9 ªÀÄzÀĪÉ¹PÀÄ M¼ÀUÉPÉ¢£À«µÀAiÀÄ §gÀĪÀ
10 ¨ÉÃPÀÄ ªÉÃ¯ÉªÉzÀÄ vÉÆÉÃÀÄ ¤£À²Ã §UÉ

No. of Correct Identification = %

SSI Score sheet-2

No. List 3- Order of Presentation: 10 1 5 8 3 9 2 4 6 7

1 PÁAiÀÄð PÀðqÀ F ºÉÆUÉ§gÀÄªÀ ºÉÆ¼ÀÄ EzÀÄ
2 §AzÀÄ CªÀgÀÄ ªÀÄ£À¸ÀÄ CªÀgÀÄ EzÀÄ FUÀ¸ÀÄ
3 ªÀÄzÀÄªÉ¹PÀÄ M¼ÀUÉPÉ¢£À«µÀAiÀÄ §gÀÄªÀ
4 ¨ÉÃPÀÄ ªÀÄ£É¯ÉªÉÆzÀÄ vÉÆÃjÀ ¤£À²Ã §UÉ
5 JµÀÄ vÀÄªÀÄ F H l CªÀgÀÄ ¤£ÀªÀÄ£É¯É
6 PÀ½vÀÄ vÉÆÃjÀ CªÀgÀÄ AiÀÄPÉCªÀgÀÄ M¼ÀUÉE£ÀÄ
7 §AzÀÄ vÀÉ£É£ÃqÀÄ ºÉÆÃUÀÄ ¢£À£ÀUÉM¼ÀUÉ
8 ¨ÉÃPÀÄ PÀðqÀ vÀÄªÀÄ ¥ÀqÀÄ ºÉgÀÄÉF ¤£À
9 ¹PÀÄ JA§ »AzÉJAzÀCªÀgÀÄ vÀÄÀ»ÃUÉ
10 EªÀgÀÄ vÀÉD ¥ÀqÀÄ PÀ½vÀÄ ²Ã PÁtÄ

No. of Correct identification= Percentage =

SET-2

List 4 – Order of Presentation: 4 5 8 3 7 1 9 10 6 2

1 ¯ÉÃl §º¼ÀÀUÁ½ vÀÄ¥ÁV E® vÀÉE® vÀÉÄ®zÀÄ½ÀUÉ
2 ¸ÀÄd §ºÀ¨ÉÆUÀ§¤Ã §¤Ã M¼ÀÉ£ÀÄ ªÀÄÀÄ
3 gÁUÀºÁqÀÄvÃAiÉ CAvÀªÀÄvÉJ°UÉ¨ÉÃPÁzÀgÀÉ PÁ¸À
4 ¥ÉÆÀÁUÀgÀÁd ¸ÀÄºÉÃzÀCAiÉÃ £ÀÄ¥À§º¼ÀZÉÁVzÉvÀÄ¨Á
5 PÀÉzÀÄ vÀÄ¨Á ZÉÁV PÉ¸ÀE® E®ªÉ E® £ÀÀ
6 ¸À ªÀÄºÁzÉªÀF ºÀqÀUÀÄ §º¼ÀJ£ÀªÀzÀÉªÀqÀªÀzÀÉ
7 §AUÁgÀ£ÀÀÉ§AUÁgÀÀªÀÄ£ÀµÀÁV ºÀnzÉ vÀqÀÁV KPÉ
8 ©ÃUÀJ°UÉºÉÃVzÉCªÀÄ §gÀvÁ£É¨Ér ¨ÉÆU½ÀÉgÀÄ
9 £ÀqÉÆÃÉAqÀÄ ºÉÃUÀÄ ¨ÉªÁ¹ð §qÉÀÉKPÉÃ EµÉ vÀÉÁ
10 AiÀÄªÀÄÀ ©¹ ©¹ PÁ¦ü¥Àr ªÀqÀªÀzÀÉPÉ¸À

