FALCONER'S LIPREADING TEST IN MALAYALAM

REG.NO.8806

AN INDEPENDENT PROJECT WORK SUBMITTED IN PART FULFILMENT

FOR FIRST YEAR M.Sc. (SPEECH AND HEARING)TO THE UNVERSITY of MYSORE

ALL INDIA INSTITUTE OF SPEECH AND HEARING MYSORE -570006.

DEDICATED TO

MY

PARENTS
AND

SU- SA- N

CERTIFICATE

This is to certify that the Independent Project entitled "Falconer's Lipreading Test in Malayalam" is the bonafide work on part fulfilment for the degree of Master of Science (Speech and Hearing) of the student with Register No.8806.

Dr.N.Rathna
Director,
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CERTIFICATE

This is to certify that this Independent Project entitled "Falconer's lipreading Test in Malayalam" has been prepared under my supervision and guidance.

Dr.M.N.Vyasamurthy

GUIDE

DECLARATION

I hereby declare that this Independent Project entitled "Falconer's Lipreading TeSt in Malayalam" is the result of my own study under the guidance of Dr.M.N.Vyasamurthy, Department of Audiology, All India Institute of Speech and Hearing, Mysore-6, and has not been submitted earlier at any Unversity for any other diploma or degree.

Mysore Reg.No.8806.

Dated: May 1989

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INTRODUCTION

Audiology has been defined as "The science of hearing" (Davis, 1970). This definition encompasses a wide range of professional interests, from microscopy of cellular structure of normal ears to the teaching of language to e deaf child. The clinical audiologist is concerned with disorders of hearing, or more properly with individual children and adults who have disorders of hearing. He is found in various professional environments - hospitals, college and university speech and hearing clinics rehabilitation centres, community hearing centers, veterans administration and other government health facilities - and some audiologists are in private practice with otologists or by themselves.

The focus of audiologist's professional existence, however is the patient, and all his skill end knowledge are brought to bear on defining the patient's auditory problems and seeking solutions to them.

However, it is found that not every patient seen in the audiology clinic is fully co-operative during hearing evaluation. The lack of co-operation may be because the patient (1) does not understand the test procedure (2) is poorly motivated (3) is physically or emotionally incapable of appropriate response (4) wishes to conceal a handicap (5) is deliberately feigning or exaggerating a hearing loss for personal gain or exemption or (6) fails to respond accurately due to unconscious motivation.

The audiologist has an obligation to serve his patient, even when he feels the patient is uncooperative. The present study undertaken emphasizes the fifth factor are mentioned above - i.e., the need for detecting those who feign or exaggerate their hearing loss from true organic hearing loss,

A hearing loss which appears greater than can be explained on the basis of pathology in the auditory system is termed as functional hearing loss or non-organic hearing loss.

As functionality itself become more readily identifiable, the problems posed by functional hearing loss - diagnosis, evaluation establishment of organic threshold, attitude toward the patient possibility of resolution of functional component or treatment of the patient - are of increasing concern to the clinical audiologist and to those involved in rehabilitation of the deafened.

Prior to world war II, little recognition was given to the problems of functional hearing loss. Limited attention was given to various aspects of functional hearing loss. The reason for the apparent lack of interest may have been related to failure to recognize the problem, the limited number of standardised bearing tests, inadequate audiometric equipment

...3)

and possibly a lower incidence of functional hearing loss than which exists t o d a y .

The importance of functional hearing loss as a problem of Considerable magnitude was first widely recognized in the armed force aural rehabilitation programs developed during world war II (Morrisset, 1946). following the war, many of the problems first racognized in the aural rehabilitation programs became a vital concern to U.S.Veteral Administration. The incidence of functional hearing loss in a VA population was eatimated as 11% to 45% (Johnson et al 1956).

Another area of concern is the problem of functional hearing loss within the industrial setting. In some states, there has recently been an increase in compensation for hearing loss sustained in the course of employment. Similar increases are anticipated in other states (Williams, 1957), The increase in industrial claims will probably be accompanied by substantial increases in cases of functional hearing loss, since the incidence of functionality tends to be high among parsons Whose hearing loss is evaluated for compensation purposes. Finally, functional hearing loss may occar within the ordinary otologic and audiologic settings. There are evidences for its incidence in Children and other populations also. In fact, functional hearing loss may arise whenever hearing is measured. The importance of the problem of functional hearing loss is clearly related to its magnitude.

Most cases of nonorganic hearing loss are examples of simulation, the most blatant being malingering (or) simulation for personal gain, but there appears to be many learner forma of simulation, as well as some cases Where actual simulation does not seem to be present. Beagley found that there is a continuum extending from pure simulation at one end of the scale, to pure organic hearing loss at the other, and that within this continuum, no less than six categories can be distinguished.

1. Pure simulated hearing loss.
2. Organic hearing loss + simulation.
3. Organic hearing loss + dissimulation.
4. Complete unilateral hearing loss + simulation.
5. Apparent simulation, and
6. Pure organic hearing loss.

The source of patient referal, history of hearing loss, symptoms and behaviors both during and outside of hearing tests are factors to be considered before making diagnosis of non-organic hearing loss. A patient whose hearing loss appears to be exaggerated may have produced these symptoms because he is incapable of more reliable behaviors, because of the willful fabrication or exaggeration of a hearing dsi-order, or because of some psychological disorder. Observation of the patient and special tests for non-organic hearing loss often lead the audiologist to the proper resolution of the problem.

Economy of time, energy and simpleness are some of the factors to be considered while developing a special test for functional hearing loss.

Ocassionally, a patient professes to have a total loss of hearing and does not respond to test material at the full output of the testing apparatus. Remarkably, though, the patient may respond adequately in ordinary conversation, with or without a hearing aid. such patients often emphasize the point that they get along so well becauae they read lips. Obviously, however, they are making at least some use of hearing. But the ease with Which he does lip reading seems disproportionately great compared with the apparent hearing loss.

These patients will usually submit to a "lipreading test" in which they can perform well only if they depend on their residual hearing alone. The test contains auditory as well as visual stlmuli and consists of monosyllabic homophenous (words which look alike on the lips, but sound different) words Which are hereby impossible to perceive by lip reading alone. The patient, however, does not know this and responds in his usual way to sound and vision. As most of the correct responses are a result of audition, the patient inadventertly reveals some degree of functional hearing. Goldman (1971) administered this test to normal, organic and funcational hearing loss groups and concluded positively of its reliability over determination of organic levels and its predicted SRT relating closely to standard puretone and speech measures and its usefulness of predicting functional problem without the subject being cautioned. According to Falconner, this technique is also effective with patients who demonstrated a much smaller degree of non-organic deafness.

Plan of the study:

To develop the test in Malayalam language and testing on normal speakers.

Need for the study:

Due to the simplicity and usefulness of test and also owing to the problem of multilingualism existing in the country, the test need to be developed in all languages. The test has already been developed and standardized in Kannada language by Subba Rao (1981) and in Hindi language by Sadia Saher (1982) and in Tamil by Sridhar (1987) and in Bengali by Ghosh Deberdish (1987) and in Telugu by Sujatha (1988).

Large population which may show the problem of functional bearing loss might involve cases whose mother tongue is Malayalam, which necessitates the development of this teat in Malayalam also.

REVIEW OF LITERATURE

Definition and Terminology:

Functional hearing loss. the term used here to designate hearing loss for which no organic basis can be determined or inferred, does not imply that the origin ia hysterical or paychogenic, nor does it necessarily imply that the origin is conscious exaggeration of an underlying organic defect, or simply deliberate malingering. A variety of terms are been used among audiologists. Broekman and Hoversten (1960) employ the term "pseudo neural hypacusis", Goldstein (1966) prefers "pseudo hypacusis; Doerfler (1951) proposed "psychogenic deafness" to include all nonorganic hearing loss. Chaiklin and Ventry (1963) suggested the term "Functional hearing loss" is most meaningful when it is defined "operationally and based on intra-test or inter-test audiometric discrepancies as well as medical examinations that rule out apparent organic conditions that might account for the discrepancies between the observed behaviour and audiometric findings".

Williamson (1974) cautions that such terms do not necessarly describe the same phenomenon. Since clinicians typically do not know whether an inflated auditory threshold is the result of conscious or unconscious motivation, it seems appropriate to use generic terms. Because of its specific reference to hearing loss the term "pseudo hypacusis" which was proposed by Carhart (1961), appears most descriptive. Other terms used for this purpose include "pseudo deafmuteness" (Fromm, 1946), pseudo organic deafness (Getz, 1954) aad pseudo deafness (Hefferman, 1955); The term "auditory malingering" refers to those persons who deliberately falsify their responses on hearing tests for some personal gain (Guttman, 1938; Doerfler and Stewart, 1946, Foamier, 1958).

