THE DEVELOPMENT AND STADARDIZATION OF A COMPETING SENTENCE TEST IN KANNADA

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A Dissertation Submitted To University of Mysore
In Partial Fulfillment of The Requirements For The Degree
Master of Science in Speech and Hearing

1982

Dedication

To my father who is a constant source of
moral support

and

To my mother who always inspires me towards
higher academic achievements

C E R T I F I C A T E

This is to certify that the Dissertation entitled " The Development and Standardization of A Competing Sentence Test in Kannada" is a bonafide work done in part fulfilment for the Degree of Master of Science (Speech & Hearing) of the student with Register No.3-

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CERTIFICATE

This is to certify that this dissertation entitled " The Development and Standardization of A Competing Sentence Test in Kannada" has been prepared under my supervision and guidance.

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D E C L A R A T I O N

This Dissertation entitled " The Development and Standardization of A Competing Sentence Test in Kannada" is the result of my own study undertaken under the guidance of Mr. M.N.Vyasamrurthy, Lecturer in Audiology and has not been submitted earlier at any University or Institution for any other Diploma or Degree.

Mysore:

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A C K N 0 W L E D G E M E N T S

I am greatly indebted to Mr. M.N. Vyasamurthy, Lecturer in Audiology, for his valuable guidance.

I also thank Mr. S.S.Murthy, Lecturer and Head of the Department of Electronics for his help in the recording procedure.

I also thank Dr.(Miss) S.Nikam, Professor and Head of the Department of Audiology, for the facilities extended.

I thank Mr. Narayana Raju and Miss Jayashree for their technical help.

I thank Mr. Chandra for providing me with equipment material.

I thank Miss Kamini, R. for agreeing to be the speaker for the study.

I thank Mr. Subbanna for typing the manuscript.

I thank Miss Suma R. for moral support and helping me with my Bibliography.

A special thanks to my subjects without whose willing participation this study could not have been done.

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Chapter 1

INTRODUCTION

Thomas Barr in 1846, was among the first to attempt an objective and systematic approach to the problem of assessing hearing loss and site of lesion testing. Since his days there has been a rapid increase in technological procedures which has served to improve the status of audiology and hearing loss testing.

In the early part of the century tuning forks were the only means of testing hearing loss. With the development and commercial production of audiometers hearing assessment has improved in finesse and sophistication.

Pure tones were considered as the ideal stimulus for quite some time, as they are standards easily quantifiable. However, when used in testing children and other naive listeners pure tones are not the best of stimuli. Speech audiometry is easier and less abstract than pure tones. Often it is the only means of testing difficult to test children (Martin, 1978). Speech audiometry not only helps determine type of hearing loss and the general site of pathology but also the type of rehabilitative measure to be adopted and its prognosis.

Pure tones, though a valuable stimulus item, has not found much validity in the testing of central auditory disorders. Hodgson (1967) reported on a patient with a complete cerebral hemispherectomy who showed normal heap-ing on pure tone tests. It has been found necessary to develop new and refined speech tests to evaluate the central auditory pathways.

The evaluation of central auditory skills has become a subject of widening interest. It is now well established that a series of unique physiological events occur in the CANS (central and nervous system) which reshape or modify auditory signals between their initiating and culminating activities.

Behaviour seen in children with central auditory disorder-

Children with central auditory problems are found to exhibit unusual auditory behaviour such as -

1. poorly executed direction taking
2. defective vocal monitoring, especially excessive loudness
3. dislike of loud sound stimuli similar to recruiting ears
4. defective serialization of phonemes and syllables
5. relating of events in a non-sequential manner
6. word finding problems
7. difficulty functioning in noise or other distracting background conditions
8. delayed development of language (Willeford, 1977).

Hodgson (1967) says the following 5 effects may be observed in the presence of a central auditory system pathology.

1. pure tone thresholds are essentially normal in both ears.
2. supra threshold pure tone tests are essentially normal in both ears.
3. speech discrimination scores may be reduced in the ear contralateral to the damaged portion of the brain. This becomes more evident if the speech is distorted.
4. Dichotic listening tasks are more difficult than for person with intact CANS (central auditory nervous system).
5. when speech is presented to one ear and a competing signal to the other ear, poorer discrimination may be evident in the ear contralateral to the lesion.

Mencher and Stick (1974) noted that there were some neonates in the high risk register who showed peculiar behaviour on sound stimulation, viz.,

1. Children who gave no response when they had normal hearing.
2. Children who gave response to broad-band noise
3. Children who gave a gross response or a moro reflex and
4. Children, no matter how often stimulated failed to adapt and continued to respond.

He suspected that such neonates may have auditory problems, other than peripheral hearing loss. Based on this premise he developed a procedure called MAST(Mencher and Stick Auditory screening test). It is not actually a formal test but a list of items which are administered in any room. It is designed to screen for auditory discrimination, auditory association, auditory closure, auditory memory, auditory localization and auditory figure-ground perception. It is applicable with children 3-4 years of age. This simple test can be administered routinely by a pediatrician, public health nurse, or audiologist.

Findings of CAD tests:

The auditory system continually refines auditory information from the time a signal enters the ear canal till it is processed in the brain. Hence a clear cut demarkation of central and peripheral parts of the system, is difficult to make with precision. However, the system upto and including the eighth nerve is called peripheral and the brain stem and brain are called central (Katz, 1978).

As the site of lesion, ascends the auditory system, its manifestation becomes more subtle(Jerger, 1965). The detection of these lesions involves the use of sensitized speech tests or degraded speech tasks, since the conventional test battery does not reveal the deficit(Katz, 1978).

It is generally seen that on a central auditory test battery, that brain stem and retrocochlear lesions show poor performance on the ipsilateral ear, while cortical lesions show contra lateral ear deficit. However, the central auditory tests by virtue of their design tap different aspects hearing. Hence no one test can he used to test the entire auditory system.

Lynn and Gilroy (1977) have been particularly successful in demonstrating the clinical value of central auditory system tests. They used low pass filtering, staggered spondiac word test, Willeford's competing sentence test and rapidly alternating speech discrimination test. The first three are useful in identifying superficial and deep lesions in the cerebrum and the last in identifying lesions lower brain stem lesions. Jerger and Jerger (1975) investigated the validity of central auditory tests and found that SSW(staggered spondiac word) is useful for cerebral lesions and SSI-ICM (sympathetic sentence tests in the ipsilateral competing mode) for brain stem lesions.

Smith and Resnick (1972) found that dichotic tests were useful in identifying brain stem lesions.

Lynn and Gilroy (1977) found that in corpus callosum section (anterior commisure) the non-dominant ear shows decreased functioning.

Willeford and Bilger (1978) found that children with learning disabilities show poor performance on central auditory tests.

Findings in children with learning disability:

Benton (cited by Pinhero, 1977) describes learning disabilities "as an inexplicable failure to learn to read in children", inspite of normal intelligence; normal sensory , capabilities and normal motivation to learn in the beginning.

Several investigators have shown that children with learning disabilities show auditory perceptual disorders (Pinhero, 1977; Willeford, 1978; Beasley, et al. 1972; Willeford and Bilger, 1978; and Beasley and Freeman, 1977).

One of the most widely used tests, for allegedly evaluating auditory perception is ITPA (Illinois test for psycholinguistic ability). The battery has 5 subtests which measure reception, association, memory, closure and sound blending. However, it has the limitation of being unstandardized, i.e., administered by live voice and by different examiners in uncontrolled environment.

Willeford and Bilger (1978) administered the following battery to children suspected of central auditory problems and found that the children failed on at least one sub test.

1. Dichotic competing sentences.
2. Filtered CNC(consonant nucleus consonant) words.
3. A binaural fusion task.
4. An alternating speech task.

They found that on the dichotic competing task, the right ear was dominant most often though the left also was

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also dominant at times. With increasing age the performance in the weak ear improved. Generally 5 and 6 year olds scored 100% in their strong ear and poorly in the weak ear. At 9 years the 2 ears were found to show equal skill and at this age the MCR (message competing ratio) could be expanded without further deterioration in performance. This is believed to be due to the maturity of the auditory processes.

The filtered or frequency distorted speech was prepared by removing much of the high frequency energy by electronic filtering procedure. The frequencies above 500 Hz. were selectively attenuated at the rate of 18 dB per octave.

The binaueral fusion task utilizes the principle of presenting low frequency information from a stimulus word to one ear, while the other ear receives high frequency information from that same word. Because both portions of the word have sharply restricted information and/or energy content each is difficult for normal listeners to perceive when presented separately. However, when both segments are played simultaneously the intact central auditory system is capable of recombining these complementary stimuli into a fairly intelligible message. The test is presented at 30 dB above 500 Hz. threshold for the low frequency component and 30 dB above 2000 Hz. for the high frequency component. Maturation pattern can be observed on this test too.

The last test, i.e., alternating speech was performed with comparative ease by 5 year old children. This test was found to be of the least diagnostic significance.

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Willeford (1977) found that the dichotic listening task was the most useful in the diagnosis of learning disabled children. One subject studied showed no dominance at all, i.e., 0% in both ears. He cites several case studies in which this batter has been found useful in diagnosis.

Speech in noise tests have also been widely used in the diagnosis of auditory perceptual disorders (Katz, 1978).

Willeford (1978) has criticized the use of several measures of "auditory processing functions" on the basis of lack of normative data and poor descriptions of test protocol. He states that "ignoring or over-simplifying the many complexities of the process that can or may occur when presuming to assess auditory functions with a simple test in a class room, without exercising proper control of the stimulus or the environment can lead to erroneous conclusions." Willeford (1977), Beasley and Freeman(1977) state that control is even more important when testing children, as variability is greater with children than adults,

They attempted to overcome these limitations by using time compressed speech test. They administered the time compressed version of the WIPI (word identification by picture index) in a closed response task and PB-IC 50 in open response task, to 60 children from 4 to 8 years of age. The results showed that WIPI, a visual painting task was easier than PB-IC 50. Intelligibility decreased as a function of increasing time compression, decreasing age and sensation level. They conclude that PBK-50 could be used with older children and WIPI with younger children.

Freeman and Beasley (1976) presented the time compressed version of WIPI to 2 groups of children; normal readers and reading impaired, in an open and closed set format. At 0% time compression the results for the 2 groups were similar. At 60% time compression the open set yielded poorer discrimination scores especially for reading impaired children.

When monosyllables are used as stimulus material, factors of vocabulary, word familiarity, word length play a major role in discrimination. Moreover it is not sufficiently challenging to test higher auditory centers. Hence sentences have been found to be more appropriate stimulus (Keith, 1977).

Hence, Freeman and Church (1977) developed s time compressed version of sentential approximations. At 40% time compression, it was found to differentiate between normal reading children from reading impaired children. Oelschlaeger and Orchik (1977) also found time compressed speech discrimination task, useful in the differential diagnosis of children with central auditory dysfunction.

