ARTICULATION FUNCTIONS FOR THE COMMON WORD LISTS BETWEEN KANNADA AND TELUGU LANGUAGES FOR NATIVE SPEAKERS OF KANNADA

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A Dissertation
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C E R T I F I C A T E

This is to certify that the dissertation entitled "ARTICULATION FUNCTIONS FOR THE COMMON WORD LISTS BETWEEN KANNADA AND TELUGU LANGUAGE FOR NATIVE SPEAKERS OF KANNADA" is the bonafide work in part fulfilment for the degree of Master of Science (Speech and Hearing) of the student with Register No.

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C E R T I F I C A T E

This is to certify that the dissertation entitled "ARTICULATION FUNCTIONS FOR THE COMMON WORD LISTS BETWEEN KANNADA AND TELUGU LANGUAGES FOR NATIVE SPEAKERS OF KANNADA" has been done under my supervision and guidance.

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D E C L A R A T I O N

This dissertation is the result of my own work done under the guidance of Dr. (Miss) Shailaja Nikam, Professor & Head of the Department of Audiology, All India Institute of Speech and Hearing, Mysore, and has not been submitted earlier at any University for any other Diploma or Degree.

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C H A P T E R - I

INTRODUCTION

Assessment of hearing has a long history with the increasing understanding of hearing mechanism and disorders of hearing, new methods have been evolved to assess hearing. In addition, the old techniques are being further evaluated and refined.

Tests using speech stimuli have been used in assessment for as long as other procedures (Noble, 1978). Indeed prior to introduction of the audiometer, soeech testing was probably the major assessment tool. Even now soeech audiometry is a basic tool of audiological evaluation.

Pure tone audiometry alone does not provide all the information about a person's ability to hear at supra-threshold,levels and hence should be supplemented by speech audiometry. Speech stimuli are used in measuring sensitivity of hearing, to evaluate the functional state of the auditory system at suprathreshold levels. Localization of specific lesions of the auditory systems could be done by using certain measures of speech audiometry, for instance, performance intensity functions of PB words are useful in the diagnosis of Will nerve lesions (Jerger and Jerger, 1971; Jerger and Hayes, 1977). Speech stimuli are extensively used in the detection of non-organic hearing loss (Hopkinson, 1978).

In addition to their diagnostic utility, outcome of otologic surgery could be predicted by speech tests (Kasden and Robinson, 1969). Audiological rehabilitative procedures also utilize the performance of individuals on speech tests. Selection of hearing aids (Davis, 1960; Harris et al, 1961; Speaks and Jerger, 1965; Bode and Kasten, 1971) is done with the help of speech stimuli. The value of therapeutic procedures such as lip-reading and auditory training could also be assessed by such measures (Goetzinger, 1978).

Speech discrimination score is one of the measures obtained in speech audiometry and various tests have been standardized for clinical use in the Western countries (Egan, 1948; Haskins, 1949; Hirsh et al, 1952; Black, 1957; Fairbanks, 1958; Lehiste and Peterson, 1959; Tillman, Carhart and Wilber, 1963; House et al, 1965; Tillman and Carhart, 1966; Jerger, Speaks and Trammell, 1968; Kreul et al, 1968; Berger, 1969). These tests cover a wide range of difficulty . which may be dependent upon the test material. At one end of the spectrum, aside from isolated phonemes are nonsense phonemes followed by monosyllabic words, words of two syllables or more and sentences (Goetzinger, 1978). Tests used to assess the function of higher auditory centres utilize speech stimuli which have been altered in certain parameters, for eg., use of filtered speech (Bocca and Calearo, 1963) and time compressed speech (Sticht and Gray, 1960; Beasley, Schwimmer and Rintelmann, 1972).

Standardization of speech stimuli in some Indian languages for discrimination testing have bean taken up. However, the number of such

attempts seem very limited when the number of languages spoken in India is taken into consideration. Studies on standardization of speech discrimination tests on Indian population could be grouped into two which are as follows:-

1. Studies which utilized English speech stimuli (Swarnalatha, 1972; Malini, 1981), and

2. Studies done in some Indian languages (De, 1973; Nagaraja, 1973; Mayadevi, 1974; Samuel, 1976; Mallikarjuna, 1984).

Owing to the importance of speech audiometry in audiological evaluation, there is a growing need to construct and standardize speech stimuli in different Indian languages.

Need for the Study:

A number of investigations have shown that speech discrimination ability of an individual is affected by his/her linguistic experience (Sapon and Carrol, 1957; Singh, 1966; Singh and Black, 1966; Nikam, Beasley and Rintelmann, 1976; Gat and Keith, 1978; Malini,1981; Sinha, 1981; Sood, 1981). These studies have pointed out that optimum discrimination scores are obtained in tests utilizing stimuli from native language. Therefore, standardization of speech stimuli in different Indian languages is essential.

There are no standardized speech stimuli for discrimination testing in Telugu, an Indo-Dravidian language. Nagaraja (1973) developed synthetic sentence Identification test in Kannada, also, an Indo-Dravidian language and reports on clinical utilization of this test for discrimina-

tion testing are not available. Often, phonetically balanced monosyllabic word lists are employed in speech discrimination testing and there are only a few monosyllabic words in Kannada. Therefore, words with two or more syllables have to be used for this purpose.

Srilatha (1983) compiled four lists of fifty bisyllabic words common to Kannada and Telugu language. It was intended that such common word lists would reduce the problem of standardization and that a clinician with the knowledge of either of the two languages could test patients in the other language with equal efficiency. However, the discriminability of these words need to be evaluated. Also, as the words were common between the two languages it is not known if a group of native Kannada speakers would discriminate them equally well irrespective of the language of the carrier phrase, i.e., either Kannada or Telugu one. The present study was designed to obtain articulation for the lists developed by Srilatha (1983) and to examine the effect of the language of carrier phrase on discrimination.

Summary and statement of the problem:-

Speech audiometry is an indespensible tool in audiological evaluation. Speech discrimination tests in Kannada language are lacking. The availability of monosyllabic words in Kannada is limited and therefore other kinds of speech stimuli have to be used for the purpose. The present study aimed at obtaining articulation functions for the lists prepared by Srilatha (1983). The study was designed to answer the following questions;

1. Does the discrimination score vary with the increase in sensation level?

2. Is there a significant difference among the four lists in terms of difficulty?

3. Is there a significant effect of the language of the carrier phrase on the discrimination scores?

4. Is there a significant interaction among the above variables?

C H A P T E R - II

REVIEW OF LITERATURE

Use of speech materials in hearing assessment is not a new practice. As early as 1874, Wolf (cited in O'Neill and Oyer, 1966) had suggested that the human voice was the "most perfect conceivable measure of hearing". He constructed a table of intensity values for the various sounds viz., consonants, syllables and words in German language and used paces instead of decibels as the unit of intensity.

There are standardized speech stimuli and testing methods available to an audiologist. Today, he/she is interested in obtaining speech reception thresholds and speech discrimination scores. Secondary measures of the threshold of detectability and tolerance or discomfort levels may also be obtained (O'Neill and Oyer, 1966).

The early development of speech reception tests was directed towards the testing of the deaf, whereas the discrimination or intelligibility tests were developed to assisst the evaluation of communication system. A number of tests have been developed to measure speech discrimination and three kinds of stimuli are available for testing, viz., nonsense syllables, monosyllabic words and sentences. Nonsense syllables, being devoid of meaning, contain no semantic cues to assisst in discrimination. They are often abstract and very confusing to the listener (Carhart, 1965). Monosyllabic words, as meaningful linguistic units of speech, are not as difficult

as nonsense syllables. In addition, monosyllabic words in sentences are more discriminable than in isolation because of contextual cues (Miller, Heise and Lichten, 1951). However, sentence materials could obscure speech discrimination difficulties of a subject as they provide more cues for correct guessing (Carhart, 1965). Considering the limitations of using nonsense syllables and sentence materials for testing speech discrimination, monosyllabic words have been utilized mostly. Further, Carhart (1970) has stated that American audiologists continue to use lists of monosyllabic words as the primary tool for determining a patient's capacity to discriminate phonetic measures.

Word Lists:-

The first widely used tests of monosyllabic words, called PAL PB-50 word lists were constructed by Egan (1948). He finalised twenty lists of fifty words each. Of these twenty, Eldert and Davis (1951) found that eight lists recorded by Rush Hughes were not equivalent in difficulty.

The PAL PB-50 words were developed to test adult subjects. So, Haskins (1949) developed four PB word lists in which the test items were within the speaking vocabularies of young children. These so called PBK lists (Phonetically balanced kindergarten) are widely used in clinics throughout the U.S. to test speech discrimination ability in children (Goetzinger, 1978). However, these lists can be administered only in monitored live-voice testing, as the

recorded versions of the lists are not commercially available.

The next significant steo in the development and standardization of speech discrimination tests was the development of CID W-22 word lists by Hirsh et al (1952). They modified the PAL PB-50 lists because of the lack of familiarity of many of the test words, and poor standardization of the recordings. Finally, four lists of fifty monosyllabic words each were obtained. The six scramblings of each of the four lists ware recorded on magnetic tapes using the carrier phrase "you will say....." (Hirsh et al, 1952).

The utility of W-22 lists is questionable. In fact, Hirsh et al (1952) themselves have pointed out that the preliminary experiments with the lists indicated that W-22 test did not permit differentiation between patients with mixed deafness and patients with pure conductive deafness. They further reported that the recordings of PAL PB-50 lists (Egan, 1948) were more effective, (Hirsh et al, 1952). The CID W-22 lists were found to be easier than the PAL PB-50 lists (Carhart, 1965). The former gave high scores at a sensation level of 25 dB. To obtain the scores, the PB-50 lists had to be presented at about 40 dBSL. Also, with W-22 words, discrimination improves rapidly as the presentation level is raised, and that scores become nearly perfect relatively close to SRT. The Rush Hughes version was much more exacting by the more gradual improvement in discrimination as the presentation level was increased

(Carhart, 1965). These differences have been attributed to the greater familiarity of the words and speaker intelligibility (Owens, 1961; Carhart, 1965).

The W-22 words, although highly familiar, are regarded as too easy for fine differential diagnosis. Also, considering the inadequancies of phonetic balancing of P8-50 lists Lehiste and Peterson (1959) developed new monosyllabic word lists consisting of 1263 words of consonant-nucleus-consonant (CNC) nature. Ten lists of fifty words each were formed and the advantages of these lists are that only CNC familiar words are used. Each list matched the phonetic balance of the parent list of 1263 words rather than English generally.

Using the list prepared by Lehiste and Peterson (1959), Tillman, Carhart and Wilber (1963) developed the North-Western University Auditory test No.4 (Nu Auditory test No.4) consisting of lists I and II. These lists were found equivalent in difficulty (Tillman, Carhart and Wilber, 1963). Further, Tillman and Carhart (1966) compiled four lists of fifty words each called as Nu Auditory Test No.6 and these four lists were randomized four times. Inter test reliability was reported to be high for subjects with normal hearing and for those with sansorineural hearing loss (Tillman and Carhart, 1966).

A somewhat different type of monosyllabic word test gained popularity in the U.S. This was the use of closed message sets called as Rhyme tests.

Rhyme tests:

Black (1957) developed a multiple choice intelligibility test. Four alternatives were given to the listener per item and he had to select from them. Each list consisted of twenty four items and Black (1957) developed twentyfour such lists. However, the criteria of phonetic balancing was not taken into consideration and the items were not restricted to monosyllables.

Fairbanks (1958) develooed the rhyme test, a refinement of the multiple-choice test, consisting of five lists of monosyllabic words which were matched in phonetic balance and word familiarity as much as possible. In this test, the listener only needed to identify the beginning consonant of each test word among five word choices. Further, House et al (1965) refined the Rhyme test and constructed the Modified Rhyme Test.

Kreul et al (1968) attempted to adopt the Modifed Rhyme test (House et al, 1965) to the needs of the clinical audiologist. They mixed the test items with noise and the composite signal was finally recorded. Three s/N ratios were chosen so as to give an average score of 96%, 83% and 75% in normal subjects.

The advantage of the above type of tests was that the un-controlled factors like the familiarity were eliminated. However,

adjustment has to be made for correct guesses while scoring the responses and this turns out to be a major disadvantage (Carhart, 1970). Further, the clinical utility of the Rhyme tests have been studied by some. Kopra, Blosser and Waldron (1968) did not find any significant difference in diagnostic capability between the Rhyme and the W-22 tests. The former was not as effective as the P8-50 lists in differentiating pathologic cases (Kryter and Whitman, 1965). Further, Northern and Hattler (1974) using the Modified Rhyme Test as described by Kruel et al (1968) obtained same results as those of the above studies.