Many terms have been used to describe exaggerated performance on hearing tests which are unconsciously motivated There are terma such as "psychic deafness" (Froeschels, 1944; Myklebust 1954) "hysterical" "psychogenic deafness (Martin, Doerfler, 1951, Truex, 1946)". The team "hysterical deafness implies a form of conversion neurosis wherein the patient loses his ability to hear due to some unconscious emotional Conflict. Exotic labels as "sinistrosis" (Fournier, 1958) appear in the literature.

Portmann and Portmann (1961) believed that it was possible to distinguish between psychogenic hearing loss and malingering and outlined a procedure for making this distinction. Goldstein takes the position that all (nonorganic) hearing losses in adults and children are feigned and should be designated as pseudo hypacusis.

Goldstein's two criteria for true psychogenic hearing loss are: (1) Consistent failure to respond at certain hearing levels in behavioural audiometry although there is response to these levels in electrophysiologic audiometry or under hypnosis and (2) auditory sensitivity to surroundings as good as but no batter than that demonstrated to behavioural audiometry.

Types of functional hearing loss:

Whan functional hearing loss is volitional, frequently teamed malingering, difficulty in hearing is feigned for a self-serving motive. The gain for a child might be simply attention from his family, friends or schoolmates. With adults, the motivation might be the financial gain to be obtained by an accident victim or an employee who has bean exposed to high noise levels, avoidance of military service etc. Nonvolitional hearing loss is more psychiatrically oriented. In hysterical deafness, for eg, the auditory dye-function is symptomatic or en underlying psychological problem. The great majority of the cases we see are of the volitional

Functional hearing lose of all types increases in times of uncertainity regarding national unemployment and recession. One small group of patients with functional hearing loss are particularly apt to appear. There are patients who conceal their hearing deficits in order to protect their jobs. This is in contrast to the more ccmmon practice of professing a non-existing loss of hearing.

Incidence:

The incidence of functional hearing loss varies dapending on the population examined. The current estimate, whem available, differ for a variety of reasons, first incidence figures vary from setting to setting depending in part, on the kind of patients evaluated in each setting. Second, the criteria for functionality probably differ from clinic to clinic. For eg. a PTA-SRT discrepancy of ± 6 dB or more may be considered as a functional sign by one iavestigator whereas a ± 12 dB or greater discrepancy will be required by another investigator before he becomes concerned about a functional hearing loss. Even order of testing (Hansel, 1960) may affect the observed incidence of functional hearing loss within a single clinic or between clinics. Third, some clinics administer special tests for functional bearing loss only when the problem is suspected (young and Gibbons 1962). Other clinics administers such tests more or less routinely. It is reasonable to assume that the Incidence estimates of that hearing loss are apt to be higher for the latter clinics. Finally, differences in incidence estimates may results from differences in the degree to which subjective evaluations are used in the identification process. In some clinics, the examiner's subjective evaluation may be given considerable weight. In other clinics, objective evidence in the form of test findings may be the sole basis for making a diagnosis of functional hearing loss.

Nilo and Sanders (1976) concluded that 1% of the general population had reported to have functional hearing loss and 85% - 90% of tha cases referred from military and 11 - 45% of the veterans administration had this problem.

Truex (1946) reported an 8% incidance of functional hearing loss among military patients at Deshon Army Hospital; Knapp and Gold (1950) give 10% as an estimated incidence of functional hearing loss among military personnel. Northern (1968) states that 3.1 percent of the total 1967 case load for the Audiology and Speech center, was diagnosed as non-organic. An Otologic group with a large surgical practice and a considerable diagnostic case load reported an estimated "less than two percent" incidence.

Feldman (1965) states - "The physician may expect three percent of his patients with hearing loss to fall in the functional hearing loss category". According to Johnson (1956) the incidence of percentage of functional hearing loss has increased by 11-45%.

Incidence among children:

Doerfler (1951) reported a survey in Which the audiology centers were asked to specify the incidence of functional hearing loss in their clinic populations. 74% of the clinic Which replied reported of a few or no child with functional hearing loss. In 21% centers, the range was 1% - 5%. In 7% of the centers, they reported an incidence greater than 5%. Dixon and Newby (1959) reported on 40 children between the ages 6 to 18 years with pseudohypacusis. Despite claimed hearing losses, 39 of the children could follow normal conversational speech with little difficulty. McCanna and Delapa (1981) reported similar findings.

The incidence is three times more in females than in males (Brockman and Hovertson, 1960, Calvert et al 1961, Dixon and Newby 1959). The reason for this sex difference is unexplained.

BEHAVIORAL, INDICATIONS OF FINCTIONAL HEARING LOS:

Indications of pseudohypacusis can be obtained from both nontest situation and the test situation.

The non-test situation:

Frequently the source of referral will suggest the possibility of pseudohypacusis. when an individual is referred by an attorney following an accident that has resulted in his client's sudden loss of hearing, suspician can arise. This is also true of veterans referred for hearing teats, the result of which decide the amount of monthly pension to be paid.

A detailed case history is of great importance here. The patient may claim an over-reliance on lip reading, may ask for inappropriate repetition of words, and may constantly readjust the hearing aid. Exaggerated or contradictory statements of difficulty or discomfort, vague dicriptions of hearing difficulties and the volunteering of unasked for supplementary Iinformation may be symptomatic for pseudohypacusis. They may turn away with hand cupped over the ear, ostensibly to amplify sound.

Johnson, Wark, and McCoy (1956) list a number of criteria Which they believe point toward possible functional loss. They include the presence of serious emotional disorder, exaggerated attempts to hear or understand, excessively loud voice, nervousness, and comments apparently intended to account for discrepencies, such as "the ringing in my ears confuses me".

Feldman (1965) adds the following: financial gain, exaggeration of the use of the "good" ear and apparent inability with unilateral loss to localize sounds normal loudness, quality and precision of speech of patients with alleged profound hearing loss.

The use or misuse of a hearing aid has frequently been cited as a clue to the presence of nonorganic hearing loss. Unfamiliarity with the aid, use of insufficient volume, unrealistic statements as to battery life, extraordinary improvemeat in hearing with the aid, the successful use of a low-gain aid with a severe loss are typical anachronisms which should warn the audiologist to investigate the possibility of functional 1oss.

Clues in medical examination:

The lack of an apparent physiologic basis (no history of ear disease; normal meatus. Tympanic membrane the middle ear functions absence of nasopharyngeal pathology or vertigo, negative responses to vascular, electroencephallic, and radiologic laboratory tests) in sudden onset of hearing loss may suggest the possibility of functionality. Lack of agreement between the alleged loss and the result of tuning fork tests may also point towards the possibility of non-organic hearing loss. Johnson and his associates (1956) list as discrepancies lack of lateralization to the occluded ear in the Weber test, variations in response to Rinne and Schwabach, momentary response to tone, and inconsistency between tuning-fork and audiometric response.

According to Ventry and Chaiklln (1965) few variables in clinical history were significant in distinguishing functional loss. Those variables were tinnitus (higher incidence), subjective loudness of tinnitus (greater), interference with hear ing by tinnitus (more), higher incidence of exposure to noise trauma, and more frequent report of history of ear disease. They found that the combination of medical history, otolaryngologic examination and tuning fork tests identified 53% correctly.

Conventional audiometric Tests with functional hearinq loss

Pure tone audiometry: —

One of the first clues to nonorganic hearing loss is inconsistency on hearing tests. When the test-retest variability exceeds 10 dB for any threshold measurement, one must consider the posslbility of nonorganicity.

Behaviour accompanying pure tone audiometry, which is considered to be characteristic of functional hearing loss.

1. Attitude implying great strain or painful effort to hear the signal.
2. Frequent adjustment of earphones, ostensibly in effort to hear better.
3. Very slow and tentative response with finger signal; very slight excession of finger to Iindicate detection of sound.
4. Slight twitch of finger as signal introduced but no definite response until signal strength has been increased.
5. Inconsistent responses, sometimes followed by improvement in consistency after audiologist's statement regarding patients possible misunderstanding of instructions.
6. Patient wearing earphones responds to softly spoken inquiry (eg. "In which ear are you hearing the tone?").
7. Flnching or nervousness in subject with alleged total loss when examiner introduces brief burst of very strong intensity. This technique, originally suggested by Fourier (1958), is not recommended.
8. Responses to "Booby catchers" (Fourier, 1958) which are sudden unexpected commands or remarks at low intensity (eg. "Stand up", "open your mouth", etc).

9. Response to second or third presentation of tone at an intensity lower than previously determined level.

Audiometric configuration:

Semanov (1947), Fournier (1958) described flat audiogram pattern showing an equal amount of hearing loss across frequencies.