No. of Correct Identification= Percentage%=

SSI Score Sheet -3

List 5 Order of Presentation: 9 6 2 4 3 8 1 10 5 7

1 §AUÁgÀ£ÀÄÉ§AUÁgÀzÀ ªÀÄ£ÀÄµÀå£ÀÁV ºÀÄnzÉ vÀqÀªÀÁV KPÉ
2 £ÀqÉ¢ÃPÉAqÀ ºÉÃUÀ ¨ÉªÁ¹ð §qÉzÀÉKPÉÃ EµÉ vÀÃÉÁ
3 AiÀÄ ªÀÀÀÀ ©¹ ©¹ PÁ¦ü¥Àr ªÀÄqÀ ªÀzÀ¥ÉPÉ¸À
4 ¯ÉÃ I §º¼ÀÀUÁ½ vÀ¥ÁV E® vÀÉE® vÀÉÄ®zÀ¼ÀUÉ
5 ¥ÉzÀÁUÀÁd ¸ÀÀºÉÃzÀCAiÉÄ £ÀÀ¥À§º¼ÀÀZÉÁVzÉvÀ ¨Á
6 gÁUÀºÁqÀvÃAiÉCAvÀªÀvÉJºUÉ¨ÉPÁzÀÀ PÁ¸À
7 ¸À ªÀºÁzÉªÀF ºÀqÀUÀÀ §º¼ÀÀJ£ÀªÀzÀÉªÀqÀªÀzÀÉ
8 ©ÃUÀJºUÉºÉÃVzÉCªÀÀ §gÀÁ£É¨Ér ¨ÉUÀÀgÀ
9 ¸ÀÀd §ºÀ¨ÉUÀ§¤Ã §¤Ã M¼ÀÉ£ÀÀ ªÀÀÀ
10 PÀzÀÄ vÀ¨Á ZÉÁV PÉ¸ÀE® E®ªÉ E® £ÀÀ

No. of Correct Identification: Percentage:

List – 6 Order of Presentation: 8 1 7 6 4 3 10 2 5 9

1 gÁUÀºÁqÀvÃAiÉCAvÀªÀvÉJºUÉ¨ÉPÁzÀÀ PÁ¸À
2 ¸À ªÀºÁzÉªÀF ºÀqÀUÀÀ §º¼ÀÀJ£ÀªÀzÀÉªÀqÀªÀzÀÉ
3 PÀzÀÄ vÀ¨Á ZÉÁV PÉ¸ÀE® E®ªÉ E® £ÀÀ
4 £ÀqÉ¢ÃPÉAqÀ ºÉÃUÀ ¨ÉªÁ¹ð §qÉzÀÉKPÉÃ EµÉ vÀÃÉÁ
5 ¯ÉÃ I §º¼ÀÀUÁ½ vÀ¥ÁV E® vÀÉE® vÀÉÄ®zÀ¼ÀUÉ
6 ¥ÉzÀÁUÀÁd ¸ÀÀºÉÃzÀCAiÉÄ £ÀÀ¥À§º¼ÀÀZÉÁVzÉvÀ ¨Á
7 ©ÃUÀJºUÉºÉÃVzÉCªÀÀ §gÀÁ£É¨Ér ¨ÉUÀÀgÀ
8 AiÀÄ ªÀÀÀÀ ©¹ ©¹ PÁ¦ü¥Àr ªÀÄqÀ ªÀzÀ¥ÉPÉ¸À
9 ¸ÀÀd §ºÀ¨ÉUÀ§¤Ã §¤Ã M¼ÀÉ£ÀÀ ªÀÀÀ
10 §AUÁgÀ£ÀÄÉ§AUÁgÀzÀ ªÀÄ£ÀÄµÀå£ÀÁV ºÀÄnzÉ vÀqÀªÀÁV KPÉ