KSU Test

Berger (1969) developed a different type of test utilizing monosyllabic words which were embedded in sentences called the Kent State University Test (KSU Test). Berger, Keating and Rose (1971) observed that the KSU test was less sensitive to hearing impairment when compared to W-22 lists. However, this test was more efficient than W-22, in predicting how efficiently one could use his hearing for communicative purposes.

Test of speech discrimination utilizing monosyllabic words have an inherent disadvantage i.e., they do not consider the changing pattern of speech over time (Jerger, Speaks and Trammell, 1968). Taking this into consideration, Jerger, Speaks and Trammell (1968) developed a new approach to speech audiometry.

Synthetic Sentence Identification;

Jerger, Speaks and Trammell (1968) developed sets of synthetic sentences of different orders of approximation to real sentences. They utilized closed message set to avoid tester errors in scoring and linguistic variables to which the open-message set is vulnerable. Ipsilateral competing message of continuous discourse at S/N of 0 dB was utilized to make the listening task more difficult. When SSI is used diagnostically a performance - Intensity function could be obtained and this in turn could be compared with performance-intensity curve for PB words (Jerger, Speaks and Trammell, 1968).

Speaks, Jerger and Trammell (1970) studied sixty subjects with hearing loss and noted that SSI-MCR and the PAL PB-50 lists gave equivalent results when the audiometric configuration was flat. As the slope of the audiomatric contour increased, the PB performance worsened while the performance on SSI-MCR remained same. The results suggested that PB scores are primarily sensitive to high frequency sensitivity, whereas SSI-MCR is sensitive to low frequency sensitivity. Thus the diagnostic utility of monosyllabic tests seem better.

All the above studies in general indicate that monosyllabic words are most often used speech stimuli to assess the speech discrimination ability of individuals. Also, discrimination tests employing monosyllabic words have been improved in several ways. Some of these tests have beenutilized to test Indian subjects.

Use of English Speech Discrimination tests on Indian Population:

The availability of standardized speech discrimination tests in India are limited and one way to over come this limitation is to use the tests standardized elsewhere. The use of English lists necessitates certain modifications to be done or different norms to be established for the English speaking Indian population. Swarnalathan (1972) and Malini (1981) have carried out such studies.

Swarnalatha (1972) standardized speech test materials in English for Indians. She reasoned that the English word lists are not suitable for Indians directly because of familiarity factor. She obtained familiarity ratings for 200 words from the PAL PB-50 lists and 200 words from W-22 lists. Familiarity ratings were obtained from 200 adult subjects and the words were rated as 'familiar', 'not so familiar' and "not familiar". Also monosyllabic words from Haskins' (1949) PBK lists were administered to 200 children for familiarity rating. Considering the familiar words two lists of twenty five words were compiled, each having words of equal familiarity and the lists were phonetically balanced. In this way, Swarnalatha (1972) arrived at two PB monosyllabic word lists for adults and two lists for children also.

The test words were recorded on tapes with the carrier phrase "say the word ....." and used for standardization. Fiftysix normal

hearing young adults and fiftysix children were tested. The lists were presented to the subjects at various intensities (0, 10, 20, 30, 35, 40, 45 and 50 dB above PTA) and articulation curves were obtained. 100% correct discrimination was obtained at 42 dB (ref: PTA, 10 dB) in case of adults and at 45 dB (ref: PTA, 13 dB) for children (Swarnalatha, 1972). She suggested in a clinical situation, the speech discrimination teat has to be administered at 33 dBSL (ref: SRT) for adults and at 36 dBSL (ref: SRT) for children.

There are some drawbacks in Swarnalatha's (1972) study:

1. The adult subjects had studied upto PUC or above, but their level of English knowledge is not specified except that they knew English. In case of children too it is just reported that they had normal intelligence and knew English;
2. While presenting the test items through the audiometer, calibration tone for the maintainence of input level was not made use of;
3. Swarnalatha (1972) considered oral responses in her study and therefore the tester bias was not controlled;
4. The lists had only twentyfive words as against the conventional practice of using fifty words;
5. No scramblings of the lists were worked out and when one tries to establish PI function, the same two lists have to be used which could bring about practice effect;

6. Although, Swarnalatha (1972) has reported that the lists ere of equal difficulty, list equivalency was not established statistically.

Further, no follow up reports of the clinical utility of the lists prepared by Swarnalatha (1972) are available. Considering this and also the advantages of Nu Auditory Test No.6, Malini (1981) evaluated the applicability of Nu Auditory Test No.6 for English speaking Indians.

Malini (1981) tested forty normal young adults using the recorded lists of Form A of the Nu Auditory Test No.6. An adult male talker recorded the words on a tape with a carrier phrase "You will say.....". Criteria of subjects' knowledge of English was controlled in the study. Five sensation levels were used for testing viz., 8, 16, 24, 32 and 40 dB (ref: SRT) and articulation functions were obtained. Recorded W-1 list of spondees were used for determining the SRT of the subjects. Each individual listened to all the four lists at different sensation levels and the list level combinations were randomized. Written responses were obtained for analysis.

The results of Malini's (1981) study showed that,

1. the discrimination scores improved with an increase in sensation level;
2. The scores did not reach an asymptotic level even at 40 dB SL (ref: SRT);

3. The difficulty level of the four lists used in the study were found to be significantly different. The order of difficulty of lists from difficult to easy was list I, List II, list III and list IV. This relative difficulty of the lists seemed to be similar for both native speakers (Rintelmann, Schumaier and Burchfield, 1974; Schumaier, Penley and Rintelmann, 1974) and for the English speaking Indians (Malini, 1981).

Malini (1981), based on her study, concluded that the test could be diagnostically useful as it seemed to be difficult enough for the normal hearing subjects and that further studies were needed to verify this.

Although the original test was made use of, the fact that, an Indian recorded the material could have introduced certain modifications. Further, a higher sensation level was not tried to see if an asymptotic level is reached or not. No follow-up reports on the clinical utility of the Nu Auditory test No.6 standardized on Indian population by Malini (1981) are available.

A few more studies were carried out using the recorded versions of the Nu Auditory Test No.6 to evaluate certain factors which are found to affect the discrimination scores. They are; effect of talker difference (Joseph, 1983), effect of training and native language of the tester on scoring of the responses (Elizabeth, 1983) and effect of age (Mani Meghalai, 1983) on the discrimination ability.

Joseph (1983) examined the effect of talker difference on word discrimination scores using the recorded lists of Nu Auditory Test No.6 (Form A). A female and a male talker recorded all the four lists with the carrier phrase "You will say....." separately. Joseph (1983) tested forty normal young adults who were native speakers of Kannada language. Criterion of knowledge of English of the subjects was controlled by administering a test of English ability. The subjects had to score at least 50% on that test. The discrimination scores for the four lists were obtained at five sensation levels (8, 16, 24, 32 and 40 dB, ref: SRT).

The results of Joseph's study (1983) indicated that the scores increased with increasing sensation levels. Contrary to Malini's (1981) findings, this study found that the four lists were equivalent.

Articulation functions obtained using the male and female talkers differed. The scores did not show a plateau at 40 dBSL (ref: SRT) for the female talker. This indicated that further improvement in scores could be made possible with increasing sensation levels. But the discrimination scores did not show much improvement with increase in sensation level from 24 dB to 40 dBSL (ref: SRT) for the male talker. There was also a significant difference ($P \leq 0.05$) in discrimination scores obtained by recorded lists of the two talkers. This calls for standardization of recorded material for a particular talker before it could be tried on a clinical population.

The discrimination scores obtained by Joseph (1983) using the

recordings of female talker were higher than that for the male talker and those obtained by Malini (1981). The differences between the findings of Malini (1981) and Joseph (1983) were attributed to the differences in recording situation viz; Malini (1981) carried out the recording in a sound treated audiometric room whereas Joseph (1983) did it in an anechoic chamber. Also, subjects of Malini's (1981) study were linguistically more heterogenous while those in Joseph's study (1983) were homogenous when the linguistic background is taken into consideration*

Using the same recorded material of male talker of Joseph's study (1983), Deuaraj (1983) examined the effect of word familiarity on speech discrimination score. She also studied the difference in word familiarity between the trained and untrained subjects. The trained subjects were individuals who had undergone training in speech and hearing field for more than two years. Totally sixty subjects were tested out of which twenty were listeners and forty subjects served as testers. Among the forty testers, twenty were trained persons and the remaining were untrained.

Normal hearing young adult subjects were tested and they were required to have an adequate knowledge of English (as in Joseph's study, 1983). Each individual listened to all the four lists of Nu Auditory Test No.6 at four sensation levels in a group of fivefiz., 8, 16, 24, 32 and 40 dB (ref; SRT). Randomized order of lists and levels were used. Both oral and written responses were obtained from all the

listeners. For each listener, two testers scored the oral responses by writing down what they heard (Devaraj, 1983).

Devaraj (1983) collected data on familiarity from all the sixty subjects. A four point scale of familiarity was utilized for the words from the four lists used in the study. The results showed that words which were highly familiar were correctly discriminated more often than those which were less familiar and this was statistically significant ($P \leq 0.01$). However, at different intensity levels, the listeners' familiarity with the test words had no influence on their discrimination scores. Also, she did not find significant difference between trained and untrained testers with respect to their familiarity with test words.

Based on the mean familiarity rating of the test words, it was found that the lists III and IV had greater number of highly familiar words (i.e., fortyeight in number) whereas lists I and II had forty-seven and fortyfive respectively in the NU Auditory Test No.6 (Devaraj, (1983). She suggested that the unfamiliar words could be excluded from the lists. She concluded that written responses should be taken during word discrimination testing as the tester's familiarity with the test words is likely to influence the discrimination socres. This was because even testers found some words not highly familiar.

Elizabeth (1983) investigated the effect of native language of the tester on scoring the responses and whether training influenced

scoring of the resoonses of a speech discrimination test. Using the recorded versions of NU Auditory Test No.6 (same recording as of Devaraj's study, 1983), sixty subjects were tested. Twenty subjects served as listeners and forty as testers. In the group of testers twenty were trained and theothers were untrained. In the above, each group of ten subjects belonged to Indo-Aryan native language group and the other ten to Dravidian language group. These testers were required to write down the oral responses of the listeners.

Articulation curves were obtained for discrimination scores of the four lists at different sensation levels (8, 16, 24, 32 and 40 dB, ref: SRT). The results indicated that there was no significant difference between the responses heard and evaluated by trained and untrained testers (Elizabeth, 1983). Further there was no significant difference between the scoring done by Indo-Aryan and Dravidian group of testers.

Elizabeth (1983) concluded that training did not bring about any difference in the ability to score the resoonses while testing speech discrimination. This, according to her,indicated that training of speech and hearing specialists at the present time did not help the testers to overcome the effect of his or her native language on scoring of a non-native language test. This, in turn, might point to the fact that practice to listen to the sounds of non-native language during the training program would help in improving the efficiency with which a non-native language test is used in speech and hearing clinics.

Mani Meghalai (1983) studied the effect of aging on the speech discrimination ability in Indian subjects. Seventyfive male subjects were selected for the study. The sample was divided into five different categories of fifteen subjects each based on age viz., 19-29 years, 30-39 years, 40-49 years, 50-59 years and the last group comprised of individuals of 60 years and above. The subjects had to have normal hearing based on the norms for different age groups as given by Indrani (1981). Also adequate knowledge of English was another criterion for selection of subjects.

Recorded speech materials viz., CIDW-1 and four lists of Form A of the NU Auditory Test No.6 were used for SRT and speech discrimination testing respectively (as in the above studies). Again, Mani meghalai (1983) used five sensitive levels (8, 16, 24, 32 and 40 dB ref: SRT). The list-level combinations were computed based on random numbers (Mc Call, 1970) and the order of presentation was also randomly chosen. Written responses were obtained from the subjects.

The analysis of the results indicated that discrimination scores improved with increasing sensation levels and this was observed in all the groups of subjects studied (Mani Meghalai, 1983). As the age advanced the discrimination scores decreased. The subjects in the age range of 19-29 years and 30-39 years performed similarly. Also, persons in the fourth and fifth decade showed similar performance on

the speech discrimination task. In general, the speech discrimination ability of persons beyond forty years was poorer than that of the younger subjects. The oldest subjects of the study viz., individuals of age 60 years and above showed greatest decrement in discriminating speech. These results reflect the speech perceptual problems encountered by the aged population. Mani Meghalai (1983) also found that the four lists of NU Auditory Test No.6 to be equivalent in terms of their difficulty and this finding is in agreement with that of Joseph (1983).