Doerfler and Carhart noted 'saucer-shaped audiogram' similar to supra-limainal equal loudness counter as the typical curve illustrating non-organicity. But Chaiklin et al reported that there is no typical pure tone configuration associated with nonorganic hearing loss.

Lack of consistency on repeated measures, i.e, the poor test-retest-reliability is another indication of non-organicity.

The relationship between air conduction and bone conduction thresholds i.e. if air conduction thresholds are better than bone conduction thresholds, we can infer that patient has difficulty in making accurate loudness judgement via bone—conduction. Bone-conduction thresholds may later represent organic thresholds (Hopkinson, 1973). Lack of lateralization in unilateral severe hearing loss. In such cases shadow curve may be absent or elevated beyond expected (Chaiklin and

Ventry (1963), Williamson (1969), Feldman (1969), Martin (1978). Contralateral response especially for bone-conduction is also an indicative of functional hearing loss (Martin, 1978; Williamson, 1969).

Speech audiometry:

The speech reception threshold (SRT) is generally expected to compare favourably with the average of the best two of the three thresholds obtained at 500, 1000 and 2000Hz, (Siagenthaler and Strand, 1964). Lack of agreement between the pure tone average and the SRT, in the absence of explanations such as slope of the audiogram or poor word discrimination (Noble, 1973) is symptomatic of nonorganic hearing loss. Carhart was the first to report that inconfirmed cases of nonorgamic hearing loss, the SRT is lower (better) than the pure tone average(PTA). Ventry and Chalklin (1965) reported that the SRT-PTA discrepancy identified 70% of their patients with pseudo hypacusis, in each came the SRT proving to be at least 12 dB lower than the PTA. The lack of SRT-PTA agreement is often the first symptom of pseudohypacusis.

Another indication is the functional subject's divergent responses to stimulus words in speech thresholds testing. He may repeat only half of the spondee ("boy" for "Cowboy", "ball" for "baseball" etc), although he has been carefully instructed to guess if he is not certain and has been thoroughly brified on the test words to be given (Fourier 1958; Chalklin and Ventry, 1963; Johnson et al 1956). It is reported that some patients will repeat only the first half and others only the second half of the stlmulus word.

Chalklin and Ventry (1965) made one quantitative analysis to find out the difference between normals and functional subjects. The formula he gives for spondee Error Index is as follows:

SERI -NRE + OS+SL/ TE X 100, where

SERI = spondee error index, NRE = no response errors, OS = one syllable response; SL = spondee from the list (eg. farewell for base ball). Scores of 86 or higher are considered positive; 85 or lower are considered negative. 85% of functional group had positive scores and 87% of nonfunctional group had negative scores. Here, the high score contracts with low number of false positive responses during puretone testing identifies a functional patient and such responses are also expected while testing discriminations .(Hopkinson, 1973, 1978).

Accurate responses to the speech discrimination test words can provide more information not merely to the presence or absence of functionality, but to the actual organic threshold as well. Regardless of the spondee-threshold level, if a patient achieves a respectable score, in sound field at a lower level, it is clear that this patient has binaural hearing for speech which is close to normal.

Campbell (1965) developed on index of 'pseudo-discrimination loss (PDL) for evaluating objectively the 'unreasonable' patient response. Errors in patient response are divided into four categories: (1) Typical or characteristic errors (2) uncommon errors; (3) missed easy words; and (4) no response. PDL values are obtained by dividing the scores of the last three categories (2, 3, and 4) by category 1. Values obtained of less than, 0.7 are negative, values from 0.6 to 1.7 are marginal; and values in excess of 1.7 are considered to be indicative of extra-auditory influence.

Menzel (1960) found that it is better to begin the audiologic examination with speech audiometry in cases of suspected functional loss. Monitored live voice is frequently preferable to have the greatest flexibility which will help to obtain maximal response.

Rintlemann and Harford (1963) found that SAL test can be used in identifying nonorgnic hearing loss. The introduction of a noise to the test ear, either by air-conduction or bone-conduction, may cause elevation in auditory threshold which suggest nonorganic hearing disorders because of their inconsistencies with predicted findings on patients with true hypacusis.

All these methods discussed above help in identifying the probable presence of some non-organic hearing disorder. But they fail to provide evidence regarding the true thresholds of hearing. For this purpose, development of special tests was necessary.

Special Tests:

The primary purpose of special tests for non-organic hearing loss is to provide information about the patients hearing even in cases where his active participation is lacking. Tests for non-organic hearing loss (N0HL) may be performed with pure tones or with speech. Some test may he carried out with the usual diagnostic audiometer, and other tests require special equipment. Newby (1972) claimed that the purpose of special test is to confirm or to reject the impressions of patients behaviour obtained through routine testing. All the tests so developed considered the factors like economy of time, energy and simplicity (Pangching, 1970).

Stenger Test:

Stenger originally described his test in Germany in 1900 and 1907. Basically it calls for two matched tuning forks. Later in 1945,indicated the use of audiometer as a source of sound. Since then Stenger test began to take quantitative form. Altschuler (1971) advocates it to be the 'most certainly to be best in unilateral cases' and with sophistication can also be used for bilateral cases.

Principle: Stenger principle states that when two tones of the same frequency are introduced simultaneously into both ears, only the louder tone will be perceived.

Methods: Divided into three classes (Altschuler, 1971) .

A - Qualitative and Quantitative methods: These tests mainly aims at screening non-organicity (Ballentyne 1960; Martin, 1978; Hailer, 1955). Based on the results of qulitative tests, quantitative tests may be interpreted. (o'Neill and Oyes, 1966; sataloff, 1966 cited by Altschuler, 1958).

The signal is presented at better ear, at near threshold level and to the poorer ear at 40 dB HL. If no response is elicited than we can infer that tone is heard in the poorer ear. Thus quantitative methods approximate the thresholds.

In this category, quantitative methods, ascending or descending signals are presented to the poorer ear. No rationale has been given for this testing. Ross and Peck (1970) compared this modes with respect to interference level (IL). But this mode was not relevant since nothing was seen for either mode to yield smaller interference level and mode.

Stenger is considered to be positive when subjects do not respond to the tone in poorer ear actually when he is supposed to hear. However, it is suggested to use both methods to arrive at a valid estimation of thresholds.

C. In this method, a "fading tone" is used. The stimulus is suddenly or gradually (after increasing the tone in poorer ear) taken off. If the tone is heard, than the tone is actually heard la the poorer ear. But validity of such method is questionable (Gaith, 1956; cited by Altschuler, 1971).

Factors affecting stenger test:

1. Intensity relationships between ears - For the stenger test to be valid, the interaural difference should be large in addition to size of the functional component in the better ear. (Altschuler, 1971; Kinstler et al 1972).
2. Diplacusis - The occurance of diplacusis phenomenon can invalidate the stenger test and this finding is been supported by Newby 1958 and Watson, 1949. This factor, according to Chaiklin and Ventry (1963) has been over rated as a main drawback in the validation of stenger test. They opine that small pitch difference could be obscured by stenger effect, whenever a critical point is passed regarding the perceived loudness. To counteract this, Altschuler recommends (1971) the use of either speech Stenger or narrow band signals.
3. Recruitment - Menzel (1965) reported that recruitment is a factor which could affect stenger test results. Though recruitment is a rare occurance in unilateral cases but enough care Should be taken with these cases who show

normal hearing through speech frequencies and sensori-neural dip at 4 KHz (Altschuler, 1971) and bilateral cases it demands more precautions.

Other considerations:

The very observations that stenger is true for speech frequencies the following call for further study and research in this regard.

1. Below 500Hz cross over of the stimulus may take place.
2. Above 2 KHz, the thresholds may be suppressed or recruitment may invalidate in test results (Ventry 1962; Haller, 1965).
3. Ear pathology in addition to centralization occurance (Chaiklin and Ventry 1963; Goetzinger and Prud, 1958; cited by Altachuler, 1971).

Modification of stenger test:

1. Speech stenger - The basis of speech stenger test is the classical pure tone stenger test (Johnson et al 1956; Tayler, 1948). Here speech spondees are used and speech signals are used to verify monoaural loss of hearing.

Procedure: The signal initially is given at 5 to 10 dB SL to the good ear. the spondees from the same input source are fed to the better ear at level at that elicits 10% correct response. At this stage, the signal is directed to the poorer ear. Test is positive if patient stops responding or continues to respond at levels significantly lower (15 dB or more) than his voluntary SRT. The lowest hearing level of the tone in bad ear producing this effect is called the minimum contralateral interference level.

Stenger test is useful in cases where interaural difference in SRT is significant. (Menzel, 1960) and existence of functional overlay for speech in poorer ear. Speech stenger tests also helps to overcome diplacusis phenomenon and beats (Martin, 1978). The procedure has been described by Newby 1958; Goetzinger and Proud 1958; Watson sod Tolan 1949, Carhart, 1966).

