An Exploratory Study of the Performance of Normal Indian Listeners on the Staggered Spondiac Word Test Developed in English for Indian Population.

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A DISSERTATION SUBMITTED IN PART FULFILMENT FOR THE DEGREE OF MASTER OF SCIENCE (SPEECH & HEARING)
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WITH LOVE,

to my two little sisters

C E R T I F I C A T E

This is to certify that the dissertation entitled "AN EXPLORATORY STUDY OP THE PERFORMANCE OF NORMAL INDIAN LISTENERS ON THE STAGGERED SPONDIAC WORD TEST DEVELOPED IN ENGLISH FOR INDIAN POPULATION" is the bonafide work in part fulfilment for M.Sc Speech and Hearing, carrying 100 aarks, of the student with Register no. 12.

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CERTIFICATE

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

GUIDE 7.5.73

D E C L A R A T I O N

This dissertation is the result of my own study undertaken under the guidance of Mr.M.N. Vyasamurthy, Lecturer and Head of the Department of Audiology, All India Institute of Speech and Hearing, and has not been submitted earlier at any University for any other Diploma or Degree.

Mysore,
Date:11th May 73 Reg.No. 12

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CONTENTS

as "difficult" speech tests. By either using poor recording methods or eliminating a portion of the frequency spectrum, or by introducing distortion, a large number of difficult speech techniques were employed by various investigators.

However these early tests, while being highly effective in identifying central auditory disorders produced a dilemma for the clinician in diagnosing the specific area of damage. Probably this was due to the wide variability in test performance.

An explanation which was given for this scatter was the interaction of variables like peripheral distortion, intelligence, memory span and other variables on the test performance. Consequently the problem appeared to be one of difficulty in handling the large number of false positives rather than demonstrating deviations. This need for techniques which would reduce the number of false positive findings later led to construction of testing procedures which employed more "stable" speech stimuli (Calearo and Lazzaroni, 1957; Feldman, 1960: Ktmura, 1961; and Katz, (1962). Stability in this ease refers to a high redundancy and familiarity content of speech stimuli. The SSW teat is a technique (has been explained in detail in page 34) which makes use of such a speech material.

It appears that a good method for localizing Central Auditory lesion in a large clinical population needs to contain a moderate position on a number of continue :

1. The vocabulary should not be so different that it forms an improbable response for most subjects. On the other hand the test material should be familiar to the subjects. However it should not be so simple that it could be correctly guessed a high proportion of the time without being heard.

8. Redundancy of the speech materials should neither be so great as to make it impossible to error on the item nor should it be so non-redundant that a simple hearing loss or mild auditory distortion could disrupt the patient's performance.

3. It is important that the material be not Very long, so that a patient is not penalized for inabilities unrelated to his central auditory lesion like memory span. However, the material must be long enough to incorporate at least one language unit because higher auditory function is more easily challenged by abstract concepts - such as language symbols.

4. The test should be short enough to avoid physical or psychological fatigue but long enough to insure reliable performance.

The aim of this investigation is to develop the test material and/or the test tape of the SSW test in the English language and to establish the mean C-SSW score for the normal Indian listeners. This is justified since it has been argued by many investigators that the tester should establish norms for the speech tests in his own environment and with his own equipment (Simonton, 1965) and moreover establishing norms is one aspect of standardization (Moakowitz, 1969). Apart from this, the following hypotheses are tested in this investigation.

1. No difference exists in the performance on the two patterns.
2. No difference exists in the C-SSW scores between the right ear and the left ear.
3. The SSW scores and the C-SSW scores of males and females do not differ from each other.

Definitions of the terms used:

Central disorders: "Central disorders" refers to impairment of the cerebral cortex and sub-cortical areas, probably down to the level of the mid brain (Katz, 1968).

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

Spondee word: "Spondee Word" contains two syllables with equal stress on both (Hirsh, 1952).

PB List: "A PB list is a list of monosyllabic words that contains a distribution of speech wounds that approximates the distribution of the same sounds as they occur in conventional American English' (Hirsh, 1952).

Speech reception threshold(SRT): "is a measure of the intensity of speech which enables a subject to correctly repeat 90% of the speech

Materials that are presented to him" (O'Neill and Oyer, 1966).

Discrimination Loss: "is the difference bet-when 100% and the percentage of words of a PB list that a listener repeats correctly when the list is presented at an intensity that is so high that a farther increase in intensity will not increase the articulation" (Hirsh, 1952).

SSW Score: "will refer to the percentage of error, whether for a specific condition, ear, or for the total test" (Katz, 1968).

Corrected SSW Score:(C-SSW) "is designated as the percentage of error (SSW Score) minus the percentage of error in the discrimination tost using the phonetically balanced words which are standardized for Indian population.

CHAPTER . II

REVIEW Of LITERATURE.

This chapter begins with a review of the uses and applications of Speech audiometry. This may be essential since Staggered Spondiac Word test is a modification of Speech audiometric procedure. Latter the basic consideration of central hearing process has been delineated and under this comes the "auditory sub-divisions" which explains in brief the five sub-divisions of hearing process. This is followed by the definition and description of central auditory lesion and justifications for using speech tests in the detection of central auditory disorders have been given. Next, the rationale of "sensitized" speech tests has been given. Then a brief mention of different "sensitized" speech tests and a description of the Staggered Spondiac Word test has been attempted in this chapter. The chapter concludes with the statement of the problem of the present investigation.

Speech Audiometry: Its uses and Applications:

Speech audiometry is an important element in the battery of audiometric tests. Speech audiometry has come into existence because of some inherent disadvantages in pure-tone audiometry. Though pure-tones are physically and mathematically simple and are easy to present they are relatively uncommon and unimportant. Moreover, pure-tone audiometry does not provide information about the person's ability to hear above threshold. Pure-tone audiometry often gives an erroneous or even misleading notion as to how an individual can handle speech communication (Donald Harris, 1965). On the other hand, speech audiometry gives information on the speech communication skill of the individual (Thomas G. Giolas, 1969). Speech audiometry helps in earlier detection of slight losses otherwise overlooked and provides better documentation of initial or alight gains after therapy. It helps in a better assessment of differences among hearing aids. For assessing the possible usefulness of a bone conduction hearing aid speech reception threshold by bone conduction is very helpful.

Speech audiometry is useful in reading the qualitative estimate of the outcome of surgery, of potential for hearing aid use, of relative efficiency with different instruments, and of phonemic perception in everyday life (Carhart, 1965). It can be uaed to determine the patient's ability to perform at supra-threshold levels, and to determine his social adequacy index. Estimates Of supra-threshold hearing for speech are helpful in determining the anatomical site of a lesion in the auditory system, in assessing ability to communicate in social situations, and in evaluating hearing aid performance (Ventry et al, 1971). Moreover, the need for speech audiometry arises mainly because speech is by far the most important class of sounds one hears. Measurement of spondee threshold also provides an independent check on the validity of pure-tone thresholds because there is well documented agreement between spondee threshold and hearing sensitivity in the speech frequencies (500, 1000 and 3000 Hz) (Ventry et al, 1971). Therefore, the findings in pure-tone audiometry should be supplemented by speech audiometry.

There are several variables involved in speech audiometry and they are: speaker, test material, method of test presentation and listener. The qualities of speaker's voice are of direct influence, articulatory pronunciation, regional accent, volume capacity and the sex, might be variables which operate under speaker. Familiarity of the test material is a very important Variable which alters the responses in speech audiometry. Because of these variables and many other variables, speech tests need to be standardized on the population to be tested. Simonton (1965) says that the tester should establish norms for the speech tests in his own environment and with his own equipment. The growth in the general acceptance and use of speech audiometry is accompanied by a need for standardizing in different populations so that the test results in one clinic can be compared with those of another clinic (Hirsh et al, 1952).

Speech audiometric Studies done in India:

A pilot study by S. Nikam (1968) has indicated that the available tests may not be wholly suitable to Indian populations because of unfamiliarity of the test material. Y.P. Kapur (1971) prepared and standardized speech tests in Tamil, Telugu and Malayalam. A modification of test material was attempted and the test material in English was developed and standardized for Indian population by swarnalatha (1972). The wprk on standardization of speech material in Kannada is under progress at All India Institute of Speech and Hearing, Mysore.

Much has been said on the advantages and applications of speech audiometry and among them its utility in detection of central auditory disorders is one. By far the most revealing and successful tests of human cortical auditory function are based on modifications of speech audiometry (Davis, 1969).

Basic Consideration of Central Hearing Process:

Auditory sub-divisions:

The area from the cochlea to the temporal lobe can be divided into five categories (fig. 1, shows the five sub-divisions) (Jack Katz, 1970). The following are the sub-divisions.

1. **The Cochlea:** The Cochlear sub-division, which includes the sensory apparatus within the bony shell, is the first step in, the sensory neural process. At this point mechanical energy is translated into bio-electrical signals.

2. **The VIII Nerve:** The VIII nerve portion include the ipsilateral cochlear nuclei of the brain stem as well as the VIII nerve proper.

3. **The Lower Brain Stem:** The nerve fibres in the lowest portion auditory brain stem beyond the chchlear nuclei are known to split into two bundles. It is thought that the majority of the fibres cross over and ascend to contralateral brain stem. It is not clear how high this subsection goes giving a consistent

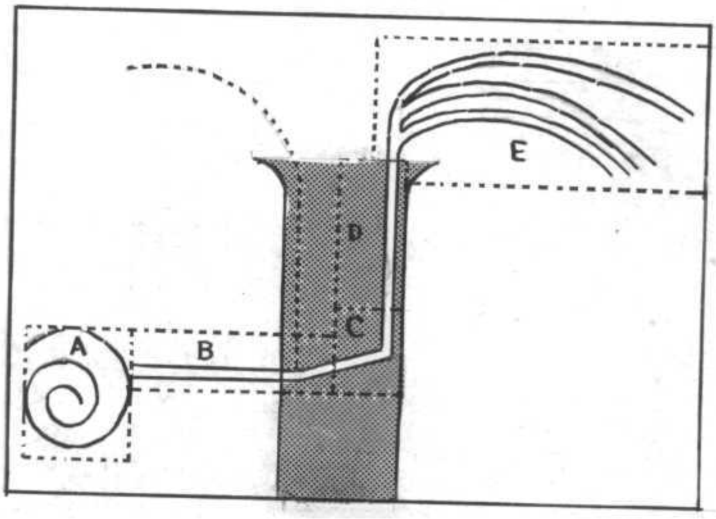


figure - 1 : Five functional subdivisions from the cochlea to the cortex.

A - Cochlea

B - VIII Nerve

C - tower Brain Stem

D - Upper Brain Stem

E - Cerebral Reception

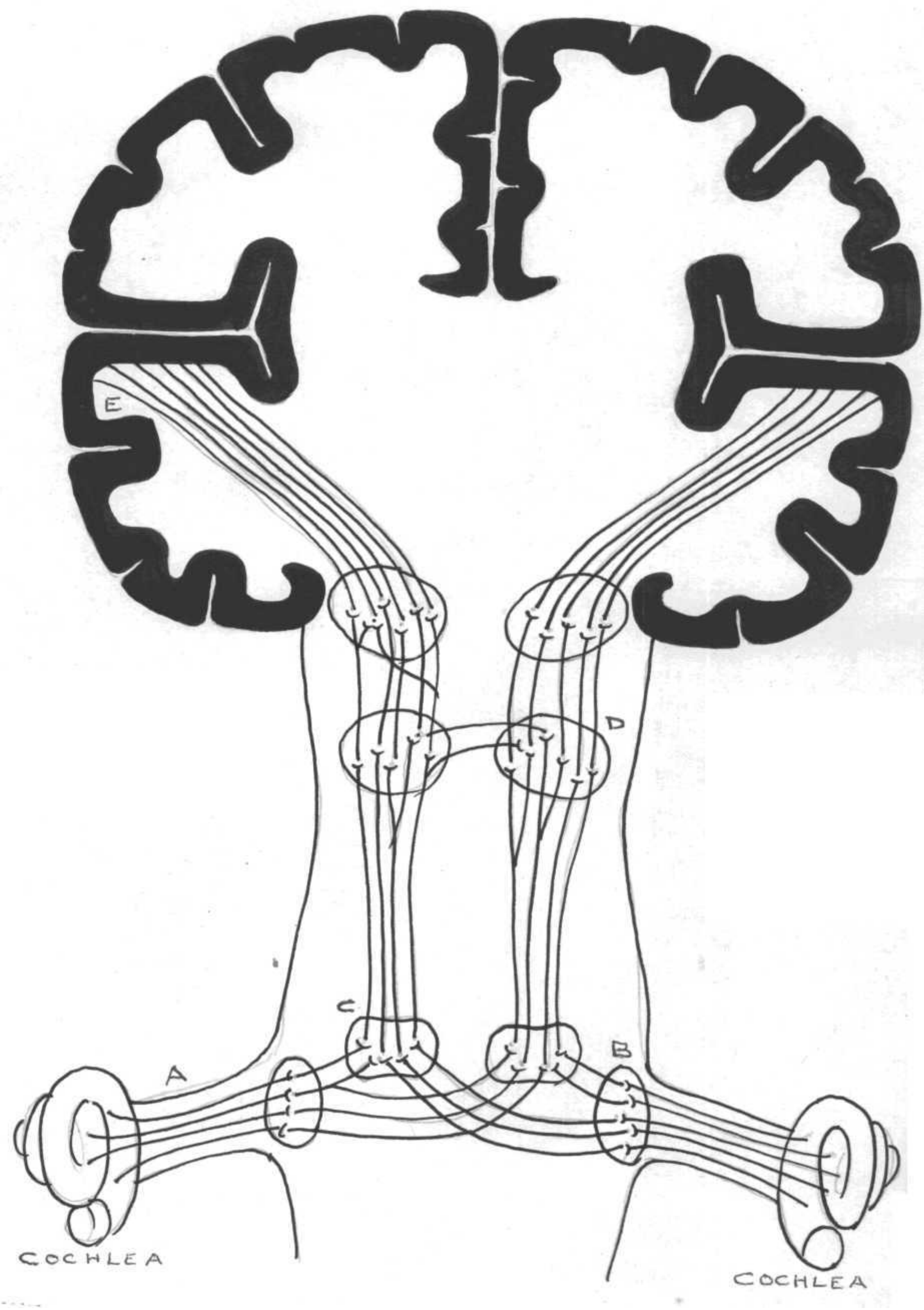


Figure 2 : Auditory Nerve Pathway.

A. Auditory Nerve

B. Cochlear Nucleus

C. Olivary Nucleus

D. Inferior Collioulus

E. Auditory cortex

audiologic picture. However it is the opinion of many authors that it reaches atleast to the superior olivary area.