The studies of Joseph (1983), Devaraj (1983), Elizabeth (1983) and Mani Meghalai (1983) could be directly compared because of the following factors;

1. They have utilized similar criteria for the selection of subjects.
2. Used the same recorded material with the carrier phrase "You will say....." fcr both SRT and speech discrimination testing (CIDW-1 and NU Auditory Test No.6, Form A respectively).
3. They have tested the subjects using the same set of equipment and under similar testing situations.
4. Written responses were considered for analysis and a similar scoring method was utilized.

Thus the above tests give a set of normative data and information about some factors which affect the discrimination scores. However, further data on clinical population is required, before which definite

conclusions on the clinical utility of the NU Auditory Test No.6 for Indian population cannot be drawn. The use of English speech material for Indian subjects is limited when one takes the knowledge of English among the individuals under consideration. Therefore, the criterion for the adequacy of English knowledge as used in the above studies may not always be met by the clinical population. Added to these factors, the linguistic experience being a very important one which influence the performance on a listening task, the development of speech discrimination tests in native language becomes crucial.

Perception of time compressed monosyllables:

In contrast to the above studies, recorded English word lists by an American talker have been directly tried out on Indians without further modifications (Nikam, Beasley and Rintelmann, 1976; Sood, 1981). These studies, using the time compressed speech discrimination tasks have shown a definite effect of linguistic factors on performance of non-native speakers. Though the studies are less in number, they - have demonstrated certain trends in factors which influence the results. Factors such as language relatedness, familiarity with and exposure to the language have been correlated with the performance.

The intelligibility of time-compressed CNC monosyllables was studied by Nikam, Beasley and Rintelmann (1976). They compared the performance of English speaker/listener whose native language was Spanish or Indo-Dravidian. The subjects were given experimental

stimuli at six time compression levels (0%, 30% through 70% in 10% steps) of NU Auditory Test No.6. The time compression levels and sensation levels were randomly presented. The results showed that intelligibility decreased as a function of increasing percentage of time compression and decreasing sensation level. Indo—Dravidian and Spanish speakers performed poorly on the English monosyllabic test when compared to native English speakers. Also, the overall performance of Indo-Dravidian speakers was poorer than the Spanish speakers. Thus, the study of NiKam, Beasley and Rintelmann (1976) pointed out that the linguistic background has definite effect upon the performance of listener on time compression tasks.

It was not known whether foreign accent had any significant effect on performance and further, time compression might have interacted with influence of foreign accent. Therefore, Sood (1981) using the same test stimuli as those utilized by Nikam, Beasley and Rintelmann (1976), examined the influence of foreign accent on speech discriminaticn by Indian subjects.

Sood (1981) administered the time-compressed CNC monosyllables (Form B of NU Auditory Test No.6) to two groups of twenty subjects each. One group was given the test at 0% time compression and the other was tested with 60% time compression. These two compression levels were presented at five sensation levels (8, 16, 24, 32 and 40 dB, ref: SRT). Apart from meeting the criteria of normal hearing, the subjects had to pass two tests of English ability (as in Malini's 1981 study).

The results of the above study showed the earlier trend of decreased performance at higher time compression levels and increased scores with increasing sensation levels. This relationship, however, was not statistically significant. The results of inter-active effects of time compression and foreign accent were complicated which did not allow for any definite conclusions (Sood, 1981).

The study by Sood (1981) demonstrated the influence of foreign accent, presumably, and time compression, but it stressed the facts that measures of time compression should be used with caution while testing non-native speakers. Therefore, speech discrimination testing with foreign accent materials should be used with caution.

Use of English word lists to test Indian population is limited taking into consideration the fact that speech discrimination is affected by an individual's linguistic experience. Cross language studies (Sapon and Carrol, 1957; Singh, 1966; Singh and Black, 1966; Nikam, Beasley and Rintelmann, 1976) have indicated that speech sound perception is influenced by mother tongue. Barr (1969) suggested that standardized spondee and PB list recordings of at least the major languages of the world should be done and to have these recordings available to all speech and hearing clinics.

Factors affecting speech discrimination:

Speech discrimination scores are affected by other factors in addition to the linguistic experience of the subject. For instance,

the type of stimuli used i.e., whether nonsense syllables (Lehiste and Peterson, 1959; Carhart, 1965), monosyllables (Miller, Heise and Litchen, 1951), or sentences (Speaks and Jerger, 1965; Berger, 1969). Phonetic balancing of lists is often cited as an important factor to be considered in speech discrimination testing (Lehiste and Peterson, 1959). Carhart (1965), however, has stated that a strict phonetic balancing is always not necessary and that as long as the test items are meaningful monosyllabic words, a list of 50-word compilation is relatively equivalent to another provided the phonetic distribution is appropriately diversified.

There are studies which have investigated the effects of use of full vs half lists (Elpern, 1961), monitored live voice vs recorded materials (Carhart, 1965; Goetzinger, 1978); presence of background noise (Carhart and Tillman, 1970) on speech intelligibility testing. Also, subjects' greater familiarity with the test words is known to yield higher scores (Black, 1952; Hirsh et al, 1952; Postman and Rosenweig, 1957; Owens, 1961; Schultz, 1964; Epstein, Goilas and Owens, 1968; Schwartz and Goldman, 1974). Kreul, Bell and Nixon (1969) pointed out that changes in talker could significantly change the test difficulty.

The effects of use of carrier phrase during speech discrimination testing have been investigated. The carrier phrase, "You will say....." was utilized in the development of the CIDW-22 word discrimination test to assist the talker in monitoring the vocal level (Hirsh et al, 1952).

In addition, the carrier phrase has been assumed to alert the listener for the test word (Gladstone and Siegenthaler, 1971). Use of a carrier phrase has yielded higher discrimination scores (Gladstone and Siegenthaler, 1971; Gelfand, 1975). Martin and Forbis (1978) reported that there was a decline in the use of the carrier phrase during speech discrimination testing clinically, among the American audiologists. Lynn and Brotmann (1981) established that the carrier phrase "You will say....." contained perceptual cues which could be used by the listener tohelp identify place of initial consonant articulation. Martin, Hawkins and Basilay (1962), on the other hand, found that carrier phrases are non-essential and only serve to confuse individuals who had severe discrimination problems.

The studies regarding speech discrimination testing in English language and factors determining the scores have been carried out extensively. It is only recently that systematic studies on speech audiometry are done in India. Reports on development and standardizatipn of speech stimuli in some Indian languages are also available.

Tests of speech discrimination in Indian languages:

Attempts have been made to construct speech discrimination tests in Indian languages based on the criteria used by the American audiologists. The report by Abrol (1971) seems to be the first attempt in India on the development of materials for speech audiometry. He constructed phonetically balanced word lists in Hindi

utilizing the frequency analysis of speech components and familiarity. The main drawbacks of the study were: practice effect was not considered, SRT level was not mentioned and articulation curves were not given. Thus, the study lacked proper standardization.

Kapur (1971) developed speech discrimination test materials in Tamil, Telugu and Malayalam. Similar methods of selection of words and methodology were utilized for different languages except for the nature of materials in Hindi and Tamil. Disyllabic words were used for the discrimination task. They yielded articulation curves with a maximum score of 97% at 45 dB. This study also lacked proper standardization as SRT level was not specified and oractice effect was omitted.

In 1973, De developed PB lists for discrimination testing in Hindi. As Hindi is a common language in India, he hoped that the lists would be used successfully for testing individuals who have knowledge of Hindi, not necessarily as mother tongue. Phonetic structure of Hindi language as in Armed Forces personnel who represent a fair cross section of the Indians of all states was taken into consideration. Also, phonetic analysis of the speech material from various sources (such as newspapers, conversation, Hindi primers and Hindi dictionary) and transcribing them phonetically. Acoustic analysis of the Hindi speech sounds were studied with respect to the relative intensities of the sounds.

Initially, utilizing familiar CVC, VC and CV words eighteen lists of fifty words each were compiled (De, 1973). Normal Hindi speaking subjects were tested using these lists and constantly missed words were replaced by easier ones. Finally, six PB lists of fifty words were accepted for clinical trial and use.

Average articulation curve for normals was given (De, 1973). Results of the data on normal individuals with mother tongue Hindi irrespective of education and service background produced a discrimination score of 98 to 100% at MCL. Normal subjects whose mother tongue was other than Hindi obtained an average score of 92 to 96% at MCL. Also, the scores of pure conductive hearing loss patients were same as normals under similar conditions. The early otosclerotic patients obtained similar results as in normals whereas the advanced cases showed a tendency to produce discrimination loss depending on the degree of hearing loss. Some roll over of articulation curve was observed for patients with perceptive deafness thereby helping in assessment. Finally, De (1973) established the reliability of these lists in a linguistically mixed population (i.e., for subjects with working knowledge of Hindi). The results did not show any marked difference between the subjects with Hindi as mother tongue or as a second language. Therefore, he concluded that discrimination score obtained with material in second language or languages was fairly reliable.

De (1973) further stated that persons obtain better and optimum

discrimination score in their mother tongue as compared to other languages. He compared the performance on discrimination tasks using a test of English language and non-sense syllables. The subjects performed better on a test in a language of Indian origin than foreign and they did not discriminate well when tested with non-sense syllables.

Utilizing four of the PB lists developed by De (1973), Sinha (1981) studied the effect of linguistic experience on auditory discrimination scores of native and non-native speakers of Hindi language. A total of twentyone normal hearing subjects were tested, out of which seven were native speakers and the remaining were non-native speakers of Hindi. The latter set of subjects were further divided into two groups viz,, 'short exposure'4'long exposure' groups depending on the duration of exposure to Hindi language. All the subjects were tested under two conditions:
(1) List 1 was presented in quiet and (2) the other three lists were presented with a competing noise with 5/N ratios of 12 dB, 6 dB and 0 dB respectively. Both the stimuli viz., speech and white noise were fed binaurally through ear phones and a constant speech level of 76 dBSPL was used. The oral responses of the subjects were recorded using a portable tape recorder for further analysis.

Sinha (1981) concluded that the linguistic experience did not affect discrimination scores in quiet provided the exposure to the language was five years or more. Performance of all the three groups of subjects studied was affected in the presence of noise. The

discrimination scores decreased more for the non-native speakers than for the native speakers suggesting that limited linguistic experience resulted in a persistent deterioration of auditory word discrimination under degraded conditions of hearing.

Studies of De (1973) and Sinha (1981) are in agreement with those of Sapon and Carroll (1957), Singh (1966) and Singh and Block (1966) in that they indicated that the linguistic experience of a person is an important factor affecting the speech discrimination ability.

There are no standardized material available for speech audiometry in Kannada language. Also, there are a few monosyllabic meaningful words and a few equally stressed disyllabic words to construct PB and spondee word lists. Considering the above factors, Nagaraja (1973) developed synthetic sentence Identification test in Kannada based on the approach of Jerger, Speaks and Trammel (1968). Synthetic sentences were compiled utilizing the most commonly used words in Kannada language. He recorded the first and second order sentences along with a continuous competing speech message to make the listening task difficult. Initially, Nagaraja (1973) administered three lists of first and second order sentences to thrity normal hearing subjects. With this data, he attempted to obtain the per-formance-intensity patterns and MCR level at which performance was maximum.

Nagaraja (1973) prepared another set of recordings as the initial one was too lengthy and that fatigue could affect the performance. This time one list of first order and another list of second order sentences were recorded on one track and the competing message on the other. These recordings were administered to thrity normal hearing subjects to compute the normative data. The performance of different types of clinical pathology cases was also studied. Cases of conductive hearing loss (eight in number), mixed hearing loss (four subjects), ten with sensorineural hearing loss and two patients with high frequency hearing loss were tested with the lists. All the subjects were tested with English PB lists whenever possible in order to compare the difference in performance.

PI functions were drawn for PB words and SSI scores at different intensity levels for four subjects with different audiometric configuration. Also, reliability of the test was computed by analyzing the data obtained on two different days for the same test on ten randomly selected subjects (Nagaraja, 1973). He inferred from the results that performance on SSI test varied directly with the level of presentation and inversely with the MCR. Normals obtained maximum scores on SSI test at 40 dBSL and at 0 dB MCR levels. Conductive pathology patients did not differ in performance on first-order sentences. Sensorineural hearing loss and other clinical pathology groups differed significantly from the performance of normals. Comparison of the audiometric configuration and performance on SSI suggested that

classifying patients solely on the basis of the pattern of audio-gram seemed fallacious.