Jerger, et al. (1968) gave the synthetic speech identification test. This test in the ipsilateral competing mode, is a useful test for site of lesion testing of brain stem pathology. However, no data on learning disabled children has been provided. Moreover the test necessitates a knowledge of reading and hence is not suitable for use with reading impaired children.

Costello (1977) found that the Flowers Costello test of central auditory abilities (CAA) was also useful in differentiating learning disabled children from normals. In this test, to there are a total of 48 items. 24 are low pass filtered sentences and 24 are sentences with a running discourse as competing message. The child is required to complete the test sentence by pointing to an appropriate picture from an array.

Though the authors report that the Flowers Costello test of central auditory abilities (CAA) was useful in differentiating learning disabled children from other problems. However Hodgson (1966) found that tests using speech passed through a single low pass filter did not separate normal children from those with learning disabilities. Moreover Treisman (1964) notes that competing signals that are irrelevant eg. running discourse are discarded during their identification. Competing message delivered by the same speaker and involving then a similar content material provide a more difficult task. Simhadri (1977) also found that when the competing message is of a different language from the primary sentences, they are less effective as competition. Hence it is possible that the CAA is not as useful as the authors claim.

Findings with competing sentence test (CST):

Keeping this in mind Willeford (1978) developed the competing sentence test in 1968. The test involves a dichotic listening task. The target sentence and competing sentence are of similar length and have a common theme. According to Willeford (1978) "The CST would seem to challenge a subject's skill for a task that occurs continuously in everyday living."

The test is administered at a - 15 dB signal to a competition ratio, viz. the primary message is given at 35 dBSL (re:pure tone average) and competition at 50 dBSL re:pure tone average. The puretone average was chosen as reference as in individuals, with hearing sensitivity within 2o dBHL the pure tone average is nearly the same as speech reception threshold. Hence either of the two may be taken as reference.

Since 1968, the CST has been widely used. Lynn and Gilroy (1977) found it useful in detecting lesions in the brain, in addition to monitoring changes in a patients neuro-logic status with respect to time or as the result of treat-ment or surgery.

Pinherio (1977) administered the following battery of tests to learning disabled children.

1. Alternating speech perception test
2. Binaural fusion tests
3. Low pass filtered words

4. Competing sentences

5. Simultaneous sentences

6. The staggered spondiac word test and

7. Pitch patterns.

She found the competing sentence test a useful measure in the diagnosis of reading impaired children.

Lynn and Gilroy (1977) note that the competing sentence test is highly sensitive to lesions in the posterior region of the temporal lobe.

Willeford (1978) states that the competing sentence test can be used to follow changes in performance with maturation, training, counselling and environmental control. This means that the competing sentence test is a very useful tool in the effective identification and rehabilitation of learning disabled children. It provides cues as to the appropriate theraputic channels to be tapped.

Why assess central auditory disorder in Children.

Central auditory testing is done mainly for 2 reasons.

1. For site of lesion testing.

2. For the diagnosis, evaluation and rehabilitation of children with auditory perceptual disorders.

Central auditory dysfunction in children is not a myth. It occurs and is associated with language and/or learning problems. It may lead to behaviorial disorders at home or school. Early intervention is required to prevent or at least ameliorate the resultant difficulties in language reading and behaviour. This requires reliable and valid techniques to use with very young children to identify and assess auditory ability.

Young a nd Pratti (1981) have recently found that when peripheral hearing loss is combined with central auditory problems, hearing aids should be prescribed. However, if the prescription is done similar to the manner in which it is done for the hard of hearing child, the aid will be of no use and may even lead to further problems. They suggest that when a monoaural aid is prescribed, it should be done to the ear contralateral to the dominant hemisphere. When binaural aids are prescribed, they suggest that the 2 aids have different frequency ranges. The aid with high frequency boosting is prescribed to the dominant ear and that with low frequency boosting be prescribed to the non-dominant ear. This entails a testing of dominance before prescription of aid. Each test developed for testing central auditory dysfunction taps a different aspect of hearing, i.e., auditory function. Hence no single test is adequate to evaluate the entire auditory system. Hence Willeford (1977) recommends the use of a test battery approach in the diagnosis and evaluation of children.

Need for the study:

So far, in India, no test for the identification of learning disabled has been developed. Two tests for central auditory problems have been developed in India, i.e., the SSW test in Indian English (Chandrashekar, 1977) and the

SSI test in Kannada language (Nagaraja, 1977).

Central auditory disorders testing is still in its infancy in India. However, one cannot ignore the presence of such an entity. To detect the patients of central auditory disorder it is essential to have standardized tests of central auditory disorder. Hence an attempt has been made to develop and standardize competing sentence test in Kannada language.

It is hoped that the test would be useful in detecting the children with auditory processing problems and also that the test would be useful to detect central auditory disorder cases.

Statement of the problem:

In addition to providing the normative data for CST (competing sentence test) in Kannada the following null hypothesis are made.

1. There is no significant difference between right ear scores and left ear scores obtained on CST.
2. There is no significant difference between the scores obtained for test A and test B.

In addition to verifying the above null hypothesis, the present study was designed to find answers to the following questions:

1. Can the test be used for finding ear dominance in normal hearing subjects?
2. Can the test identify the children with auditory processing problems?

Brief plan of Study:

The study was conducted in two stages. The first stage involved the development of the competing sentence test. In the second stage three experiments, viz., I, II, III were carried out.

Development of the Test:

25 pairs of Kannada sentences were developed such that, the sentences were of approximately equal length and had the same theme. Care was taken to ensure that the language level of the test does not penalize children and individuals with low intelligence level.

a) ರಾಮು ಈಗ ತಿಂಡಿಗೆ ಬತ್ತಾನೆ.
b) ರಾಜು ಮನೆಗೆ ಊಟಕ್ಕೆ ಹೋಗ್ತಾನೆ.

a) Ramu will come for breakfast now

b) Raju will go home for lunch.

The two pairs were recorded on two tracks of a speed tape recorder (Uher SG631 logic) and later the recorded sentences were transfered to a cassette. The recording was such that the sentences began and ended at the same time.

Administration of the test:

Instructions for experiments I (a & b) and II (a & b)

"First you will hear pure tones, when you hear the sound raise your finger, when the sound stops drop your finger. You should raise your finger even if the sound is very soft."

"Next you will hear two sentences in your ears simultaneously. Your job is to ignore the sentences in your right/left ear and to identify those in the left/right ear by repeating. Have you understood?"

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In Experiment Ia and 1b ear effect was tested. The experimental let up was as shown in Fig. 1 and 2.

Fig. 1

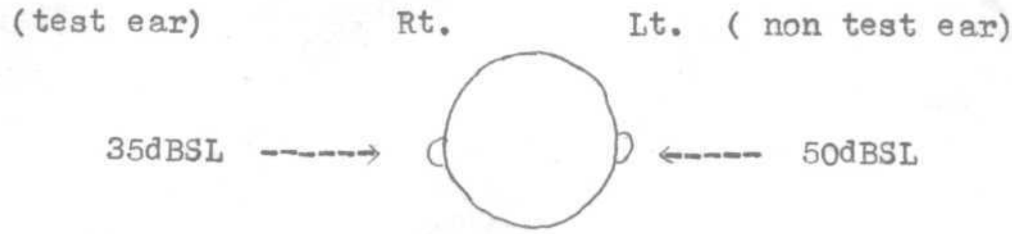
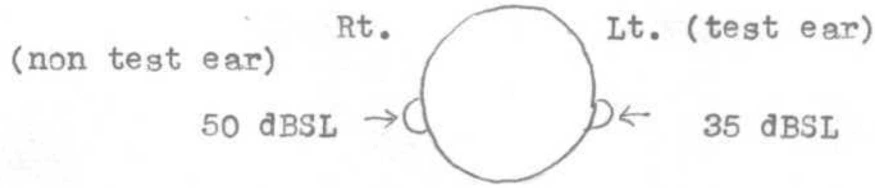


Fig. 2

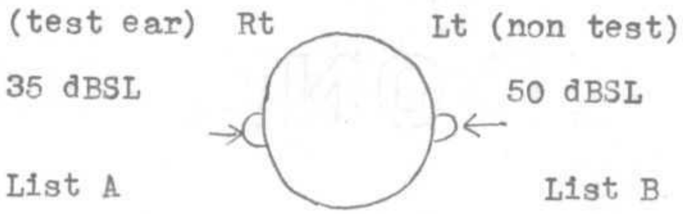


. The test was administered to 15 native adult Kannada speakers (4 males and 11 females). They first received the test sentences in the right ear and competing sentences in the left ear. After an internal of one month (to overcome any effect of memory) the test was administered to the same subjects in the reverse order.

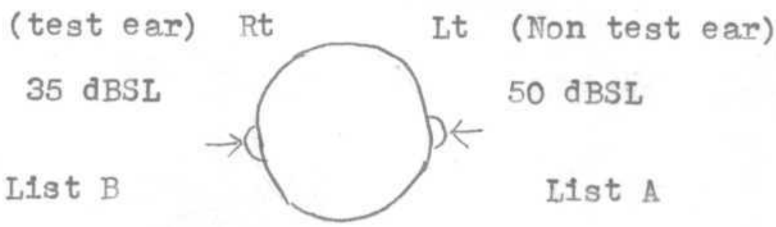
In Experiment IIa and IIb list effect was studied. 15 native adult Kannada speakers (4 males and 11 females) who were different from the subjects used in the above study were tested

The experimental set up was as shown in Fig. 3 and 4.

Expt. II_a (Fig.3)



Expt. II (Fig.4)



In IIa , list A served aa the target sentences while list B was the competing message. In IIb sentences of list B were used as the target sentences and the sentences of list A were used as competing sentences. The target sentences were given at 35 dBSL and competing sentences were presented at 50 dBSL (relative to pure tone average)

Experiment III was similar to Experiments IIa and IIb . Here the subjects had to repeat both the sentences (target and competing). The sentences were administered at 35 dBSL. This was done to determine dominance.

Instruction for Experiment III:

"You will hear the sentences presented simultaneously to the two ears. Your job is 0 to repeat both the sentences. Do not try to concentrate on any one ear while ignoring the other. The task is a bit tough; hence you should concentrate on the task".

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Definitions of terms used:

1. Dichotic stimulation: Simultaneous presentation of two different sentences to the two ears.
2. Target and competing sentences: In the competing sentence test two sentences are presented to the two ears. The sentences presented to one ear are at 35 dBSL (re pure tone average). These are referred to as target sentences. The sentences presented to the other ear are at 50 dBSL (re pure tone average). These are referred to as competing sentence.
3. Learning Disability; This refers to the inexplicable failure to learn to read by a child whose intelligence level, oral language development and sensory capacities appear to be fully adequate to permit the development of reading skills (Pinheiro, 1977).
4. Central Auditory Disorder: Auditory disorders resulting from a lesion to the auditory pathway beyond the level of the cochlea nuclei upto the auditory cortices (Willeford, 1977).