4. **The Upper Brain Stem:** The upper fractional limit of the upper portion of the auditory brain stem when damaged shows a different audiologic picture from the lower portion.

5. **The Primary Auditory Reception Center:** The Auditory radiations and the primary auditory reception centers are often considered the highest area in the auditory hierarchy. Functionally this subsection starts in the area of basal ganglion and ends in the middle and posterior portion of the superior temporal gyrus. Two separate areas in the cerebral cortex have been ideatified as taking part in hearing. They are, a short latency area sad a long latency area. The short latency area is directly excited by projections from the medial geniculate body, while the long latency area is usually excited secondarily by impulses from tha short latency area but to some extent also by projections directly from tha medial

Table l: Audiologic tests which may be used to identify lesions in the five auditory areas.

Diseased Area and Ear Under Test	Tests	giving positive results
A Cochlear Ipsilateral	Ear	ABLB A monaural (MLB) procedure is used when ABLB is not appropriate.
	SISI	
		Bekesy Audiometry (Bekesy) Cochlear pattern (Type II).
		Tone Decay (TD)- Cochlear pattern on Owens test.
		Continuous Tone Masking Test (CTM) Cochlear pattern.
B VIII Nerve Ipsilateral Ear	Bekesy	Audiometry- Retrocochlear pattern (Type III).
		Tone Decay (TD)- Retrocochlear pattern on Owens test.
		Continuous Tone Masking Retrocochlear pattern.
		Word Discrimination Score(WDS) (using recorded W-22 lists).
		Score severely depressed relative to pure tone thresholds.
		Vestibular Tests(V) - Such as caloric (given by physician) or electromystagmography.
C Lower Brain Stem Ipsilateral	Ear	Bekesy Audiometry - Retrocochlear pattern (Type III).
		Tone Decay - Retrocochlear pattern on Owens test.

Table 1 - contd.

	Word Discrimination Score- Severely depressed relative to pure tone thresholds.
D. Upper Brain Stem Primarily Ipsilateral Bar when bilaterally affected.	Bekesy Audiometry - Retro-cochlear pattern ((Type III).
Tone	Decay - Retrocochlear pattern on Owens Test.
Continuons	Tone Masking - Retrocochlear pattern.
	Word Discrimination Score - Moderately depressed relative to pure tone thresholds.
	Staggered Spondiac Word Test(SSW) Corrected (C-SSW) depressed in ipsilateral ear.
B Cerebral Reception Contralateral Ear	Staggered Spondiac Word Test Corrected (C-SSW) depressed in contralateral ear.
	Rush "Hughes Test (RH) Score depressed relative to WDS also filtered speech and other tests.

geniculate body (Guyton, 1966). The abort latency area is frequently called the primary auditory cortex and the long latency area the secondary auditory cortex.

Table I shows the audiologic teats which nay be used to identify lesions in the five auditory - areas. These tests characteristically show positive results with lesions in the specific area. Of course, where multiple auditory lesions exist the results of alasion not under investigation may cause confusion. By judicious use of various tests at various frequencies the portions of the loss corresponding to each locus usually can be isolated.

Detection and Description of Central Auditory Disorder:

The detection and description of central auditory lesions with differential techniques is still in the exploratory stage of development (Noel D. Matkin and Wayne 0.01sen,1971). There are a number of reasons why the study of central auditory disorders la largely an unexplored area. In the first place, few patients with central lesions will be referred for audiological study and consequently most available research is based upon the evaluation of a relatively small sample of patients. Sometimes even in those cases whose auditory function has been assessed, the referring physician often has been unable to state in the central nervous system the precise site and extent of the lesion. The extreme neurological complexity of both the auditory tracts in the brain stem and the auditory centers in the cortical region would indicate that it is naive to expect a particular profile of test results when damage may occur at any one of many levels within the central auditory system. Thus lesions within the higher auditory system may be difficult to detect.

However, Jerger (1960) suggests the following generalizations regarding auditory response patterns in unilateral lesions involving the auditory pathways within the central nervous system:

1. Threshold loss for pure-tones is minimal atleast for frequencies below 2000Hz.
2. Scores on distorted speech tests are characteristically lower on the contralateral than on the ipsilateral ear.
3. There is a gross alteration in the interaural intensity relations producing equal loudness at the two ears.

4. Medial plane localization may or may not be affected, apparently depending Upon the nature and extent of the lesion.

Commenting on the usefulness of pure-tones in the detection of central auditory disorder, Bocca and Calearo (1963) say,

> "The significance of elementary pure-tone tests in the investigation of lesions of the central auditory pathway is decreasing so much that one may conclude that the mere analysis of the parameters of frequenoy and intensity becomes an operation of less and less significance as one moves from the cochlear nuclei to the cerebral cortex".

For this reason a number of special speech tests have been developed for evaluating patients with suspected lesions at the level of the brain stem and temporal cortex.

Speech tests for the Detection of Central Auditory Disorder:

Some forms of damage within the auditory nervous system disturb the patients' ability to receive speech. This fact has led to a special type of speech audiometry namely, the use of "sensitized" speech tests to help in diagnosis of neurological disorders. These "sensitized" speech tests use verbal material that has been made more difficult than usual by some kind of physical distortion or change. Such test demonstrate abnormalities in function of the central system which would not be apparent when the patient is listening to ordinary speech.

Rationale of "Sensitized" Speech Tests:

The theoretical basis of speech tests lies in the necessity of using strongly structured messages such as may constitute a repertoire that is adequate to test the functional properties of the channels and of the stations along the central auditory pathways. It is certain that complex sound patterns better investigate the defects affecting integrative functions at the central level. Even under conditions of wrong transmission or wrong representation at the central level, the extrinsic redundancy at the level of the hearing stations and centers ensure correct formal integration of the constituent elements of information. Bocca and Calearo (1963) say that the greater these two redundancies are, the easier it will be to bring out minor integration disturbance due to noncritical deterioration either of the quality of the message, or of neurophysiological performance, furthermore, they theorize that the greater the peripheral redundancy, the easier it will be to obviate errors due to defects of the peripheral receptor, which are, a source of uncertainty in the recognition of single phonemes but cause practically no hinderanee to the reception of words, and less still of sentences.

Observations with pure-tone and speech audiometry led to the formation of the "subtlety principle". This dictum states that the more central the lesion the more subtle is its manifestations (Jerger, 1960). A dysfunction of the central auditory system is quite elusive in its manifestation. Lesions in the peripheral auditory mechanism may be detected with conventional auditory tests. However, a deficit at the level of the first auditory center in the brain stem, i.e., the cochlear nuclei may be an exception to the subtlety principle. Such a lesion may in fact be exhibited through the use of both routine audiometry and the peripheral auditory test battery (Carhart, 1967). This may be because the cochlear nuclei are quite unique in that they constitute the only way station in the central auditory system where one does not find a representation of neural coding from both ears. Therefore lesions at this level may be manifested in a far less subtle manner. However, at higher auditory levels there is dual representation of both ears through numerous inter connections (Galambos, 1958). Hence a lesion above the cochlear nuclei or even a hemispherectomy does not present information presented to either ear from reaching one of the interpretive centers (Hole D.Matkin and Wayne 0. Olsen, 1971).

At the central level there appears a pattern of nervous activity which softens out and blurs the details, and forms itself in the main according to the fluctuations of intensity, frequency, duration and to the relative values of these. The accuracy of this configuration depends on the activation of large number of structures or relays (Bocca and Calerao, 1963). On the contrary, a single discriminative tone will activate at most a minute proportion of neural channels, consequently it may be useless to try to expire the delicate defects of the functioning of these structures by means Of a single discriminative tone. Therefore the method of exploration of the integrity of the central auditory system must use messages with a complex and integrated structure such as to provoke the partial type of activity that is characteristic of the auditory processes at the central level. All of this serves to justify the use of meaningful speech material in the study of different stages in the process of integration.

A lesion within the central auditory system reduces the number of neural channels available for processing speech. However, such a reduction in internal redundancy may not affect the ability of the listener to understand speech of good fidelity to any substantial degree. Bocca and Cakearo (1963) attribute this finding to the ability of the patient to compensate for a disturbance in the central auditory pathways by capitalizing upon the large number of redundant cues in speech stimuli. They later theorize and suggest that by reducing the redundancy contained within a sample of speech, the presence of a central dysfunction may be highlighted. Therefore, a number of testa for the detection of central disorders have utilized speech in which the redundancy has been reduced by distorting it in any number of ways. The end result in such a reduction of speech redundancy is to increase the probability that even the normal listener may misinterpret some acoustic phonemes contained within the message (Noel D. Matkin and Wayne O.Olsen, 1971). However, in contrast, it is expected that a lesion in the central auditory tracts will result in a significant increase in the number of errors made while decoding a distorted speech signal. Probably the increased difficulty encountered by the latter subjects is due to a dual reduction in redundancy; that is in the speech stl-muli(extrensic redundancy) and in the number of intact central auditory tracts available for processing a me-ssage (intrinsic redundancy).

The validity of , all the speech tests can be jeopardised by disturbances at the level of the language center; because it is obvious that all speech tests depend on the correct activation of the language centers for a response to the stimulus. However, isolated or associated language disturbances are easy to recognize and can be excluded, barring rare eases of agraphia, by Baking the subject to write his responses instead of repeating them. As such, the activation of the language centers is a gurantee that the message has arrived, as such, at the cortex, thus testing all the stages of in-tegration as far as, the higher level. This cannot be said for tone message, involving an elementary motor response, which can be provoked below the cortex (Bocca and Calearo, 1963).

These are the reasons and/or justifications which confirm that speech audiometry specifically developed ("sensitized" speech tests) is the most suitable way of detecting hearing disturbances at the integrative level, i.e., at the higher stage of the central auditory pathways.

Types of "Sensitized" Speech Tests:

The speech tests which are described are based on the principle of the reduction of extrinsic redundancy by various means. Lafon calls these tests as "phonetic tests", Bocca, Tato and Quiros fefer these testa as "sensitized speech tests" and Calearo and Bocca name these as "low redundancy speech tests".

Four va-rietied of central speech tests (Sensitlzed"speeeh tests)are now in use. Distorted speech materials delivered monaurally were the first central speech tests to be employed. The distortion may be accomplished by acoustic filtering, low fidelity and other means (Bocca, 1964; Goldstein, 1956; Gleiner and Lafon, 1957). A second technique is time distortion (Bocca, 1956; Calearo and Lazzaroni, 1957; Calearo and diMitri, 1958; Puricelli et al, 1958 and Quiros, 1961). The third major category is that of supplementary messages or integration (Matzker, 1958; Calearo, 1967; Hellema, 1960 and Tillman et al, 1966). These methods usually require the listeners to combine binaural sources of information in order to obtain an accurate response. A, fourth approach to uncovering central auditory disorders is the competing message technique (Kimura,1961 1963, Feldman 1962; Katz 1962, 1963 and 1968 and Jerger 1964).

Monaural Distorted Speech Tests

In 1954, Bocca. et al, delivered lists of phonetically balanced words using low pass filters (500Hz). The results showed that in all cases where lesion of the auditory cortex had been proved, the discrimination curve was distinctly worse in the contralateral ear. Walsh and Goodmen (1955) followed the same approach, as did by Bocca et al by employing a distorted speech message to give an indication of the affected ear and thus the dysfunctioning hemisphere. They found that by subtracting the difference between W-22 word 1ist scores from the score on the Rush Hughes PB 50 tests, that they could localize site of lesion. Goldstein et al in 1956 used lists of monosyllables that were difficult to recognize insted of distorted words. The difficulty in their recognition was due to the bad quality of the recording. The results showed that in cases of hemispherectomy due to infantile hemiplegia the discrimination score was 25 per cent lower in the tar contralataral to the hemispherectomy as against the homolateral one. Calearo (1962) in an other experiment periodically switched continuous discourse from ear to ear and required the subjects to repeat the phrases.

Time Distortion:

The tests under this sub-division are also called as time compressed speech (Bocca and Calearo, 1963) and accelerated speech tests (Quiros, 1961).

In 1956 Bocca reported on an audiometric accelerated speech test and suggested that this test provides a Measure of:

1. reaction tine (i.e. the fixation time of the verbal message),
2. the speed of the transmission across the cortical synapses,
3. the speed of the transmission along the auditory pathways.

Later similar results were obtained by Bocca and Calearo (1956), Calearo and Lazzaroni (1957) and Bocca, Calearo and Cassinari (1957). According to Calearo and Lazzaroni, a decrease in intelligibility of accelerated speech may be indicative of cortical lesions of an increase in synaptic transmission.

In a similar investigation by Calearo and di Mitri in 1958 the speech presentation was periodically switched from one ear of the listener to the other. In studies employing this technique, normal subjects were tested as well as patients with central auditory lesions. In normal persons, it was observed that the intelligibility of the speech message was decreased when the rate of switching from side to side was faster than 0.2 - 0.3 seconds, and when the message rate exceeded twice the normal speed (250 words per minute). In patients with central auditory lesions intelligibility decreased even though messages were given at normal speed either because of the increased reaction time or because of a decrease in the capacity to integrate these binaurally presented messages.

In actual tests, subjects were asked te repeat verbal messages delivered to them at various speeds (140, 250 and 380 words per minute). This audiometric test was thought to provide useful information, mainly in cases of central lesion (Quiros, et al 1961). However none of the time distortion studies gave any results as clear and as uniform as did frequency distortion. On this Bocca and Calearo (1963) reports that time compression generally produce abnormal results that are particularly evident in the contralateral ear, similar to what happens with the distorted voice. Furthermore, the authors report that time compression gives the lowest discrimination values in diffuse disorders of central auditory pathway.

Modified Logo Audiometry

This procedure was proposed by Quirox(1960). Here lists of phonetically balanced bisyllables are presented to the two ears separately, and a speech discrimination curve is plotted. Later the same words are delivered in groups of three, separated by a gap aad new speech discrimination curve is plotted.

The results obtained using this procedure shewed that in disorders of the central auditory pathways the two curves do not coincide and the curve obtained for the groups of words is unilaterally or bilaterally inferior. A poor unilateral curve indicated organic Or functional disorder of the contralateral auditory cortex.

Quiros (1960) attributes the inferior performance obtained with groups of wards to the greater effort of integration required for this kind of delivery; this according to him, necessitates greater attention since one is dealing with groups that are not normally used and with a rhythm different from that of ordinary language.

Binaural Speech Integration Tests:

These tests are based on the principle of the central summation of the two parts of a monaural message, each of these two parts being insufficient for identification. These methods usually require the listeners to combine binaural sources of information in order to obtain an accurate response. It is therefore more a appropriate to refer them as summation tests rather than integration tests (Bocca and Calearo, 1963).