The comparison of performance of PB-list and SSI did not yield any valid conclusions as the comparison of tests on two different languages may not be logical. More discrepancies in performance on first order sentences were seen than on second order sentences which could be attributed to the nature of latter type of sentences. Therefore, Nagaraja (1973) suggested that the second-order sentences could be used as a valid clinical tool and to test speech discrimination for individuals with the knowledge of Kannada only.

The use of SSI for discrimination testing though proved to be promising, further information on its clinical utility as a test of speech discrimination is not available. Often several tests developed in India for speech audiometry are criticized for the fact that they can be used only with literate population (Mayadevi, 1974).

Considering the problems of illiteracy and multilingualism in India, Mayadevi (1974) developed a common speech discrimination test for Indians. She also reasoned that there was difficulty in constructing a test in each language as it would affect the tester's efficiency and that the time and effort involved becomes very great in producing tests in all languages in India. Mayadevi (1974) arrived at a final list of twenty CV (consonant always followed by vowel /a/) monosyllables ranging in terms of intelligibility and meaningfulness. Initially, the common syllables of CV combinations in Indian languages

(not necessarily as independent monosyllables) were listed based on the data from native speakers and by a comparison of different languages available in the literature. The consonants were selected from phonetic readers written by linguists.

The list of twenty CV monosyllables was presented to thirty normal subjects at different sensation levels, starting from the pure-tone average level. Each test item was preceded by a Kannada carrier phrase. Normal subjects belonging to different language groups were tested at the level where the original set of subjects achieved maximum score. Also, PI functions were determined for different clinical groups. Six scramblings of the same list was presented at six different levels (at 10 dB steps) to each subject. However, the equivalency of the scramblings was not established statistically. Discrimination measures in quiet and under noise were obtained for normals and sensorineural hearing loss cases. Also "Discrimination Index" (Jerger, 1970) and "Social Adequacy Index" (Davis, 1948) measures were obtained for normals and clinical groups. Further, Mayadevi (1974) tried to establish the validity of the test by comparing the results of her test with English P8 lists to normals and to clinical population having a knowledge of English. Test-retest reliability was also determined.

Based on the results, Mayadevi (1974) concluded that the performance of normal subjects from different language backgrounds followed the same pattern and a score of 90 to 100% was obtained at 40 dBSL

(ref: PTA). Performance of sensorineural hearing loss differed from that of clinical groups and noise adversely affected the discrimination scores of the former group of subjects. The social adequacy measure of normals differed from that of the clinical groups. Analysis of the responses showed that /na/, /da/ and /la/ were the sounds erred on most frequently. She stressed that PI function should be obtained for the clinical population while testing discrimination. Oral responses were considered for the purpose of data, as she found no difference between oral and written responses.

There are certain drawbacks in the methodology used by Mayadevi (1974). She considered only CV combinations, the vowel always being /a/. This did not take into consideration the temporal factors important in speech perception. The consonants were chosen based only on commonality among different languages and distributional aspect of the sounds in various languages has not been taken into consideration. In addition, it has been assumed that the consonants chosen, occur in the language in the same form as they do in the list. This is not true when one considers the occurrence of normals in a particular language. For eg., Bengali native speaker giving a response of /b/ for /v/ is scored as being incorrect which could be attributed either to the subject's language background or to a discrimination problem. There is no way to differentiate between the two.

In addition, nonsense syllables, being devoid of meaning, contain no semantic cues to assist in discrimination. According to Lehiste and Peterson (1959) individual phonemes are not recommended for testing discrimination as they tend to test the 'recognizability' and notintelligibility against one's interest. The date of Zakrzewski et al (1975) suggested that sound recognition scores are informationally intermediate between results obtained by discrimination speech audiometry and pure tone audiometry. Therefore, the phenomena related to speech sound recognition occur in subcortical part of the auditory pathway. Hence, a test of using individual phonemes fail to measure the discrimination ability, a phenomenon of the cortex. Also, the use of nonsense syllables is not recommended for speech discrimination testing (Carhart, 1965).

Mayadevi (1974) used only Kannada carrier phrase to test the subjects of different language groups. The test might give different results when a different carrier phrase cr a carrier phrase of native language is used with a listener.

Considering the drawbaks of testing speech discrimination with nonsense syllables and also the importance of testing subjects in their native language, Samuel (1976) constructed PB lists in Tamil language, Mallikarjuna in 1984 reported the development of PB word lists in Gujarathi language.

Kapur (1971) had introduced word lists in Tamil for discrimination testing. There were shortcomings in phonetic composition and also lack of proper standardization. Samuel in 1976 attempted to arrive at a proper test material overcoming the above shortcomings. He collected meaningful CNC words which were familiar and administered them to ten people for familiarity determination. Four lists of twenty five words were compiled using the functional load of sounds in Tamil. These lists of words were recorded on a magnetic tape with an appropriate carrier phrase in Tamil by a male adult talker. Tamil spondee words were recorded by the same talker for obtaining SRT. Also, English PB words and spondees developed and standardized for Indians by Swarnalatha (1972) were recorded (Samuel, 1976).

The recorded lists were administered to ten normal subjects to ensure list equivalency. Later, articulation gain function was plotted by testing thirty normal Tamil speaking subjects. Oral responses were taken for the purpose of analysis (Samuel, 1976). Optimum scores of discrimination for normals were obtained at 35 dBSL (ref: SRT). The four lists used were found equivalent in difficulty. Samuel (1976) also reported that the test-retest reliability was high. And comparison of this test results with those obtained for PB lists (Swarnalatha, 1972) used in the study showed that the results of the two tests were similar. The use of

lists developed by Samuel (1976) on patients with hearing impairment has not been reported so far.

Mallikarjuna (1984) developed a speech discrimination test in Gujarathi language. The test construction was carriedout using similar criteria as those utilized by Egan (1948). Mallikarjuna (1984) selected words from student vocabulary books and collected 150 monosyllabic words. Using these words three lists of fifty PB words each were formed.

The speech discrimination scores were obtained at various sensation levels above the SRT level for spondee words in Gujarathi (Mallikarjuna, 1984). He reported that the findings were on par with those of Hirsh et al (1952) on W-22 lists and Samuel (1976) on Tamil PB lists. The three Gujarathi PB lists were matched and could be used as a valid test for speech discrimination for Gujarathi speaking population (Mallikarjuna, 1984).

Most of the investigators have standardized speech discrimination tests in Indian languages for adult subjects and studies reported on these for children are very few. Swarnalatha (1972) standardized English PB lists for children. Yet another report on speech discrimination test in children was by Anand and Kishore (1974).

Discrimination test for children:

Utilizing words from De's (1973) PB lists in Hindi language, Anand and Kishore (1974) developed a Hindi Picture Identification

(Discrimination) Test for children. They utilized twentyfive picture cards which represented the twentyfive PB words. Children in the age range of 5-11 years were tested. The children selected for the study were those who had normal development of soeech upto three or four years and had acquired hearing loss at a later age (Anand & Kishore, 1974). Identification of the picture was the response expected of the child. The words were presented at 25 dBSL (ref: PTA). They concluded that the PID test was reliable and that it could be used with children between 5-11 years of age who have acquired hearing loss of mild to moderate degree.

The details of the above study were not reported. Also, Anand and Kishore (1974) themselves have cited that the test could be administered only to those children who had normal speech development upto at least 3-4 years of age.

From the review of studies of soeech discrimination tests in Indian language. it could be inferred that only a few standardized tests are available for an audiologist in India. Also, the data on the clinical utility of these tests are sparse. Another common problem in using many of the tests is that the recorded versions of the word lists are not available. Further, an audiologist in India is at a greater disadvantage while testing soeech discrimination because of multi-lingualism. Srilatha (1983) compiled lists of common words between Kannada and Telugu languages, both the languages are of Indo-Dravidian origin. If such lists could be used to test speech

discrimination of subjects belonging to both the language group: an audiologist knowing one of the two languages would able to carry out speech discrimination testing in both the languages. In general, use of common word lists among different languages would reduce the problem of speech discrimination testing in various Indian languages.

C H A P T E R - III

METHODOLOGY

The present study aimed at obtaining the articulation functions for the word lists common between Kannada and Telugu languages by Srilatha (1983). This was carried out for the native speakers of Kannada.

Teat Material:

Srilatha (1983) compiled lists of words common to the Kannada and Telugu languages. 200 disyllabic words were divided into four lists of fifty words each. Srilatha (1983) found that the native speakers of the two languages namely, Kannada and Telugu, recognized the words to be in their languages.

In the present study the words were recorded on a cassette tape and evaluated for their intelligibility by the native speakers of Kannada at different sensation levels. Also, two different carrier phrases, one each from Kannada and Telugu languages, were made use of. The lists of words used in the study are given in Appendix I.

Recording procedure:

Recording was done on a cassette tape (Sony CHF90) using a Cassette Tape Deck (Philips F 6112 Stereo Cassette Deck) with a micro-phone (Philips LBD 8202). The recording was carried out in a sound

treated audiometric room. The measured noise levels in that room is given in Appendix III.

The four lists of words were read out by a talker who spoke Kannada and Telugu languages from early childhood. This was done in order to exclude speaker as a variable since the carrier phrases of both the languages were used. The Kannada carrier phrase "i : ga he : li" preceded each word for the four lists. "ippudu chappandi" was the Telugu carrier phrase utilized in the study. Thus, the word lists were recorded twice separately with different carrier phrases.

The speaker (a young adult male) was instructed to maintain the level of the carrier phrase so that the peak would be at 0 of the VU meter on the Cassette Deck and to utter the word in a natural manner. A gap of 8 seconds was allowed between each utterance, to enable the subjects to write down their responses. Sufficient practice was given to the speaker prior to the final recording. This was done with both the carrier phrases.

The recorded words lists were played on the Cassette Tape Deck (Philips F 6112 Stereo Cassette Deck) and its output was fed to the graphic level recorder (B and K Type 2305). The average peak level was found by averaging the peak levels of the words in each list. Corresponding to this average peak level, a calibration tone of 1000 Hz from a low distortion Audiogenerator (Type Unitec LD011) was recorded on the tape before each list. This was done in order to maintain

the level of the input signal to the audiometer from the tape recorder.

Instrumentation:

A clinical Audiometer (Madsen, 08 70) and a Cassette Tape Deck (Philips F 6112 Stereo Cassette Deck) were used to collect the required data. The recorded materiel was played on the cassette Tape Deck, the output of which was given to the input of the eudiometer. The output of the eudiometer through the earphones (TDH 39) housed in supra aural cushions (MX 41/AR) was delivered to the test ear of the listenere.

Calibration:

An objective calibration of the audiometer was carried out before testing was started. The calibration procedure is given in the Appendix II.

Test environment:

The experiment was carried out in e sound treeted, two-room combination. The noise levels in the test room were measured with a sound Level Meter (B and K type 2209) with a condenser microphone (Bend K type 4165). The noise levels in the test room were within the permissible limits (Appendix III).

Subjects:

A total of forty subjects (eighteen females and twentytwo males) were tested. All the subjects were native speakers of Kannada language. The age range was 18 years 3 months to 28 years 2 months with a mean age of 22 years 6 months and a median of 21 years 6 months.

The criteria for the selection of subjects were the following;

1. The subjects should have had hearing within normal limits bilaterally (ANSI, 1969) and
2. They should have had no history of ear infection or head injury.

Test procedure:

Initially the subjects' threshold of hearing for air conducted puretones was obtained at frequencies 250 Hz to 8000 Hz at octave intervals and at 6000 Hz. Thresholds for bone conducted pure tones were determined for 250 Hz to 4000 Hz at octaves. Puretone threshold average of 500 Hz, 1000 Hz and 2000 Hz thresholds for air conduction was calculated for each subject. This served as the reference level above which the word lists at different levels were presented to obtain the discrimination scores.

Speech discrimination test procedure:

Four lists of words common to Kannada and Telugu languages were used to test discrimination. Fire presentation levels namely 8 dB, 16 dB, 24 dB, 32 dB and 40 dB above subjects' puretone average

were utilized. A group of twenty subjects each listened to lists with Kannada and Telugu carrier phrases. All the subjects listened to the four lists. No list or presentation level was repeated for a given subject. This was accomplished by randomizing the list and sensation levels using a random number teble(Mc Call, 1978).