2. Shifting voice test: This is helpful in detection of unilateral functional hearing loss subjects. It is modification of speech stenger test. The stimuli (Which can be instruction, question or spondees) is shifted between the ears. The subject has to indicate the ear in which he is hearing the stimulus. A case of functional hearing loss will respond inconsistently.

Davis and Goldstein (1966) found this tests to be useful with unilateral cases and that Johnson (1956) and Carhart (1960) suggests its use with the bilateral cases having slight intaraural difference.

According to Newby (1972) its difficult to rely on this test since it puts pressure on the patient. Thus again depends upon patients confusion (Watson, 1949). Carhart, 1960 concludes that there is disagreement whether test results approximate to true thresholds.

3. Rapid random loudness judgement (RRLJ): This test is more or less based on Fowler's ABLB test. This tests confuse tbe noncooperative subjects to elicit response for which be was previously denies its existence. Initially, patients voluntary SRT and pure tone thresholds are obtained in each ear. Then the tones are presented alternativly. He has to report which of the tone is perceived as louder. The instruction that follows with each presentation of stimuli are - this is number 1, this is number 2, which is louder?

In each rapid succession, tone skipps variously in one or more octave, varying the SL with equal time given in each ear for each pair of tones.

An evidence of confusion in each ear signifies indication of functional hearing lose. Whereas an organic case will elicit consistent response.The teat can be used with uni-lateral or bilateral cases.

Nagel (1964) reported that if the method of stimulus pre-sentation are programmed, then the efficiency of test will be increased.

Fusion Inferred threshold test (FIT teat):

FIT tests does not attempt at unmasking nonorganicity but tries to determine a close estimate of true thresholds with patients who are otherwise difficult to evaluate. According to Bergman, it uses stenger phenomenon to determine thresholds of hearing sensitivity when standard audiometry yield uncertain results.

Method: Subject is presented stimulus in the better ear at 10 dB SL. Then the stimulus im the poorer ear is increased until median plane localization occurs. Thus the true threshold of the poorer ear will be the sensitivity required for median plane localization minus 10 dB SL.

Other modifications:

All these tests have little relevance for testing of children having functional hearing loss especially with Stenger test.

Altschuler (1971) tested 12 children on the stenger test and have found its significance. He recommends the following.

1. Use of ascending technique in the poorer ear or starting at 0 dB HL.
2. Simultaneous presentation and withdrawl of pulsed tone to be uitilized.
3. Tone to the good ear should not be faded away.

4. Tone should be presented directly and should be in 5 dB steps with the pause time and stimuli time sporadically altered to avoid rhythmicity.
5. Test should be initiated with the tone being presented to the good ear close to subjects thresholds to precipitate constant response.
6. The test should be incorporated into the routine puretone audiometry preceded by adequate instructions and should be accomplished quickly.

Fourier (1958) has described four methods, which allow the examiner to establish thresholds.

Vyasamurthy (1971) found that the stenger test can be administered to equal loss cases.

Based on binaural summation and basic principle of stenger test, vyasamurthy (1971) described two methods. The first method is based on the finding (hirsh 1952) that the difference between binaural threshold and monoaural thresholds at 35 dB above the subject's threshold is 6 dB. The second method is based on the finding (Hirsh, 1952) that binaural threshold is better than monoaural threshold by 3 dB at threshold level.

<u>ABLB</u>: A test for functional hearing loss:

ABLB (Alternate binaural loudness balanced) (automatic) test can be used to identify unilateral functional hearing loss.

the rationale of the test is based on the prescription that all unilateral SN hearing loss cases exhibit complete recruitment (within the limits of $\pm$ 20 dB) at high intensity levels, irrespective of tone decay, to ABLB (automatic) test. At the point of balance, if the hearing level of the tone presented to the normal ear is less than the hearing level of the tone. (30 dB SL) presented to the suspected ear by 20 dB or more, functional hearing loss is indicated. However, if there is mo significant difference in the hearing levels at the point of balance (i.e. if 'R' is present, R=recruitment), functional hearing loss cannot be ruled out.

The Lombard Test:

The Lombard test is based on the experience that persons increase their vocal level when they speak in a background of noise. If a noise is presented to the ears of a speaker who does not hear the noise, there will be no Change in the loudness of voice. If however, the level of a person's voice goes up as noise is added to his ears, it is obvious that the noise is audible to him.

Procedure: Subject is positioned with air conduction receivers over his ears and asked to read or speak aloud. A neatly typed paragraph helps to avoid some difficulties professed during pexrformance of this kind of test. As the subject reads, a masking noise is added to both ears and gradually increased in intensity. The examiner listens for increased vocal loudness. To help detect this loudness increase, the subject may be asked to read into a microphone, and his speech is fed into the VU meter of the Speech audiometers being used. Any increase in loudness of the reader's voice can be visually observed as an increase in the value of the peaks on the VU meter. This indicates that the noise was at least loud enough to him to cause this voice reflex. No change in loudneas might suggest that the noise was not heard or was not loud enough to cause the reflex. If a person with a 90 dB lose of hearing show positive result oa the Lombard test at 75 dB, NOHL is immediately suspected.

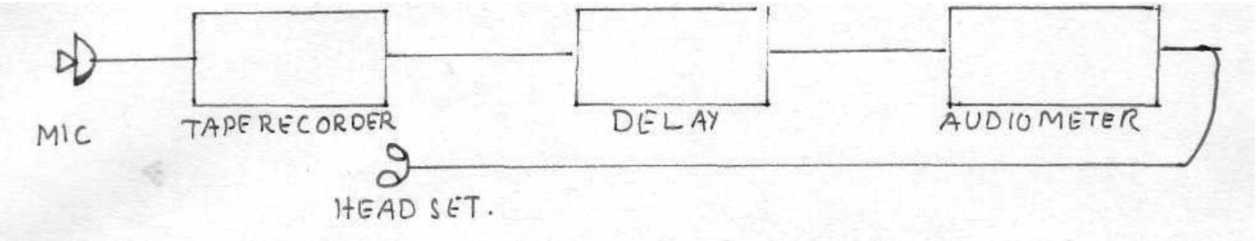
Limitation: (1) If the patient is illiterate, reading is not possible (2) If the person know the principle, be may beat the test.

Delayed Auditory feedback:(DAF):

Ruhm and Cooper (1964) developed this technique for the diagnosis of NOHL based on the concept putforth by Black and Lee (1951, 1950). Black and Lee observed that many normal speakers experienced nonfluent speech when speech is delayed under various conditions such as earphones (Newby, 1972).

Principle of the test: In the presence of DAF, the reading rate becomes slow.

Instrumentation:



Procedure: The subject is placed before a microphone, preferably in the patient room of a two room audiometric suite. He wears a pair of air conduction receivers. A prepared text is provided Which should be easy to read and should be completed in one-half to one minute.

- Ask the patient to read the passage aloud. Note down the time taken to completely reading the passage.
- Let the equipment be on. Stimulus is going to the headset now. Ask the subject to read the passage again and note down the time taken to complete the passage.

Delay can be adjusted by varying the distance between recording head and playback head.

Introduce the DAF (usually the delay will be 0.18 sec) at level equal to normal intelligibility level (usually 30 dB HL) After each reading, the level is raised 10 dB until a positive result is seen.

- Repeat the third procedure with increase in the level of DAF. Note down the time.
- Repeat the procedure until the subject's reading rate reduces

Note down the level of DAF at which the subject's reading rate reduced.

If the level of the DAF is less than the admitted SRT of the subject, pseudohypacusis is suspected.

Doerfler Stewart Test:

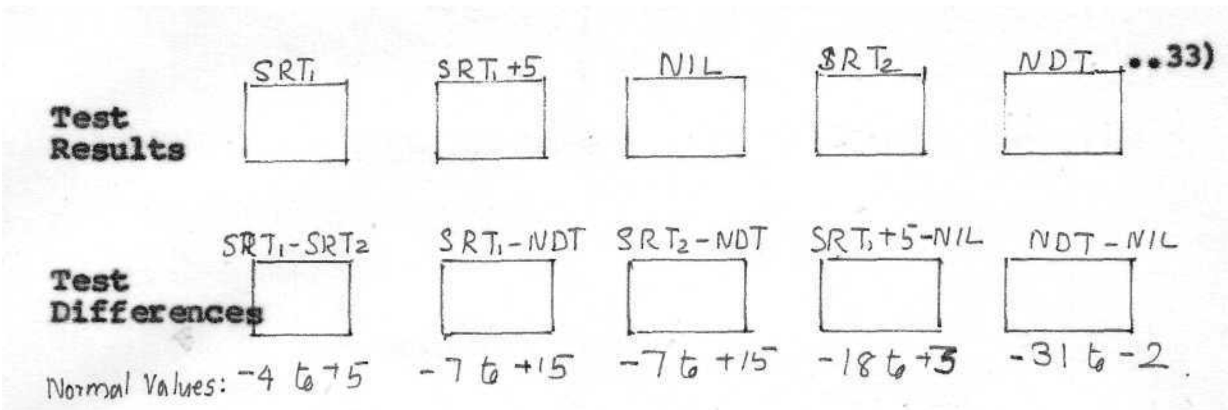
The Doerfler-Stewart (D-S) test is a confusion test, using spondee words and saw-tooth noise; and is named for the audiologist and engineer who devised it (Doerfler Steward and Doerfles Epstein 1946).The test is performed binaurally and is contrived to confuse the patient by presenting the noise in his ears so that he loses his "Yard stick" if his intention is to consistently respond to the words above threshold as though they were at his SRT. Menzel (1960) has recommended that the D-s test should be performed early in the battery of hearing tests to discourage nonorganicity in these patients whose intention is to malinger.