Experiments in binaural summation have equivocally shown that the two auditory cortices add together the two parts of a message by using well known connections, and thus achieve its correct integration. Consequently this summation may be defective when the associations of the auditory pathways in the encephaloua are impaired. This has resulted in the development of new procedures for the detection of central auditory lesion using the phenomenon of binaural summation.

In one procedure a speech message, which was unfiltered, at subliminal values was presented to one ear, and the same message, filtered at an intensity well above the threshold was presented to the other ear (Bocca, 1955). Discrimination score of 100 per cent was obtained for normal subjects. On the other hand the discrimination score did not exceed the best monaural discrimination score in subjects with auditory cortex pathology (Calearo, 1957; and Jerger, 1960).

Based on the above procedure Matzker (1958) suggested a similar procedure. However in this procedure the same vocal message was passed through two filters, one low pass and one high-pass, each of which made the message difficult to understand. The simultaneous delivery of the two semispectra of the message, one in each ear, allows a normal subject to attain discrimination score of 100 per cent. However discrimination may become poor in lesions of the auditory pathways at the level of the brain stem since the effect of binaural summation may be completely abolished.

According to the suggestion and methodology already presented by Cherry and Taylor (1954) and by Hennebert (1955), Bocca (1960) and Calearo (1960) have suggested yet an other procedure where in the vocal message oscillates periodically between one ear and the other, for equal periods of time so that each ear receives half of it. The period of oscillation can vary between 2 and 40 alternations per second. In a normal subject the Integration of messages consisting of short sentences of simple and elear meaning, pronounced at normal speaking speed, is not compromised at any period of oscillation and there is invariably 100 per cent discrimination.

Bocca and Calearo (1963) however report no discrimination loss on this test in isolated pathology of the temporal auditory cortex, while on the pther hand characteristic dips in integration have been reported by the authors which are corresponding to the lower frequencies of oscillation in some cases of diffused cerebral pathology, and in a considerable number of disturbance of the brain stem.

These results may show that the integration of the two complementary parts of the message, delivered to each of the two ears separately aay be possible if fusion takes place at the subcortical level, or more exactly at the level of the crossing of the auditory pathways. If this fusion is lacking, the two temporal auditory areas are not Capable of integrating the message and on the other hand, the non-functioning of one of the two auditory areas, as appears for instance in unilateral cortical pathology, does not seem to hamper the comprehension because the other area receives the message preliminarily integrated at the mesencephalic level (Bocca and Caleare 1963).

Competing Message tests:

This is an other method for the evaluation of Central auditory disorders and to this group belongs the Staggered Spondiac word test. In these tests speech material is presented to both ears. A primary speech massage (usually monosyllabic words) is presented te one ear while a secondary or competing message (usually sentences) is presented to the Opposite side. Ignoring the presence of the competing message the persons with normal auditory function can successfully attend to the primary signal. Similarly responses are not affected by the competing signal when it is delivered to the ear contralateral to the side the lesion, and the primary message is heard in the other ear in persons with unilateral lesions at the level of the auditory cortex* On the other hand, when the signal presentations to the two ears are reversed a marked breakdown in performance is observed.

Kimura (1961) conducted an investigation using Broadbent test (1956). Six different digits were presented to the two ears simultaneously in pairs of in rapid succession. The author found that in unilateral temporal lobectomized patients the message received in the contralateral ear was impaired. Furthermore he found ear preference in case of normals. The right ear responses were better than left ear responses. In an other study Kimura (1963) reported a decrease in this difference between the ears as a result of increasing age from four years to nine years. This leveling off between right and left ear efficiency was thought to be the result of an overall improvement on the test by older subjects.

In 1962 Feldman reported a method of ascertaining the presence of central disorders. This was a dichotic test where in two different numbers (in German) were presented to each ear simultaneously one acted as competing stimuli to the other. On this test Feldman observed that normals relatively had no difficulty in recognizing the words. They were able to attain 100 per cent scores for words repeated correctly. However, lesions in one hemisphere resulted in a deficiency to perceive the message in the contralateral ear. This approach lends further support to localizing central lesions by providing contralateral interference.

However, at present it is not certain what is to be expected with the competing message procedure in the instance of unilateral brain stem involvement (Noel D. Matkin and Wayne O.Olsen, 1971).

There are many other tests which have been used for the detection of central auditory disorder. However, many of the following tests are not in common use in the audiology clinics. They are, faint discrimination of words at 30dB, discriminations at 50dB, tonal flicker, Speech with alternate masking index (SWAMI), synthetic speech Index (SSI), Rush Hughee test, fusion and auditory tracking tests,

In an investigation done by Berlin et al (1965) en the auditory findings of temporal lobectomized patients it was found that the following tests failed to show consistent enough effects to be considered as cortical tests in the battery: low pass filtering, faint discrimination at 30 dB, discrimination at 50 dB, speech with alternate masking index (SWAMI), tonal flicker, fusion and auditory tracking tests. From these tests it was not possible to identify the locus of cortical lesion. It was latter concluded by the authors that Staggered Spondiac Word (SSW) test is a very consistent auditory test.

Criticisms on the effectiveness of speech tests used for the detection of Central Auditory Disorder:

> "The various tests aimed at exploring the central hearing processes are still insufficiently standardized; indeed, very little is known about the modalities and the levels of integration, and each new test may show up some new disorder whose diagnostic value must then wait upon valid confirmation on the theoretical and clinical plane" (Bocca and Calearo, 1963).

Several promising audiological procedures have been proposed for identifying lesions of the central nervous system. However, most often it is not clear from these measures at what level in the pathways the breakdown occurs (Katz, 1962). Furthermore, etiological groups are not necessarily consistent in their test behaviour. Hence, improved specificity and reliability are of major importance to present day investigators.

Speech material which is ambiguous or which has few distinguishable elements may suffer considerable loss of intelligibility when "sensitized" by any of the current difficult speech methods. These subtle stimuli which are then further processed by any of the current techniques may become more difficult to individuals lacking central integrity, and this inability is primarily demonstrable in the ear contralateral to the affected hemisphere. However, at first glance such an approach seems ideal, nevertheless, these methods which employ ambiguous speech stimuli incorporate an element of undesirability. The more precarious or "unstable" the speech material, from the standpoint of intelligibility, then greater will be the probability of artifacts due to individual differences which may be totally unrelated to central disturbance (Katz, 1962).

Most of the techniques investigated to-date have employed relatively "unstable" speech stimuli, namely, English monosyllabic words or their equivalents. Hence it is not surprising that consistent normative data are lacking. Probably, as a result of the heterogenity of the test items, and of the great amount of variability among individual listeners, little emphasis in difficult speech tests has been placed on the Absolute test score.

Because of the expenditure of testing time necessary to cope with factors of unreliability, investigators have been unable to shorten their diagnostic measures. Rather extensive test batteries have been utilized by several research workers in order to provide the added reliability and accuracy in diagnosis. Since all of these approaches tend to be time consuming, they may increase the possibility of psychological and physiological fatigue in the patient (Katz, 1962).

In addition to variables inherent in particular subjects such as age, intelligence, attention span,etc., most of the current methods are difficult to interpret in the presence of peripheral aural pathology. This is because the peripheral hearing loss has an unpredictable influence upon the test procedures and furthermore, the possibility of confounding important information concerning the status of "cortical hearing" may be enhanced. Equivocal test findings may arise due to interaction of distortions such as reduced word discrimination ability. Consequently one may hesitate to make a diagnosis on the basis of current techniques especially with individuals exhibiting less than normal hearing for the frequencies within the speech range and also good word discrimination ability. With very few exceptions most of the "sensitized" speech test employ ambiguous, "unstable" speech stimuli. But without material which is impervious to individual differences and which is relatively unscathed by peripheral auditory distortions, serious limitations may be placed on the methodology of the test.

However, greater certainty in diagnosis may be obtained by using "stable" speech stimuli as the test material, because of the likelihood of clearcut normative data and relative resistance to associated or coincidental auditory deviations of a peripheral nature. Calearo and Lazzaroni (1957) and Bocca (1961) have shown an increment in the test reliability when "stable" speech material was used. They have also shown that by using "stable" speech material which is neither distorted nor employs difficult words, age and intelligence factors are of little importance.

Short sentences and spondiac words may be grouped under "stable" speech material. This la because spondiac words and sentences contain greater redundancy and therefore much information can be omitted without noticeable reduction in intelligibility (Katz, 1962). Since difficulty in identifying a word is related to considerations of familiarity, phonetic structure, length, stress, part of speech, etc., (Giolas, 1960), the word which has rare usuage, may be more difficult to identify. Thus a commonly used word with unique structure and stress will be intelligible at a weaker level than an unfamiliar word with less specific features (Katz,1962). Probably for these reasons English monosyllabic words require greater sound intensity for reception than short sentences or spondiac words.

The stability of spondiac words is revealed by the fact that there is a reliable relationship between their reception thresholds and pure-tone thresholds in the speech frequencies. Nearly perfect intelligibility of spondiac words may be expected even at intensity levels only slightly above the average threshold for the speech frequencies. This relationship is essentially unaltered when auditory sensitivity is reduced and this estimate is also appropriate even in cases in which moderate difficulty in discriminating monnosyllabic words is present (Katz, 1962). This stability common to spondiac words in provide a high degree of test-retest reliability (Epstein and Bopkinson, quoted from Katz, 1962). Thus by employing spondiac words as the test material the test could be made more reliable.

Test Staggered Spondiac Word test:

The staggered Spondiac Word test was first described by Jack Katz, in the year 1962. In the past eleven years large amount of information has been gathered on the usefulness of this test. Great use of this test has been made in locating brain lesions in children and adults. Attempts have also been made to use this test to help in the diagnosis of brain stem problems, particularly high brain stem lesions.

Some new features are present in the Staggered Spondiac Word test which probably accentuate its potential value. First, the Staggered Spondiac Word test incorporates "stable" speech material i.e., Spondiao words. Second, it has the demanding features of a competing message technique in order to study insufficiency of the higher auditory nervous system. As stated by Groen and Hellema (1963) not only the discriminative power of one ear or the other ear but the co-operation And/or competition between the ears can be studied when stimuli are presented to both ears and this is achievable by using the Staggered Spondiac Word test. Third, in this test "sensitization" of the test material is obtained by the introduction of two complex presenta-0 tion methods. This test requires that the patient first attend to one side, then to both sides simultaneously and than only to the second side, with different information presented concurrently to each ear. The Staggered Spondiac Word test follows the same concept of binaural competition. However, in this procedure the patient is required to respond to the stimuli in both ears as opposed to Jerger's test. Furthermore, it has been indicated that this test also indicates contralateral effect in cortical lesions as noted by all previous investigations (Katz, 1963).

The spondiac words are employed in the Staggered Spondiac Word test in order to utilize their ability to pass through the peripheral auditory mechanism comparatively unscathed by concomitant or coincidental hearing loss and/or distortion. Because of the use of spondiac words which are being considered as "stable" speech material the test may provide greater intra and inter subject consistency within various auditory disorder groups.

In the Staggered Spondiac Word test, clear, relatively familiar spondiac words are presented to each ear in a partially overlapped manner. A momentary pause separates the two individual monosyllables of each of the two spondees in a test item. She items are presented through earphones, setting the intensity to 50dB HL (re: 22dB SPL) when SRT is 0 dB HL or better, but when one or both SRT's are poorer than zero the test is presented at 50dB SL in that ear (Katz, 1968). This level is expected to provide a maximum score (Balas and Simon, 1965) and therefore, deviations from normal performance cannot be attributed to lack of sensitivity. In some cases where there is a sharp drop in hearing within the speech frequencies (500, 1000, and 2000Hz) the intensity of the signal may be increased to insure that the listener is not penalized for his peripheral hearing status, and rather large errors in intensity may be made without significantly affecting the test results. (Katz, 1968).

The "Staggered Spondiac Word Score" will refer to the percentage of error, whether for a specific condition, ear, or for the total test. Katz, Basil and Smith (1963) reported that word discrimination score correlates extremely with the Staggered Spondiac Word results. A correlation of 0.93 was obtained for their group of subjects with peripheral hearing loss. In addition the scores differed no more than 10%. Since that time the Staggered Spondiac Word test has been corrected for word discrimination loss by subtracting the "SSW Score" from discrimination score. Thus the listener is not penalized for auditory distortion which is primarily attributable to lesions below the level of the brain. This score was called "C-SSW Score" and was designated as the percentage of error ("SSW Score") minus the percentage of error on the W-22 word discrimination test.

Staggered Spondiac Word Lists!

Till now several types of SSW lists have been prepared. They are: List C-EC, List EC, List 1B and List ED-2. list C-EC has only 20 items, list EC has 40 items, list 1B has 52 items and list ED-2 has 90 items. However, Katz (1968) writes that out of these lists, the list EC and the list 1B were the most successful. Furthermore, he writes that the ED-2 list might have particular value as a research tool because it has been divided into two equated lists, with two scramblings of each. The list C-EC was found much useful with young children.

Ear effect on the Staggered Spondiac Word Test:

Goetzinger et al (1961) states, that in adults, discrimination ability decreases as age increases and this difficulty is associated with changes involving all levels of the auditory mechanisms. This was tentatively supported in an unpublished study by Katz, Balas and Fisman on the age effects of performance on the Staggered Spondiac Word test. This study suggests an increase in both peripheral and central dysfunction beyond the age of 60 years. Furthermore, the authors observed a considerable individual difference in performance among subjects in the 60 and 70 age groups. In his unpublished thesis, Myrick (1965) observed a superior right ear performance en the staggered Spondiac Word test when the subjects were children and the author observed no difference between the two ears in the adult control group.

Katz (1968) writes that ear performance is generally a more accurate indicator of central auditory function than either the SSW conditions or total score. Furthermore, the author writes that defective performance in one ear suggests that the dysfunction in the contralateral hemisphere. However, ear preferences were absent in normal listeners on the Staggered Spondiac Word test.

Response Bias:

Response bias refers to any one of a number of unlikely responses that persist in the patients test performance. Usually it is presumed that a normal cooperative subject will make random errors ' when the items are presented to the right ear first or to the left ear first. If the subject makes errors consistently when the left ear was leading, then this type of response bias is called "ear effect. Ear effects seem to have diagnostic significance whether or not the C-SSW score exceeds the normal limits (Katz, 1968). "Order effect" is an other response bias which is seen when the patient makes more errors on the first spondee than on the second or vice versa. Similarly there is an other response bias wherein two different configurations of errors are exhibited for the right ear first items as opposed to the left ear first items. This is referred as the "pattern effect". The other major response bias is the "reversal". A reversal is any response by the patient in which all mono-syllables are repeated correctly but in order that differs from the one presented on the test tape. A "partial reversal" is a response in which an item is repeated out of order but one of the monosyllables is also incorrect.