In each group of subjects, four listened to a given list at the same sensation level. Also, ten subjects in a group were tested for the right ear and the remaining ten listened in the left ear. Only one ear was tested for a subject. Better ear was tested whenever a difference between the two ears was found or the test ear was chosen randomly.

Each subject was instructed in Kannada before testing and was provided with four response sheets to write down the responses.

The instructions were as follows:

"You will hear four lists of words. Each list has fifty words. Some words will be louder and some softer. Each word will follow a phrase "i:ge he:li" (or "ippudu chappandi" in case of Telugu carrier phrased words). Listen carefully to the word that follows the phrase and write it down against the number on the sheet. Try to guess and write the word if you are doubtful. If you cannot guess a particular word, leave the line blank against a number and go on to the next. Do you have any questions?"

After the subject was instructed, the lists were presented at previously determined levels and order. The testing was done in a single session. While presenting the lists from the tape recorder to the audiometer, the gain of the audiometer was adjusted so that the 1000 Hz calibration tone would peak at 0 on the VU meter.

Scoring:

Each response was hand scored either as 'correct* or "in-correct*. A correct response was given a score of 2%. Total percentage of correct responses at each level was computed for each list.

The scores obtained were analyzed using statistical methods. Results and the details of analysis are discussed in the next chapters.

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C H A P T E R - IV

RESULTS

The data obtained for the two groups of subjects namely, one group of subjects who listened to the words preceded by a Kannada carrier phrase and another group who heard to the words preceded by a Telugu carrier phrase, were analyzed separately. The mean and median scores for each list of words at different levels were computed for both groups. Standard deviation was obtained in order to determine the dispersion of discrimination scores at different sensation levels. Table 1 and Table 2 show the mean, median and standard deviation scores for the four lists at different sensation levels obtained with Kannada and Telugu carrier phrases respectively.

Effect of level:

From Table 1 and Table 2, it may be noted that in general, discrimination scores increased with increasing sensation level. Variability in scores did not, however, consistently decrease with increase in sensation levels in all the lists and this can be seen from the standard deviation scores obtained for the two groups of subjects.

Articulation functions:

Articulation functions for the four lists are shown in Figure 1 when the subjects were tested with words following a Kanneda carrier phrase. Figure 2 shows the articulation functions for the same lists of words which were preceded by Telugu carrier phrase. In general, the articulation functions show that there is increase in discrimination scores with increasing levels.

The slopes of the articulation function in case of lists with Kannada carrier phrase are 4.12%/dB (list I), 2.7%/dB (list II), 2.81%/dB (list III) and 4.18%/dB (list IV). When the words were preceded by Telugu carrier phrase the slopes obtained ere 2.31%/dB, 1.87%/dB, 2.7%/dB and 2.7%/dB for lists I, II, III & IV respectively.

Two-way Analysis of Variance (Guilford & Fruchter, 1978) was also computed in addition to the measures of central tendency and variability. The results of two-way ANOVA are given in Table 3 and Table 4.

Sensation level effect on discrimination scores emerged as statistically significant for both groups of subjects. This can be seen from Table 3 andTable 4.

Table 1* Mean, Median and standard deviation of discrimination scores obtained for four lists at different sensation levels when the words were preceded by Kannada carrier phrase.

lists	List I			List II			List III			List IV		
levels dB SL (ref:PTA)	Mean	Median	S.D.	Mean	Median	S.D.	Mean	Median	S.D.	Mean	Median	S. D.
8	48	46	5.67	52.5	51	8.39	56	56	9.93	45.5	46	23
16	81	81	5.77	74	72	11.20	78.5	78	5.74	79	77	8.72
24	83.5	87	10.63	87.5	88	4.43	84.5	84	3	91.5	91	5
32	83.5	82	4.73	87.0	92	10	88.5	89	5	95	95	2.58
40	90.5	96	11	92.5	93	3.42	95.0	97	6.22	95.5	96	4.43

Table 2; Mean, Median and standard deviation of discrimination scores obtained for four lists at different sensation levels when the words were preceded by Telugu carrier phrase.

lists / level dB SL (ref:PTA)	List I			List II			List III			List IV		
	Mean	Median	S.D.	Mean	Medium	S.D.	Mean	Median	S.D.	Mean	Median	S.D.
8	55	55	7.02	71.5	76	11.82	69.0	69	15.19	64.5	65	13.3
16	73.5	74	10.25	86.5	88	4.43	90.5	93	7.19	86.0	85	2.83
24	93.5	93	1.92	90.5	92	6.81	93.5	94	4.12	93.5	94	1
32	94.5	96	4.73	90.5	92	9.15	91.5	93	5.26	93	93	2.58
40	94.5	96	6.81	98	99	2.83	97.5	98	2.52	95	96	3.46

Table 3: Results of Two-way ANOVA for the main effects of lists, levels and their interaction when the words in the lists were preceded by Kannada carrier phrase.

Sources of Variance	Sum of squares	Degree of freedom	Mean sum of squares	F. Ratio
levels (A)	18703.3	4	4675.83	61.96 *
lists (B)	294.2	3	98.07	1.3
Interaction (A X B)	570.3	12	47.53	0.63
within sets	4528	60	75.47	
Total	24095.8	79		

* Significant at $P \leq 0.01$ level.

Table 4: Results of Two-way ANOVA for the main effects of lists, levels and their interaction when the words in the lists were preceded by Telugu carrier phrase.

Sources of Variance	Sum of Squares	Degrees of Freedom	Mean sum of squares	F Ratio
levels (A)	10171.7	4	2542.93	47.89 *
lists (B)	415.6	3	138.53	2.61
Interaction (A X B)	939.9	12	78.33	1.48
within sets	3186	60	53.1	
Total	14713.2	79		

* Significant at $P \leq 0.01$ level

Table 5: Results of Two-way ANOVA for the main effects of levels, carrier phrases (Kannada and Telugu) carrier phrases) and their interaction.

Sources of Variance	Sum of squares	Degree of Freedom	Mean sum of squares	F Ratio
levels (A)	28199.65	4	7049.91	106.13 *
Carrier phrases(B)	1768.9	1	1768.9	26.63 *
Interaction (A X 8)	675.35	4	168.84	2.54 +
Within sets	9964	150	66.43	
Total	40607.9	159		

* Significant at $P \leq 0.01$ level.

\+ Significant at $P \leq 0.01$ level.

\+ Significant at $P \leq 0.05$ level.

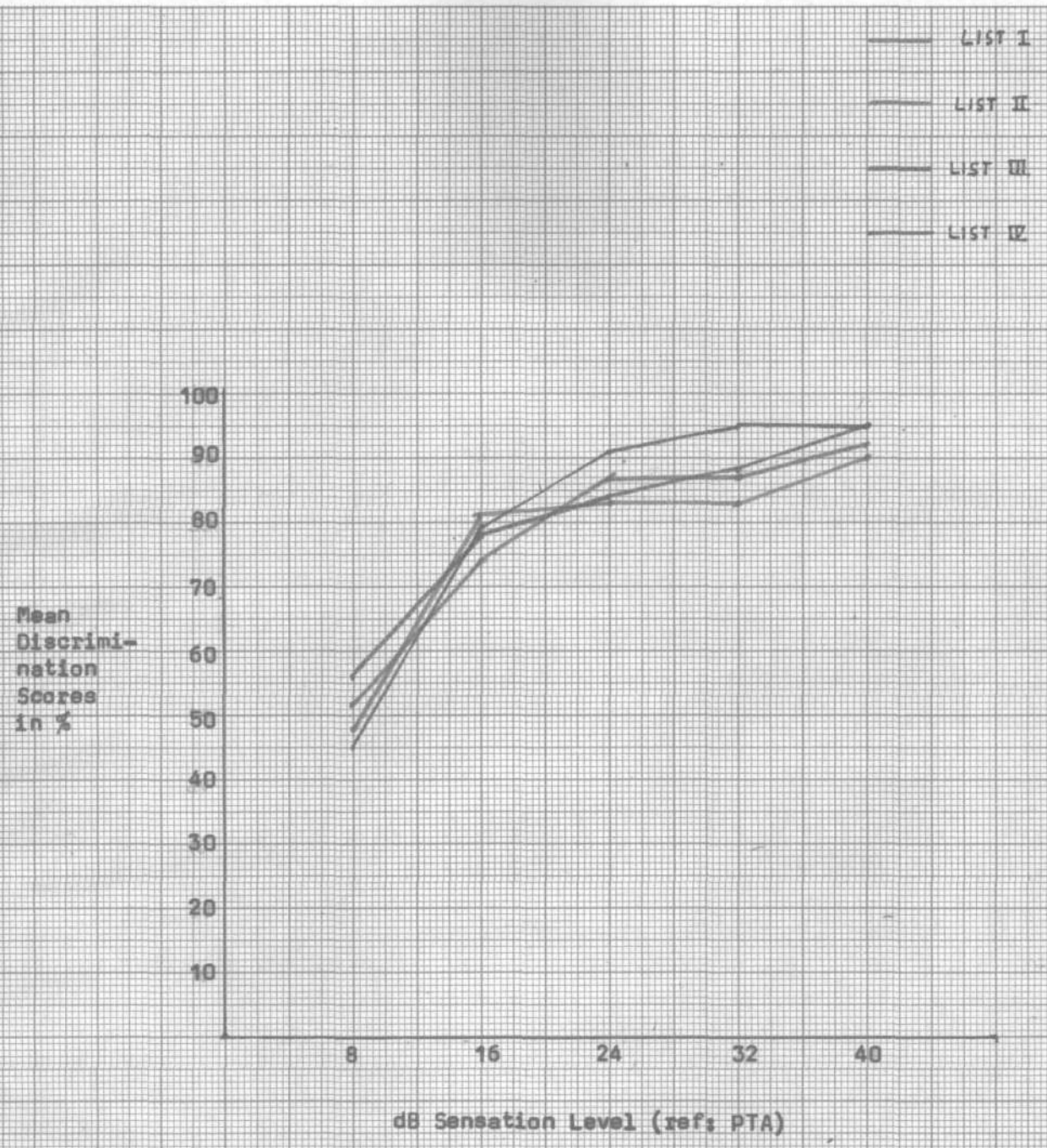

FIGURE 1 Articulation functions for four different lists when the words were preceded by Kannada carrier phrase.

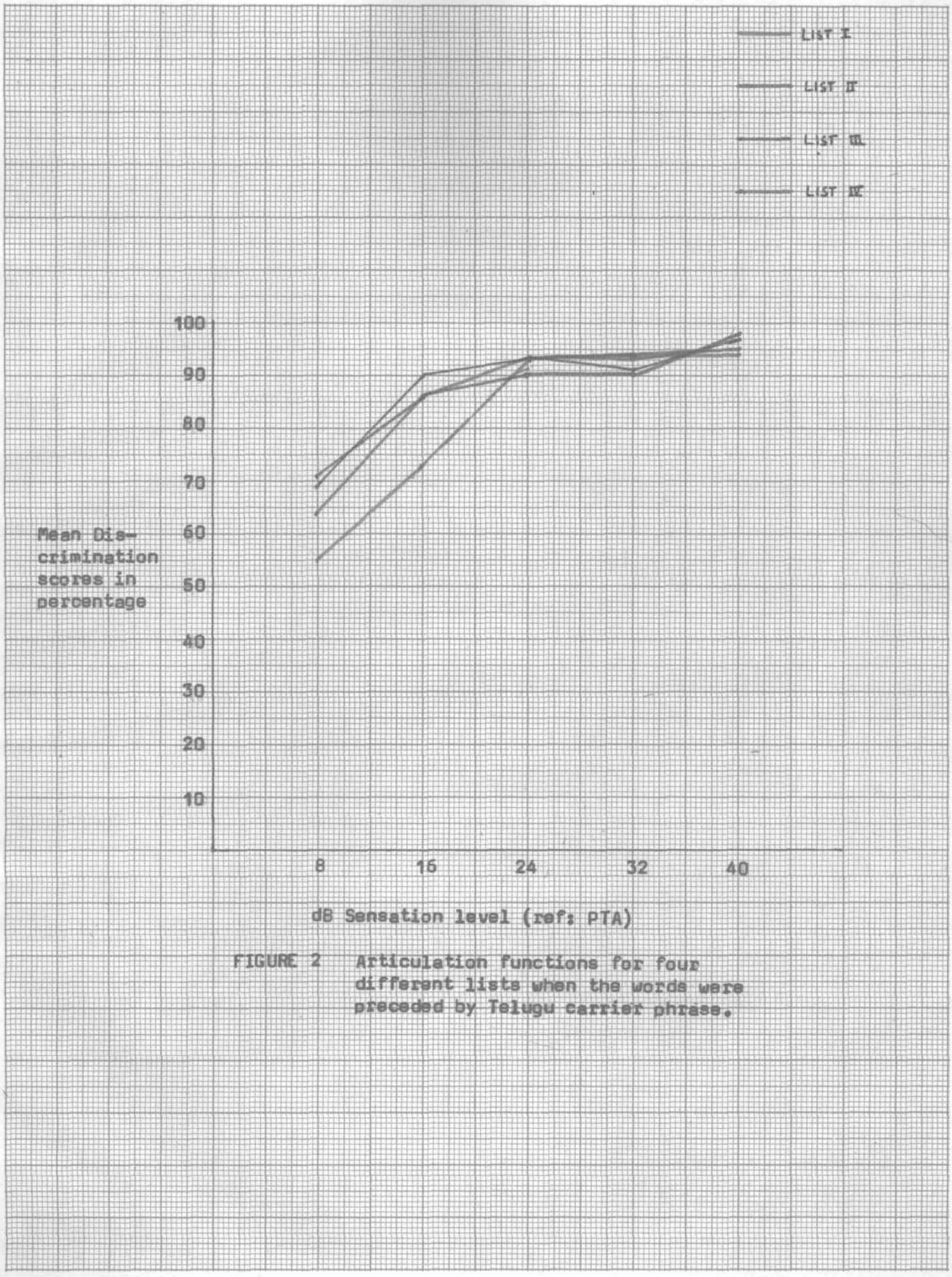

FIGURE 2 Articulation functions for four different lists when the words were preceded by Telugu carrier phrase.