Chapter 2

REVIEW OF LITERATURE

Structure of the auditory system:

The auditory system in man is complex consisting of: a sound conducting apparatus (the outer and middle ear), the organ of corti with its hair cells in the cochlear canal of the inner ear, and a number of inter-connected nuclei - the spiral ganglion, the cochlear nuclei, the superior olivary nucleus and the trapezoid body, the inferior colliculi, the medial geniculate body and the auditory cortex.

There are several levels of relays and conussures which make for a wide representation of information in all auditory nuclei, from the right and left cochlea. A unilateral lesion of all structures located higher than the cochlear nuclei can give rise only to partial diminution of hearing due to the presence of these crossed and uncrossed fibers.

The Rationale and principle of CAD testing:

Disturbances of hearing discovered with the aid of "classical" methods of investigation, viz. pure tone audiometry, speech reception threshold, speech discrimination score and impedance audiometry, frequently yield identical results regardless of whether the pathological system is in the brain stem or cerebral cortex.

Jerger (1975) gave the subtlety principle which is as follows: " The more centrally the lesion is located, the more subtle is its manifestation". In other words central auditory lesions are more elusive to dignose. Such cases may pass of a normal in a conventional audiometric battery.

Barn and Karaseva (1972), state that "lesions of all central parts of the auditory system are characterized by absence of sound lateralization in Weber's test despite asymmetry of the threshold of audibility, shortening of bone conduction and absence of the rapid increase in loudness phenomena".

They also report that the entire temporal lobe can be removed without causing a decrease in hearing of pure tones. However, they report a few cases with bilateral temporal lobectomy in whom complete deafness resulted. However, such reports are rare.

This only goes to show the complexity of the hearing mechanism and the sophistication required by any test to identify site of lesion in the higher centers. It also goes to show the inadequacy of the classical test battery in the identification of such lesions.

The validity of a test procedure for the evaluation of auditory disorders rests in that the test yields expected results in patients with auditory disorders and that false

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positive results usually do not appear in patients without auditory disorders.

Jerger and Jerger (1975) in investigating the potential sources of errors in central auditory testing found that :

1. The physical discomfort characterizing central nervous system pathology does not produce abnormal test results in a central auditory disorder test battery.
2. If the direct involvement of auditory pathway is not present then abnormal test results on any test is not probable.
3. The presence of aphasia reduces the value of degraded speech audiometry but this deficit is seen both contralaterally and ipsilaterally on monotic presentation.
4. Auditory tests do not differentiate between brain stem and 8th nerve lesions.

Willeford (1977) and Katz (1968) have stated that conventional auditory tests lack the structure and sensitivity for the identification of lesions in the auditory cortex. Hence they have attempted to design special auditory test measures which require the cortical integration of complex signals, in order to assess the function of higher auditory centers.

Central auditory tests have used both pure tones and speech stimuli. Speech happens to be the most complex and sophisticated stimuli which is,also, highly redundant as occurring in natural situations. This extrinsic redundancy of speech should be minimized sufficiently to challenge the integrity of higher auditory centers (Willeford and Bilger, 1978).

According to Berlin and Lowe (1972) this is one of the cardinal principle of central auditory disorder evaluation.

Speech signals lend themselves to more complicated manipulation in frequency, time and intensity domain than do tones. Words and sentences can be filtered, split, interrupted, completed, accelerated, reversed and have their redundancy reduced. Hence, speech has been used most extensively in central auditory testing. Booca and Calero (1963), were the first to attempt reduction of redundancy by filtering speech.

Several authors have attempted to develop tests for central auditory problems (Katz, 1978; Jerger, Speaks and Tramvel, 1968; Mencher and Stick, 1976; Willeford, 1978; Beasley and Freeman, 1977; Matzker, 1959; Booca and Calero, 1963).

Attempts have been made to use localization audiometry in the detection of central problems. Rosenweigh (1951) found that lateralization of sound is disturbed in patients with a unilateral lesion of the temporo-parieto-occipital and inferior parietal region of the brain. Sahchez-Longo and Forster (1958), and Jerger (1963) found disturbances of localization of sound in patients with unilateral lesions of the temporal lobe.

Tests based.on use of monosyllabic words as test stimuli were proposed by Bocca, Calero and Cassinari (1954), They found that low pass filtered speech tests using PB words yielded poorer scores in cases with temporal lobe lesions. Hodgson (1967) confirmed the utility of low pass filtered PB words as diagnostic and prognostic indicators, in pre-and post operative hemispherectomies. Conventional test battery showed no difference in results . Post operatively, however, low pass discrimination scores were drastically reduced in the ear contralateral to lesion,

The Rush Huges/W-22 test was also found to be useful in the diagnosis of temporal lobe and subcortical lesions.

The test is performed by administering monoaural word discrimination test using the recorded version of W-22 tests at 40 dB above Speech Reception Threshold and the Rush Huges Test at 50 dB above SRT or below the uncomfortable loudness level, whichever is lower. The difference scores of the 2 ears are determined by subtracting the Rush Huges score from the W-22 score. The diffference score of 30% or greater in one ear is suggestive of contra lateral temporal lobe lesion (Martin, 1975).

Jerger, Speaks and Trammel (1968) proposed a new test for CAD. The test makes use of synthetic syntences. In older to overcome guessing by subjects. They are made more difficult to identify by using competing message. The SSI-ICM i.e., in the ipsilateral competing mode is more susceptible to brain stem lesions and SSI-CCM i.e. in the contralateral competing mode is more susceptible to temporal lobe lesions.

Beasley and Freeman (1977) gave a time altered speech test called 'Time Compressed Speech Test'. They used as electromechanical time compressor/expander Ø to compress the speech signal. The end product was some specific percentage shorter (compressed)or langer (expanded) than the original signal. This time compression of speech reduced the external temporal redundancy of be the normal speech signal, thereby increasing the difficulty of the processing task by the internally redundant central nervous system.

As the percentage of compression increased the scores contralateral to the lesion decreased. The difference scores between 0% and 60% time compression was greater in ear
the/contralateral to the lesion as compared to the ipsilateral ear.

Matzker (1959) gave a test using binaural resynthesis of 2 bands of filtered speech. He used a. list of German PB words which were low pass filtered (500-800 Hz.)

and fed to one ear and high pass filtered (1815-2500 Hz.) and fed to the other ear. The test was given in both, a dichotic and diotic mode and the results of the 2 modes are compared brain stem pathology cases showed poorer scores in the dichotic mode than diotic mode of presentation.

Dichotic competing tests are a way of reducing redundancy. Matzker (1959) gave one of the earliest dichotic integration tests. Jerger (1964) developed the SWAMI (speech with alternate masking index) test which is a dichotic integration test of brain stem.

Katz (1978) developed the SSW (staggered spondiac word) test which is a dichotic listening test using spondee words at supra threshold levels. Different spondees are presented to each ear, with some overlaps for both ears. The test is performed at 50 dB above SRT. The patient is requested to repeat both spondees. The scoring and interpretation of SSW test requires a special form which is commercially available. This is one test in which precaution to rule out peripheral disorders is maintained. Poor scores on the SSW test suggest a lesion in the higher brain centers on the contralateral side.

2. Dichotic vs. Diotic listening;

In dichotic stimulation both ears are stimulated but each ear receives a different message from well separated channels of a tape recorder or similarly independent signal sources via ear phones. It is neither binaural hearing nor true stereo hearing both of which are similar to diotic stimulation. In diotic stimulation identical message is given to both ears simultaneously.

3. Acoustic variables in dichotic stimulation

3.1 Target stimuli and competing message:

Various types of stimuli such as CV's (consonant-vowel) mono-syllables; sentences and musical chords have been used in tichotic stimulation tests (Berlin, 1972.b)

The right ear is seen to show an advantage in the perception of linguistic stimuli. Natural words gave smaller laterality effects than nonsense syllables. This may be due to linguistic differences in listening capability and in word familiarity. This linguistic and phonetic effects is an important variable and must be dealt within dichotic listening.

When CV's (consonant vowel) are used as stimuli in dichotic listening tasks, the temporal onset becomes very critical in dichotic perception . In cases of sentences, however, the temporal onset is not so critical(willeford, 1978). Matzker (1959) was among the first to give dichotic integration test using speech sentences. The competing sentence test (CST) developed by Willeford (1977) also uses sentences stimuli.

The length of the competing and target stimuli should be approximately the same. The use of competing digits that have different syllabic length and phonetic content is an inherent methodologic short-coming in most teats, e.g. it is easier to differentiate 'one' from 'six' but not so with /upa/ and /ba/.

Usually a continuous discourse or a babble of several voices, environmental noise, wide band noise, accelerated speech, backward speech, et., have been used as the competing message. This type of competition differs from the test stimuli. Triesman (1964), suggests that the use of similar content material, delivered by the same talker prooves a more difficult listening task. Willeford (1977) has adopted this in his competing sentence test (CST). The sentences in the competing sentence test (CST) contain a common theme, are of similar length and content and are spoken by the same talker. This is supposedly assumed to resemble the everyday listening task which normals face.

Musical chords, have also been used for dichotic listening tasks. It was found that the left ear performs better (Berlin, 1972b).

3.2 Intensity of stimuli:

In dichotic listening tasks the competing message has got to be more intense before it is effective.

When dichotic CV's were given at 80 dBSPL the right ear out-performs the left. As the signal to the right is attenuated the right maintains its superiority over left

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till the CV's in the left are d 20 dB more intense than those in the right. At 50 dBSPL the right ear advantage (REA) is overcome when left is only 10 dB more intense than right (Cullen, et al. 1974).

On the whole it can be concluded that the attenuated ear performs more poorly and the unattenuated ear improves its performance in a reciprocal fashion.

Berlin et al. (1973) suggests that in dichotic listening tests, the competing sentences do not serve as maskers but the 2 ears interact. Since, a marked drop in performance of weak ear is seen only with speech stimuli and not noise.

3.3 <u>S/N ratio variations:</u>

An 18 dB S/N ratio to the left ear is enough to overcome REA(right ear advantage). This 18 dB S/N ratio is barely enough to interfere with connected speech though it will interfere, to some extent with monoaural syllable intelligibility.

Willeford (1978) uses a S/N ratio of -15dB in his CST (competing sentence test) to overcome ear effect.

3.4 <u>Band width:</u>

When the band width of left ear is low pass filtered at 4000 Hz. but the right ear message is low pass filtered at 3000 Hz. the REA (right ear advantage) is overcome. The total number of syllables perceived by both ears remains constant. As one ear decreases in accuracy the other increases.