Procedure: The patient is instructed to repeat every spondee word he hears. No mention is made of the noise that will be presented. The level of the spondee words is controlled by one hearing level dial and the level of the noise by the other hearing -level dial. Both channels are directed to both receivers. Monitored live voice is used.

The SRT is measured in the beginning. The criterion is two correctly identified words out of four. When this level is reached, the hearing threshold level is recorded as sRT_1 on a form as shown in the figure. The sRT is than raised 5dB and the words again presented preferably in a rapid fashion. At this level, the patient should be able to repeat all the words. This is recorded as $SRT_1 + 5$.

After $SRT_1 + 5$ is found, the examiner continues to repeat the spondees as be introduces the noise into both ears, starting at zero dB HTL. The noise is raised in 5 dB steps until the patient stop repeating the spondees. This is called the noise interference level (NIL). The noise level is raised above the NIL, in 5dB steps, with one spondee word presented at SRT_1, + 5 each time the noise is increased until a noise level 20 dB above the NIL is reached. The level of the spondee words is then reduced in 5 dB steps, presenting one spondee word at each step until a level 15 dB below SRT_1, is reached. The noise level is then reduced in 5dB steps to zero dB HTL. A second SRT, labelled SRT_2 is then obtained in the same fashion as SRT_1 Then noise detection threshold (NDT) is obtained for both ears in a fashion similar to that used for pure tone threshods.

The norms are determined by Doerfler and Epstein (1956). They are given in the following figure.



When the extremes of these norms are exceeded on two or more measures, the test is considered positive and strongly suggests that the SRT of the patient is lower than the SRT that he volunteers.

Disadvantage:

1. The D-S test does not tell us the extant of non-organicity nor does it reveal the true SRT.
2. The test is binaural and therefore eliminated in unilateral cases.
3. When word discrimination is poor, either real or feigned, the patient may appear unable to repeat 100% of a list of spondee words at any sensation level.

Ventry and Chalklin (1965) found that the D-S test may not be as efficient in detecting nonorganic hearing loss components as the PTA-SRT comparison. A significant number of their patients with organic hearing loss yielded positive D-S results.

Many audiometers today do not provide sawtooth noise generators. White noise does not provide sufficient intensity in the 125 to 500 Hz range, which will give meaningless results. the D-s list is not often performed today.

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Marvin Engelberg (1970) found DF test not to be valid and recommended that it not to be utilized for detecting unreliable hearing loss responses.

The Modified D-s Test:

Martin and Hawkins (1963) modified the procedures so that it could be used with children, unilateral losses, and those patients who are incapableor unwilling to repeat spondee words. The test is performed in one ear, using pure tones and white noise as a masker.

The same procedure is uaed. T_1 and (T+5) are found out by ascending approach. A white-noise is then presented to the test ear at 0 dB HTL and raised in 5 dB steps. Each time the noise level is raised, a tone is presented at T_1 + 5. When a noise level is reached at which no response is obtained to a tone at T_1+ 5, this is the NIL. The noise level is then reduced in 5 dB steps until either a response to a tone (presented once at each noise level) is seen zero dB on the noise-level dial is reached. A second pure tone threshold is then obtained (T_2)

The norms for the modified D-S test are also given. It is necessary for the clinician to determine his own norms on a set of normal hearing persons before he can perform this test. If the difference between T_1 and T_2 exceed plus or minus 5 dB, or if the NIL - T, + 5 exceed the values determined for the effects of masking on the pure tone, the test frequency is suspected of nonorganic contaminations.

This test also got the similar disadvantages as, the first one.

swinging story test:

Another way of confusing a patient who alleges a unilateral hearing loss is to administer the swinging story test. The patient is asked to listen to a story, parts of which are presented to the better ear, parts to both ears, and parts to the poorer ear. The story is read so rapidly that it is difficult for the listener to be certain what information was obtained from which ear. The test requires the use of a two channel speech audiometer with a switch that allows for rapid switching to the left ear, right ear, or binaural position, A two room audiomatric set up is essential. While this test is generally performed using monitored live voice, the test can be prerecorded on a stereophonic tape.

The patient is advised only that he will be told a story, and that he is to repeat all of the story that he can remember. The earphone positioned over both ears and the test is begun. The examiner reads one of the swinging stories (or plays through a tape recorder), The hearing level dials are set so that the story will be presented 10 dB above the threshold of the better ear and 10 dB below the threshold of the poorer ear, at the completion of the test, the patient is asked to repeat the stody.

If the patient includes any information provided to his poorer ear only, the conclusion must be drawn that he has hearing in that ear below his admitted SRT.

The swinging test is limited to unilateral cases. It the SRT of the poor ear is more than 40 dB above the bone conduction levels of the better ear, the test may be contaminated by cross-hearing. This test must be performed with considerable experience of monitored live voice is to be used, since it obviously requires a great deal of dexterity and sophistication on the part of the examiner. The test does not identify the true threshold la the poor ear, but demonstrate graphically that the subject is feigning or exaggerating a unilateral hearing loss.

Confusion tests:

A series of tones may be introduced above and below the voluntary threshold and the patient is asked to count the tones and tell the number he has heard. (Ross, 1964). This becomes a problem for the nonorganic patient, since he has to remember which tones he is willing to admit to hearing. The same procedure may be used to pulse the tones rapidly from one ear to the other in a unilateral case. The tones should be above the threshold of the "better" ear and below the admitted threshold of the "poorer" ear (Nagel,1964).

Tone-in-noise test (TIN):

Chaiklin and Ventry (1965) have questioned the efficiency of D-S test in the detection of 6 nonorganic hearing loss cases. According to them, the test is difficult and complex in terms of administration.

Based on the above findings Pangching Glenn (1970) modified D-S test. This test measures the difference between the thresholds in noise and pure tones. The subjects first threshold (T_1) is obtained in ascending method. Then with the intensity at (T_1+5) dB wide band noise is introduced suddenly at 10 dB above (T_1+5 dB) level. Then Second time threshold is obtained in this condition with interrupted tone. According to Pangching (1970), the difference of 5 dB in thresholds between quiet and in noise is indicative or organic and when this difference exceeds 10 dB indication of functional hearing loss. However, this test does not provide estimation regarding the threaholds.

Eyeblink response test:

The cochlear palpebral reflex is an involuntary eye blink reflex to the onset of level auditory atimuli which is approximately 90-100 dB SL in normal and organic loss cases. This phenomenon was made use by Glanabos (1953).It does not help to determine absolute thresholds (Chaiklin and Ventry(1963).

This test was used by Gallonery and Buller (1956) reported a difference of 5 dB between voluntary and involuntary thresholds and insists of prolonged training needed. The eyeblink responses rate after prolonged conditioning is below a desirable level for threshold determination (Lowell, 1960).

Switched speech,test:

This test is given by Calearo (1957). The test consists of several maaningful short sentences recorded at an average speed of 85 words/minute. The sentences are switched back sad forth between the ears at 30 dB above better ear threshold with 50% of the signal going to each ear. Two switching rates are used (2-3 sec). The patient hears the message in the better ear as relatively unintelligible interrupted speech, bat intelligibility increases when switching rate is increased. In functional hearing loss cases, case is unaware of the portion that is presented to the better ear. when the subject has high intelligibility at low switching rates, or unable to understand message even at high switching rate is indicative of functional hearing loss (Chaiklin and Ventry, 1963).

Yes-No Test:

This test is used with children for diagnosis of functional hearing loss. The thresholds are established by ascending and descending procedure and child has to respond in terms of "yes" or "no". The authenticity of the test depends upon the child responses following the tone being presented (Miller, 1968; Miller and Rehman, 1970). This test is easy to administer and does not require any special equipment. This technique helps in diagnosis of degree and type of hearing loss (Fank tan, 1976).