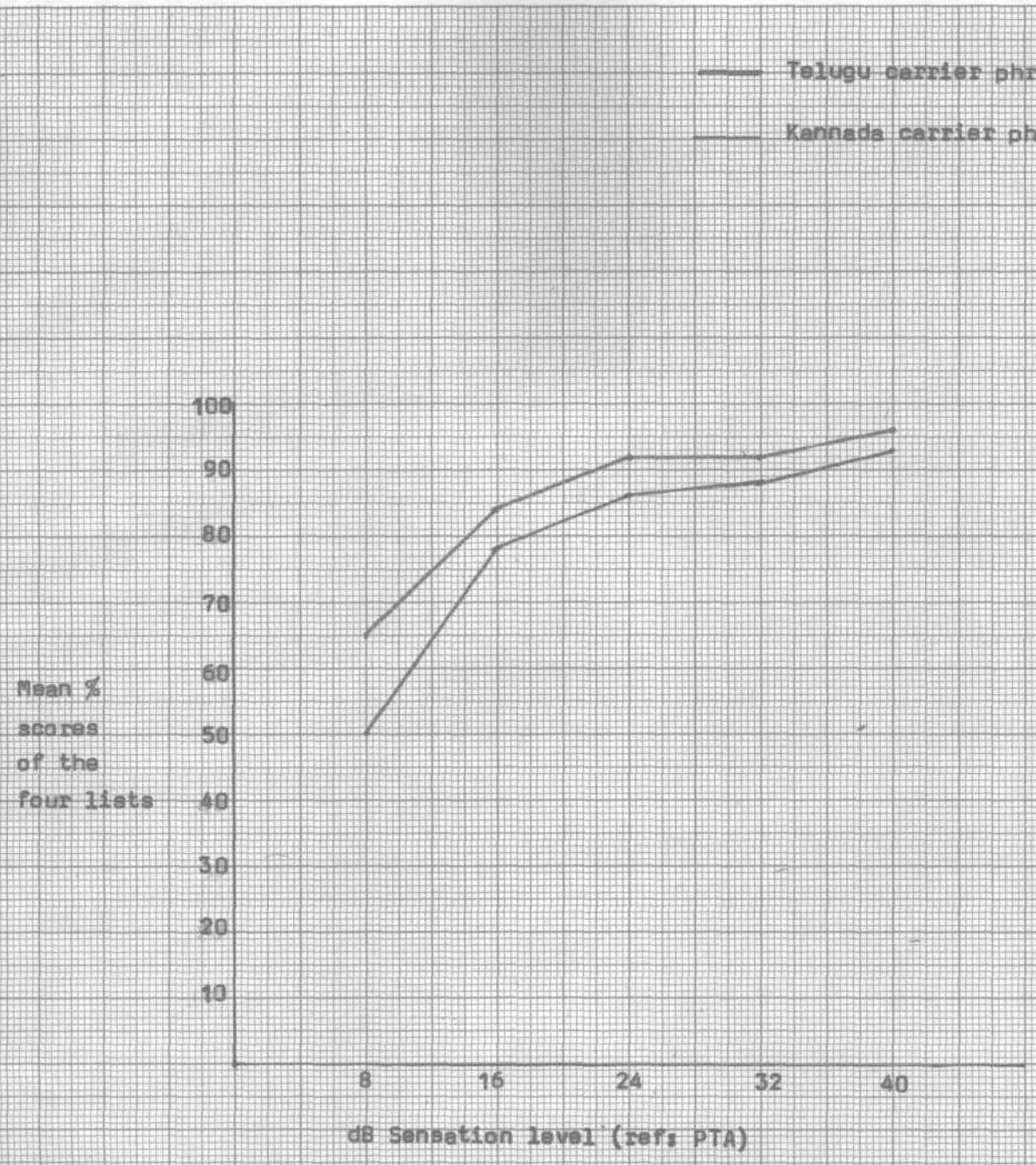

FIGURE 3 Articulation functions of the four lists together when the words preceded by Telugu and Kannada carrier phrases.

Inter-list difference:

Difference among the lists was not found to be significant in both conditions (Teble 3 and Table 4). Also, the interaction between list and sensation level was not significant.

Effect of language of the carrier phrase:

As the lists in two different conditions were found equivalent in terms of difficulty as seen from Teble 3 and Table 4, the data on four lists with a particular carrier phrase was combined and treated together.

Figure 3 gives the curves of mean discrimination scores of the four lists together at different sensation levels for the two conditions studied. The curves show that discrimination scores obtained with lists of words when the carrier phrase was Telugu were better at the five senseation levels used in the study when compared to those obtained with Kannada carrier phrase.

Again, Two-way ANOUA was computed to determine the effect of carrier phrase and different sensation levels (Table 5). Difference in carrier phrases had a significant effect on discrimination scores and as observed earlier difference among the sensation levels were significant. However, the sensation levels and the carrier phrase interacted significantly at $P \leq 0.05$ level.

The results obtained in the present study are discussed in the next chapter.

C H A P T E R - V

DISCUSSION

The results are discussed under two headings namely, effect of sensation level and effect of language of the carrier phrase.

Effect of sensation level:

The effect of sensation level on the mean performance for the two groups of subjects are graphically depicted to give Articulation functions (Figure 1 and Figure 2).

Figure 1 shows the articulation functions obtained with Kannada carrier phrase end it may be observed that discrimination scores increased with increase in sensation level. Approximately 93.4% (Figure 3) was obtained at 40 dBSL (ref: PTA) and none of the mean scores of the four lists reached 100% at 40 dBSL (ref: PTA). Figure 1 further indicates that plateau was not observed between 32 and 40 dBSLs (ref: PTA). In contrast to the present study, Tillman, Carhart and Wilber (1963) obtained perfect discrimination score at 24 dBSL (ref; SRT) using NU Auditory Test No.4. Tillman and Carhart (1966) observed an asymptote at 32 dBSL (ref; SRT) with NU Auditory Test No.6. These two studies gave forth essentially similar articulation functions. Inspite of using bisyllabic words for testing discrimination in the present study, lower discrimination scores were obtained when

compared with the other two studies (Tillman, Carhart end Wilber, 1963; Tillman and Carhart, 1966) which utilized monosyllabic words. This probably could be attributed to the fact that PTA was used as the reference level here and not the SRT level. Therefore, increase in discrimination scores could be expected with further increase in sensation level.

When discrimination testing was carried out with Telugu carrier phrase approximately 96.4% score (Figure 3) was obtained at 40 dBSL (ref: PTA), Discrimination scores increased with increasing sensation level (Figure 2). The effect of sensation level on discrimination scores was found to be significant (at $P \leq 0.01$) when either Kannada or Telugu carrier phrase was used (Table 3 and Table 4). The scores obtained with the latter carrier phrase were higher than those obtained with the former carrier phrase. An improvement in discrimination was observed from 32 to 40 dBSL (ref: PTA) in case of lists II, III and IV with Telugu carrier phrase. The score did not show an increase between 32 and 40 dBSL (ref: PTA) for list I with Telugu carrier phrase. The inter list difference in terms of difficulty was not significant in both the conditions studied (table 3 end Table 4). On the whole, further increase in sensation level might bring about improvement in the scores.

The slopes of the articulation functions obtained with Kannada carrier phrase is somewhat similar to those obtained by Rintelmann, Schumaier and Jetty (1974) between 8 and 16 dBSL (ref: SRT) for NU Auditory Test No.6. However, the elopes are less steeper with

Telugu carrier phrase than in the above two studies.

In general, the studies have indicated that variability of the scores was found to be greater at lower sensation levels and reduced progressively with increasing levels (Tillman, Carhart and Wilber, 1963; Carhart, 1965; Rintelmann, Schumaier and Jetty, 1974; Malini, 1981). The present study did not show such systematic decrease in variability with increasing sensation level either with Kannada or Telugu carrier phrase. Probably the nature of the words used in this study would account for the lack of such an effect observed in other studies.

Effect of language of the carrier phrase:

When the slopes of the two groups of date are compared, the slopes obtained with Telugu carrier phrase show more gradual increase then those obtained with Kanneda carrier phrase. Further, percentage of scores obtained with Telugu carrier phrase is greater than those obtained using Kannada carrier phrase. The mean scores at different sensations levels for all the lists using different carrier phrase show that the scores are higher when Telugu carrier phrase wes used at all the levels (Figure 3).

The above effect was examined by computing Two-Way ANOVA for sensation levels end carrier phrase differences. As the interaction effect between sensation level and carrier phrase was found to be

significant at $P \leq 0.05$ level, the generalization of the main effects are not to be made. However, carrier phrase difference brought about changes in discrimination scores.

The effect of different carrier phrases on speech discrimination was studied by several people (Gladstone and Siegenthaler, 1971; Gelfand, 1975; Lynn and Brotman, 1981). These studies in general indicated that changes in carrier phrasee bring about changes in speech discrimination and therefore inconsistent use of carrier phrases during testing is not correct. The present study also showed that carrier phrase does have an effect on discrimination.

Kreul et al (1969) also found significant differences in scores as a function of the carrier phrase. They, however, used word lists, procedures and carrier phrases not used in most clinics. Therefore, Gladstone and Siegenthaler (1971) studied the above effect using the carrier phrases "Say the words.....", "You will say.....* and "point to the.....". Thirty two normal hearing subjects were tested using W-22 test words at 5 dBSL (ref: SRT). Twentyfive monosyllabic words from W-22 lists were scrambled four times, once with no carrier phrase and three other times preceded by the three carrier phrases. In one condition the phonemic interaction between the carrier phrase and test word was allowed and recorded. In another condition no such interaction was allowed.. This was done by speaking phrases end words in isolation and splicing them together. For the interaction conditions

ell phrases yielded significantly higher scores than the control no-phrase list. Also, intelligibility scores with the carrier phrase "You will say....." was maximum. This effect was supposed to be because of the long vowel in the end /ei/, in contrast to other endings, has a greater potential for being influenced by the phonemes of the words to follow and thus gave additional cues for intelligibility.

Further, Gelfand (1975) evaluated the effects of carrier phrase use in monitored live voice discrimination testing on sensori-neurel hearing loss individuals. Discrimination socres were signi-ficantly higher when the carrier phrase was included. He concluded that carrier phrases should be routinely employed when discrimination is estimated by monitored live voice and further, that carrier phrases are of increased importance when live voice testing is accomplished with half lists.

In a different type of study, Lynn and Brotman (1981) provided evidence that the carrier phraae "You will say....." contains per-ceputal cues which can be used by the listener to help identify place of initial consonant articulation for many test words. The study showed that normal hearing subjects identified piece of articulation for selected CID W-22 test words solely on the basis of information contained in the carrier phrase. In addition, when acoustically identical test words with end without carrier phrases were presented to the subjects, the words without carrier phrase were significantly

more difficult to identify. These results indicated that the CID W-22 carrier phrase contain information concerning at least the initial coneonant of many test words and that detection of the carrier phrase produces a different test result.