This information on response bias could be used as a qualitative method to analyze the patients disorder and furthermore, it is possible to "adjust" the SSW Score for order or ear effect by eliminating the most deviant portion (Katz,1968). The specific Order effect, ear effect and reversal combinations provide information regarding the site of lesion of some auditory and non-auditory involvements.

Staggered Spondiac Word Test Norms:

The initial attempts to determine the Staggered Spondiac Word test's value was described by Katz, Basil and Smith (1963) who found that the test differentiated normal listeners from those with histories of skull trauma. Later, many normative studies were attempted on the Staggered Spondiac Word test in

United States and in other countries. However, till now a normative study on Staggered Spondiac Word test has not been attempted for Indian population.

In his unpublished thesis, Myrick (1965) attempted a normative study for US children population. In this study the performance of a group of normal children ages 7 to 11 was investigated. The Staggered Spondiac word test consisting of twenty items (list C-EC) was administered to each young subject aa wall aa an adult control group. The author observed a decrease in number of errors with an increase in chronological age. As demonstrated by Kimura (1963) lateral dominance effect was demonstrated by the superior right ear performance on the Staggered Spondiac Word test when the subjects were children. However, no difference was found between the two ears in the adult control group for the Staggered Spondiac Word test.

Katz (1962) reported no apparent difficulty in performance of children as young as 8 years. However, using another form of test Myrick (1965) found 11 years to be the cut-off point for adult performance and 10 to be the transitional plateau between child and adult performance. Similarly Brunt (1965) reported that there existed a cut-off point for adult performance between the ages of 10 and 13 years of age, below which children cannot successfully perform on the Staggered Spondiac Word test. Brunt (1965) also found some effects (in younger children) of cerebral dominance as the poorer scores were obtained for the left ear.

Turner (1966) attempted an other normative study for US population. In this unpublished thesis the Staggered Spondiac Word test was administered to one hundred and twelve normal hearing subjects. Sixteen subjects were tested in each of seven age groups: 9 years, 10 years, 11 years, 12 years, 20-29 years, 40-49 years and 50-50 years.

The Staggered Spondiac Word teat was administered using two lists of 40 items (list ED-2). Each subject heard both lists making a total of 80 items which represented 320 monosyllables. Two scramblings of list A and list B were used. They were designated as Al and A2; B1 and B2. Bach subject was presented one A list and one B list. Lists and order of presentation were randomized;

The following conclusions were delineated in this investigation:

1. the 20 and 40 year old groups are statistically better than the other group.

2. normal performance on the SSW test is considered 5% or fewer errors on the non-competing and 13% or fewer errors on the competing conditions.

3. Normative data for this study does not apply to groups of children twelve years and younger.

4. normative data for the 12 year group differs from the adult population for the left competing condition only. For this condition a corrected score of 20% or better is needed to fall within the normal category.

5 there is no significant difference between the left and the right ear performance.

6. there is no significant effect of socio-economic conditions on the SSM test.

Table 2 provides the normative data obtained in various investigations. All the investigations cited in the table were done on American population. Table 3 summarizes the C-SSW criterion which was used by Katz (1968) in evaluating adult performance on the Staggered Spondiac Word test.

TABLE : 2

Mean corrected SSW scores and standard deviations fer various age groups and lists.

Study	N	List	Age	Age range	C-SSW	S.D.
Katz, Basil & Smith (1963)	20	1A	20	14-28	-0.4	1.5
Katz & Fishman (1964)	10	1B	22	20-29	0.8	1.9
Katz & Fishman(1964)	20	1B	39	30-49	1.3	1.9
Katz & Mylick (1965)	10	C-EC	23	19-29	-1.3	2.2
Katz & Galdman(1965)	24	1B	24	18-39	- 0.3	2.2
Katz & Brunt(1967)	15	EC	38	16-55	-3.2	2.6

Table. 3.

Upper limits for C-SSW scores (Katz, 1968)

C-SSW	Normal	Mildly Abnormal	Moderately Abnormal	Severaly Abnormal
Total Score	5	15	35	100
Ear Score	10	20	40	100
Condition Score	15	25	45	100

STATEMENT OF THE PROBLEM:

..... There must exist in the afferent channels of the Auditory system a centre where the stimuli, generated in each organ of corti, come together, resulting in some type of fusion..... In pathological cases it is obvious that, if this centre, which may be constituted by single or multiple formations would be unable to carry out the function assigned to it. the meeting of the signals coming from the periphery could not take place any more or at least follow the normal course. This would be apparent by judging the degree and type of deviation from normal function (Azzi and Azzo, 1964).

The SSW test offers the diagnostician many sources of information concerning an individual's ability to respond to and cope with complex speech stimuli (Katz, 1962),. Higher auditory functioning from both theoretical and diagnostic points of view is now receiving considerable interest.

In light of the increasing use of the SSW test and its potential for both a clinical as well as a research tool, it was the purpose of this investigation to pursue the following:

I. to study the performance of normal Indian listeners on the SSW test, and establish the mean C-SSW scores for normal Indian listeners.

2. to investigate pattern effects on the SSW test,

3. to investigate ear effect on the SSW test,

4. to investigate sex differences on the SSW test, and ,

5. to establish which errors are typical of normal Indian listeners.

CHAPTER . III

METHODOLOGY

Subjects:

Sixty subjects were chosen for participation in this study. The selection of the subjects was dependent on the following criteria and the same criteria were maintained for all the subjects regardless of the Age and sex of the subject.

a) patient indicating essentially normal hearing in both ears, obtaining pure tone average of not more than 80 dB Hearing Level (ISO)

b) no family history of hearing disorders

c) no extreme exposure to noise

d) no history of trauma caused by a blow to the head

e) no significant otological history

f) no significant neurological history

The above criteria were felt to be not very stringent. The effect on the norms probably will be to increase the mean number of errors and also perhaps the standard deviation. This is felt to be more realistic and/or conservative standard.

The subjects tested were in the age group of 16 to 29 years. The population consisted mostly of college students representing all parts of the country. All the subjects were tested at the All India Institute of Speech and Hearing, Mysore. The total number consisted of thirty males (a large group according to GARRETT, 1967) having an age range of seventeen to twenty nine years (l7-29) and thirty females having an age range of sixteen to twenty eight (16-28)yrs children were not taken up for the study because the word list which was chosen in this study for preparing the SSW test tape, was standardized only for adult Indian population. The mean age of the males was 20.8 years and that of females was 19.8. years.

All subjects were naive listeners with regard to the SSW Test. No attempt was done in this study to control for socio-economic conditions as it has been shown by Turner (1966), that the C-SSW scores will not be biased by the socio-economic conditions.

General Procedure:

Measures obtained for each subject were:

a) pure tone average for eaeh ear

b) Discrimination scores usihg PB words for each ear

c) staggered Spondiac Word test.

The pure tone average for each ear was always obtained prior to the SSW testing since the presentation level for the SSW test was dependent upon pure tone average for each ear in this investigation. However, Katz (1962, 1963 and 1968) and others keep the presentation level for the SSW teat dependent Upon SRT But this was not followed in this investigation since it was felt that the subject would be familiarized with the spondee list during SRT testing and hence their performance on the test might be biased. This was a special problem for Indian condition since the number of spondees available for testing was fifty, and moreover from the same list of spondees the SSW list was prepared in this investigation.

Recording of the SSW items:

The SSW items were recorded in the sound-treated room using two Philip's Casette monophonic tape recorders, one UHER Variocord 263 stereo tape recorder and one Amplivox 103 clinical audiometer.

The output of the two monophonic tape recorders was fed into the stereo tape recorder through the audiometer. When the required overlap as seen in the cathode ray oscilloscope (RADART,530-A) was obtained, on the two monophonic tape recorders, it was transferred to the stereo tape recorder. The recording on the stereo tape recorder was done at seven and one-half inches per second.

In the recording of teat material a 20 year old male (the author) spoke the test items. In connected discourse his dilect may be described as Indian English common to the southern regions of Mysore State. Prior to this activity, he had four years experience in the monitored live-voice technique of speech audiometry. Recording of the test material was done in a sound- . treated room. All the test items were recorded preceded by a carrier phrase "Are you ready?" A time interval of ten seconds was allowed for the subject to respond.

In order to rule out the possibility of lack ef intelligibility of the test tape due to other factors, apart from the overlap like distortion during recording, individual channels of the tape were presented to ten normal listeners. The words were given at SO d3 above the pure tone average of the individual. Since the results indicated no difficulty on individual channels, the prepared SSW test tape was taken up for the study.

Material

Spondiac words of the auditory test lists which have been standardized for adult Indian population

(Swamalatha, 1972) were employed to construct the SSW list. Each list consisted of twentyfive spondiac words. These spondiae words were chosen from the W-l and W-2 word lists. The PB word list standardized for Indian population (Swamalatha, 1972) was used to establish word discrimination scores. The PB words for this list were chosen from the W-22 word list.

The staggered spondiae word test-list consisted of twenty four items. One of the justifications for using twenty four sets of items is that, for Indian population only fifty spondiae words have been standardized!. Thus employing these fifty spondiae words, only twenty five pairs of spondees are possible avoiding repetition of a spondiac word. Consequently, twenty four sets of spondees can only be borrowed for constructing the SSW test list, because in this test equal number of items are given both for right ear leading and left ear leading conditions. If twenty five sets of spondees are made use of, then one of the ears will be getting one set more Hence, in order to counteract this limitation only twenty four sets have been taken avoiding repetition of a spondiac word.

Furthermore, it has been observed that a SSW teat list consisting of twenty five items is just about enough for most cases (Katz, 1972).

Moreover, by adopting twenty four items the test becomes more brief, i.e., about ten minutes ana hence the chances of patient's fatigue biasing the test score, is less. As the performance on the SSW test may need deep concentration on the part of the subject it may be more fatiguing to the subject if the test becomes lengthy. Thus it may be possible to get scores reliably and also without much Affecting the validity of the test by employing only twenty four items. A study by Myrick (1965) where he used twenty SSW items, provide further support to this.

Equipment and Test environment:

A calibrated diagnostic speech audiometer which satisfies the ASA criteria of essential elements of speech Audiometer (Arphi, Model II 700) and UHER Variocord, four-tract, stereo tape recorder were used in this study. Since the audiometer used had only one input for tape, it was modified at the All India Institute of Speech and Hearing, Mysore. The output of the stereo tape recorder served as the input for the audiometer. One channel of the stereo tape recorder was fed to the audiometer via the tape input provision in the audiometer, and a provision was made to feed the second channel of the stereo tape recorder.

TABLE: 4

Sound pressure levels in the sound treated room at various frequencies

Sl. No.	Central freq. of the octave havd in Hz	SPL values in the test room in dB re; 0.0002 dyn/cm^2	ISO specifications SPL values in audis metric rooms re: 0.0002 dynes/cm^2
1.	125	28	31
2.	250	22	25
3.	500	25	26
4.	1000	22	30
5.	2000	20	38
6.	4000	18	51
7.	8000	16	51

T A B L E - 4 (A)

Sound pressure levels in the sound treated room using weighted scale.

Sl. No.	Scale.	SPL. Values Re: 0.0002 Dynes cm^2
1.	A	24 dB
2.	B	34 dB
3.	C	36 dB

The audiometer was calibrated using Bruel and Kjaer equipment (artificial ear - B & K type 4152, SPL meter - B & K type 2203, Octave filter B & K type 1613 and pre amplifier B & K type) in a sound treated room. A talk-back system was used for the subject's responses. The scale of hearing level attenuator of the audiometer varied from -10 to +100dB on one dial and 0 to +100 dB on the other dial. Howover this discrepancy was not found to be disadvantageous during the study. The audiometer was provided with TDH 39 ear phones with MAX 41 ear muffs.

The study was conducted in sound-treated environment. The audiometric room was located in an area away from the noisy localities. Table 4 gives the noise levels in the testroom measured by B & K SPL meter type 2203 with a B & K Octave filter set-1613.

Audiologic Proceedures

a. Pure tone average;

The thresholds at 500 Hz, l000Hz and 2000Hz were obtained by adopting the Hughson-Westlake's method of determining AC pure tone thresholds. The average of the thresholds at these three frequencies was taken as the pure tone average.

b. Discrimination Score:

1.Administration:

All subjects were given the PB word list standardized for Indian population. In order to reach PB maximum score, the words were presented at 40 4B Sensation level.

2. Instruction

Subjects were instructed as follows: "Now" you are going to hear a list of words. Every word is preceded by a phrase "Say the word". Do not repeat this phrase but repeat the word that follows it. If the word is not clear to you guess what it is and repeat it. These will all be common English words such as 'chair' or 'book'."