3.5 Temporal offset:

In dichotic listening tasks the temporal onset of paired V CV's should be simultaneous; otherwise the 'lag effect' is seen. This is a condition where the delayed channel is heard better than the lead channel. When left ear signals follow those presented to the right by 30-90 msec; the REA(right ear advantage) is overcome; conversely, when the messages are lagged to the right ear the REA(right ear advantage) is enhanced, to that seen in simultaneity.

Berlin, et al. (19733 suggests that perhaps the contralateral pathways conduct faster hence the lagging stimuli is perceived better. This may be related to dominance.

4.0 Non-Acoustic variables in Dichotic testing:

4.1 Articulation and reauditerization interaction:

An interesting difference in the writing down and speaking back response mode of dichotic experiments has been found. The items recalled second in dichotic digit testing tasks were more accurately recalled when the subjects wrote down the answers than when they repeated. This may be due to interference by the vocal output of the recall of the digit spoken. The notion that speaking interferes with recall of recently perceived verbal stimuli suggests that there may be an interaction between articulation and reauditerization (Berlin, 1973 c).

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Abbs and Smith (1970) used DAF and found that more articulatory errors were made when DAF was given to right ear and conclude that a control or interaction between right ear and articulatory movements is possible. This finding supports Studdert-Kennedy and Shankwhieler(1970) that left hemisphere monitors primarily, the consonants and both hemispheres monitor vowel activity.

4.2 Semantic levels of information:

Lewis (1970) did a study to determine whether an unattended message in a dichotic listening task is perceived. He concluded that an unattended message is perceptially analysed and can interfere with the perception of an attended message.

4.3 Order of report vs. order of arrival

Order of report refers to the subjects reporting all the messages from one ear before all messages to the other ear. Order of arrival refers to the temporal order, i.e. first one in is the first one out. Given enough time between messages the subjects organize the stimuli into perceptual wholes regardless of the order of arrival (Yates, 1970).

Gerber and Goldman (1971) did a study using 3 types of reporting strategies, viz. free recall, ordered before and ordered after. In free recall subjects reported as they heard or in whichever order they felt comfortable. In ordered before, the subjects were informed as to which ear to report, before the stimulus was presented. Thus they

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listened to one ear while ignoring the other. In ordered-after the subjects were asked to repeat the sentences which had been given to a particular ear. The right ear was superior in all three conditions. The immediate channel was more accurate than the delayed channel in all three conditions. In the free recall right was reported first.

Pizzamiglio (1974) report that results were 30% in-consistent in test retest correlation with he the same same subjects when dichotic listening tasks were used. The ear preference of subjects was consistent.

4.4 Role of Syntax

Zurif and Salt (1970) report that on using structured and unstructured stimuli they found that the structured stimuli had connective words like- to, for, be, etc., left in. Therefore the sentences could be read with normal intonation and prosody. The unstructured stimuli was read like a laundry list. The structured was found to generate a larger laterality ear effect.

Sussaman (1971) suggests that the neuro-psychologic systems which process the effects of Intonation, rhythm, pause, stress with constituent structure are lateralized and these enhanced processing at the phonetic level.

4.5 Development of Brain laterality:

Berlin et al. (1973 a) found that girls have the adult pattern of ear dominance for speech earlier than boys. Nagafuchi (1970) found that 6 year old children and young adults achieved almost identical dichotic results for the right ear. At 3 years of age girls are superior to boys on both dichotic and monotic listening tasks. By 5-6 years boys and girls show about the same laterality effects.

Berlin, et al. (1973,a) have found that REA (right ear advantage) is fixed by 5 years of age and is independent of sex. The ability of the speech processor to correctly identify two simultaneous stimuli increased with age, on a double report paradigm. However, on a single report paradigm RBA (right ear advantage) did not vary with age of subjects.

Willeford (1978) claims that CST (competing sentence test) can be used to follow changes in performance with maturation. According to him dominance is established by 9 years of age as established by CST (competing sentence test) However, there is a great deal of variability as to when this skill is achieved.

Beaumont (1976) states that MBD (minimal brain damaged) children develop laterality later than normal children. They had longer reaction time when stimuli was given to left ear than to right. Left ear had more errors. Their performance is similar to normals.

5.0 Role of left hemisphere in dichotic listening:

Berlin and Lowe (1972) state that when normal ears are individually tested they show similar PTA (pure tone average) and WDS(word discrimination score). However,

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when two simultaneous or nearly simultaneous signals are presented dichotically, asymetrics in ear function related to brain asymetry are uncovered.

Studdert-Kennedy and Shankweiler (1970) investigated REA (right ear advantage) using CVC (consonant-vowel-consonant) nonsense syllables presented dichotically. Only one sound of the CVC was manipulated systematically and they found significant REA (right ear advantage) for consonants but not for vowels. Hence they conclude that specialization of the dominant hemisphere in speech perception is caused by its possession of a linguistic device which analyses primarily, consonant-features independent of most other acoustic features of speech.

Lowe, et al. (1970) reported that noiseless consonants were more intelligible dichotically than voiced consonants regardless which ear received the noiseless consonant. The REA (right ear advantage) could be overcome by putting noiseless consonants in the left ear and voiced consonant in right ear.

According to Dobie and Simmons (1971) the ipsilateral pathway to the dominant hemisphere is adequate in normal listeming conditions, but became strongly inhibited during dichotic competition. According to Lowe (1970) in dichotic listening tasks both ears are suppressed as compared to monotic listeming tasks.

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Ascribing REA (right ear advantage) to left hemisphere dominance does not explain the function of the left ear in dichotic listening tasks. Berlin, et al. (1975) note that in normal listeners, both ears receive information that prevents either ear from reaching the 100% performance level. In short it can be concluded that dichotic listening does not involve masking but the interaction between the ears. In normals the right ear may be more effective in suppressing competition.

Corpus callosum sectioning produces similar assymetry in dichotic listening and supports that non-dominant hemisphere plays an important rule in processing speech. The effect of corpus callosum sectioning is manifest in the ear ipsilateral to the speech and language hemisphere.

6.0 Findings in pathological cases:

The various tests of central auditory dysfunction, by virtue of their design are not equally sensitive to the effects of brain lesions. However, findings in selected pathological groups is discussed below.

Baru and Karaseva (1972) report that in patients with local lesions of the temporal lobe, there was a disturbance of the perception and reproduction of fast rhythms.

Kimura (1961) showed that healthy subjects made fewer errors in the recognition of tunes presented to the left ear and fewer mistakes in the recognition of verbal material, including numbers, presented to the right ear.

Lesions in the parieto-temporo-occipital region leads to impaired localization ability. The ability to identify the duration of the tone is also lost in temporal lobe patients (Baru and Karaseva, 1977).

Lynn and Gilroy (1977) state that in left temporal lobe lesions and brain stem lesions the contralateral ear shows depressed function on sensitized speech tests. Subjects who had their corpus callosum sectioned found difficulty in understanding digits in left ear when pairs were presented- dichotically. Parietal lobe tunors and nascular tunors showed similar results.

Berlin, et al. (1975) studied several pathological groups and found that

1. In temporal lobectomees, as the weak ear's performance declines the strong ear may perform better than normal in a right temporal lobectomee. However, despite chance performance in the weak ear, the strong ear, never reaches 100% level.

2. By contrast, as the weak ear of the hemispherectomee performs near chance, the strong ear almost always performs at 100% level. Apparently some information is still being transmitted, in a temporal lobectomee from the weak ear to the strong side, which is sufficient to interfere with the strong ear's performance. In contrast, no information is transmitted from the weak ear of the hemispherectomee that interfere with the processing of Information from the stronger.

In temporal lobectomees there is no lag effect and the strong ear continually out-performs the weak ear even at 90 msec. In hemispherectomees no lag effect was seen but the strong ear performed with unusual efficiency as compared to the strong ear of either normal or temporal lobectomy. In the hemispherectomee, the weak ear is drastically suppressed but the strong ear is functioning at virtually a 100% level. This implies that the weak ear information is not interfering at all with the processing of the information coming to the strong ear.

In the right temporal lobectomy the weak ear performs poorly but the strong ear tends to perform better than that in normals. In contrast, in the left temporal lobectomee the strong ear performs less efficiently than the strong ear in normals. Patients with sectional corpus callosum behave similar to hemispherectomees, with little or no interference from the left ear in dichotic listening.

Willeford (1978) administered CST (competing sentence test) to several pathological groups and found that with parietal lobe tumorss, no ear difference was obtained on monotic stimulation. With dichotic stimulation differences were seen in deep seated tumors. In frontal lobe tumrors, variable results were obtained. Some subjects showed abnormal results on dichotic stimulation. With other brain lesions, eg. vascular and degenerative types of lesion CST (Competing sentence test) showed significant results.

Lynn and Gilroy (1977) administered CST (competing sentence test) and found poor results on corpus callosum sectioning. In parietal lobe, temporal lobe and Thalamic lesions normal scores were obtained. This is in contrast to Willeford's (1978) findings. He states that tasks requiring a response to both stimuli is more difficult.

Berlin, (1970) found that patients with agenisia of corpus callosum showed no strong laterality effect but those with commisurectomy did.

Willeford (1978) claims that CST is helpful for monitoring changes in patients neurologic status as a result of treatment or surgery.

7.0 Findings in children with learning Disabilities:

Children with hearing loss are difficult to identify at an early age. More so it is to establish thresholds children are difficult to motivate, they are not very co-operative and they have short attention span. So any test designed for children should be short, attractive and concrete. If the child has multiple handicaps then the problem becomes compounded.

In recent years auditory perceptual disorders in children is gaining more and more importance. The diagnostic and theraputic aspects are receiving rigorous research investigations. These children with auditory perceptual deficits have been variously designated as learning disabled, minimal brain damaged, etc.

Pinhererio (1977) has cited the definition of learning disabled children as proposed by the National Advisory Committee on handicapped children, i.e. children with specific learning disabilities exhibit a disorder in one or more of the basic psychological processes involved in understanding or using spoken or written language. These may be manifested in disorders of listening, thinking, talking, reading, writing, spelling or arithmetic. They include situations which have been referred to as perceptual handicaps, Brain injury, minimal brain damage, dyslexia, developmental aphasia, etc. They do not include learning problems which are due to visual, hearing or motor handicaps, or to mental retardation, emotional disturbance or to environmental disadvantage."

From this definition we can see that these children show a reading failure inspite of normal intelligence, and normal sensorimotor development.

In order to provide effective rehabilitation at the earliest stage early diagnosis is essential. Several investigators have studied auditory processing in learning disabled children(Myklebust 1967, Witkin 1970, Dobic and Simmons 1971, Beasley and Freeman 1977, Pinheiro 1977, Willeford and Bilger 1978, and Freeman and Beasley 1976).

The investigators have shown that learning disabled children have auditory perceptual difficulty. Normal children first learn language through their auditory systems.

Reading is a secondary language skill which depends on visual auditory integration. Since much of the learning in school depends on reading, those children with problems in integrating the visual symbols of printed words with the auditory representation of that word, are under-achievers. Moreover there may be a more specific central auditory processing deficit - temporal sequencing may be deficient. These children show the following behavioral problems.