Also, investigations concerning the acoustic cues important for identification of certain consonants would suggest that the carrier phrase contributes to intelligibility of the test words. When a prevocalic consonant (CV) is embedded in a phrase such as "You will say CV" it must be considered as an intervocalic consonant ($V_1 CV_2$), where the syllabic nucleus of the teat word is V_2. Place of articulation information for most intervocalic consonants is contained in both $V_1 C$ and the CV_2 formant transition patterns. Furthermore, there is evidence that VC formant transitions provide more consonantal place of articulation information than do CV transitions (Sharft and Hemeyer, 1972).

The results of the present study also support the above that differences in carrier phrases can bring about differences in discrimination scores. However, the differences found in this study can not be attributed to the changes brought about by the final sound of the carrier phrase on the test word. The two carrier phrases used in this study ended with a short vowel /i/ and therefore such effects, if present, should be same in both cases.

The native speakers of Kannada obtained better scores when tested with a Telugu carrier phrase than when tested with a Kannada carrier phrase. This difference is not directly attributable to the talker difference as a single talker recorded the lists twice. However, Brandy (1966) has pointed out that one talker introduces significant variability on successive days of live voice testing when using identical modes of presentation and it was assumed that even more variability would be introduced when one speaker changes his mode of presentation on successive days. Brandy (1966) found significant differences among the discrimination scores obtained by listeners on three indpendently recorded word lists by a single talker. These factors might pertly explain the differences observed in the present study. That is, a single talker can introduce variability on subsequent recordings end especially so when different modes (here carrier phrases) are used.

The fact that lists with Telugu carrier phrase yielded better scores for native speakers of Kannada is not explained easily. The Telugu carrier phrase used in this study had more stress on the whole when compared with the Kannada carrier phrase. Also, the number of syllables in the former case was more(six in number) than the latter (four in number).

Another factor that could have led to better scores is thet the subjects were more careful in listening to words when the carrier

phrase used was not from their language. This is thought in the light of the tendency of the subjects to ask and confirm that the words were from Kannada language, while instructing them. When the subjects were instructed that words will follow a phrase "ippudu chappandi" and that they have to write the word, they generally asked for confirmation that the words belonged to Kannada. This must have made them pay more attention to the test words than otherwise. This, in turn, yielded better discrimination scores.

The present study also supports both the views that recorded materials on which standardization is done should be used and a consistent use of carrier phrase is essential during speech discrimination testing. The present test, however, needs to be administered on clinical population to draw definite conclusions on the clinical utility of common word lists for discrimination testing.

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C H A P T E R - VI

SUMMARY AND CONCLUSIONS

The present study aimed at obtaining the articulation functions for the word lists common to Kannada and Telugu languages for the native speakers of Kannada. In addition, effect of language of the carrier phrase on discrimination scores was also investigated. The lists of words were recorded with two carrier phrases (one each of Kannada and Telugu languages) on magnetic tapes. The recorded stimuli were presented to the subject's ear at five different sensation levels viz., 8, 16, 24, 32 and 40 dBSL (Ref: PTA). A clinical audiometer (Madsen 0870) was used to carry out the experimentation.

The subjects of the study were normal hearing young adults (age range from 18 years 3 months to 28 years 2 months with mean age of 22 years 6 months and medien of 21 years 6 months), forty in number. They were all native speakers of Kannada language. Twenty out of forty subjects listened to word lists with a Kanneda carrier phrase and another group of twenty individuals listened to the same, lists of words but recorded with a Telugu carrier phrase. In both the groups, ten subjecte were tested for discrimination in their right ears and the other ten subjects in their left ears. The

subjects listened to the four lists at any four sensation levels from a group of five levels (8, 16, 24, 32 and 40 dBSL, ref: PTA). The list level combinations were presented in random order.

Percentage of discrimination scores were calculated for written responses. The scores were analyzed by computing measures of central tendency and variability. Two-way Analysis of variance was also computed. Further, articulation functions for the two groups of date were drawn. Effect of the language of carrier phrase was statistically analyzed.

The following conclusions can be drawn from the results of the study;

1. Discrimination scores increased with increasing sensation level and this was observed for both the groups of subjects.
2. There was no statistically significant difference in terms of difficulty among the four lists of words when either Kannada or Telugu carrier phrase was used.
3. The discrimination scores obtained using Telugu carrier phrases were higher than those obtained using Kannada carrier phrase. However, an interaction effect significant at $P \leq 0.05$ level was found between different sensation levels and the two carrier phrases used in the study.

The study showed that the lists could be utilized for testing discrimination. As the carrier phrase was found to affect discrimination scores, different norms should be utilized while testing speech discrimination. However, the clinical utility of the common word lists for discrimination testing should be established.

Implications of the present study:

1. The recording of speech stimuli done at two different times by the same speaker introduces certain amount of variability. Therefore, the standardization of speech stimuli should be done for different recordings.
2. The use of different carrier phrases inconsistently during speech discrimination testing should be avoided.

Suggestions for future research:

1. To investigate whether further increase in the sensation level would result in 100% discrimination.
2. To investigate the diagnostic utility of the test on clinical population.
3. To analyze the error responses obtained in the present study to investigate if the errors follow a consistent pattern and to see whether the pattern differs with differences in the carrier phrase.

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APPENDECES

APPENDIX - I

LIST I

	KANNADA	I.P.A.	KANNADA	I.P.A.
1	ಮಿಟ	miṭṭi	ಕೂಡು	ku:ḍu
2	ಇಂಪು	impu	ಕಾಲು	ka:lu
3	ಪುಷ್ಟಿ	puṣṭi	ಕಡ	kaḍa
4	ಬಲ	bali	ತ್ರಿಪ್ತಿ	ṭṛipṭṛi
5	ತಾಜ	ṭa:dʒa	ಅರ್ಜಿ	arḍʒi
6	ಕತ್ತಿ	kaṭṭi	ಭ್ರಾಂತಿ	bʰra:nṭṛi
7	ಮುಕ್ಕು	mukku	ಪಕ್ಕ	pakka
8	ಮರಿ	mari	ದಮ್ಮು	dammu
9	ಪೇಟ	pe:ṭa	ವಾದಿ	va:ḍi
10	ಜಾಕು	ʤa:ku	ಮಾಟ	ma:ṭa
11	ನೀರು	ni:ru	ಮಂದ	manḍa
12	ನಟ	naṭi	ಕಾದು	ka:ḍu
13	ತುಲ	ṭula	ಅಂಟು	anṭu
14	ಅಷ್ಟಿ	astʰi	ವಿದ್ಯಾ	vidja
15	ಮೀರು	mi:ru	ನಾಂದಿ	naːndi
16	ಕ್ರಿಮಿ	krimi	ದ್ವಂದ್ವ	dwandwa
17	ಪ್ರತಿ	praṭi	ಪಟ್ಟು	paṭṭu
18	ಪೃಷ್ಠ	a:sṭṛi	ತಪ್ಪು	ṭappu
19	ದಂಡ	ḍanḍa	ಕೋಟು	ko:ṭu
20	ಪಾಪ	pa:pa	ಮೂಲ	mu:la
21	ಧೃತಿ	dʒʰṛti	ಇದೆ	ide
22	ಪೆಟ್ಟು	peṭṭu	ಅಚ್ಚು	aʧʧu
23	ಪಿಂಡಿ	piṇḍi	ವೃದ್ಧಿ	vṛuddʰi
24	ಅಂಚು	anʧu	ಅತ್ತ	atta
25	ಡಾಣಿ	ḍa:ni	ಬಂದಿ	bandi

LIST II

	KANNADA	I.P.A.	KANNADA	I.P.A.
1	ಗಟ್ಟಿ	gaṭṭi	ಬಿಟ್ಟು	biṭṭu
2	ಎತ್ತು	eṭṭu	ಅರ್ಧ	arḍʰa
3	ನಾಯಿ	na:yi	ಬಂಡ	banḍa
4	ಬೀಡು	bi:ḍu	ಆಮೆ	a:me
5	ಬಂದು	o:ḍu	ಸಂಧಿ	sanḍi
6	ಕೋಟ್ಟು	ko:ṭṭu	ಸ್ಪೂರ್ತಿ	spu:rṭṛi
7	ಸೀಸ	si:sa	ತೀರು	ṭe:ru
8	ಬೊಟ್ಟು	boṭṭu	ಕುಂಡ	kunḍa
9	ಪತಿ	paṭi	ವಾಪು	pa:vu
10	ಬಾವಿ	ba:vi	ಚೂಪು	ʧu:pu
11	ಕಪಿ	kapi	ಸ್ಥಿತಿ	sṭʰiṭi
12	ಬಸ್ಸು	bassu	ನಲ್ಲಿ	nalli
13	ಪಡಿ	paḍi	ಕೀರ್ತಿ	ki:rṭṛi
14	ಮರ	mara	ಬಾಟು	ba:ṭu
15	ತಾಳಿ	ṭa:ḷi	ರವಿ	ravi
16	ಮಂದಿ	manḍi	ಲಕ್ಷ	lakʃa
17	ವ್ಯಕ್ತಿ	vjakti	ಬಡಿ	baḍi
18	ಒಪ್ಪು	oppu	ತಂತಿ	ṭanṭi
19	ನಾರು	na:ru	ಮಾತ್ರ	ma:ṭṛa
20	ನೆಗು	nagu	ಕೊಡಿ	ko:ḍi
21	ಊರು	u:ru	ತಕ್ಕ	ṭakka
22	ರಾಗಿ	ra:gi	ಓಟು	o:ṭu
23	ಪಕ್ಷಿ	pakʃi	ರೈಲು	railu
24	ನೂರು	nu:ru	ನೂಕು	nu:ku
25	ಡಾಬು	ṭo:ḍu	ಡಬ್ಬಿ	ḍabbi

APPENDIX - I [CONTD.]

LIST III

	KANNADA	I.P.A.	KANNADA	I.P.A.
1	ಜೊಡು	dʒo:ɖu	ಕಟ್ಟು	kaʈʈu
2	ಗುಂಡಿ	gunɖi	ಬುದ್ಧಿ	buɖɖʰi
3	ಋಣಿ	ʀu:ni	ದೃಷ್ಟಿ	ɖʀuʃʈi
4	ಶೃತಿ	ʃʀuʈi	ಜೋಬು	dʒe:bu
5	ಆದಿ	a:ɖi	ಅನ್ನ	anna
6	ಸರಿ	sari	ಗಲ	ga:li
7	ಜ್ಞಾನಿ	gnɑ̃:ni	ಅಮ್ಮ	amma
8	ಋತು	kʰaʀʈu	ಮಸಿ	masi
9	ಮೃಗ	mu:ʀgi	ಅಕ್ಕ	akka
10	ಮುನಿ	muni	ಕನ್ಯ	kanja
11	ಭೀಕರ	bʰi:ʀgi	ಬೇಡಿ	be:ɖi
12	ತಗ್ಗು	ʈaggu	ಮುಜ್ಜಿ	mujji
13	ದಾಸಿ	ɖa:si	ಬಚ್ಚಿ	ʧi:ʈi
14	ಹಂಸ	hamsa	ಟೊಪಿ	ʈo:pi
15	ಚೆಲ್ಲು	ʧellu	ತ್ಯಾಗಿ	ʈja:gi
16	ಋಷಿ	ʀuʃi	ಕಾಂತಿ	ka:nʈi
17	ಕವಿ	kavi	ಗತಿ	gaʈi
18	ತೀರ್ಪು	ʈi:ʀpu	ಬತ್ತಿ	baʈʈi
19	ದೇವಿ	ɖe:vi	ಡೇರ	ɖe:ʀa
20	ಮಂತ್ರಿ	manʈʀi	ಪೈರು	paiʀu
21	ನಡಿ	naɖi	ನಿವ್ಯ	ni:vu
22	ಅತಿ	aʈi	ದ್ರೋಹಿ	ɖʀo:hi
23	ಗುದ್ದ	guɖɖa	ನಾಡು	na:ɖu
24	ದರ್ಜಿ	ɖaʀdʒi	ಭಾವಿ	bʰa:vi
25	ಟಾಂಗ	ʈa:nga	ಪೆದ್ದ	peɖɖa