Masking Test:

This test is based on the fact that existence of one to one relationship between the levels of the masking noise and of the masked pure tone thresholds. Hood (1959) used this principle to diagnose unilateral functional hearing loss cases. When noise is raised by 20 dB, the pure tone threshold is also raised by equal amount (Shadowing effect). Chalklin and Ventry expressed doubt on this test in the diagnosis of non-organic Cases.

Bekesy Audiometry:

Jerger and Herer (1961) described a fifth type of tracing Wherein the pulsed tone threshold appears to be poorer (lower in the audiogram) than the continuous tone threshold. They associated nonorganicity to this type of tracing.

A number of writers have reported type-V tracings as being symptomatic of nonorganic hearing loss, when a person is trying to respond consistently at some suprathreshold level, he must remember how loud the tone was the last time he responded. The subject must set up his own internal standard for the loudness of the tone to be traced. For subjects with normal hearing, more intensity is required for pulsed tones than for continuous tones for the tones to appear equally loud at levels above threshold (Rintleman and Carhart, 1964).

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Hattler (1970) found that the Type V pattern was accentuated when he used a lengthened off time (L0T). Instead of using the normal pulse rate of 200 milli seconds on and 200 milliseconds off, Nuttier used 200 milliseconds on and 800 milliseconds off. He found that type v patterna often appeared with this arrangement, Where they did not with the normal 50% duty cycle. The other four Bakesy patterns were unaffected by the lengthened off time.

Finding that the Type V pattern did not always appear in cases of nonorganic hearing loss, Hood, Campbell, and Hutton (1964) developed a procedure called BADGE, an acronym for Bekesy Ascending Descending Gap Evaluation. The procedure involves the use of a fixed frequency, comparing three Bekesy tracings alleged to be threshold. The first trace is obtained with a continuous tone that increases in intensity from zero dB HTL, called a continuous ascending (CA) tone. The second trace is made with a pulsed ascending (PA) tone. The third and last trace is obtained with a pulsed descending (PD). A number of patients with nonorganic hearing loss gave sharp differences on these through one minute tracings, which should have been identical in an organic hearing loss. Positive BADGE results were seen in nonorganic patients Who did aot exhibit Type V tracings. This comparison of ascending and descending thresholds had been described much earlier using a conventional audiometer as a test for nonorganic hearing loss by Harris 1958.

Dleroff and Jena (1970) found that Type-V tracing given by Jerger should correspond to the normal reaction of the human ear as loudness depends on duration of sound.

Performance of tracking behaviour on an automatic audiometer requires more attention and cooperation and the tracking behaviour is undoubtedly influenced by a number of interrelated factors, such as physiological and psychological readiness fatigue, boredom, motivation and personality. Another disadvantage is that the accurate threshold cannot be obtained using these Bekesy audiometric procedures.

Electrodermal Audiometry:

This is another objective audiometric method i.e. the patient himself plays no voluntary role in stating when he hears or does not hear the stimulus. Electrodermal audiometry (EDA) combines the use of Pavlovian conditioning with measurements of the psychogalvanic response. It has been known that the skin serves as a conductor of electricity. By placing electrodes on the surface of the skin at two neighbouring points, as at two adjacent finger tips, the voltage cam be amplified and studied in terms of its electrical resistance. Skin resistance is measured in electrical ohms.

Bordley and Hardy (1949) were the first to apply psychogalvanometry to audiometry. By pairing a tone presented through an earphone with a small electrical shock delivered by electrodes to the fingers of the hand opposite the pick up electrodes, the patient could be conditioned to respond to the tone. Since the shock always results in a drop in resistance, tones could be followed by Shocks until the subject associated the two. The purpose of the electrodermal audiometry is to cause the conditioned stimulus (the tone) to give rise to the same response on the psychogalvanometer as the unconditioned stimulus (i,e. the shock).

The Galvanic skin response audiometry helps to explore thresholds and thus to detect the presence of non-organicity with high degree of validity and reliability with proper methodology. This method can determine air-conduction and bone-conduction thresholds. Doefler and Machune (1954); Busk, (1958) and Hanley at al (1958) have reported that GSR thresholds are generally within $\pm$ 5 dB of the voluntary threholds.

Chaiklin and Ventry also found this method as an effective procedure for identifying pseudohypacusis and determining the thresholds. Using speech measures in electrodermal audiometry could be very useful in identifying the non-organic hearing loss cases (Hopkinson, 1973).

Disadvantages:

All cases cannot be conditioned. Use of electrical stimulus itself is a difficult method. A person who has acquaintance with the test can confound it since small movements results in the movement of stylus leading to misinterpretation.

Electrocochleography and evoked response audiometry:

Cortical response audiometry is one of the most objective avenues in determining the pseudo hypacusis cases. It does not involve any shock, or patient's cooperation (Martin 1978). It is valid and objective index of auditory sensitivity (McCandles et al 1968), Voluntary pure tone thresholds and ERA thresholds are within ± 10 dB (Alberti, 1970).

The ERA consists of computer, an electroencephalograph (EEG) an averaging computer where components of evoked response are analyzed (50–300 m.sec). Hearing loss which is not evident in electrophysiologic testing but is evident at routine audiological testing is indicative of non-organic hearing loss. However, the confirmation should be informed through other tests. (Cody and Townsend, 1973: Beagley, 1973).

Electrocochleography (EcochG) measures the 8th nerve potentials without artifact that are seen with EDR or ERA. It is gaining popularity in recent years (Martin). It is expensive and time consuming (Beagley, 1973).

Acoustic Impedance Measurements:

Acoustic impedance measurements (stapedial reflex threshold measurements) also can be used as a quick and simple method for the identification of functional hearing loss. It has been used for this purpose since 1950 and this doesnot need much cooperation of the patient. In normals the stapedial reflex is about 80 dB above pure tone thresholds. In cases of Meniere' disease and positive recruitment test, a gap of 30 dB between the two is expected. But When It is less than 5 dB it should be expected as non-organic hearing loss (Lamb and Peterson, 1967; Feldman, 1963). Many procedures have been identified for detecting hearing level (Jerger et al 1974; Keith, 1977; Hall, 1978, Rizzo and Greenberg 1979; Popelike et al, cited by Hall and Bleskney, 1981, Baker and Lilli, 1976; Jerger at al 1978). However caution should be taken whenever conductive pathology occurs. In cases of suspected pseudohypacusis, test signals are presented to the ear in question with measurement probe in the contralateral ear.

Modified speech test:

THis test includes repetition of 3 spondaic words in a sequene, monosyllables repetition in the lowest sensation levels and discrimination measures.

Falconers lip reading test in English:

Falconer (1966) developed this test using homophenous words presented at various intensity levels (SRT + 10, SRT + 0, SRT -10, and SRT - 20 dB). Both auditory and visual clues were made use of . He presented the lists starting with +12 dB above SRT. Then intensities are reduced at other presentations.

Weiss,Betty Goldman (1971) conducted a study to determine the usefulness of the Falconer's lip reading test for nonorganic deafness in the resolution of test discrepencies, and the establishment of the organic hearing levels. Weiss indicated that "audition plays an important role in lip reading". Falconer's test predicted SRT of the subjects more accurately than other test which was used in the study.

Thus this teat helps to predict the true thresholds in patients Who attempt to exaggerate or increase the thresholds and explain that their communication abilities are due to the lip reading ability .

The applicability of the modified bivariate plotting procedure:

This method was initiatly proposed by Popelka (1981) and its applicability proposed by Silman, Silverman, showers and Gelfand (1984) is found to be effective in detecting patients with functional hearing loss.

In thia method, 2 acoustic reflex variables which increase aa hearing loss increases are plotted. Tonal acoustic reflex threshold (ART) along the ordinate and ratio of ART in noise, to the tonal ART along the abscissa. A vertical line and a negatively sloped diagonal line are then drawn so that at least 90% of the normal hearing subjects data are located below and to the left of the lines on the graph. ART data should be obtained from a group of hearing loss subjects and plotted on the graph. The false positive rate can be calculated by finding out the 'miss rate' i.e. the ratio of the normal hearing ear. which fall in the hearing loss region to the total number of normal hearing ear, multiplied by 100. They found that the bivariate graph is easily applied clinically.

METHODOLOGY

The study is conducted in two steps.

1. Development of test material.
2. Testing it on normal hearing subjects.

Development of test words in Malayalam was done as suggested by Falconer (1966) who has developed this test in English using monosyllabic words to predict the organic thresholds. Homophenous words are those words which looks alike on lips but sounds different.

The test material used in the present study consists of disyllabic words, which are homophenous.

Development of the test material:

The test consists of four lists of twenty homophenous words each. The four lists were divided again into two subjects in such a way that each list contains ten words and its homophenous counterpart in other words in other three lists.