1. Difficulty in localizing sound source.
2. Inability to comprehend meaning of environmental sounds.
3. Discrimination among sounds and words.
4. Difficulty in reproducing the pitch, rhythm, and melody of music
5. Inability to distinguish and select the significant or important from other sounds.
6. Difficulty in speech to combining syllables to form words and words to make sentences.
7. They have normal intelligence.

In order to detect any central auditory disorder in children any one of the several central auditory disorder tests can be used. However, each test taps on a different site of lesion and on a different aspect of auditory experience. Moreover not all have been standardized with children. The following tests may be used with children.

1. Alternate speech perception test.

2. Bu Binaural fusion test.

3. Low pass filtered word tests.

4. Competing sentence test.

5. Simultaneous sentence test.

6. Staggered spondiac word test.

7. Pitch patterns.

All these tests were administered and a profile was drawn up; in which it was seen that all learning disabled children had similar profiles (Pinheiro, 1977).

Casetello (1977) reports that the Flowers Castello test of central auditory abilities (CAA) was useful in the diagnosis of central auditory disorders in children. In this test, there are a total of 48 items. 24 are low pass filtered sentences and 24 are sentences with a running discourse as competing message. The child is required to complete the test sentence by pointing to an appropriate picture from an array.

Beasley and Freeman (1977) have administered time compressed speech test to learning disabled children and found that it was a useful measure to differentially diagnoise the learning disabled children from normal children, Normative data has been provided by them.

Beasley (1977) used monotic stimulation with time compressed speech and found a REA (right ear advantage). Beasley et al. (1976) used time compressed versions of

WIPI (word identification by picture index) and PBK-5O (phonetically balanced words for kindergarten) etc., and found that average intelligible scores increased as a function of increasing age, sensation level and decreased with increasing amounts of time compression.

Manning, et al. (1977) found that auditory perceptually disordered children performed just as normals when the rate of presentation was normal, i.e., o% time compression or slightly faster, i.e., 30% . However with 60% compression performance decreased. Since the learning disabled childs problem is with short term memory. Time compression facilitates short term memory function in learning disabled children. This may be the reasons for normal performance at 30% time compression.

Willeford and Bilger (1978) suggest that the reticular activating system may be faulty in learning disabled children and it allows too many sensory stimuli to stimulate the child. This discrimination is faulty. The other auditory stimuli, i.e., competing messages act as distractors, hence poor results on dichotic listening tasks is obtained.

White (1977) has provided normative data on the SSW (staggered spondiac word) test and CST (competing sentence test) in normal and learning disabled children. Both tests provide information about the development and maturity of the auditory centers besides providing site of lesion testing.

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Willeford (1978) used CST (competing sentence test) with learning disabled children. The CST (competing sentence test) reveals subtle dysfunction in auditory behaviour. It can be used to follow changes with maturation, training, counselling and environmental control.

8. Speech Audiometry in Indian Languages

Several Indian authors have attempted to develop and standardize several tests in speech audiometry(Nikam 1968; Abrol 1971; Kapur 1971; Chandrashekar 1973; Swamalatha 1972; Samuel 1976; Nagaraja 1973; Rajashekar 1976; Malini 1981; Sood 1981).

Among them Chandrashekar (1973), Nagaraja (1973) and Sood (1981) have developed the SSW (Staggered spondiac word test), SSI (synthetic speech test) and time compressed speech. All these tests can be used in central auditory disorder testing.

However, the time compressed speech test and SSW are both in Indian English; hence cannot be used with the local population.

The SSW test involves an elaborate scoring system which requires intensive training before it can be administered easily and accurately with speed.

The SSI test is in Kannada and provides a reliable measure of higher order testing. However a continuous discourse is used as the competing message. According to Treisman (1964) this is a gross limitation in competing message tasks as the competing message is ignored, since it is regarded as irrelevant. Hence the task prooved to be easier and not sufficiently challenging to the higher cortical centers. Simadri (1977) noted that when the competing message was of the same language as the target sentence the task was more difficult. Hence poorer results were obtained. Hence it can be concluded that the closer the competing message approaches that of the target sentence the more difficult is the task. This is what is done in the competing sentence test.

The competing setence test when administered under a double report paradigm is a very difficult task (Lynn and Gilroy, 1977).

Chapter 3

METHODOLOGY

Subjects: Thirty seven native Kannada speakers in the age range 18 years to 25 years were selected. Of them, 30 subjects (22 females and 8 males) were used to establish the normative data for competing sentence Test.

7 adults (5 females and 2 males) were used in another study which required the subjects to repeat sentences presented to both the ears.

All the subjects had normal hearing (20 dBHL ANSI 1969). None of them had any history of otologic or neurologic disorder. Incidental sampling was done. The subjects' sample was drawn from the urban literate population.

All subjects were right handers except for one female subject who was left handed. However, no tests were administered to determine the dominant hemisphere other than enquiring as to which hand was most commonly used for activities such as writing, eating, etc.

Materials: 25 natural sentences in Kannada were used as test items. The sentences were of similar length and contained approximately equal number of words and syllables. Both thecompeting sentences and target sentences contained a common theme, i.e., family, food, safety, etc.

a) ರಾಮು ಈಗ ತಿಂಡಿಗೆ ಬರ್ತಾನೆ.

b) ರಾಜು ಮನೆಗೆ ಊಟಕ್ಕೆ ಹೋಗ್ತಾನೆ.

Translation:

a) Ramu will come for breakfast now.

b) Raju will go home for lunch

The complete list with translation is given in Appendix III.

The sentences were recorded on a two channel tape recorder using the same talker, with a Mysore dialect. The sentences began at the same time and ended at approximately the same time. The sentence construction was such that they could be easily inter-changed, i.e., The first half of the target sentence and the second half of the competing sentence could be combined to make a third sentence which was syntactically and semantically acceptable. The sentences were designed to minimize perception by key words alone. The items were employed in an open set paradigm.

The language level was selected so as not to penalize low intelligence people, low literacy levels. The vocabulary used in the sentences was well within the range of children.

Apparatus and test equipment:

The following equipment was used for the recording of the test materials.

A 4 track stero spool tape recorder (uher SG 631 Logic) with a ominldirectional mic (uher M 534) and a stereo cassette tape deck (cosmic co 88xD) with a review and cue system. For the administration of the test item the equipment used was a dual channel diagnostic audiometer (Beltone 200 C). The audiometer was coupled to the right and left channels of the stereo cassette tape deck (Cosmic Co-88xD) via the tape input and external input. The list items were delivered to the right and left ears through the Transducers TDH 49 housed in supra aural cushion (MX - 41/AR)

Test environment:

Pure tone audiometry and speech audiometry was done in a two room situation. The sound treated rooms of the All India Institute of Speech and Hearing were used. The noise levels of the rooms were measured using sound pressure level meter (B&K 2209 with B&K condensor mic 4144). The levels are tabulated in the Appendix I.

Recording procedure:

Primary recording of the natural sentences was made in a sound treated room of the All Indian Institute of Speech and Hearing using an omnidirectional mic (uher M534).

The two lists were recorded on track I and II of a 4 track stereo spool tape recorder (uher SG 631 logic) at 7½"/sec tape speed. The recording was done such that the onset of the paired test stimuli was simultaneous. This was achieved by nothing the counter leading, on the spool tape recorder, at the beginning of each target sentence. The competing sentences were then recorded by rewinding the spool and starting the second list of sentences at exactly the same counter reading as that of the target sentences on Track I. The speaker practised this several times in order to achieve accuracy. This mode of recording was found to be accurate, hence no oscillograph was used to align the sentences.

Berlin et al. (1973) have stated that time matching of the onset of the stimulus pairs is a critical factor in the dichotic listerning tasks involving CV's, where the brief signals differ by only by a single consonant. However, Willeford (1978a) has shown that exact time matching of the onset of the paired stimuli is not so critical as several other on going factors, viz., the nature of test stimuli and competing message, play a major role in the dichotic listening of sentences, unlike that in CV's.

The two sentences, however, had nearly the same onset and termination time.

An inter stimulus interval of 6 sec. was given between each stimulus pairs for the subject to respond.

A 1000 Hz. calibration tone with RMS value, the same as the vocalic amplitudes of the syllables in the sentences was placed on the tape as a reference calibration signal.

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The test items were read by a native adult female Kannada speaker whose fundamental frequence was 250 Hz.

The test items were spoken naturally, peak intensities of the sentences were monitored on the recorder's VU meter, to avoid distortion.

The entire recording was made in a single session. This was the master tape.

The sentences from the master simultaneous tape was then dubbed on to a dual track cassette using a stereo tape recorder (cosmic co-88xD) which was found to be compatible with the stereo spool tape recorder (uher SG 631 logic). This cassette was used for the test administration.

Instructions for Experiments Ia and Ib and IIa and

"First you will hear pure tones; when you hear the sound raise your finger; when the sound stops drop your finger. You should raise your finger even if the sound is very soft."

Specific instructions for Experiment No.I

"You will hear two sentences in your ears simultaneously. Your job is to ignore the sentences in your right/left ear and to identify those in the left/right ear by repeating. Have you understood?"

"You will hear the sentences presented simultaneously to the two ears. Your job is to repeat both the sentences. Do not try to concentrate on any one year while ignoring the other. The task is a bit tough, hence you should concentrate on the task."

Procedure:

Two experiments were conducted. Experiments Ia and Ib were conducted to study the ear effect on the performance of normal hearing subjects for the competing sentence test.

Experiments IIa and IIb were conducted to study whether the two lists would yield different results.

The target sentences were delivered at 35 dBSL (re. pure tone average 0 dBSRT = 13 dBSL) and the competing message was given to the other ear at 50 dBSL (re.pure tone average. 0 dBSRT - 13 dBSBL). Thus a signal to competition ration of -15 dB was adopted.