3. Recording responses:

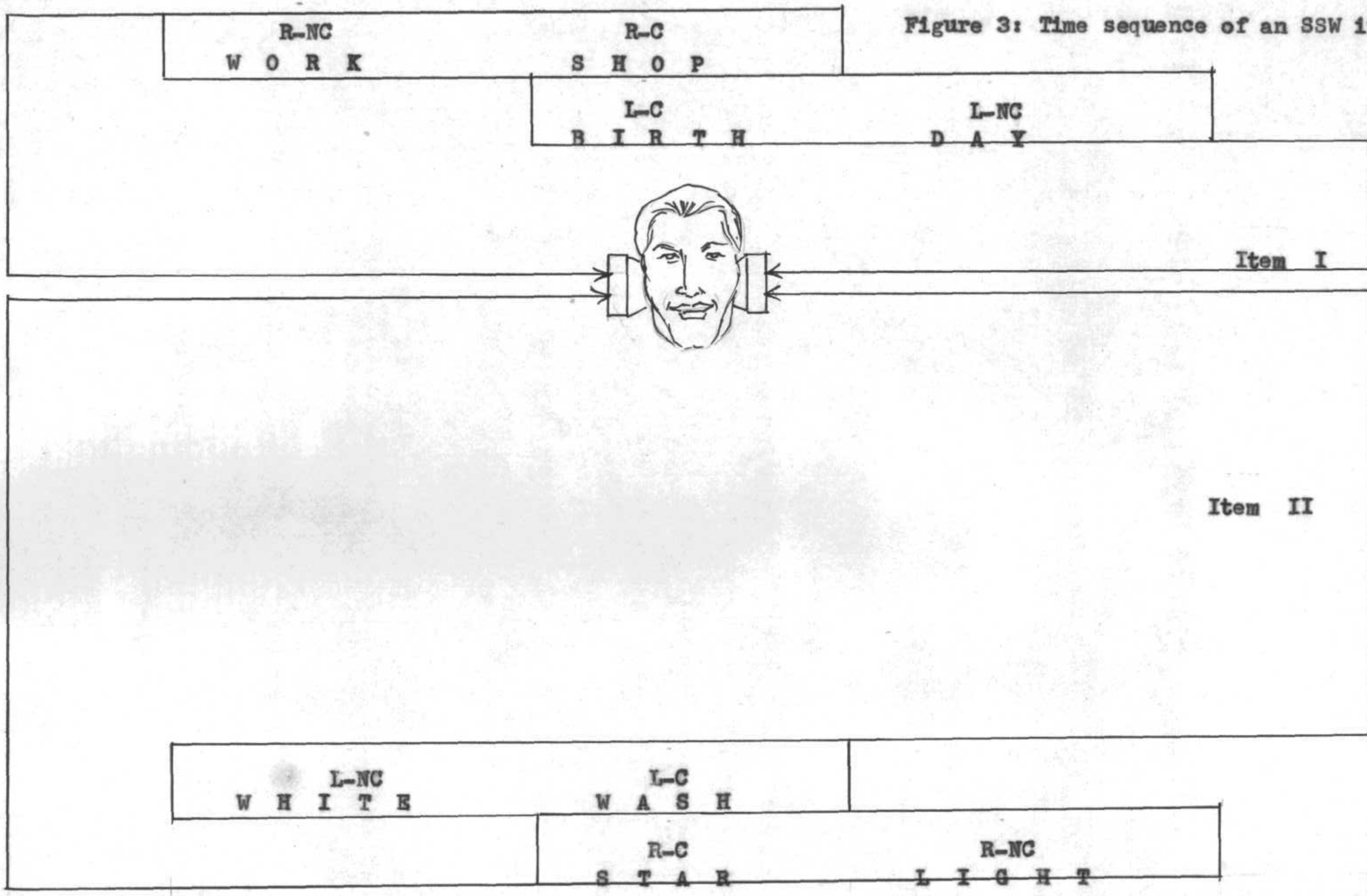
Using the talk-back system, all errors were recorded and a percentage score for correct responses was obtained.

C. Staggered Spondiac Word Test:

a) administration:

A list consisting of twenty fear items was presented by means of a two-track stereophonic recording of spondiac words. Each subject heard the whole list which represented ninetysix monosyllables. Each item was introduced by the carrier phrase,

Figure 3: Time sequence of an SSW item



"Are you ready?". The carrier phrase was heard in the ear which was to receive the initial word. Items were arranged so that the ear getting the first word was alternated. A diagram of the time sequence is shown ia Figure 3. It can be seen in this figure that each ear receives stimulation in isolation aa well aa in competition with the other. For example "Work" is heard as a right non competing (R-NC) condition while "shop" and "Birth" are heard as right competing (R-C) and left competing (L-C) conditions, respectively. Finally "Day" is heard as the left non competing (L-NC) condition. As illustrated, the ear stimulated first changes from item to item. Attempt was done during the construction of the items, to pair the test words in such a way that the non-competing words formed yet a third meaningful word as "Work day". Subjects were required to repeat both spondee words, and a time gap of ten seconds was allowed between each item for the subject to respond.

The test was administered at 50 dB above the pure tone average. Katz' 1962 has pointed out that at 50 dB above SRT, the young normals had little or no difficulty.

Ten practice items consisting of spondiac words taken from the children spondee-list and which were not overlapped in time sequence were given prior to the twenty four item SSW test list. The subject was given the twenty four item SSW test list if the subject repeated five items correctly out of the ten items in the practice session. If the subject failed to repeat five items during the practice session, he was again given a practice session. However if the subject failed consistently on all the three practice sessions, than he was not taken up for the study.

b) Instructions

Subjects were instructed as follows:
"You are going to hear a group of words which will be presented to one or both of your ears. As soon as the group of words is completed I would like you to repeat them all back to me. If a word is not clear to you guess what it is and repeat it. Before each item you will hear the phrase "Are you ready?". Please do not repeat this phrase. But just repeat the group of words that follow it".

In order to confirm whether the subject had understood the instruction, he was asked a few questions regarding the work he had to do.

6. Recording Responses:

The first ear to which the stimuli was to be presented, was noted down on the form.

Items were totaled in five ways:

(i) Total monosyllables missed:- The total per centage of correct responses indicates an individual's overall success on this test. There were 48 possible errors for each ear.

(ii) Right ear non-competing errors(R-NC): These monosyllables were heard in the right ear when no stimulus was presented in the left ear. There were 24 possible errors on this.

(iii) Left ear Non-competing errors(L-NC): These monosyllables were heard in the left ear when no stimulus was presented in the right ear. There were 24 possible errors on this.

(iv) Right ear competing errors(RC): These words were heard in the right ear while simultaneously a monosyllable was heard in the left ear. There were 24 possible errors on this.

(v) Left ear competing errors(LC): These words were heard in the left ear while simultaneously a monosyllable was heard in the right ear. There were 24 possible errors on this.

All scores were corrected for discrimination scores obtained on the PB word list standardized far Indian population.

CHAPTER IV

RESULTS AND DISCUSSION

The sample tested in the present investigation consisted of thirty (30) males and thirty (30) females which constituted a large sample according to Garrett (1967). Majority of the subjects tested were college students. All the subjects were right-handed. However, no attempt was made in the present investigation to control the level of knowledge of English in the subjects and to match the subjects according to whether English was their "first language" or "second language" (Houston, 1972).

Appendix B presents the raw data for each group regarding the pure-tone average, PB word discrimination test. In addition it provides information regarding the *ge and sex of each subject. Appendix C,D,E and F present the raw data on the SSW test as well as the corrected SSW error scores.

The corrected SSW error score is designated as the per centage of error(SSW Score) minus the per centage of error in the discrimination test using the phonetically balanced words. A negative corrected error score indicates that the performance on the SSW test was even better than one would predict on the basis of his word discrimination score. A positive corrected SSW error score indicates that errors were made in excess of those predictable on the basis of word discrimination.

Test-retest reliability of the scores was verified in the following way:

The SSW test was administered to eighteen(18) (9 males and 9 females) randomly selected subjects from the original sample for a second time, one week after the first test. The results were compared with the results obtained during the first test. No significant differences were found in the total error score between the two findings. However, variation was seen in terms of the individual items on which errors were seen. This latter finding probably indicates that the subject is committing errors randomly on the test though his total error score is constant. The correlation coefficients obtained between the scores of two testings were 0.81 and 0.88 for males and females respectively. The obtained correlation coefficients were significant at 0.01 and 0.05 levels both in the cases of males and females.

The results of the present investigation were analyzed. Tables 5, 6, and 7 present the mean of the SSW error scores for each condition, each ear, and for the whole test. The results on the SSW list prepared in this investigation tend to support some of the previous SSW data obtained using other lists on American population.

TABLE: 5.

The mean C-SSW error scores and σ scores of males and females for all the eight conditions (all tha mean scores are expressed in percentages).

CONDITION	MALES		FEMALES	
	M	σ	M	σ
R-NC(A)	11.50	7.40	12.80	9.00
R-C(B)	20.00	6.15	21.12	8.85
L-C(C)	18.00	8.50	21.82	8.90
L-NC(D)	9.70	7.90	10.37	8.55
L.NC(E)	7.16	7.10	10.25	7.00
L-C(F)	17.65	10.80	19.61	10.20
R-C(G)	14.50	9.30	17.40	9.10
R-NC(H)	8.00	7.15	8.16	6.05

TABLE: 6

The C-SSW scores of the competing and non-competing conditions for right and left ears, the total C-SSW score of right ear, and left ear, total competing scores and total non-competing scores and lastly the total test score.

conditions	MALES	FEMALES
R-NC	9.75	10.22
R-C	17.25	19.76
L-C	17.82	20.71
L-NC	8.26	10.31
R-Ear Scroes	13.50	14.99
L-Ear Scroes	13.04	15.51
TOTAL NCN-COMPETING SCORE-	9.005	10.26
TOTAL COMPETING SCORE	17.53	20.23
TOTAL TEST SCORE	13.27	15.25

TABLE: 7.

The raw SSW scores of the competing and non-competing conditions for right and left ears, the total raw score of right and left ear, total non-competing, and total competing score and the total test score.

CONDITIONS	MALES	F3MALES
R-NC	10.15	11.80
R-C	19.30	21.35
L-C	20.35	23.30
L-NC	10.30	12.50
R-EAR SCORE	14.72	16.57
TOTAL NON-COMPETING SCORE	10.22	12.15
L-EAR SCORE	15.32	17.90
TOTAL COMPETING SCORE	19.82	22.32
TOTAL TEST SCORE	15.02	17.23

The first consideration of the present investigation was to establish the mean corrected SSW error scores for normal Indian listeners. Table 5 provides the results for this problem. Table 6 indicates the corrected SSW error scores for competing and non-competing conditions in right and left ear, the total corrected SSW error score for right and left ear and also indicates the total corrected SSW score.

In the present investigation the raw SSW error score was given less importance. This is because the raw SSW error score may be contaminated by peripheral distortion (Katz, 1968). But the test aims at quantifying the patient's difficulty at the central level. Consequently the SSW error score which is corrected for the peripheral distortion may be more informative than the raw SSW error score. However, table 7 indicates the competing and non-competing raw SSW error scores for right and left ear, and gives the raw SSW error scores for right and left ear; and furthermore it provides the total raw SSW error score.

It is obvious that the criterion based on total corrected SSW error score is more likely to sort out individuals with bilateral problems rather than those with unilateral or simply unilateral competing errors. For

TABLE : 8

Estimatian of the population mean for the male gronp.

CONDITIONS	S.E.M.	LEVEL OF CONFIDENCE	
		0.05	0.01
R-NC(A)	1.35	8.86 - 14.14	8.02 - 14.98
R-C(B)	l.12	17.81 - 22.19	17.ll- 22.89
L-C(c)	1.55	14.97 - 21.03	14.01 -21.99
L-NC(D)	1.44	6.88 - 12.52,	5.82 - 13.52
L-NC(E)	1.20	4.81 - 9.51	4.069-10.26
L-C(F)	1.96	13.81 -21.39	12.60 -22.70
R-C(G)	1.79	11.00 - 18.00	9.89 - 19.11
R-NC(H)	1.304	5.45 - 10.55	4.64-11-36

TABLE: 9.

Estimation of the popultion mean for the female group.

CONDITIONS	S.E.M.	LEVEL OF CONFIDENCE 0.05	LEVEL OF CONFIDENCE 0.01
R.NC(A)	1.64	9.07 - 15.49	8.05 -16.51
R-C(B)	1.61	17.34 - 24.90	16.15 - 26.09
L-C(C)	1.62	18.65 - 24.99	17.65 - 25.99
L-NC(D)	1.56	7.32 -13.42	6.35 - 14.39
L-NC(E)	1.27	7.74- 12.76	6.78 - 13.72
L-C(F)	1.86	15.97 -23.25	14.81 - 24.41
R-C(G)	1.59	14.15 - 20.65	13.12 - 21.68
R.NC(H)	1.104	6.19 - 10.13	5.56-10.76

this reason it would be important to have additional criteria which would cover abnormal SSW patterns of a unilateral nature. Consequently emphasis was given to all the eight conditions which comprise two R-NC conditions (A and H), two R-C conditions (B and G), two L-C conditions (C and E), and two L-NC conditions (D and E), apart from finding the ear score and the total test score. Table 5 provides the data regarding this. However, the values mentioned there are corrected SSW error scores.

The estimated range whithin which the population mean may lie at 0.05 and 0.01 levels of confidence are given in table 8 and 9.

An analysis of the response patterns indicated unique type of responses on particular SSW items. Generally, the responses emitted were 'text-book' for 'cook-book', 'plum-cake' for 'pan-cake' and'mid-wife' for 'mid-way', Of course; these responses were considered as errors. However, these responses can be explained since they probably differ qualitatively from the other types of responses. These typical responses probably indicate that knowledge of the lexical, semantic and syntactic rules of the language, which the listener already has, is influencing his present performance.

The SSW item is probably a "complex linguistic context' since the listener will be getting speech stimulii in a time sequence which staggers the words which are being presented. Hence, the performance in this "com-p-lex linguistic context" may be influenced by the ab-stractions of the linguistic rules on the part of the listener. Though the listener is being given the word 'pan-cake' in association with an other word to the opposite ear, he might be rounding it off to 'plum-cake This might be because of the greater probability of the word 'cake' preceded by the word 'plum' rather than by the word 'pan' (at least this may be true in the Indian situation). A similar thing might have happened with the words 'cook-book' and 'mid-way'.

The above analysis is probably supported by B. Malmberg (1967) who says:

> "... any act of perception is intimately tied up with the perceiver's background i.e. his anterior experience, his memory, and his attitudes"

Furthermore, the finding that a listener in the mode of perception has capabilities (with regard to discrimination and identification of the signal) that are governed almost entirely by the framework of linguistic segments and features that are at his disposal as the user of a particular language (Stevens and House, 1972), is in support of the above anatysis. Similarly Katz and Fodor (1964) write that in decoding an acoustic speech signal into a sequence of segments, a listener not only uses his knowledge Of relations between the sequences of phonemic segments and the resulting acoustic signal, but also his knowledge of the phonological and syntactic rules, the lexicon, and the semantic rules of the language.

Thus from an analysis of the errors using the 'Analysis by Synthesis' model given by Stevens and Halle (1967), which involves a process of specifying an unknown sign in terms of the best match selection from a standard inventory, it may be possible to explain these unique error responses observed in tha normal Indian listeners in the present investigation.

In 1965 when Jack Katz finalized the forty item clinical version of the SSW list EC, he found that on some words the rate of error was high for normals and also they appeared relatively unfamiliar. However such things have also been found in the present investigation. Subjects had the greatest difficulty on some items. For example, the rate of errors was high on the item 'although-farewell' and also on the item 'outlaw-cargo'. Probably this is either due to the unprobable nature of these words appearing on a test such as this, or, indeed, the words may not appear in the vocabulary of the subjects.

In a normative study done by Turner (1966) on the American population, the normal performance on the SSW test is taken as 5% or fewer errors on the non-competing condition. Acc-ording to Katz (1968) normals got a total score of 5%, ear score of 10% and condition score of 15%. However in the present investigation the total mean corrected SSW error scores were 15.25% and 13.27% for females and males respectively. Males obtained a mean corrected SSW error score of 9.005% on the non-competing condition and a mean corrected SSW error score of 17.53% on the competing condition. The female group got a corrected error score of 10.28% and 20.23% for non-competing and competing conditions respectively.