No. of correct Identification = Percetage%=

SSI TEST IN KANNADA – SCORE SHEET FOR TAPE -2

SSI SCORE SHEET – II

NAME AGE SEX-M/F

List1. Order of Presentation: 10 1 5 8 3 9 2 4 6 7

1 PÁAiÀÄð PÀAqÀÄ F ºÉÆUÉ§gÀÄªÀ ºÉƼÀÄ EzÀÄ
2 §AzÀÄ CªÀgÀÄ ªÀiÁ¸ÀÄ CªÀ£ÀÄ EzÀÄ FUÀ¸ÀÄ
3 ªÀÄzÀĪÉ¹PÀÄ M¼ÀîÉPÉ ¢£À«µÀAiÀÄ §gÀĪÀ
4 ¨ÉPÀÄ ªÀiÁ¯ÉªÉzÀÄ vÉÆÃzÀÄ ¤£À²Ã §UÉ
5 JµÀÄ vÀÄAÄ F H l CªÀ£ÀÄ ¤£ÀªÀiÁ¯É
6 PÀ¼ÀvÀÄ vÉÆÃzÀÄ CªÀgÀÄ AiÀÄPÉ CªÀgÀÄ M¼ÀîÉ £ÀÄ
7 §AzÀÄ vÀAÉ£ÉÃqÀÄ ºÉÆUÀÄ ¢£À£ÀÀÉ M¼ÀîÉ
8 ¨ÉPÀÄ PÀAqÀÄ vÀÄAÄ ¥ÀqÀÄ ºÉÆgÀÉ F ¤£À
9 ¹PÀÄ JA§ »AzÉJAzÀ CªÀgÀÄ vÀ£À»ÃUÉ
10 EªÀgÀÄ vÀAÉD ¥ÀqÀÄ PÀ¼ÀvÀÄ ²Ã PÁtÄ

No. of Correct Identification= Prcentage

Second Order Sentences

Order of Presentation: 4 5 8 3 7 1 9 10 6 2

1 ¯ÉÃl §º¼ÀÀUÁ½ vÀÄ¥ÁV E® vÀAÉE® vÀAÉÄ®zÀ¼ÀUÉ
2 ¸ÀAiÀÄd §ºÀÄ¨ÉÆUÀ§¤Ã §¤Ã M¼ÀîÉ£ÀÀ ªÀÄgÀÀ
3 gÁUÀºÁqÀÄvÃAiÉ CAvÀªÀÄvÉJ°UÉ¨ÉPÁzÀgÀÉ PÁ¸ÀÄ
4 ¥ÉÆ£ÁUÀgÁd ¸ÀÄ°ÉÃzÀCAiÉÄÃ £ÀÄ¥À§º¼ÀÀZÉÁVzÉvÀÄ¨Á
5 PÀÉzÀÄ vÀÄ¨Á ZÉÁV PÉ®¸ÀE® E®ªÉ E® £ÀÀ
6 ¸ÀÄ ªÀÄ°ÁzÉªÀF ºÀqÀUÀgÀÄ §º¼ÀÀJ£ÀĪÀzÀÉ ªÀÄqÀĪÀzÀÉ
7 §AUÁgÀ£ÀÀÉ§AUÁgÀªÀÄ£ÀµÀÁV ºÀÄzÉ vÀqÀÁV KPÉ
8 ©ÃUÀJ°UÉºÉÃVzÉCªÀ£ÀÄ §gÀÄvÁ£É¨ÉÃr ¨ÉUÀ¼ÀÉgÀÄ
9 £ÀqÉÆÃPÉAqÀÄ ºÉÃUÀÄ ¨ÉªÁ¹ð §qÉzÉKPÉÃ EµÉ vÀAÉÁ
10 AiÀÄªÀÀÀ ©¹ ©¹ PÁ¦ü¥Àr ªÀÄqÀĪÀzÀÉPÉ®¸À

No. of Correct Identification = Percentage:

B I B L I 0 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 Delhi: A.I.I.M.B.

BERGER, KENNETH (1969) A Speech discrimination task using Multiple choice Key word instances; J. Auditory Research. 3247-262.

BERGER, KENNETH (1971) Speech Audiometry in Audiological Assessment (Ed) Rose, D.B., Engle Wood Cliffs; Prentice-Hall.

BEYER, M.R. et al (1969) Revalidation of the Clinical test versions of the Modified Rhyme Testa; J.Speech & Hearing Research; 12,374-378.

BLACK, J.W.(1957) Multiple Choice Intelligibility Tests; L. Speech and Hearing Disorder: 22-213-235.

BLACK, J.W. (1959) Equally Contributing Frequency bends in Intelligibility testing: J.Speech and Hearing Res. 2.81-83

BLACK, J.W. and HAAGEN, C.H. (1963) Multiple Choice Intelligibility Test forms A and B. J.Speech & Hearing Dis. 28-77-86.