Before constructing the test material, care was taken to group the sounds of Malayalam alphabets according to their place of articulation. The place and also the manner of articulation was taken into consideration While selecting homophenous words et. bilabial sounds /m/, /b/ and /p/ and their aspirated sounds look alike on lips but will be heard differently. So, when /m/ is replaced, it should be replaced or substituted either by /p/ of /b/. Likewise one of thre forms of the word will have its counterpart in the other set Eg.. /pana/ /പന/ in list IA has its counterpart /pala/ /പല/ in list IB, /mala/ , /മല/ in IC and /bala/ , /ബല/ in list ID. Care was taken to maintain equal phonetic distribution in the sets thereby maintaining equal difficulty in both the sets All the words were selected in such a way that they were familiar bo the speakers of the language and were meaningful. The total number of words aalselected were 80. The words in each list were randomzied in accordance with Fisher's rand number tables.

Four levels for prresentation were taken with reference to speech reception threshold (SRT) of each subject. The levels of presentation were (1) SRT+10 dB; (2) SRT+0dB; (3) SRT-10dB and (4) SRT-20dB.

The test used both auditory and visual clues. Each list was presented at different levels as given below:

Subject group:

1.	L_1I_1	L_2I_2	L_3I_3	L_4I_4
2.	L_4I_3	L_2I_1	L_1I_2	L_3I_4
3.	L_3L_2	L_4I_1	L_2I_3	L_1I_4
4.	L_2I_4	L_1I_3	L_3I_1	L_4I_2

(L indicates tbe list and I indicates the intensity level. No lift waa presented at the same intensity level of an earlier presented list for a particular subject)

subjects:

Normal groups:

Twelve subjects, nine females and three males were selected for the present study. Their mothertongue was Malayalam. Their ages ranged from 17 years to 26 years and the average age was 20.17 years. All the subjects underwent audiometric screening test at 20dB HL at octave frequencies - 250Hz, 500Hz, 1000Hz, 2000Hz, 4000Hz and 8000Hz. This normal group also underwent various medical and otolaryngological examination and were found to be normal. Vision was also normal. The subjects were divided into four groups including three subjects in each group. The subjects of the same groups were tested in the similar manner and were exposed to the same lists and levels of presentation as shown in the table-A.

Instruments:

A two-channel clinical audiometer GSI-16 was used TDH-39 earphones and MX 41/AR ear cushions. Speech audiometry setting was used and one channel was utilized. Live voice testing was carried out. The subjects response were noted through a talk–back system Whose gain control waa adjustable. The audiometer was calibrated to the ISO (1964) specification.

Testing environment:

Testing was done in sound treated room and in two room situation. The testing stimulas was delivered from the control room was brightly illuminated so as to facilitate the subjects to lip-read during the 'lip reading' testing. During administration of the test, the test room was darkened which facilitated the lip-reading aspect of the test. This also eliminated the glass reflection free observation window. The subjects and examiner head was almost at the same height. The noise level of the testing zoom was well within the maximum allowable noise levels in dB SPL.

procedure:

The testing procedure involves the following:

1. Instructions
2. Obtaining SRT without visual clues
3. Administration of the 'speech reading test' with both visual and auditory clues.

1. Instructions for SRT:

The subjects were instructed as follows:

"You are going to hear words like /vastram/ /വസ്ത്രം/ /mesa/ etc. /മേശ/ As soon as you hear them, repeat them loudly. when you are douhtful, try to guess the words". Instruction was given in Malayalam.

Instructions for the lip reading test:

"You are going to hear some words through the earphone. you will have to look at the examiners face when the words are uttered. Repeat the words by hearing them and also by trying to lipread them. Using both auditory and visual clues, try to repeat the word". Instructions were made clear before the testing commenced.

2. Obtaining the initial SRT:

The subject was comfortably seated in a darkened, isolated, sound treated room. He wore the headphones. Using a cal-brated audiometer (GSI-16), the subjects were screened at 20 dB at 250Hz, 500Hz, l000Hz, 2000Hz, 4000Hz and 8000Hz. Prior to SRT subjects hearing thresholds at 500Hz,lKHz and 2KHz were obtained using Hudgson and westlake's modified ascending descend-ing technique.

After obtaining the pure tone average (i.e. the average of admitted thresholds at 500Hz, 1KHz, and 2KHz), the SRT was obtained. Malayalam spondee lists Which was constructed by Swarnalatha was made use of. The testing was initiated at 20 dB above the pure tone average. One word was presented at each level and the level was decreased in 10dB steps until no spondee word was repeated correctly. The intensity was again increased by 5dB and at each level four spondeeswere presented. when two spondees were repeated correctly then the level warn decreased by 5dB. This procedure continued until 50% of the words presented were repeated correctly. This level was considered to be the SRT. This level was taken as reference for presentations of the other word list of 'Speech reading test'.

3. Administration of the speech reading test:

The testing procedure and administration of the "speech reading test" was as advocated by Falconer in his test of lip reading (1966) in English.

The steps are as follows:

1. The subject was seated comfortably 1m mound treated room. He wore headphones mad faced the observation window through which he watched the face of the examiner. The examiner sat ia the control room. The face of the examiner was illuminated by a fairly bright light - the light in the control room and the darkened room dramatized the lip reading aspect of the situation. The subject's and the tester's line of vision was maintained. The reflection from the observation window was avoided.

2. During the presentation of words, the examiner held her head erect, with the microphone about six inches in front and below the skin. The examiner monitored her speech with a VU meter, which was located close to her line of vision with the subject.

3. The subjects were instructed as mentioned earlier. It was explained that the test was aimed at complementing his lip reeding ability and the affect of his hearing in lip reading.

4. After each presentation, pause was given till the patient responded. Articulation was unexaggerated. The subjects were given maximum two chances (When it was felt that the subject was not attending for a particular word).

5. After each response, a mark was made to record whether the response was correct or not. This was done in such a way that the subject cannot determine correctness of his/her response. No facial expression or gesture was given that would reveal information about the responses.

6. The number of words repeated at each presentation level was noted. An articulation gain function was plotted with the number of words repeated correctly at each level.

RESULTS AND DISCUSSIONS

The purpose of the present study was the establishment of a relationship between the predicted SRT and the obtained SRT in normals using the homophenoue words, the results obtained in this study can be made use of for predicting SRTs in "Effectiveness of lip reading test for no deafness has proved its worth as a clinical tool on a number of occasions". This was further supported by Weiss (1971). He found an excellent agreement among the other test measures (AC thresholds, speech and Falconer's lip reading teat). However, he mentioned that while predicting SRT as a measure of substantiating organic hearing levels, factors like sloping audiogram, poor speech discrimination should be considered.

The list of 80 homophenoue were used and the results were obtained by averaging the scores obtained by 12 normal subjects. The four intensity levels used were SRT-20 dB, SRT-10 dB, SRT +0DB and SRT+10 dB). She data thus obtained was used for analysis.

The average SRT obtained with normal subjects was 11.8dBHL. The most suitable criteria for predicting SRT from the lip-reading test in Malayalam is the level at which six words or score nearer to it being repeated correctly (i.e, 60% of the total list of 10 words in each set). In the study, it was found that with increase in intensity level, there was general increase in the number of words correctly repeated in all the sets. Maximum response was noted at SRT+10 dB Where 85% Of the words were repeated correctly.

There warn little difference in the responses obtained by using two lists as seen in the table. Hence the lists are equally difficult and balanced.

Comparison of the results of thia study and studies done earlier it is revealed that (l) falconer (1966) criteria for predicting SRT was the level at which 5 words were repeated correctly (2) Goldman (1971) too confirmed the same criteria (3) Subba Rao (1991), 5 dB below the level at Which subjects repeated 10 words correctly (4) Sadia Sahir (1982) concluded, that the level at which 11 woads are repeated correctly is the predicted SRT In their studies, Ghosh (1987) and Sujatha (1988) observed this as the level at which 5 words are correctly repeated. In this study, the level at which 6 words are re-peated correctly becomes the predicted SRT.

Further, Falconer (1966), Goldman (1971),Subba Rao (1981), Sadia Sahir (1982), Ghosh (1987), Sridhar (1987) observed that the increase in scores with the increase in presentation level. Stmilar also i.e. in general discrimination scores seem to increase as the intensity level increases.