The second consideration of the present investigation was to investigate pattern effect on the

SSW test. The Wilcoxon Matched Pairs Signed Ranks lest, was used in the present investigation to test the null hypothesis formulated for this problem. The two patterns employed in the present investigation are:

Pattern I : R-NC(A) R-C(B) L-C(c) L-NC(D)
Pattern II : L-NC(E) L-C(F) R-C(G) R-NC(H)

The null hypothesis was accepted at 0.01 level in all the four conditions indicating no pattern effect on each condition. However, the null hypothesis was rejected at 0.05 level for R-NC and R-C conditions. This was seen both in males and in females.

A wealth of studies on the dichotic listening tasks suggest an asymmetry between the ears with respect to the analysis of auditory input. Attempts have also been made to explain this. A substantial body of evidence indicates that two cerebral hemispheres in man are functionally asymeetrical with respect to the analysis of auditory input. Studies in patients with temporal lobectomy indicate that the left and right temporal Debes serve somewhat complementary functions, with the left temporal region primarily for the perception of speech sounds (Kimura, 1961), and the right temporal region primarily for identification of non-verbal characteristics such as tonal pattern and tonal quality (Milner, 1962 and Shaukweler) 1968).

Verbal material dichotically presented has been found to yield a higher score for the right ear (Kimura 1961), whereas some dichotically presented non-verbal material, yields a higher score for the left ear (Kimura, 1964 and Curry, 1967).

The explanation offered for the dichotic phenomena is that when a stimulus is presented binaurally and simultaneously, it is more efficiently transmitted along with the crossed pathway to the contralateral hemisphere (Kimura, 1967). Thus verbal material presented to the right ear is more efficiently conveyed to the left hemisphere (in which speech sounds are analyzed) than is verbal material presented to the left ear.

The above findings are suggestive of laterality effect on SSW test since the test has similarity with the dichotic listening experiments. Consequently, the third consideration of the present investigation was to investigate the laterality effect on SSW test. The Wilcoxon Matched Pairs Signed Ranks Test was used in the present investigation to test the null hypothesis formulated for this problem. The null hypothesis was accepted at 0.01 level both in males and females for all the conditions. However, in females the null hypothesis

Table -10

The 'Z' values and the respective table values obtained when the Wilcoxon Matched pairs Sign Bank test was applied to test the statisbical significance of the difference between conditions. In All these cases except in Raw-C-SSW, the test was two tailed. But in the later case it was one tailed. Hence the table value has not been doubled in the later case.

was rejected at 0.05 level indicating significant difference at this level between L-C(F) and R-C(G) conditiona. Nevertheless, it can be tentatively said that laterality effect is absent on SSW test.

The above results on the laterality effect on SSW test are in accordance with the findings of Turner (l966), Katz (1968) Brunt and Goetzinger (1968) and Chapnick and Brunt (1970). In all these investigations no laterality effect was seen on SSW test. However, in a study by Chapnick and Brunt (1970), the results indicated laterality effect, i.e., right ear superiotity when filtered version of the SSW test was administered.

With the results of the present investigation in hand, and also having the findings of other studies, however, it may be said that the SSW test seems free of a clinically significant laterallty effect, except under conditions modified from the usual presentation.

Several factors may contribute to the SSW test's resistance to this effect. Most reports on dichotic listening utilize items in which all portions of the verbal signal are overlapped in time. In contrast, on the SSW test for each item, one ear always leads in the time of stimulation. This may allow the listener to batter separate the spondiae words, and this way be reflected in the subject's questioning whether any portion of the items are competing. Apart from item formation, correct responses are facilitated by word association as the two monosyllables of each spondiac word, are highly associated, This may be related to the lack of ear laterality en the SSW test.

The fourth consideration of the present investigation was to find out the sex differences on the SSW test. The Mann-Whitney U Test, was used in the present investigation to test the null hypothesis formulated for this problem. The null hypothesis waa accepted at 0.01 level in all the conditions indicating statistically insignificant difference in the performance between males and females. The null hypothesis was rejected at 0.05 level for L-C (C) condition only. However, with the available data it can be said that sex differences are insignificant on the SSW test.

The fifth consideration of the present investigation was to establish the type of errors which were apparent in the case of normals. The type of errors consisted of omissions and substitutions. The Wilcoxon

TABLE: 11.

The 'Z' values and the respective table values obtained when the Manuwhitney U test was Applied to test the statiatical significance of the difference between males and females in all the conditions. In all the canditions the test was two tailed. Hence the table values have been doubled.

	Z VALUE	TABLE VALUE
R-NC(A)	O	1.0000
R-C(B)	-0.58	0.5620
L-C(C)	-2.16	0.0300
L-NC(D)	-0.50	0.6160
L-NC(E)	-1.69	0.0910
L-C(F)	-0.49	0.6242
R-C(G)	-0.74	0.4592
R-NC(H)	-0.40	0.6892

Matched Pairs Signed Rank Test was used in the present investigation to test the null hypothesis formulated for this problem. The null hypothesis was accepted at 0.01 level and also at 0.05 level in all the conditions both in the case of males and females.

However, the most apparent response bias Seen in the present investigation, was reversal and partial reversal and the other types of response-biases were either absent or if present, were insignificant. Probably the reversal responses are due to the influence of the instructions which were given to the subject apart from the standard instructions. The subjects were instructed that they can repeat the spondiac words which they heard in any order and they were also told that they will not be penalized for any change in the original order. Probably, this instruction might have influenced the subject's performance and that the subject might have become less curious, as far the order of presentation was concerned, in his attempt to repeat both the spondees correctly.

The Wilcoxon Matched Pairs Signed Ranks Test was used in the present investigation to test statistical significance of the difference between raw SSW scores and

T ABL E-12.

The 'Z' values and the respective table values obtained when the Wilcoxon matched pairs sign rank test was applied to test the statistical significance of the difference between substitutions and omissions. In all the conditions the test was two tailed. Hence the table values have been doubled.

	MALES		FEMALES	
	Z Score	Table Value	Z Score	Table Value
R - NL(A)	-1.94	0.0524	-0.18	0.8572
R - L (B)	-1.12	0.2628	-1.35	0.1770
L - L (C)	-1.65	0.0990	-1.07	0.2846
L - NL(D)	-0.52	0.6030	-0.91	0.3628
L - NL(E)	-0.89	0.3734	-1.02	0.3078
L - L (F)	-0.56	0.5754	-0.64	0.5222
R - L (G)	-0.57	0.5686	-0.97	0.3320
R - NL(H)	-1.48	0.1388	-0.61	0.5418

corrected SSW error scores. The null hypothesis was tested against the hypothesis that raw SSW error scores are higher than corrected SSW error scores How ever,both in the case of males and females the null hypothesis was rejected at 0.01 and 0.05 levels confirming the hypothesis that the total raw SSW error scores are higher than the total corrected SSW error scores.

Similarly using the Wilcoxon Matched Pairs Signed Ranks Test the stastical significance of the diffe-Pence between competing and non-competing conditions, was determined. The null hypothesis was tested against the hypothesis that competing scores are higher than the non-competing scores. However, both in case of males and females the null hypothesis was rejected at 0.01 and 0.05 levels confirming the alternative hypothesis. This finding is in accordance with the results of other stu-dies on SSW test. Probably this finding is of little diagnostic significance except to underscore the proba-bility that most errors will be made in the competing conditions when normal subjects are tested.

On an experimental basis the SSW test tape prepared in the present investigation, was administered on three cases who had reported at the AIISH clinic either with the complaint of hearing loss or speech defect.

The case, X, a male aged 28 years reported to the AIISH clinic with the complaint of speech defect and hearing loss. The following data was obtained through case history

The case sustained head injury at the age of fiteen due to motor cycle accident. At that time there was profuse bleeding from nose and ears and the case was unconscious for three days. It was also reported that since then the case had developed hearing loss in both the ears and speech defect. Regarding his speech defect it was complained by the case that he could not make fast movements of his articulators.

The following are the findings obtained on examination at the AIISH clinic:

	R	L
P T A	50	68
S R T	55	75
W D S	95%	80%
W D L	5%	20%

Other audiological special tests were not administered as the case did not return for further testing.

Inference:

Bilateral Mixed Hearing Loss

Speech evaluation report:

Slurring speech.

There was nothing significant in the other examinations.

SSW Test Data:

The following is the data obtained on this patient when the Staggered Spondiac Word test prepared in the present investigation was administered:

	R-NC A	R-C B	L-C C	L-NC D	L-NC E	L-C F	R-C G	R-NC H
Raw	74.97	74.97	74.97	74.97	91.63	91.63	58.31	49.98
3-SSW	69.97	69.97	54.97	54.97	71.63	71.63	53.31	44.98
Total errors	9	9	9	9	11	11	7	6
Substitutions	1	1	0	0	0	0	1	0
Omissions.	8	8	9	9	11	11	6	6

All the scores are expressed in percentage .

Mean of R-NC	Mean of R-C	Mean of L-C	Mean of L-NC
57.47%	61.64%	63.30%	63.30%

Right ear Score	Left ear Score
59.55%	63.30%

Competing Score	Non-competing Score
- 62.47%	60.38%

Total score

61.42%

It may be argued in this case that the number of error responses have increased because of the patient's speech defect since talk-back system was employed in the present investigation. Though this is a possibility its chances are fewer, because, the analysis of the patient's responses show that out of the 71. error responses, 68 error responses were omissions and the remaining 3 error responses were substitutions. Consequently the chances of the patient's speech defect influencing the SSW error scores are very few, because the error may be committed only on 3 responses and not on others since they are omissions. Out of the 96 monosyllables presented, the patient repeated only 25 monosyllables correctly, omitted 68 monosyllables and substituted 3 monosyllables. Eight partial reversals were seen and other response biases were absent.

An interesting finding in this case is that though the test is administered at 30dB SL for left ear and at 50dB SL for right ear, the corrected SSW scores of right and left ears is almost equal with a small difference of 3.75%. This finding seems to go with the finding of Balas and Simon (1965) where the authors reported insignificant difference in the test performance on SSW test when the test was administered at 50dB SL and at 30dB SL.

The ease, Y, a male aged 22 years reported to the AIISH clinic with the complaint of speech defect. The following are the findings obtained on examination at the AIISH clinic:

Audiological Report

	R	L
P T A	28dB	32 dB
S R T	25dB	30 dB
W D S	88%	88%
W D L	12%	12%

Inference:

Bilateral Sensory Neural Hearing Loss

Speech Evaluation:

Speech is jerky, arythmic and explosive cerebellar type.

Neurological Evaluations:

I Higher functions normal

II. Dysarthria: Often staccato type of speech
Occasionally stuttering present.

III. Cranial Nerves:

i) Paresis of the lateral rectus of the right eye. Involvement of right VI nerve,

ii) Involvement of VII nerve - torsion spasm present.

IV. Spinal Motor System:

i) Torsion spasm of the trunks and limbs occasionally present.

ii) In-coordination present in left upper and lower limbs. Rombergism is absent.

V. Spinal Sensory System:

Nil abnormal

VI. Reflexes:

Both superficial and deep within normal limits.

VII. Cerebellar System:

Cerebellar deficiency present particularly on the left side.

VIII. Diagnosis: Dystonia musculoram defarmans
Cerebellar degeneration; Basal nuclear lesion; Post Kernicteric sequealle.

SSW Test Data:

The following is the data obtained on this patient when the SSW test prepared in the present investigation was administered:

	R-NC A	R-C B	L-C C	L-NC D	L-NC E	L-C F	R-C G	R-NC H
Raw score	58.31	66.64	49.98	33.32	41.65	49.98	41.65	33.32
C-SSW	46.31	54.64	37.98	21.32	29.65	37.98	29.65	21.32
Total error	7	8	6	4	5	6	5	4
Substitutions	6	7	3	3	5	6	5	4
Omissions.	1	1	3	1	0	0	0	0

All the scores are expressed in percentage .

Mean of R-NC	Mean of R- C	Mean of L-C	Mean of L-NC
33.81%	42.14%	37.98%	25.49%

Right ear score	Left ear score
37.97%	31.23%

Non-competing score	Competing score
29.64%	40.06%

Total score

34.10%

In order to confirm that the obtained results are not influenced by the patient's speech defect, the patient was asked to repeat as well as write what he heard. Since there was agreement between the two types of responses, the obtained results were taken as reliable measures.

The ease, Z, a male aged 19 years reported to the AIISH clinic with the complaint of hearing loss. The following are the findings obtained after examination at the AIISH clinic:

Audiological report:

	R	L
P T A	50 dB	75dB
S R T	50 dB	85 dB
W D S	85% at 40dB SL	85% at 25dB SL
W D L	15%	15 %

Inference:

Moderate Sensory Neural Hearing loss of the Tight ear and severe Mixed Loss in the left ear.

No significant findings were reported in the other examinations.

SSW Test Data:

The following is the data obtained on this patient when the SSW test prepared in the present investigation was administered.

	R-NC A	R-C B	L-C C	L-NC D	L-NC E	L-C F	R-C G	R-NC H
Raw score	24.49	49.98	41.65	16.66	8.33	33.32	16.66	16.66
C-SSW	9.99	34.98	26.65	1.66	-6.27	18.32	1.66	1.66
Total error	3	6	5	2	1	4	2	2
Substi-tutions	0	2	3	0	0	3	0	0
Omissi-ons	3	4	2	2	1	1	2	2

All the scores are expressed in percentage

R-NC	R-C	L-C	L-NC
6.85%	18.32%	22.48%	-2.3%

Right ear score	Left ear score
12.08%	10.09%

Competing	Non-competing
20.40%	1.77%

Total score

11.08%

TABLE - 13

COrrected ssw error ScoreS of normal males, normal females, Case X, Case Y and case Z.

	Normal Males	Normal Females	Case X	Case Y	Case Z
R-NC	9.75	10.22	57.47	33.81	5.85
R - C	17.25	19.76	61.64	42.14	13.32
L -C	17.82	20.71	63.30	37.98	22.48
L-NC	3.26	10.31	63.30	25.48	-2.3
N- C	9.005	10.26	60.38	29.64	1.77
C	17.33	20.23	62.47	40.06	20.40
R	13.50	14.99	39.55	37.97	12.03
L	13.04	15.51	63.30	31.23	10.09
TOTAL	13.27	15.25	61.42	34.10	11.08

In this case the "ear effect" seems to be operating because during the right ear leading conditions, the case made 16 error responses, and however, in left ear leading conditions he made 9 error responses.

Table 13 - gives the corrected SSW error scores of these patients and the corrected SSW error scores of the normal males and normal females.

CHAPTER V

Summary and Conclusions

Staggered Spondiac Word test tape was prepared in English for Indian population employing the spondees standardized for Indian population. The test was administered on sixty normal Indian listeners (30 males and 30 females) in the age range of 16 to 29 years. From the results obtained the following conclusions are tenable:

1. The mean of the corrected SSW error scores were 9.75%, 17.25%, 17.82% and 8.26% for R-NC, R-C, L-C, and L-NC conditions respectively in males.