Experiment Ia and Ib were carried out to study ear effect. The same 15 subjects were used in both experiments. In Experiment Ia the subjects received the target sentences in the right ear and the competing sentences in the left ear. After an interval of one month, to overcome any effect of memory on the results, the same subjects were retested in Experiment I where they received the sentences in a reversed order, viz. the target sentences were in the left ear and the competing sentences in the right ear. See Figs. 1 and 2

Expt. I_a

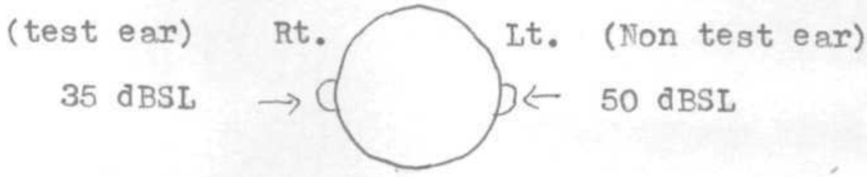


Fig.1

Expt. I_b

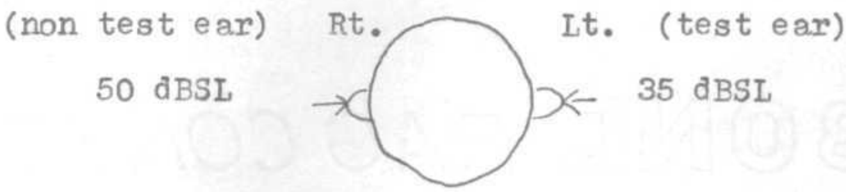


Fig.2

To control list effect another 15 subjects were used. In Expt. IIa , the subjects first received list A (target sentences in right ear and list B (competing sentences) in left ear. The target sentences were always given at 35 dBSL (re:pure tone average 0 dBSRT = 13 dBSPL) and the competing sentences were always given at 50 dBSPL (re.pure tone average. 0 dBSRT - 13 dBSPL). In Experiment IIb , the same subjects were then given list B (target sentences) in right ear and list A (competing sentences) in left ear. See Figs. 3 and 4.

Expt. II_a

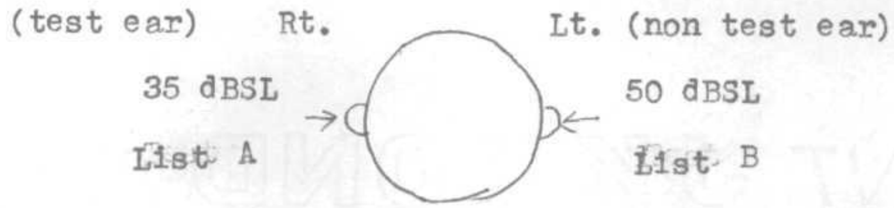


Fig.3

Expt. II_b

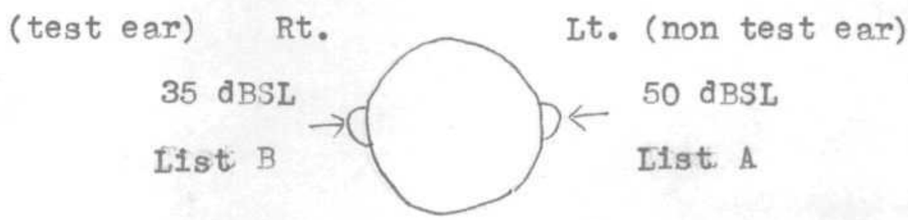
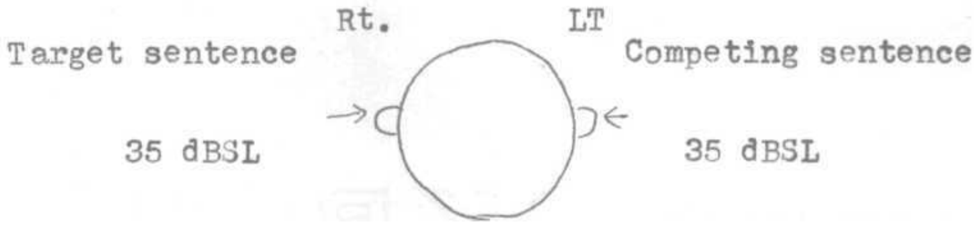


Fig.4

Experiment III was conducted to find out if the CST could be used as a test for dominance. Both the sentences (target and competing) were administered at 35 dBSL (re. pure tone average). Subjects were required to repeat both sentences.



For this study 7 subjects (2 males and 5 females) were tested. All subjects were right handed and met the same criteria as for the above two experiments.

The single left handed subject was tested again in Experiment III to check for dominance. However care was taken to ensure that the results would not be contaminated by memory effect. This was done by interposing an interval of 1 month after Experiment II and before conducting Expt. III

Response mode and scoring:

A single report paradigm was employed for the competing sentence test. The subjects listened and reported the items presented to one ear while ignoring the other ear.

Two types of responses were scored in this paradigm, i.e., either correct response or error. Error was defined as:

1. Any instances where portions of the two sentences were interchanged resulting in a new sentence.
2. Instances of syntactic confusions.
3. Omission or substitution of any crucial words which would alter the meaning of the given sentences.

In the two responses paradigm subjects repeated both the competing and target sentences. Three types of responses were scored.

a) Both the sentences were correct (double correct).
b) Only one member of the stimulus pair was correct (single correct).
c) Neither member of the stimulus pair was correctly identified (double error).

In the single report paradigm absolute accuracy was stressed. In the double report paradigm the sentences were scored correct even if the words were changed provided the meaning of the sentences remained the same.

Each sentence received a score of 4% . If all the sentences were correctly identified a score of 100% was detained.

Plan of Analysis:

Mean a values of the percentage of correct response was calculated for right, left and both ears, in the single and double report strategy. The scores obtained from the males and females was compared using the Will coxon matched pairs signed ranks test.

The single left hander's scores was compared with the performance of right handers. The competing sentence test scores for normal adults was established.

Chapter 4

ANALYSIS, RESULTS AND DISCUSSION

Thirty seven normal hearing subjects were tested (10 males and 27 females).

The number of items repeated correctly by the subjects was converted into percentage scores. The mean percentage score was computed for each experiment. The Wilcoxon matched pairs signed ranks test was used to find the significance of the difference between the scores obtained in -

1) In Experiments Ia and Ib
2) In Experiments IIa and IIb
3) In Experiment III

Results and discussion:

The results of the experiment I (Ia and Ib); Experiment II (IIa and IIb) and Experiment III are presented in tables 1, 2 and 3 respectively. In a single report paradigm, the mean percentage score for right ear was 95%, and for the left 93%. There is a slight difference(2%) between the means of Right and Left ears. However, this was found to be statistically not significant as determined by the Wilicoxon matched pairs signed Ranks test. Hence it can be concluded that the test results are not likely to be based by the ear effect. This is in accordance with Beasley, et al. (1972). According to them " In order to validly use the same test for both right and left ear performance of normal subjects would warrant that test results between ears be essentially equal."

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However, most of the subjects did report greater ease in attending to the right ear. They subjectively felt that they had to concentrate more when the left ear was tested, and had greater difficulty in ignoring the right ear competing message. This is in accordance with Berlin et al. (1973 c). He state that the contralateral pathway is stronger and since the left hemisphere is dominant for speech, listening in the right ear is easier.

The means for right and left ears in the case of male subjects were; 96% and 89% respectively. The means for right and left ears in the case of female subjects were: 95% and 94% respectively.

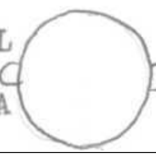
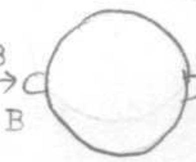
The results show that there is slight right ear advantage in male subjects.

By comparing, the results of IIa and IIb , any possible difference in the results due to different lists was evaluated. The results showed that there was just 2% difference between the means obtained for the lists A and B. This difference between the scores obtained for list A and list B was not statiatically significant at 0.5 level (Wilcoxon matched pairs signal ranks test). The results show that the two lists are similar.

In Experiment III a double report paradigm was used. A mean score of 79% in right ear and 47% in left ear was obtained. This difference was found to be statistically significant at 0.05 level of significance as determined by

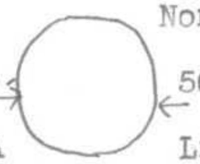
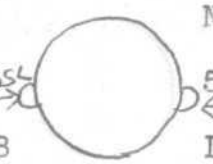
EAR EFFECT

Table 1

M/F	Expt. I_a Rt.ear (test) Lt.ear (non test) 35dBSL → List A 50dBSL ← List B 	Expt. 1_b Rt. non test Lt test 50dB → List B 35dB ← List A 
F	100%	92%
F	92%	100%
F	l00%(Lt.hander)	92%
F	96%	100%
F	96%	100%
F	92%	100%
F	96%	92%
F	100%	80%
F	88%	96%
F	96%	100%
F	96%	88%
M	100%	100%
M	92%	88%
M	100%	76%
M	92%	92%
Mean	95.73%	93%

LIST EFFECTS

Table 2

	Expt. IIa Rt. Test 35db →  ← 50 dB Lt. Non test List A — List B	Expt. IIb Rt. Test 35dBSL →  ← 50dBS Lt. Non tes List B — List A
F	100%	88%
F	96%	96%
F	100%	96%
F	100%	84%
F	96%	92%
F	100%	96%
F	96%	92%
F	100%	96%
F	100%	100%
F	96%	92%
F	88%	92%
M	100%	88%
M	92%	92%
M	96%	96%
M	68%	100%
	95.2%	93.3%

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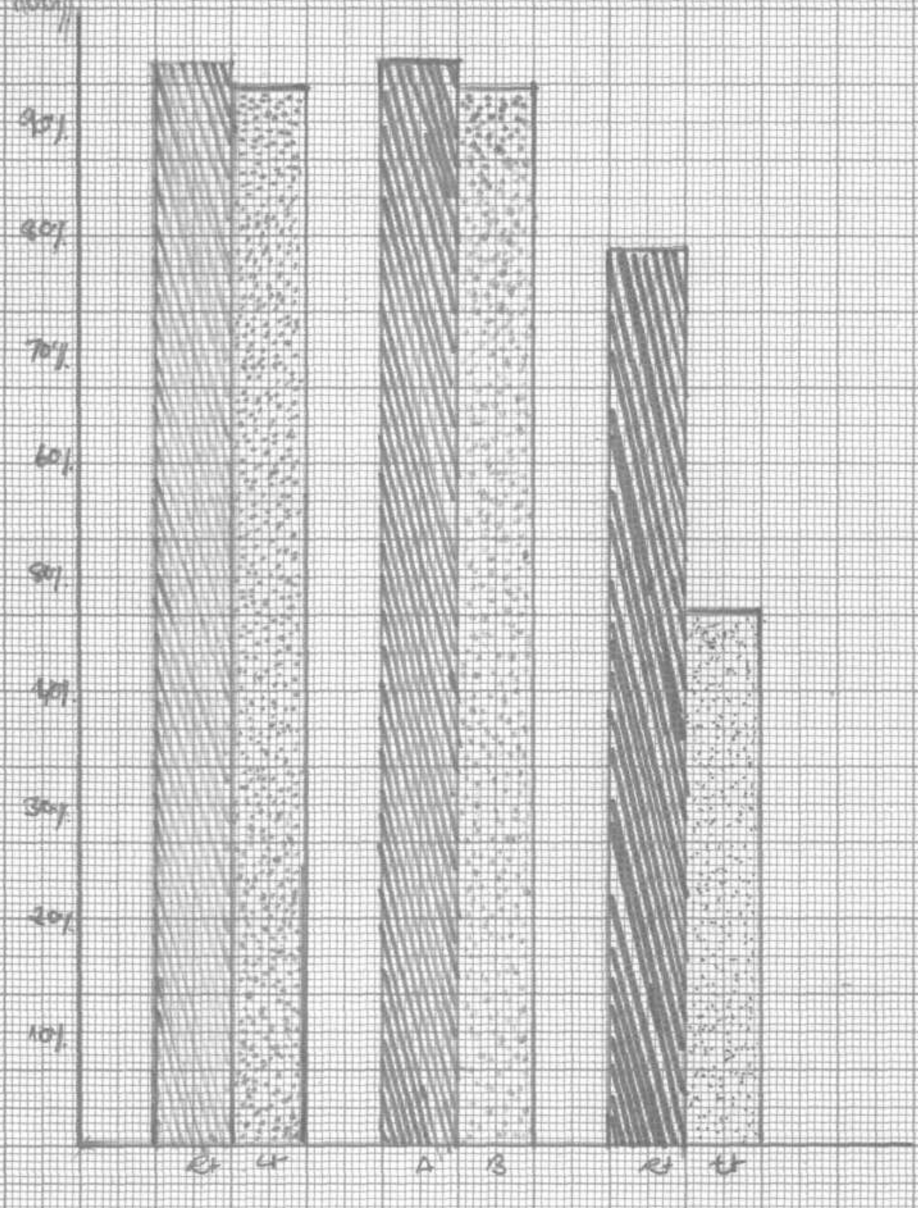
DOUBLE REPORT PARADIGM