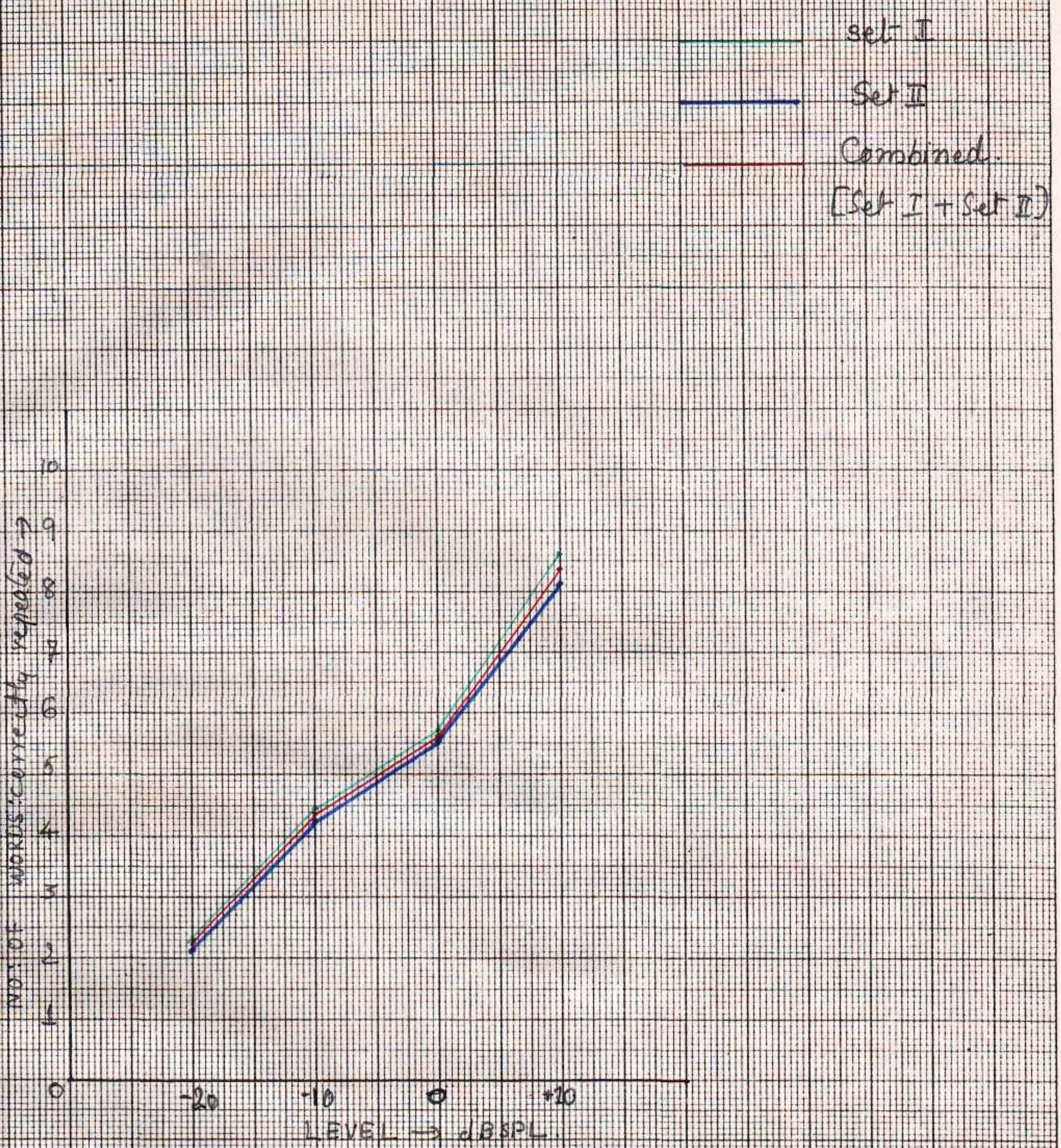
Discrepancies between the highest scores obtained at SRT + 10 is almost in agreement with earlier studies e.g. In Sadie's (1982) study, it was 14.36; in Subba Rao (1981), it was 12.25, and according to Falconer (1966), it was 16.1. These studies had 20 words in each set. If the scores of Falconer (1966) and this study are converted in percentage, the scores are in agreement.

The lowest scores at SRT-20 dB is also comparable to the results obtained in the previous studies.

The test can be administered binaurally or monoeurally (Goldman 1971, and Falconer, 1966). The articulation gain function is drawn and it is indicative of use of any list,

Thus lip reading test can be administered in cases where unexplainable audiological controversies occurs to predict the SRT in monoaural or binaural pseudohypacusis cases.

	L_1		L_2		L_3		L_4		Average		Combined
	SET A	SET B	SET A	SET B	SET A	SET B	SET A	SET B	SET A	SET B	SET A - SET B
I_1 SRT+10	8.67	8.67	8.34	7.67	8.67	9.0	8.67	7.67	8.59	8.15	8.37
I_2 SRT+0	5.67	5.34	5.34	5.34	5.67	4.3	5.67	5.69	5.59	5.66	5.63
I_3 SRT-10	4.33	4.67	4.67	4.0	4.3	4.67	4.3	4.0	4.4	4.34	4.37
I_4 SRT-20	1.67	2.67	3.3	1.3	2.3	2.67	2.0	2.0	2.32	2.16	2.24



ARTICULATION-GAIN FUNCTION.

SUMMARY AND CONCLUSIONS

The test "Falconer's lip reading test in Malayalam" is based on Falconer's (1966) lipreading test in English, which was used to predict SRT in pseudohypacusis cases.Subbarao, (1981), Sadia Sahir (1982), Ghosh (1987), Sridhar (1987) and Sujatha (1988) developed thia test in Indian languages - Kannada, Hindi, Bengali, Tamil and Telugu. The purpose of this study was to develop this test in Malaymlam language.

The test consists of 20 sets of four homophenous words. The sets are divided into eight lists of ten words each. Each word has its homophenous counterpart in other three lists of that form.

Twelve normal subjects were taken for this study. They were divided into four groups, each group containing three subjects. The subjects of the same group are tested in the same manner. It was emphasized that their lip reading ability is being evaluated. Testing was done in a sound treated two-room situation. A two-channel audiometer GSI-16 was made use of for the testing.

Responses were noted baaed on the four levels of presentation i,e. SRT+10 d8; SRT+0 dB; SRT-10 dB and SRT-20 dB. The criteria that was developed to predict SRT using this tedt was the level at Which six words are repeated correctly. The results and the scores are shown in the Table (Page.57). An articulation gain function graph is also plotted.

Higest repetition score was obtained at SRT+10dB level, where 90% of the words were repeated correctly. With increase in intensity level, there was general increase in the number of words correctly repeated. These findings were found to be in agreement with the results obtained by Falconer (1966), who developed the original test in English. Since there is not much difference between the sets, any set can be used for the prediction of SRT.

Recommendation

1. Development of this test in all other Indian languages.
2. The test should be conducted with clinical population for validation.
3. The recommended prediction for SRT is level at which five or six words correctly repeated.

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APPENDIX

WORD LISTS.

LIST-I

Set-I

pādam	പാടം
tattə	തട്ട്
pālam	പാലം
pana	പന
jalam	ജലം
talam	തലം
paṇam	പണം
tʃaja	ചായ
tʃatti	ചട്ടി.
nāgam	നാഗം.

Set-II

paṯa	പത
varam	വരം
pallə	പല്ല്
puṇṇə	പുണ്ണ്
ṯinnə	തിന്ന്
veḷḷam	വെള്ളം
ṯaḷam	തളം
palli	പള്ളി
maṇi	മണി
minnə	മിന്ന്.

LIST-II

Set-I

pāṭa	പാട
tʃalam	ചലം
nākam	നാകം
balam	ബലം
tiṭṭə	തിട്ട്
jāya	ജായ
ni:lam	നീലം
pa:lam	പാലം
maṇam	മണം
tʃetti	ചെട്ടി.

Set-II

vāram	വാരം
ninnə	നിന്ന്
vaḷḷam	വള്ളം
tālam	താലം
pana	പന
mannə	മണ്ണ്
panni	പന്നി
paṇi	പണി
puttə	പുട്ട്
mallə	മല്ല്.

WORD LISTS

LIST-III

Set-A		Set-B	
māla	മാല	pāṯa	പാത
ḏānam	ദാനം	madi	മടി
nattə	നട്	paṯhù	പത്ത്
piṇam	പിണം	vanam	വനം
rāgam	രാഗം	vaṇṇam	വണ്ണം
tʃitti	ചിട്ടി	nāṇam	നാണം
tʃʰaya	ഛായ	millə	മില്ല്
pʰalam	ഫലം	malli	മല്ലി
mādam	മാടം	muttə	മുട്ട്
jaːlam	ജാലം.	ṯhannə	തണ്ട്

LIST-IV

Set-A		Set-B	
janam	ജനം	vanam	വാനം
nakham	നഖം	nann	നന്
jaya	ജയ	vanam	വനം
māḷam	മാളം	pana	പാന
bāla	ബാല	ninam	നിന്
nāḏam	നാദം	maṯṯə	മറ്റ്
pʰaṇam	ഫണം	paṯṯi	പറ്റി
netti	നെററി.	puḷḷə	പുള്ള്
malam	മലം	minnə	മിന്ന്
nīttə	നീട്.	padi	പടി.