8. The mean of the corrected SSW error scores were 10.26%, 19.76%, 20.71% and 10.31% for R-NC, R-C, L-C and L-NC conditions respectively in females.

3. The total ear scores for right and left ears were 13.50% and 13.04% respectively in males, and, 34.99% and 15.51% reapectively in females. All the scores were corrected SSW error scores.

4. The mean of the corrected non-competing error scores were 9.0005% and 10.26% for males and females respectively.

5. The mean of the corrected competing error scores were 17.53% and 20.23% for males and females respectively.

6. The total corrected test scores were 13.27% and 15.25% for males and females respectively.

7. The performance of normal Indian listeners on the SSW test list prepared in the present investigation is considered 10.26% or fewer errors on the non-competing conditions and 20,23% or fewer errors on the competing conditions. Both the scores are corrected error scores.

8. Normative data for this does not apply to groups of children below 16 years.

9. Pattern effect on the individual items was statistically insignificant at 0.01 level.

10. Sex differences on the SSW test were statistically insignificant.

11. Laterality effect on the SSW test was not satistically significant.

12. The frequency of appearance of substitutions and omissions were same in all the conditions.

13. There was significant difference between total raw SSW error scores and the total corrected SSW error score at 0.01 and 0.05 levels.

14. The most apparent response biases observed were reveraal and partial reversal. Other response biases were either absent or insignificant.

Implications of the Study;

As the manifestationsof central auditory disorders are subtle and as they cannot be disclosed by the usually employed battery of tests, Staggered Spondiac word test employing the SSW test tape prepared in the present investigation can be administered routinely as a test for the detection of central auditory disorders. The brevity of the test tape (about ten minutes) further helps the clinician to use the test routinely in the test battery.

Limitations of the present study:

1. In the present investigation, subjects were not matched according to whether English was their "first language" or "second language".

2. Subjects were not matched for intelligence quotient.

3. No attempt was made to control the level of knowledge of English in the subjects.

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Suggestions for further Research:

1. Attempt may be made to reconstruct the SSW list by deleting certain items which have been found to be more difficult for the normal listeners An the present investigation.

2. Norms may be established for central auditory disorder group.

3. Further work on standardization of the test could be carried out.

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APPENDICES

A P P E N D I X 'A'

Staggered Spondiac Word List (S S W List)

	A	B	C	D
	R-NC	R-C	L-C	L-NC
1	Work	Shop	Birth	Day
3	Black	Board	Mush	Room
5	Al	Though	Fare	Well
7	Life	Boat	Door	Step
9	Out	Law	Car	Go
11	Car	Drum	Head	Light
13	Black	Out	Pan	Cake
15	Wood	Work	Tooth	Brush
17	Eye	Brow	Cough	Drop
19	Grand	Son	Air	Plane
21	Horse	Shoe	Door	Step
23	Door	Mat	Pad	Lock

	E	F	G	H
	L-NC	L-C	R-C	R-NC
2	White	Wash	Star	Light
4	Day	Break	House	Work
6	Out	Side	Sun	Set
8	Hard	Ware	Earth	Quake
10	Rail	Road	Play	Mate
12	Ship	Wreck	School	Boy
14	Back	Bone	Yard	Stick
16	There	Fore	Mid	Way
18	Cow	Boy	Plat	Form
20	North	West	Stair	Way
22	Play	Ground	Cook	Book

Continuation of Appendix 'A'

	A	B	C	D
	R-NC	R-C	L-C	L-NC
23	Door	Mat	Pad	Lock

	E	F	G	H
	L-NC	L-C	R-C	R-NC
24	Arm	Chair	Watch	Word

APPENDIX-B

Subject's Sex, Ages, Handedness, Pure Tone Average and PB - word discrimination Score.

Sl. No.	Sex	age	Handed ness	PTA		WDS	
				R	L	R	L
1.	F	21	R	20.00	15.00	92	100
2.	F	19	R	15.00	15.00	92	92
3.	F	18	R	10.00	10.00	92	96
4.	F	20	R	1.66	1.66	92	96
5.	F	29	R	8.33	8.33	100	100
6.	F	28	R	6.66	6.66	100	100
7.	F	21½	R	15.00	11.66	88	88
8.	F	18	R	5.00	10.00	100	100
9.	F	19	R	5.00	15.00	96	92
10.	F	21	R	8.33	5.00	100	100
11.	F	23	R	3.33	8.33	92	100
12.	F	24	R	6.66	13.33	100	100
13.	F	20	R	16.66	18.33	100	100
14.	F	20	R	20.00	20.00	100	100
15.	F	20	R	0.00	15.00	100	96
16.	F	18	R	11.66	6.66	96	96
17.	F	20	R	18.33	8.33	96	96
18.	F	19	R	20.00	2.00	100	100
19.	F	21	R	5.00	10.00	100	100
20.	F	24	R	13.33	13.33	100	100

Appendix B contd.

Sl. No.	Sex	Age	Handed ness	PTA R	PTA L	WDS R	WDS L
21.	F	21	R	11.33	10.00	100	96
22.	F	20	R	11.66	13.33	96	96
23.	F	18	R	18.33	18.33	100	100
24.	F	19	R	10.00	13.33	100	100
25.	F	18	R	13.33	13.33	100	100
26.	F	21	R	5.00	13.66	100	100
27.	F	20	R	0.00	5.00	100	100
28.	F	20	R	5.00	6.66	100	100
29.	F	19	R	10.00	3.33	100	100
30.	F	16	R	3.33	1.66	100	100
31.	M	21	R	1.66	0.00	100	100
32.	M	21	R	8.33	11.33	96	96
33.	M	20	R	16.66	16.66	100	100
34.	M	23	R	5.00	6.66	92	92
35.	M	19	R	8.66	10.00	100	100
36.	M	29	R	5.00	5.00	100	96
37.	M	24	R	15.00	13.33	100	100
38.	M	23	R	11.66	0.00	100	100
39.	M	25	R	11.33	10.00	96	96
40.	M	20	R	8.33	5.00	100	100

Appendix B contd.

Sl. No.	Sex	Age	Handed ness	PTA		WDS	
				R	L	R	L
41.	M	19	R	8.33	6.66	96	100
42.	M	19	R	5.00	1.66	100	100
43.	M	17½	R	6.66	6.66	96	96
44.	M	20	R	15.00	13.33	96	100
45.	M	18	R	6.66	3.33	92	100
46.	M	20	R	8.33	11.66	92	88
47.	M	19	R	20.00	15.00	100	100
48.	M	20	R	8.33	11.33	92	92
49.	M	17	R	15.00	8.33	92	100
50.	M	19	R	8.66	6.66	96	96
51.	M	20	R	8.33	11.33	100	100
52.	M	21	R	15.00	15.00	100	100
53.	M	19	R	5.00	5.00	100	100
54.	M	24	R	8.33	8.33	100	100
55.	M	22	R	11.33	15.00	100	100
56.	M	28	R	16.66	8.33	100	100
57.	M	17½	R	10.00	13.33	100	100
58.	M	173/4	R	1.66	5.00	100	100
59.	M	25	R	13.33	3.33	100	100
60.	M	21	R	10.00	15.00	96	92

APPENDIX - C

Raw SSW errors scores for each conditions.

Sl. No. 1-30 gives the scores of females subjects .

Sl. No. 31-60 gives the scores of male subjects

	RNC	RC	LC	LNC	LNC	LC	RC	RNC
Sl. No	A	B	C	D	E	F	G	H
1.	16.66	24.99	49.98	33.32	33.32	49.98	24.99	16.66
2.	16.66	24.99	41.65	33.32	33.32	41.65	24.99	16.66
3.	16.66	24.99	33.32	1.33	8.33	24.99	33.32	16.66
4.	16.66	24.99	24.99	8.33	8.33	8.33	16.66	8.33
5.	3.33	33.32	24.99	8.33	8.33	33.32	16.66	0,00
6.	16.66	24.99	24.99	16.66	16.66	24.99	24.99	16.64
7.	33.32	41.63	41.65	41.65	24.99	33.32	33.32	33.32
8.	16.66	24.99	24.99	8.33	8.33	24.99	24.99	8.33
9.	8.33	24.99	24.99	16.66	16.66	24.99	24.99	16.66
10.	a.33	24.99	24.99	3.33	8.33	24.99	24.99	8.33
11.	24.99	41.65	16.66	8.33	8.33	16.66	8.33	8.33
12.	16.66	16.66	8.33	8.33	8.33	8.33	8.33	0.00
13.	8.33	8.33	8.33	8.33	8.33	24.99	16.64	8.33
14.	16.66	16.66	24.99	8.33	0.00	8.33	8.33	8.33
15.	8.33	16.66	24.99	16.66	8.33	16.66	16.66	8.33
16.	16.66	33.32	33.32	16.66	24.99	41.65	41.65	24.99
17.	8.33	33.32	24.99	16.66	16.66	16.66	8.33	16.66
18.	8.33	16.66	16.66	8.33	8.33	16.66	16.66	8.33
19.	16.66	24.99	24.99	16.66	0.00	8.33	8.33	0.00
20	33.32	33.32	33.32	16.66	24.99	33.32	33.32	0.00

	RNC	RC	LC	LNC	LNC	LC	RC	RNC
Sl. No	A	B	C	D	E	F	G	H
21.	16.66	16.66	24.99	24.99	16.66	16.66	8.33	8.33
22.	24.99	49.93	41.65	16.66	24.99	33.32	24.99	8.33
23.	24.99	24.99	24.99	24.99	16.66	24.99	24.99	34.66
24.	8.33	16.66	16.66	8.33	8.33	16.66	16.66	8.33
25.	16.66	16.66	16.66	16.66	8.33	24.99	24.99	16.46
26.	0.00	3.33	8.33	0.00	0.00	8.33	8.33	0.03
27.	8.33	16.66	16.66	8.33	8.33	16.66	16.66	8.33
28.	8.33	8.33	8.33	8.33	8.33	16.66	8.33	8.33
29.	8.33	16.66	24.99	8.33	0.00	0.00	8.33	0.00
30.	0.00	8.33	8.33	0.00	8.33	16.66	8.33	8.33
31	16.66	24.99	16.66	0.90	0.00	16.66	16.66	0.03
32.	8.33	16.66	16.66	8.33	8.33	24.99	16.66	8.33
33.	24.99	33.32	33.32	24.99	24.99	33.32	33.32	16.66
34.	16.66	24.99	24.99	8.33	16.66	24.99	24.99	16.66
35.	24.99	33.32	16.66	8.33	24.99	33.32	33.32	16.66
36.	8.33	24.99	33.32	8.33	8.33	16.66	16.66	8.33
37.	0.00	8.33	8.33	0.00	0.00	8.33	0.00	0.00
38.	8.33	16.66	16.66	16.66	0.00	16.66	8.33	0.00
39.	24.99	33.32	33.32	16.66	8.33	93.32	24.99	16.66
40.	16.66	16.66	16.66	16.66	24.99	33.32	16.66	16.66

	RNC	RC	LC	LNC	LNC	LC	RC	RNC
Sl. No.	A	B	C	D	E	F	G	H
41.	8.33	3.33	3.33	0.00	0.00	16.66	16.66	8.33
42.	16.66	24.99	16.66	3.33	8.33	24.99	8.66	8.66
43.	16.66	33.32	16.66	8.33	8.33	16.66	16.66	16.66
44.	8.33	24.99	16.66	3.33	8.33	16.66	16.66	8.33
45.	16.66	16.66	16.66	8.33	0.00	8.33	16.66	8.33
46.	24.99	33.32	33.32	24.99	16.66	16.66	24.99	24.99
47.	16.66	16.66	8.33	8.33	8.33	8.33	24.99	8.33
48.	16.66	33.32	49.93	33.32	41.65	58.31	41.65	33.32
49.	16.66	16.66	16.66	16.66	8.33	16.66	33.32	16.66
50.	8.33	24.99	16.66	8.33	8.33	33.32	8.33	0.00
51.	8.33	3.33	16.66	0.00	0.00	0.00	0.00	0.00
52.	16.66	16.66	33.32	16.66	8.33	16.66	16.66	0.00
53.	16.66	16.66	16.66	8.33	8.33	24.99	16.66	8.33
54.	16.66	24.99	16.66	16.66	8.33	8.33	8.33	8.33
55.	16.66	33.32	16.66	16.66	8.33	24.99	24.99	16.66
56.	0.00	3.33	8.33	0.00	8.33	16.66	16.66	3.33
57.	8.33	24.99	24.99	16.66	8.33	16.66	16.66	8.33
58.	8.33	24.99	16.66	8.33	8.33	8.33	8.33	16.66
59.	3.33	16.66	24.99	16.66	8.33	8.33	8.33	8.33
60.	24.99	24.99	3.33	8.33	8.33	16.66	8.33	0.00

A P P E N D I X 'D'

Mean Raw SSW Error Score of R-NC, R-C, L-C & L-NC Conditions.

All the scores are expressed in percentage .

SSW - Test Score Sheet.

Sl. No.	RNC	RC	LC	LNC	LNC	LC	RC
	Mean of (A & H)	Mean of (B & G)	Mean of (C & F)	Mean of (D & E)	Rt. Ear Score	Lt. Ear Score	Total Score
1.	16.66	24.99	49.98	33.32	20.82	41.65	31.23
2.	16.66	24.99	41.65	33.32	20.82	37.48	29.15
3.	16.66	29.15	29.15	8.33	22.90	18.74	20.82
4.	12.49	20.82	16.66	8.33	16.65	12.49	14.57
5.	4.16	24.99	29.15	8.33	14.57	18.74	16.60
6.	16.66	24.99	24.99	16.66	20.82	20.82	20.82
7.	33.32	37.48	37.48	33.32	35.40	35.40	35.40
8.	12.49	24.99	24.99	8.33	18.74	16.66	17.70
9.	12.49	24.99	24.99	16.66	18.74	20.82	19.78
10.	8.33	24.99	24.99	8.33	16.66	16.66	16.66
11.	16.66	22.49	16.66	8.33	19.57	12.49	16.03
12.	8.33	12.49	8.33	8.33	10.41	8.33	9.37
13.	8.33	12.49	16.66	8.33	10.41	12.49	11.45
14.	12.49	12.49	16.66	4.16	12.49	10.41	11.45
15.	28.33	16.66	20.82	12.49	12.49	16.65	14.57
16.	20.82	37.48	37.48	20.82	29.15	29.15	29.15
17.	12.49	24.99	20.82	16.66	18.74	18.74	18.74
18.	8.33	16.66	16.66	8.33	12.49	12.49	12.49
19.	8.33	16.66	16.66	8.33	12.49	12.49	12.49
20.	16.66	33.32	33.32	20.82	24.99	27.07	26.03

Appendix : D contd.