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

BOWLING, L and ELPERN, B. (1961) Relative Intelligibility of Items on CID Auditory Teat W.1; J. Speech & Hearing Re. 4 152-157.

BRANDY, W.T. (1966) Reliability of Voice Tests of Speech Discrimination; J.Speech & Hearing Res; 9 461-465

CAMPBELL, (1954) Form and Style in Thesis Writing: Boston: Houghton Miffin.

CAMPBELL, R.A. (1965) Discrimination Test Word Difficulty; J. Speech & Hearing Dis.. 8, 13-22.

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

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

CARHART R. & JERGER, J (1967) Preferred Methoda for Clinical Determination of Pure Tone Thresholds; J. Speech & Hearing Res: 10, 361-366

CARHART, R. (1970) Contemporary American Tests and Procedures in Second Symposium on Speech Audiometry (Ed) Rajskjar C. University Hospital Odense-Denmark; p. 28-36.

CARHART R (1970). Principles of Competing Speech Message speeeh Audiometry in Second Symposium of Speech Audiometry (Ed) Rojskjar, C. University Hospital, Odense, Denmark; pp. 112-122.

CARHART, R. (1970) Discussion; Daily Routine Tests and Methods and Purposes of Speech Audiometry in Second Symposium on Speech Audiometry (Ed) Rojskjar, C. University Hospital Odense - Denmark; pp. 251-52, 254 & 259.

C.CRESTON (1965) Speech Audiometry; Taped Vs. Live Voice dah Abstracts - 6

DIRKS, D.B. and BOWER, D. (1969) Masking Effects of Speech Competing Messages; J. Speech & Hearing Res; 12-229-245

EWING A.W.G. and IRENE EWING (1937) The Handicap of Deafness London, Longmans, Green & Co. Inc. pp.128-149.

EGAN, P. JAMES (1948) Articulation Testing Method, Laryngoscope L VIII 955-91. in O'Neill J. and Oyer J.H. (1966) "Applied Audiometry"; Dodd, Mead & Co., Inc.; p. 80.

FLETCHER HARVEY (1929) Speech and Hearing D Van Nostrand Co. INC. New York, pp. 255-90 in O'Neill J. and Oyer J.H. Loc. Cit.

FAIR BANKS (1958) Test of Phonemic differenciation. The Rhyme Test; J.acoust. Soc. Amer., 30, 596 to 600 in Kreul.J.et al 1968 Op cit - 536-552.

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

GL0RIG, ARAM (1965) Audiometry: Principles and Practices: Baltimore: Williams and Wilkins.

GRUBB, P. (1963-a) A Phonemic Analysis of half list Speech Discrimination; J. Speech & Hearing Res. 6, 271-275

GRUBB, p. (1963-B) Some Consideration in the use of half list Speech discrimination Test; J. Speech & Hearing Res 6.294-297

HIRSH, I.J. (1947) Clinical Application of two Harward Auditory Teats - J. Speech & Hearing Pis. 12-151-158

HIRSH, et al (1952) Development of Materials for Speech Audiometry; J. Speech & Hearing Pis. 17, 321-337.

HIRSH, J.I. (1952) The measurement of Hearing: New York; MacGraw Hill.

JERGER, J. Et al (1959) Some Relation between normal Hearing for Puretones 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.

JERGER, J. (1970) Development of Synthetic Sentences Identification as a tool for Speech audiometry. Second Danvoc Symposium on Speech Audiometry (Ed) by Rojskar. University Hospital, Odense-Denmark; pp. 44-65.

JERGER, J. (1970) Diagnostic Significance of Speech Test Procedures; Second Danvox Symposium Op.Cit. p. 91

JERGER, J. (1970) Diagnostic Significance of SSI Test Cochlear Site. Second Danvox Symposium: Op. Cit: p. 140

JERGER, J. (1970) Diagnostic Significance; SSI Test Retro Cochlear Site; Second Danvox Symposium: Op.Cit: p. 163

JERGER, J. (1970) SSI Test Procedure and Auditory Rehabilitation Second Danvox Symposium: Op.Cit.p. 200

JERGER, J. (1970) Discussion, Question, Answer and Comments on PB and SSI Test; Second Danvox Symposium: Op.Cit. 230, 231, 233 & 250-51.