Table 3

	Rt.	Lt.
M	88%	56%
M	56%	22%
F	88%	52%
F	68%	22%
F	88%	60%
F	84%	36%
F	84%	84%
	79%	47%

..59

Scores obtained on the single and double Report Paradigm.



Rt scores obtained for Rt ear when listing for ear effect.
Lt scores obtained for Lt ear when listing for ear effect.

A scores obtained with list A
B scores obtained with list B.

Rt scores obtained in Rt ear on double report paradigm
Lt scores obtained in Lt ear on double report paradim.

Wilcoxon matched pairs signed ranks test. Hence it can be concluded that when the CSTfcompetlng sentence test) is used in a double report paradigm, it can be used to identify dominance and to study ear effects. From the table 3 we can see that neither of the two ears reached 150% level in any of the subjects. This supports Berlin et al.(1975) statement that even the ipsilateral pathway participates in dichotic listening.

When used in a double report paradigm the test may serve to be sufficiently challenging to detect any subtle differences in auditory perception. Hence it will be useful in the differential diagnosis of learning disabled children who show essentially normal results on the conventional test battery (Willeford, 1978).

It was also seen that fatigue of any form - mental or physical resulted in poorer scores.

The single female left handed subject revealed 100% scores in both ears. No ear difference was seen.

Same subjects showed better performance in left ear - upto 8%. This may be due to chance of fatigue or other irrelevant variables which could not be controlled.

Chapter 5

SUMMARY AND CONCLUSIONS

In recent times with increasingly advanced and sophisticated tools at our finger tips, audiologists are beginning to take a greater interest in the diagnosis and evaluation of problems whose manifestation is very subtle, viz. Central Auditory Disorders.

Recent literature is flooded with reports about the incidence of auditory perceptual disorders in children and the difficulties associated in their evaluation (Hodgson, 1967; Martin, 1978; Willeford, 1978 a, b., 1976; 1977; Manning et al. 1977; penheiro, 1977; Beasley and Freeman, 1977).

These children seemingly failed to benefit from normal education procedures inspite of normal intelligence, maturation and sensory abilities.

They show normal hearing sensitivity to pure tones (Hodgson, 1967).

Delayed development of language is seen along with poor reading skills. These children are often misdiagnoised due to the confusing picture they present. They are mistaken as having hearing loss, mental retardation or just behavioral problems (Martin, 1978).

Faulty diagnosis can lead to drastic problems in these children as they are wrongly penalised and fail to receive appropriate remedial help. This leads to social and educational retardation.

Attempts have been made for the identification of such children at the earliest possible stage. Mencher and Stick (1974) gave MAST (Mencher and Stick Auditory screening test) a procedure by which children 3-4years of age can be ruled out for central auditory disorders.

Beasley and Freeman (1977) and Manning, et al. (1977) have found compressed speech tests useful in h the identification of learning disabled children.

These children show more number of errorson the SSW test (Willeford, 1978).

The Flowers Castello test of central auditory abilities (CAA) was used by Castello (1977) and found useful in differentiating auditory perceptual disorders from normal children.

Willeford developed the CST (competing sentence test) in 1968. Pinheiro (1977) found this test was useful in diagnosing children with central auditory disorders.

Lynn and Gilroy (1977) reported that the CST was useful in the diagnosis of deep temporal, frontal and parietal lobe tumors. The CST is also useful for monitoring the maturation process and establishment of dominance. It can be used to assess surgical or other treatment procedures used with patients with central auditory disorders.

In view of the many clinical applications of CST, a similar test in Kannada language was considered essential

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to test the subjects (patients) who know Kannada language only.

An attempt was made in this study to develop such a test. A kannada version of Willeford's competing sentence test wag developed and standardized on the normal adult population.

25 pairs of Kannada sentences of equal length and common theme served as stimulus material. Care was taken 1 to ensure that the language level was appropriate for children. The sentences were administered in a dichotic mode to a total of 37 subjects (27 females and 10 males) in 3 experimental modes.

Conclusions:

In Experiment I (a and b) ear effect was determined. The results showed no significant(as determined by Wilicoxon matched pairs signed rank test) difference between the scores of the right and left ear at .05 level of significance.

In Experiment II (a and b) list effect was determined. The results showed no significant (as determined by Wilicoxon matched pairssigned ranked test) difference between the scores obtained on the lists (A and p) at .05 level of significance.

In Experiment III laterality effect was studied. A double report paradigm wa s utilized. The scores of the right and left ears showed significant (as determined by Wilicoxon matched pairs signed ranks test) difference at the .05 level of significance. A right ear advantage was seen in most of the subjects.

No difference in the performance of males and females could be seen. This may be due to the small number of subjects tested.

The single left hander's performance was compared with the performance of right handers. No difference was noted either in the single or double report paradigm.

Hence it can be concluded that any results obtained using the Kannada version of CST, are not likely to be based by ear or list effects. It is - a sufficiently challenging test to be used with cases of central auditory dysfunction or in the identification of children with learning disabilities.

Normal subjects obtained a score of 95% in right ear and 93% in left ear.

When presented in a double report paradigm the test can be used to determine dominance.

Recommendations for further research

1. It can be administered on clinical population for greater validity.
2. The effect of different message to competition ratios should be explored.
3. Effect of handedness and sex differences can be determined by studying a larger population.

Limitations of the study

1. Clinical population was not tested using the developed CST in Kannada language.
2. Normative data on children could not be obtained due to limited time.

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FRONT PANEL INDICATORS, CONTROL KNOBS OF BELTONE 200-C

1.	A,(AA)	Output (Hearing Level Control)
2.	B,(BB)	Tone Interruptor
3.	C,(CC)	Tone 'On' Lamp
4.	D,(DD)	Automatic/Manual Switch
5.	E,(EE)	Tone reversing Switch
6.	F,(FF)	Output Selector
7.	G,(GG)	Monitor Control
8.	H	Frequency
9.	J	Patient Signal Lamp
10.	K	Talk back gain
11	L	Talk over Switch
12.	M	Talk Over gain
13.	N	Tone Bar Lock
14.	O	VU Meter Selector Switch
15.	P	Frequency Input
16.	Q	Monitor ear phone
17.	R	Power
18.	S	Speech unit
19.	T	SISI
20.	U	VU Meter
21.	X	Channel one VU Meter gain Control
	XX	Channel Two VU Meter gain Control

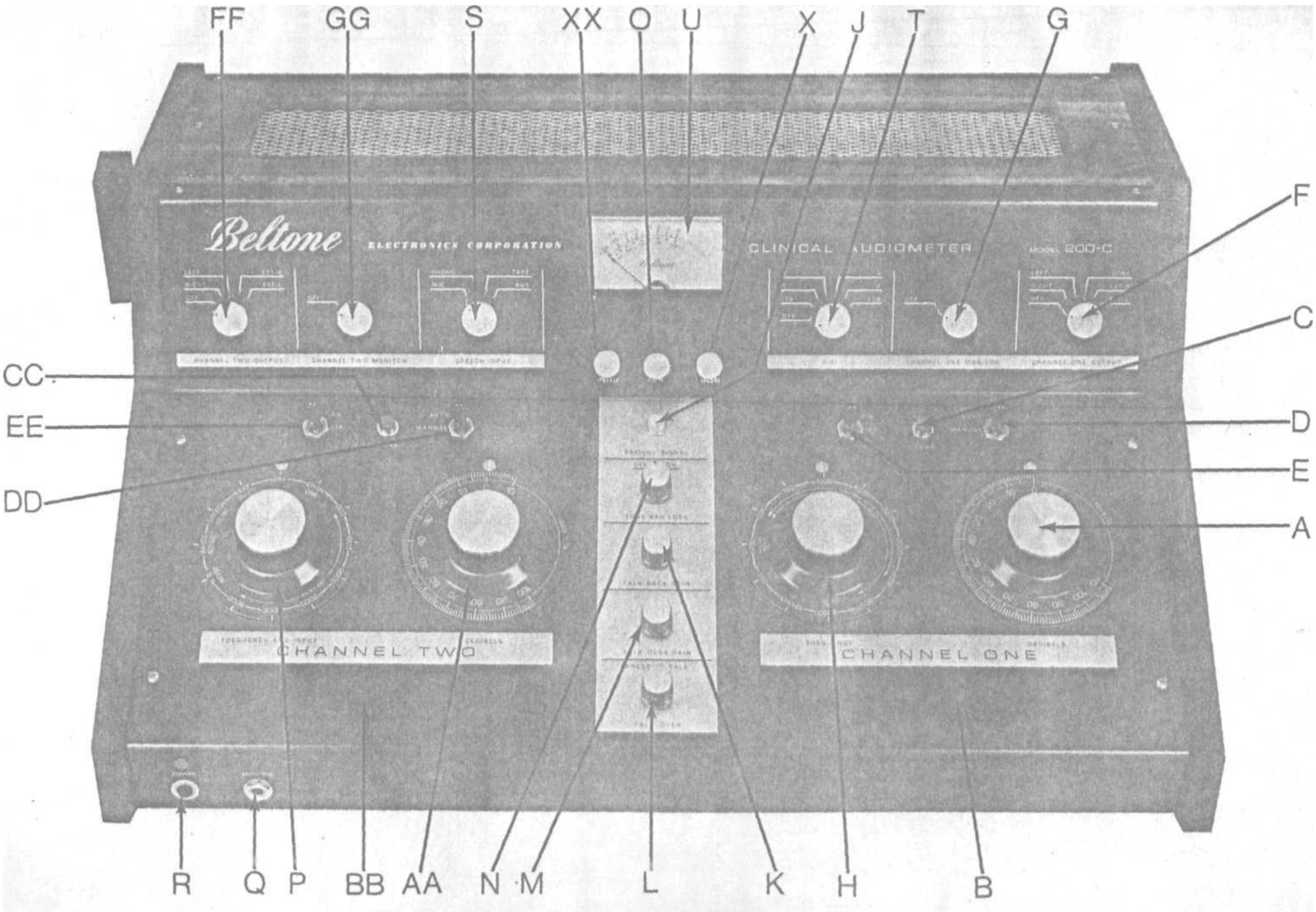

FIGURE 2.1 ILLUSTRATION, OPERATING CONTROLS

Appendix I

Noise level in dBSPL inside the audiometric test room

SI. No.	Central Frequency of the Octave band in Hz.	SPL value in the room (re. 0.0002 dj/cm^2	IS0(1969) SPL values in the audiometric room
1	125	37	31
2	250	35	25
3	500	26	26
4	1000	25	30
5	2000	36	38
6	4000	28	51
7	8000	39	56

Appendix II

Calibration.