Sl. No.	RNC	RC	LC	LNC	LNC	LC	RC
	Mean of (A & H)	Mean of (B & G)	Mean of (C & E)	Mean of (D & E)	Rt. Ear Score	Lt. Ear Score	Total Score
21.	12.49	12.49	20.82	20.82	12.49	20.82	16.60
22.	16.66	37.48	37.48	20.82	27.07	29.15	28.11
23.	20.82	24.99	24.99	20.82	27.90	22.90	25.40
24.	8.33	16.66	16.66	8.33	12.49	12.49	12.49
25.	16.66	20.82	20.82	12.49	18.74	16.65	17.69
26.	0.00	8.33	0.00	4.16	4.16	4.16	4.16
27.	8.33	16.66	16.66	8.33	12.49	12.49	12.49
28.	8.33	8.33	12.49	8.33	8.33	10.41	9.37
29.	4.16	12.49	12.49	4.16	8.32	8.32	8.32
30.	4.16	8.33	12.49	4.16	6.24	8.32	7.28
31.	8.33	20.82	16.66	0.00	14.57	8.33	11.95
32.	8.33	16.66	20.82	8.33	12.49	14.57	13.53
33.	20.82	33.32	33.32	24.99	27.07	26.03	26.55
34.	16.66	24.99	24.99	12.49	20.82	16.65	18.73
35.	20.82	33.32	24.99	16.66	27.07	21.86	24.46
36.	8.33	20.82	24.99	8.33	14.57	16.66	15.61
37.	0.00	4.16	8.33	0.00	2.08	4.16	3.12
38.	4.16	12.49	16.66	8.33	8.37	12.49	10.43
39.	20.82	29.15	33.32	12.49	24.98	22.90	23.94
40.	16.66	16.66	24.99	20.82	16.66	22.90	19.78

Appendix: D contd.

Sl. No.	RNC	RC	LC	LNC	LNC	LC	RC
	Mean of (A & H)	Mean of (B & G)	(Mean of (C & F)	(Mean of (D & E)	Rt.Ear Score	Lt.Ear Score	Total Score
41.	8.33	12.49	12.49	0.00	10.41	6.24	8.32
42.	12.66	16.82	20.82	8.33	14.74	14.57	14.65
43.	16.66	24.99	16.66	8.33	20.82	12.49	16.65
44.	8.33	20.82	16.66	8.33	14.57	12.49	13.53
45.	12.49	16.66	12.49	4.16	14.57	8.37	11.47
46.	24.99	29.15	24.99	20.82	27.07	22.90	24.98
47.	12.49	20.82	8.33	8.33	16.65	8.33	12.49
48.	24.99	37.48	54.14	37.48	31.28	45. 81	38.54
49.	16.66	24.99	16.66	12.49	20.82	14.57	17.69
50.	4.16	16.66	24.99	8.33	10.41	16.66	13.53
51.	4.16	4.16	8.33	0.00	4.16	4.16	4.16
52.	8.33	16.66	24.99	12.49	12.49	18.19	15.64
53.	12.49	16.66	20.82	8.33	14.57	14.57	14.57
54.	12.49	16.66	12.49	12.49	14.57	12.49	13.53
55.	16.66	29.15	20.82	12.49	22.90	16.65	19.77
56.	4.16	12.49	12.49	4.16	8.37	8.37	8.37
57.	8.33	20.82	20.82	12.49	14.57	16.65	15.61
58.	12.49	16.66	12.49	8.33	14.57	10.41	12.49
59.	8.33	8.33	16.66	12.99	8.33	14.57	11.85
60.	12.49	12.49	12.49	8.33	12.49	10.41	11.45

APPENDIX – E.

Corrected SSW error scores for each condition.

Sl.No. 1 -30 gives the scores of male subjects .

Sl.No. 31- 60 gives the scores of female subjects.

	RNC	RC	LC	LNC	LNC	LC	RC	RNC
Sl. No	A	B	C	D	E	F	G	H
1	16.66	24.99	16.66	0.00	0.00	16.66	16.66	0.00
2	4.33	12.66	12.66	4.33	4.33	20.99	12.66	4.33
3	24.99	33.32	33.32	24.99	24.99	32.32	33.32	16.66
4	S.66	16.99	16.99	0.33	8.66	16.99	16.99	8.66
5	24.99	33.32	12.66	4.33	20.99	29.32	33.32	16.66
6	1.33	24.99	29.32	4.33	4.33	12.66	16.66	6.33
7	0.00	8.33	8.33	0.00	0.00	6.33	0.00	0.00
8	8.33	16.66	16.66	16.66	0.00	16.66	6.33	0.00
9	20.99	29.32	29.32	32.66	4.33	29.32	20.99	12.66
10	16.66	16.66	16.66	16.66	24.99	33.32	16.66	16.66
11.	4.33	4.32	8.33	0.00	0.00	16.66	12.66	4.33
12	16.66	24.99	16.66	8.33	8.33	24.99	8.66	8.66
13	12.66	29.32	12.66	4.33	4.33	12.66	12.66	12.66
14.	4.33	20.99	16.66	8.33	8.33	16.66	12.66	4.33
15	3.66	8.66	16.66	8.33	0.00	8.33	8.66	0.33
16.	16.99	25.32	21.32	12.99	4.66	4.66	16.99	16.99
17.	16.66	16.66	8.33	8.33	8.33	8.33	24.99	8.33
18.	8.66	25.32	41.98	25.32	33.65	50.31	33.65	25.32
19.	8.66	8.66	16.66	16.66	8.33	16.66	25.32	8.66
20.	4.33	20.99	12.66	4.33	4.33	29.32	4.33	-4.00

Appendix: E contd.

	RNC	RC	LC	LNC	LNC	LC	RC	RNC
Sl. No.	A	B	C	D	E	F	G	H
21	6.33	8.33	16.66	0.00	0.00	0.00	0.00	0.00
22.	16.66	16.66	33.32	16.66	8.33	16.66	16.66	0.00
23.	16.66	16.66	16.66	8.33	8.33	24.99	16.66	8.33
24	16.66	24.99	16.66	16.66	8.33	6.33	8.33	8.33
25	16.66	33.32	16.66	16.66	6.33	24.99	24.99	16.66
26	0.00	8.33	8.33	0.00	8.33	16.66	16.66	6.33
27	8.33	24.99	24.99	16.66	8.33	16.66	16.64	3.33
28	8.33	24.99	16.66	6.33	8.33	6.33	6.33	16.66
29	8.33	16.66	24.99	16.66	8.33	8.33	6.33	8.3
30	20.99	30.99	0.33	0.33	0.33	6.66	4.33	-4.00
31.	8.66	16.99	49.98	33.32	33.32	49.98	16.99	8.66
32.	8.66	16.99	33.65	25.32	25.32	33.65	16.99	6.66
33.	8.66	16.99	29.32	4.33	4.33	20.99	23.32	6.66
34.	8.66	16.99	20.99	4.33	4.33	4.33	8.66	0.33
35.	8.33	33.32	24.99	8.33	8.33	33.32	16.66	0.00
36.	16.66	24.99	24.99	16.66	16.66	24.99	24.99	16.66
37.	21.32	29.65	29.65	29.65	12.99	21.32	21.32	21.32
38.	16.66	24.99	24.99	8.33	8.33	24.99	24.99	8.33
39.	4.33	20.99	16.99	8.66	8.66	16.99	20.99	12.66
40.	8.33	24.99	24.99	8.33	6.33	24.99	24.99	6.33

	RNC	RC	LC	LNC	LNC	LC	RC	RNC
Sl. Wo.	A	B	C	D	E	F	G	H
41	16.99	33.65	16.66	8.33	8.33	16.66	0.33	0.33
42	16.66	16.66	8.33	8.33	8.33	8.33	8.33	0.00
43	8.33	8.33	8.33	8.33	8.33	24.99	16.66	8.33
44	16.66	16.66	24.99	8.33	0.00	8.33	8.33	8.33
45	8.33	16.66	20.99	12.66	4.33	12.66	16.66	8.33
46.	12.66	29.32	29.32	12.66	20.99	37.65	37.65	20.99
47.	4.31	29.32	20.99	12.66	12.66	12.66	12.66	12.66
48.	8.33	16.66	16.66	8.33	8.33	16.66	16.66	8.33
49.	16.66	24.99	24.99	16.66	0.00	8.33	3.33	0.00
50.	33.32	33.32	33.32	16.66	24.99	33.32	33.32	0.00
51.	16.66	16.66	20.99	20.19	12.66	12.66	8.33	3.33
52,	20.19	4.5.98	37.65	12.66	20.19	29.32	20.19	4.33
53.	24.99	24.99	24.99	24.99	16.66	24.19	24.99	16.66
54.	8.33	16.66	16.66	8.33	8.33	16.66	16.66	3.33
55.	16.66	16.66	16.66	16.66	8.33	24.99	24.99	16.66
56.	0.00	8.33	8.33	0.00	0.00	8.33	8.33	0.00
57.	8.33	16.66	16.66	8.33	8.33	16.66	16.66	9.33
58.	8.33	8.33	8.33	8.33	8.33	16.66	8.33	8.33
59.	8.33	16.66	24.91	8.33	0.00	0.00	8.33	0.00
60.	0.00	8.33	8.33	0.00	8.33	16.66	8.33	3.33

APPENDIX - F

Corrected SSW error scores for each ear and the

total test score.

	RNC	RC	LC	LNC	LNC	LC	RC
Sl No	Mean of (A&H)	Mean of (B&G)	Mean of (C&F)	Mean of (D &E)	R	L	Total
1	8.66	16.99	49.98	33.32	12.82	41.65	27.23
2	8.66	16.99	33.65	25.32	12.82	29.48	21.15
3	8.66	21.15	25.15	4.33	18.90	14.74	14.82
4	4.49	12.82	12.66	4.33	8.65	8.49	8.57
5	4.16	24.99	29.15	8.33	14.57	18.74	16.60
6	16.66	24.99	24.99	16.66	20.82	20.82	20.82
7	21.32	25.48	25.48	21.32	23.40	23.40	23.40
8	12.49	24.99	24.99	8.33	18.74	16.66	17.70
9	8.49	20.99	16.99	8.66	14.74	12.82	13.78
10	8.33	24.99	24.99	8.33	16.66	16.66	16.66
ll	8.66	14.49	16.66	8.33	11.57	12.49	12.03
12	8.33	12.49	8.33	8.33	10.41	8.33	9.37
13	8.33	12.49	16.66	8.33	10.41	12.49	11.45
14	12.49	12.49	16.66	4.16	12.49	10.41	11.45
15	28.33	16.66	16.82	8.49	12.49	12.65	12.57
16	16.82	33.48	33.48	16.82	25.15	25.15	23.15
17	8.49	20.99	16.82	12.66	14.47	14.74	14.74
18	8.33	16.66	16.66	8.33	12.49	12.49	12.49
19	8.33	16.66	16.66	8.33	12.49	12.49	12.49
20	16.66	33.32	33.32	20.82	24.99	27.07	26.05

Appendix: F Contd.

	RNC	RC	LC	LNC	LNC	LC	RC
Sl. No.	Mean of (A&H)	Mean of (B&G)	Mean of (C&F)	Mean of (D&E)	R	L	Total
21	12.49	12.49	16.82	16.32	12.49	16.82	14.60
22	12.66	33.48	33.48	16.32	23.05	25.15	24.11
23	20.82	24.99	24.99	20.82	27.90	22.90	25.40
24	8.33	16.66	16.66	8.33	12.49	12.49	12.49
25	16.66	20.82	20.82	12.49	18.74	16.65	17.69
26	0.00	8.33	8.33	0.00	4.16	4.16	4.16
27	8.33	16.66	16.66	8.33	12.49	12.49	12.49
28	8.33	8.33	12.49	8.33	8.33	10.41	9.37
29	4.16	12.49	12.49	4.16	8.32	8.32	8.32
30	4.16	8.33	12.49	4.16	6.24	7.28	7.28
31	8.33	20.82	16.66	0.00	14.57	8.33	11.95
32	4.33	12.66	16.36	4.33	8.49	10.57	9.53
33	20.82	33.32	33.82	24.99	27.07	26.03	26.33
34	8.66	16.99	16.99	4.49	12.82	8.65	10.73
35	20.82	33.32	20.99	12.66	27.07	17.86	22.46
36	8.33	20.82	20.99	4.33	14.57	12.66	13.61
37	0.00	4.16	8.33	0.00	2.08	4.16	3.12
38	4.16	12.49	16.66	8.33	8.37	12.49	10.43
39	14.82	25.13	29.32	8.49	20.98	18.90	19.94
40.	16.66	16.66	24.99	20.82	16.66	22.90	19.78

Appendix:F contd

	HNC	RC	LC	LNC	LNC	LC	RC
Sl. No.	Mean of (A & H)	Mean of (B & G)	Mean of (C & F)	Mean of (D & E)	R	L	Total
41.	4.33	8.49	12.49	0.00	6.41	6.24	6.32
42.	12.66	16.82	20.82	8.33	14.74	14.57	14.65
43.	12.66	20.99	12.66	4.33	16.82	8.49	12.65
44.	4.33	16.82	16.66	8.33	10.57	12.49	11.53
45.	4.49	8.66	12.49	4.16	6.57	8.37	7.47
46.	16.99	21.15	12.99	8.82	19.07	10.90	14.98
47.	12.49	20.82	8.33	8.33	16.65	8.33	12.49
48.	16.99	29.48	46.14	29.48	23.28	37.81	30.54
49.	8.66	16.99	16.66	12.49	12.82	14.57	13.69
50.	0.16	12.66	20.99	4.33	6.41	12.66	9.53
51.	4.16	4.16	8.33	0.00	4.16	4.16	4.16
52.	8.33	16.66	24.99	12.49	12.49	18.79	15.64
53.	12.49	16.66	20.82	8.33	14.57	14.57	14.57
54.	12.49	16.66	12.49	12.49	14.57	12.49	13.53
55.	16.66	29.15	20.82	12.49	22.90	16.65	19.77
56.	4.16	12.49	12.49	4.16	8.37	8.37	8.37
57.	8.33	20.82	20.82	12.49	14.57	16.65	15.61
58.	12.49	16.66	12.49	8.33	14.57	10.41	12.49
59.	8.33	8.33	16.66	12.49	8.33	14.57	11.95
60.	12.49	12.49	12.49	8.33	12.49	10.41	11.45