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

KOPRA, L.L. and BL0SSER (1968) Comparison of Fair Banks Rhyme Test and CID Auditory Test W-22 in Normals 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.

KREUL, E.J. et al (1969) Factors affecting Discrimination Test Difficulty; J. Speech A Hearing Res. 12, 281-287.

L.A. FON, J.C. (1966) Auditory Basis of Phonetics in Manual of Phonetics (Ed) Malamberg, Amastardom; North Holland.

LOVRINIC, J.H. et al (1968) A Comparative Evaluation of Five Speech Discrimination Measures; J, Speech & Hearing Res. 11,372-381.

MILLER, G.A. (1951) Speech and Language in Handbook of Experimental Psychology (Ed) S.S. Stevens; New York "Johnwile & Sons; Inc.

NBWBY, HAYES, A. (1970) Audiology Vission Press, 157, Knights Bridge, London.

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

NELSON et al (1970) Write down Vs. Talk back scoring and scoring bias in Speech Discrimination Testing; J. Speech & Hearin? Research. 13 654-645.

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

PALMER, J. (1955) The effect of Speaker Differences on the Intelligibility of Phonetic Balanced Word Lists; J.Speech and Hearing Dis. 20, 192-195.

PETERSON, G.E. and I. LEHISTE (1962) Revised CNC Lists for Auditory Tests; J. Speech & Hearing Pis 27, p. 62-70.

RESNICK (1963) Reliability of the 25 PB Word Lists dsh Abstracts

RORE, D.E. (1971) Audiological Assessment: Englewood Cliffs; Prentice Hall.

SCHULTZ, M.C. (1964) Word Familiarity Influences in Speech Discrimination; J. Speech & Hearing Res. 7, pp. 395-400.

SILVERMAN, 3.R. A HIRSH, I.J. (1965) Problems related to the use of Speech in Clinical Audiometry. Ann Otol. Rhinol. Lamynogology 64, 1234-45.

SHUTTS et al (1964) Derivation of 25 word PB Lists; J. Speech A Hearing Pis. 29-442-447.

SPEAKS, C. and JERG3R, J. (1965) Method for Measurement of Speech Identification; J. Speech & Hearing Reg. 8; p. 185-194.

SPEAKS, c. et al (1966) Performance Intensity Characteristics of Synthetic Sentences; J. Speech & Hearing Res. 9, 305-312.

SPEAKS, C. (1967-a) Intelligibility of filtered Synthetic. Sentences; J. Speech & Hearing Res. 10, 289-298.

SPEAKS, C. (1970) Performance Intensity Characteristics of Selected Verbal Material? J. Speech & Hearing Res. 10, 344-347.

SPEAKS, C. and JERGER, J. (1967) Synthetic Sentence Identification and Receiver Operating Characteristics; J. Speech & Hearing Res. 10, 110 to 119.

SPEAKS, C. and KERMEN, L.J. (1967) The effect of Noise Synthetic Sentence Identification, J. Speech & Hearing, 10 - 381-389.

SPEAKS, C. et al (1967) Effect of Competing Message on Synthetic Sentence Identification; J. Speech & Hearing Res. 10, 390-395

SPEAKS, C. et al (1970) Comparison of Sentence Identification and Conventional Speech Discrimination Scores; J. Speech & Hearing Res-13. 741-754.

SPEAKS, C. et al (1970) Measurement of Hearing Handicaps: J. Speech & Hearing Research 13, 768-776.

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

TRAMMEL et al (1970) On the Distracting Properties of Competing Speech; J. Speech & Hearing Res. Vol. 13, 442-445.

V.R.A. Report (1970-71) Report No. 6; Project S.R.S. 19-P-58134 -F-01 From All India Institute of Speech & Rearing, Mysore

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

WOLFOSCAR (1874) New Investigations on the Methods of Examination and Derangements of Hearing; Arch Ophtholmology, Otology, IV, 67-86. in O'NEILL J.J. & OYER, J.H. "Applied Audiometry", Op. Cit. 76-77.