LIST IV

	KANNADA	I.P.A.	KANNADA	I.P.A.
1	ಅತ್ಮ	a:ʈma	ಎದ್ದು	eɖɖu
2	ಕಳ್ಳ	kaɭɭa	ಗುಂಡು	gunɖu
3	ಊಟ	u:ʈa	ಜಾತಿ	dʒa:ʈi
4	ಕಪ್ಪು	kappu	ಗೋಶಿ	go:ʃi
5	ಕಟ್ಟು	kaʈʈu	ಗಿಶಿ	giʃi
6	ಗೋವು	go:vu	ಗೂಡು	gu:ɖu
7	ತಾತ	ʈa:ʈa	ಪದ	pada
8	ಕಾವ್ಯ	kavu	ತಟ್ಟು	ʈaʈʈu
9	ಜಾಗ	dʒa:ga	ಕಾಟ	ka:ʈa
10	ನಿಧಿ	niɖʰi	ಕಾಳಿ	ka:ɭi
11	ಅಂಗಿ	angi	ಶಿಶು	a:ʃu
12	ಜಮ	dʒama	ಮಗ	maga
13	ಜಶಿ	dʒaʃi	ಪೂಶಿ	pu:ʃi
14	ಪೈಸ	paisa	ಮುಟ್ಟು	muʈʈu
15	ಐದು	aiɖu	ತೂಕ	ʈuka
16	ಶ್ವೀತ	pu:ʃʈi	ಸ್ವಾಮಿ	swa:mi
17	ಲೆಕ್ಕ	lekka	ಧ್ವನಿ	ɖʰwani
18	ರೋಗಿ	ʀo:gi	ನೀಲಿ	ni:li
19	ಚಿನ್ನ	ʧinna	ರುಬ್ಬು	ʀubbu
20	ಕೋತಿ	ko:ʈi	ತಾವು	ʈa:vu
21	ಪ್ರಾಣಿ	pra:ɳi	ಪತ್ನಿ	paʈni
22	ಕಾರು	ka:ru	ದಯಾ	daja
23	ಮಾಡು	ma:ɖu	ನೋಟು	no:ʈu
24	ದಾಶಿ	ɖa:ʃi	ನೀತಿ	ni:ʈi
25	ಅದೇ	aɖe:	ಉಪ್ಪು	uppu

APPENDIX II

CALIBRATION PROCEDURE

Pure tone calibration:-

Both frequency and intensity calibration was done for the pure tones generated by the clinical audiometer (Madsen 08 70).

1) Intensity Calibration:

Intensity calibration for air conducted tones were carried out with the output of the audiometer set at 70 dBHL (ANSI, 1969), through the earphones (TDH 39 with MX-41/AR ear cushions) the acoustic output of audiometer was given to a condenser microphone (B and K 4144) which was fitted into an artificial ear (B and K 4152). The signal was then fed to a sound level meter (B and K 2209) through a pre-amplifier (B and K 2616). The SLM was fitted with a half inch to one inch adapter (B and K, SB 0962). At each of the test frequencies, i.e., 250 Hz to 8 KHz, the output SPL values was noted. A discrepancy of more than 2.5 dB between the observed SPL value and the expected value (ANSI, Stds, 1969), was corrected by means of internal calibration, by adjusting the presets in the audiometer. Intensity calibration for the bone vibrator (X120 - Denmark) was done, for the frequencies 250 Hz to 4 KHz. The output of the audiometer was set at 40 dBHL (ANSI, 1969). From the bone vibrator (X-120 - Denmark) the acoustic signal was fed to the artificial mastoid (8 and K 4930). This output was then fed via a

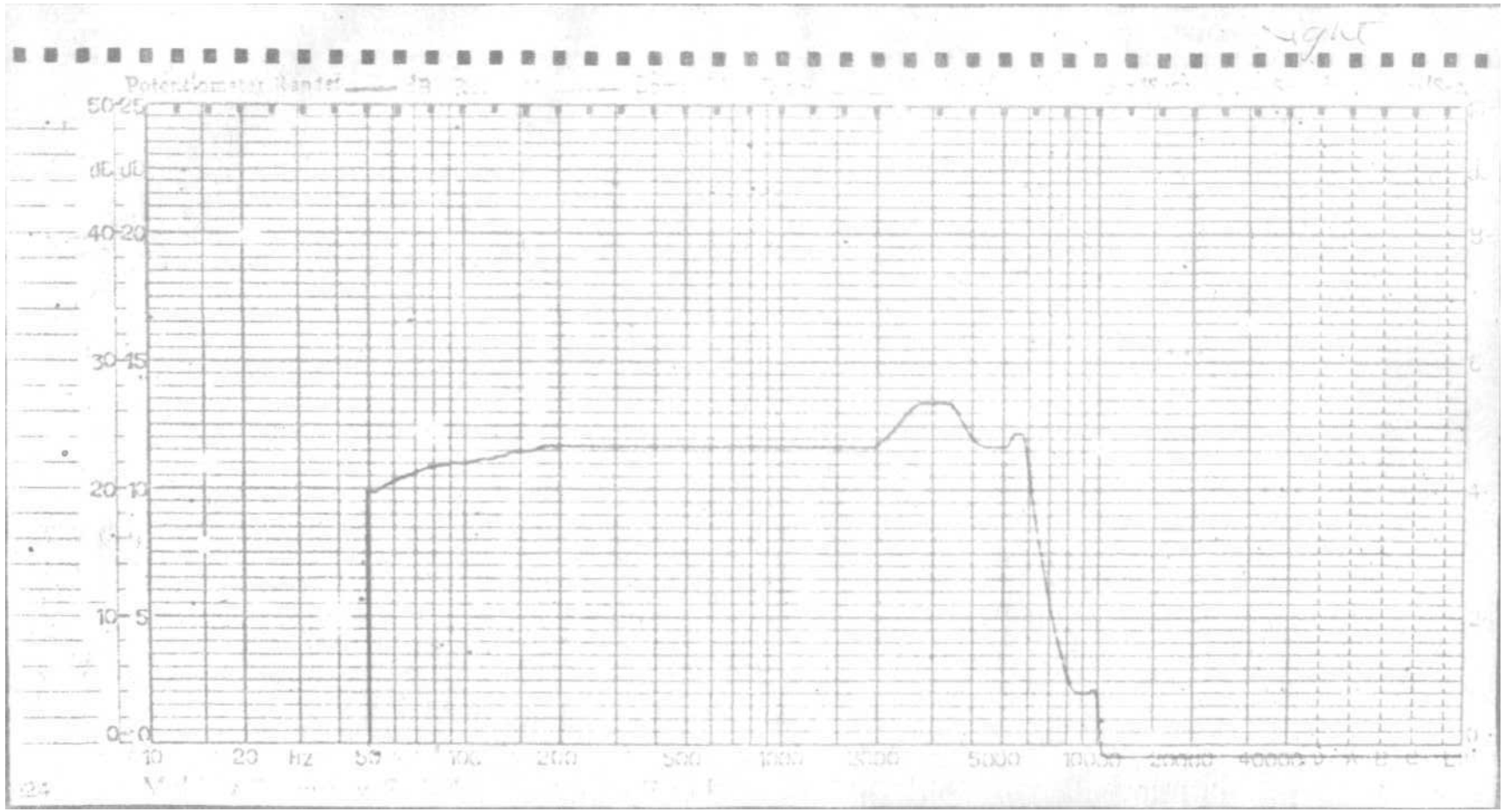
pre-amplifier (B and K 2616) to the SLM (B and K 2209). A difference of more than ± 2.5 dB between the observed SPL value and the expected value, (ANSI standards, 1969), was internally calibrated. Thus the output of the audiometer was maintained within 2.5 dB of the standards (ANSI, 1969).

ii) Frequency Calibration:

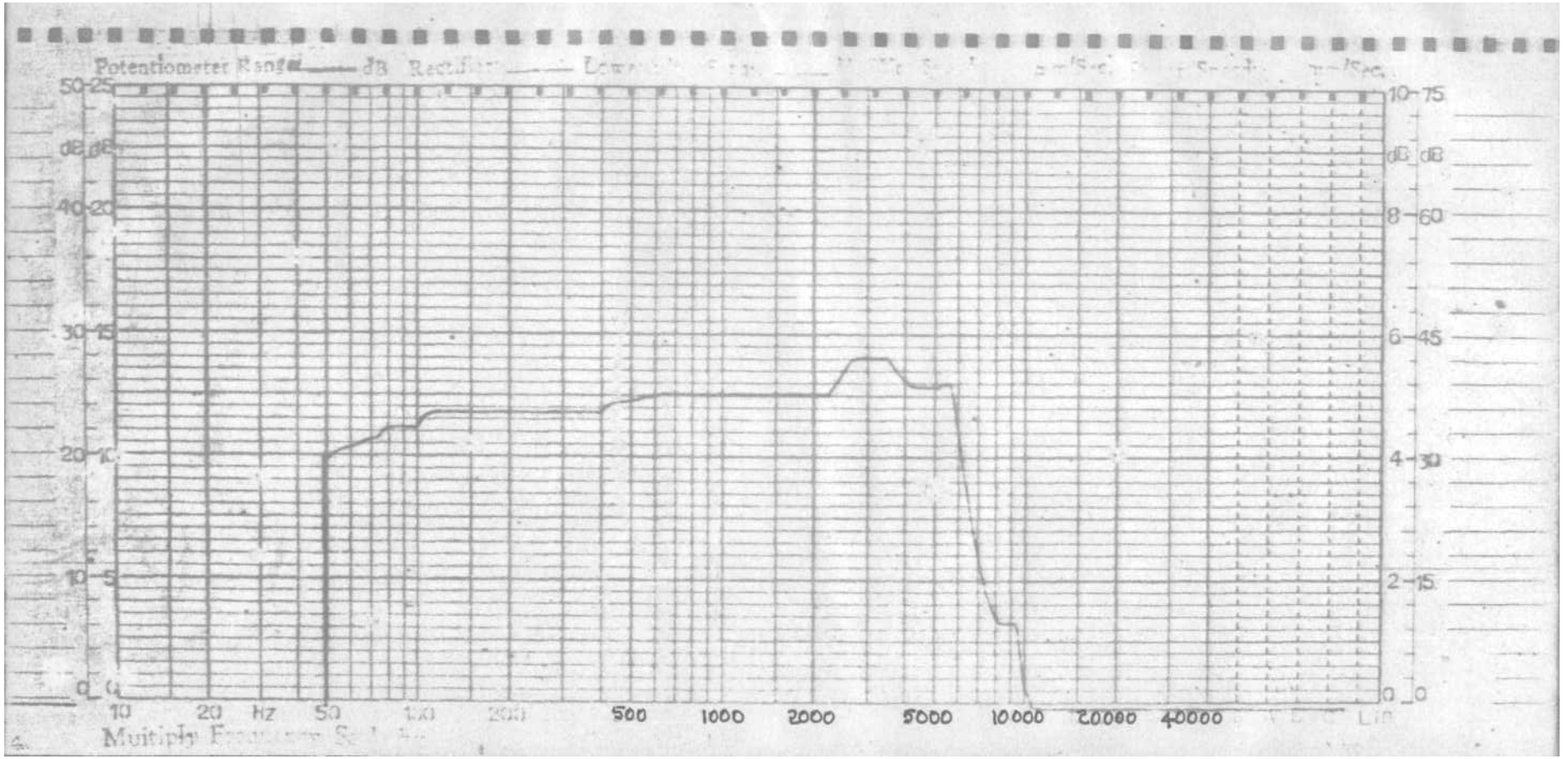
A time/counter (Rodert 203) was utilized to calibrate the frequency of the pure tones. The electrical output of the eudiometer was fed to the counter which gave a digital display of a given frequency, did not exceed ± 3% of each other.

iii) Earphone Frequency Response Cheracteristics:-

A beat frequency oscillator (B and K, 1022) and a level recorder (B and K 2305) were utilized to establish the frequency response characteristics of the earphones. Frequency calibration had been previously carried out for the BFO using a timer/counter (Rodart 203). The electrical output of the BFO were fed to the earphones (TDH 39, with MX-41/AR ear cushions) that were used during the study. The earphone output was picked up by a micro-phone (B and K 4144) which was connected to a pre-amplifier (B and K 2616). Further, this output was fed to a level recorder (B and K 2305). Thus a graphic recording of the frequency response of the earphones was established on recording paper and the copies of the recordings are given.



Frequency Response Characteristics of Earphone 1 RIGHT



Frequency Response Characteristics of Earphone 2 LEFT

APPENDIX III

The noise levels in the test room were as follows;

Octave frequencies in Hz	Level in dBA
125	29
250	20
500	11
1000	13.5
2000	12.5
4000	14.5
8000	8

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