The following procedure was adopted for the calibration of the audiometer (Beltone 200 C) for puretones and speech.

For intensity calibration purposes, the test ear phones (TDH 49) of the audiometer (Beltone 200 c) was coupled to an artificial ear (B&K Type 4153) The sound level meter (B&K type 2203) with its associated octave band filter set (B&K, 1613) was connected to the artificial ear. The attenuator was set at 60 dBHTL. The output of the sound level meter was checked at each frequence from 250 Hz. to 8000 Hz. The values are as shown in Table 4.

Linearity was checked at 1000 Hz. The intensity of the pure tone was increased in 5 dB steps and the output was measured using the sound level meter. The corresponding increase in SPL value was noted. The dial was found to be linear.

For frequency calibration, the test frequencies (500, 1000 and 2500 Hz) was fed to the standard frequency counter (ITI 203). Keeping the intensity constant the frequencies were checked. They were found to be within the permissible limits as indicated by ANSI 1969.

Calibration of the speech audiometer.

The set up of the instruments was the same as for pure tones. The vowel 'a' was uttered into the microphone, such that the VU meter peaked at '0' level. The output SPL was measured with the sound level meter. '0' dBSRT was found to be equal to 13.5 dBSPL.

Table 4

EAR PHONE CALIBRATION VALUES

Test Frequency	Right ear phone dBHTL	dBSPL
250	30dB	102
500	80	89
1000	80	83
2000	80	86.5
4000	80	87
6000	80	89
8000	80	87.5
	Left ear phone	
250	80	97
500	80	85.6
1000	80	78.5
3000	80	82.5
4000	80	82
6000	80	84.5
8000	80	82.5

APPENDIX III(a)

KANNADA SENTENCES USED AS STIMULUS IN THE COMPETING SENTENCES TEST

	Competing Sentences	Target sentences
1.	ನಮ್ಮ ತಾಯಿ ಮನೆಗೆ ಬಂದಿದ್ದಾರೆ.	ಅಣ್ಣ ಈಗ ಊಟ ಮಾಡ್ತಾರೆ.
2.	ರಾಮು ಈಗ ತಿಂಡಿಗೆ ಬರ್ತಾನೆ.	ರಾಜು ಮನೆಗೆ ಊಟಕ್ಕೆ ಹೋಗ್ತಾನೆ.
3.	ಹುಡುಗರು ಆಟ ಆಡ್ತಿದಾರೆ.	ಹುಡುಗಿಯರು ಈಜ್ತಾ ಇದಾರೆ.
4.	ಮೇಷ್ಟ್ರು ದಿನಾ ಸ್ಕೂಲಿಗೆ ಹೋಗ್ತಾರೆ.	ವಿದ್ಯಾರ್ಥಿಗಳು ಬೋರ್ಡ್ ಮೇಲೆ ಬರೀತಾರೆ.
5.	ನಮ್ಮ ಅಮ್ಮ ಅಂಗಡಿಗೆ ಹೋಗ್ತಾರೆ.	ನಿಮ್ಮ ಅಪ್ಪ ಮನೆಗೆ ಬರ್ತಾರೆ.
6.	ಬೆಂಕಿಯ ಹತ್ತಿರ ಹೋದ್ರೆ ಅಪಾಯ.	ಕಾಡಿಗೆ ಒಬ್ಬರೇ ಹೋಗಬಾರದು.
7.	ಅವಳು ಚೆನ್ನಾಗಿ ಹಾಡು ಹೇಳ್ತಾಳೆ.	ನನಗೆ ರಮ ಸಂಗೀತ ಕಲಿಸ್ತಾಳೆ.
8.	ರೈತರು ಕಷ್ಟಪಟ್ಟು ದುಡೀತಾರೆ.	ಕೂಲಿಗಳು ತುಂಬಾ ಬಡವರು.
9.	ಹಸು ಹಸಿ ಹುಲ್ಲು ತಿನ್ನುತ್ತೆ.	ಎಮ್ಮೆ ಕೊಚ್ಚೇಲಿ ಮಲಗುತ್ತೆ.
10.	ರವಿ ರಾಮಾಯಣ ಓದ್ತಾನೆ.	ಸುರೇಶ ಚಿತ್ರ ನೋಡ್ತಾನೆ.
11.	ನಮ್ಮ ತಾಯಿ ಕೆಲಸ ಮಾಡ್ತಾರೆ.	ನಿಮ್ಮ ಅಣ್ಣ ಅಲ್ಲಿ ಹೋಗ್ತಿದ್ದಾರೆ.
12.	ಗೋಪಿ ಹತ್ತಿರ ದುಡ್ಡು ಇಲ್ಲ.	ರಾಮು ನನಗೆ ಹಣ ಕೊಡಬೇಕು.
13.	ನಮ್ಮ ನಾಯಿ ತುಂಬಾ ಚೆನ್ನಾಗಿದೆ.	ಬೆಕ್ಕು ಮನೆ ಮೇಲೆ ಓಡ್ತಾ ಇದೆ.
14.	ನಮ್ಮ ಮನೆ ಹತ್ತಿರ ಮಾರ್ಕೆಟ್ ಇದೆ.	ನಿಮ್ಮ ಹಳ್ಳಿಯಲ್ಲಿ ಸಂತೆ ಇದೆ.
15.	ಇವತ್ತು ಅವನ ಮನೇಲಿ ಹಬ್ಬ.	ನಾಳೆ ಇವನ ಹಳ್ಳಿಯಲ್ಲಿ ಜಾತ್ರೆ.
16.	ಸೀತೆ ಮನೇಲಿ ಗುಲಾಬಿ ಗಿಡ ಇದೆ.	ಕಮಲನ ತೋಟದಲ್ಲಿ ಮಲ್ಲಿಗೆ ಗಿಡ ಇದೆ.
17.	ಅಲ್ಲಿ ಮರದ ಕುರ್ಚಿ ಇದೆ.	ಇಲ್ಲಿ ಸ್ಟೀಲ್ ಟೇಬಲ್ ಇದೆ.
18.	ದಿನಾ ಬೆಳಿಗ್ಗೆ ಕೋಳಿ ಕೂಗುತ್ತೆ.	ಸಂಜೆ ಆರು ಘಂಟೆಗೆ ಕತ್ತಲಾಗುತ್ತೆ.
19.	ಈ ರಸ್ತೇಲಿ ವಾಹನಗಳ ಓಡಾಟ ಜಾಸ್ತಿ.	ಆ ದಿನ ಒಂದು ಅಪಘಾತವಾಯ್ತು.
20.	ಶೋಭ ಕೆಂಪು ಲಂಗ ಹಾಕ್ಕೊಂಡಿದಾಳೆ.	ಲೀಲ ಹಸಿರು ಸೀರೆ ಉಟ್ಕೊಂಡಿದಾಳೆ.
21.	ಆ ಪಕ್ಷಿ ಆಕಾಶದಲ್ಲಿ ಹಾರ್ತಾ ಇದೆ.	ಎಲ್ಲಾ ಕಾಗೆಗಳ ಬಣ್ಣ ಕಪ್ಪು
22.	ದೋಣೀಲಿ ನೀರಿನ ಮೇಲೆ ಹೋಗಬಹುದು.	ಹಡಗಿನಲ್ಲಿ ಊರಿಂದ ಊರಿಗೆ ಹೋಗ್ತಿವಿ.
23.	ನಮ್ಮ ಮನೆ ಹತ್ತಿರ ಅಂಗಡಿ ಇದೆ.	ನಿಮ್ಮ ಬಟ್ಟೆ ವ್ಯಾಪಾರ ಜೋರಾಗಿದೆ.
24.	ನಾನು ಶನಿವಾರ ದೇವಸ್ಥಾನಕ್ಕೆ ಹೋಗಿದ್ದೆ	ನೀನು ಇವತ್ತು ಪೂಜೆ ಮಾಡಬೇಕು.
25.	ನನ್ನ ತಂಗಿ ಹತ್ತಿರ ಬಳೆ ಇದೆ.	ನಿನ್ನ ಅಕ್ಕನ ಸರ ಚೆನ್ನಾಗಿದೆ.

Appendix III

English translation of the Kannada sentences used for CST

Target sentences.	Competing Sentences.
1. Our mother has come home	My elder brother will have lunch now
2. Ramu will come home for breakfast now	Raju will go home for lunch now
3. The boys are playing	The girls are swimming
4. The teacher goes to school everyday	The students write on the board
5. Our mother is going shopping	Your father is coming home
6. Gang near the fire is dangerous	We should not go to the forest alone.
7. She sings songs well	Rama will teach me singing
8. The ryots work hard to earn	The coolies are very poor
9. The cows eat green grass	The buffalow lies in the swamp
10. Ravi reads the Ramayana	Suresh looks at the pictures
11. Our mother works hard	Your brother is going there
12. Gopl hag no money with him	Ramu has to give me money
13. Our dog is very beautiful	The cat is running on the roof
14. There is a market near our house	There is a fair in your village

15.	There is a feast in his house today	There is a carnival in his village tomorrow
16.	There is a rose plant in Sita's garden	There is a jasmine bush in Kamala's garden
17.	There is a wooden drain there	There is a steel table there
18.	The cock crows every morning	It is dark by 6 O'clock in the evening
19.	There is heavy traffic in this road	That day, there was an accident here
20.	Shoba is wearing a red lunga	Leela is wearing a green saree
21.	That bird is flying in the sky	The ciow's colour is black
28.	/ We can sail in a boat over water	We can go from place to place in a ship
23.	There is a shop near our house	Your textile business is good
24.	I had gone to the temple on Saturday	You have to conduct prayers today
25.	My younger sister has some bangles	Your elder sister's chain is good