FALCONER'S LIPREADING TEST IN TAMIL LANGUAGE

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An Independent project submitted as part fulfilment for
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TO MY DEAR
AMMA AND APPA
SIDDU AND SUHRIT

CERTIFICATE

This is to certify that the Independent Project entitled; "Falconer's Lipreading Test In Tamil Language", is the bonafide work in part fulfilment for the degree or Master of Science (Speech and Hearing), of the student with Register No.8612.

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CERTIFICATE

This is to certify that the Independent Project entitled: "Falconer's Lipreading Test in Tamil Language" has been done under my supervision and guidance.

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DECLARATION

This Independent Project is the result of my own work done under the guidance of Dr.M.N.Vyasamurthy, Dept. of Audiology, All India Institute of Speech and Hearing, Mysore, and has not been submitted earlier at any University for any other Diploma or Degree.

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Dated: May 1987

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INTRODUCTION

It is not an uncommon situation for an audiologist to attempt to make the most of available diagnostic skills when he encounters a patient in whom there exist discrepancies between observed behaviour and audiometric findings but no organic condition is apparent, such a patient may be well motivated, physically and mentally alert for the test but yet may deliberately feign or exaggerate a hearing loss for personal gain or exemption or fail to respond accurately because of a psychogenic disorder. The subject of functional hearing loss has over the years received and needs further, increasing attention from the audiologist.

Functional hearing loss has been best defined by Ventry and Chaiklin (1962) as "the appropriate diagnosis when there are audiometric discrepancies and/or discrepancies between observed behaviour and audiometric findings and when no apparent organic condition can be found to account for the discrepancies". Controversy regarding usage of terminology still exists as not all audiologists and other specialists concerned with hearing use the term 'non-organic hearing loss'. Chaiklin and Ventry (1963) stress the use of the term 'functional hearing loss' as it is more meaningful and operational. Martin (1981) comments that, while the term 'functional' may be used for any kind of non-organic disorder, the term 'pseudohypacusis' relates specifically to hearing. Such differences apart, the need for clinical tests to measure organic thresholds of such patients has been felt by audiologists all over the world.

The primary purpose of special tests for pseudohypacusis is to provide information about the patient's hearing even in cases where cooperation is lacking. Such tests provide, qualitative and quantitative information about hearing by making use of pure tones or speech stimuli by means of diagnostic audiometers or other special equipment.

Lipreading ability has been used as a tool in detection of functional hearing loss. It can be checked by using minimal visual cues, eliminating voice or switching to whisper or continuing conversation by turning away from the patient (Feldman, 1967). Falconer (1966) found that in patients with functional hearing loss, the claim of getting along well in ordinary conversation using lipreading would not be possible and require at least some use of hearing.

The lipreading test developed by Falconer (1966) contains auditory as well as visual stimuli and consists of monosyllabi homophenous words which are nearly impossible to perceive by lipreading alone. The patient does not know this and as expected correct responses as a result of audition would make him a 'victim' of his 'lipreading ability' and hence inadvertently reveal some degree of hearing loss.

Goldman (1971) found the test to be useful in determining organic hearing threshold levels with the predicted SRT relating closely to standard pure tone and speech measures.

Subba Rao (1981) and Sadia Sehar (1982) worked on the lines of Falconer (1966) and developed lipreading tests in Kannada and Hindi languages. Both concluded that such tests would help in predicting SRT, which very closely corresponded to the true SRT in normals and in sensorineural loss patients. They indicated that similar tests may be constructed in other Indian languages.

Need for the study:

Since, there is a need to identify pseudohypacusis in Tamil speakers particularly monolinguals, the present study was carried out.

Plan of the study:

The study was designed to develop the test material in Tamil language and standardize the test material in normal hearing Tamil population.

REVIEW OF LITERATURE

2.1 Introduction:

Not every patient seen in the audiology clinic is fully cooperative during the hearing evaluation. This lack of cooperation may be because the patient (1) does not understand the test procedure (2) is poorly motivated (3) physically or emotionally incapable of appropriate responses (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 because of unconscious motivation.

Many terms have been used to describe a hearing loss which appears greater than can be explained on the basis of the pathology in the auditory system. The most popularly used terms in the literature today are "pseudohypacusis", "psychogenic hearing loss" and"malingering*. Martin (1978) supports the use of terms "pseudohypacusis" and "nonorganic hearing loss" because of their specific reference to hearing loss. Ventry and Chalklin (1962) have attem ted to resolve confusion in terminology by using the term 'functional hearing loss' which is neither the antonym of 'organic' nor the synonym for 'psychogenic'. Many audiologists use the terms interchangebly tg. Martin (1978) uses the terms 'pseudohypacusis' and 'nonorganic hearing loss'.

2.2 Pseudohypacusis in adults:

One of the factors which may encourage a person to feign a hearing loss or to exaggerate an existing hearing loss is financial gain. Altshuler (1982) reports that a significant amount of stress is directly attributable to economic instability.

Other factors which may contribute to pseudohypacusis are psychosocial and Include the wish to avoid indesirable situations. There may be many other gains which the individual may feel are afforded to 'hearing handicapped persons, including excuses for lack of success advancement in position, poor marital situation and so on' (Altshuler, 1982).

The number of persons with pseudohypacusis is increasing since implementation of federal laws regarding hearing safety in the workplace. The promise of financial reward is bound to be a factor precipitating pseudohypacusis in workers who are in danger of incurring noise induced hearing loss.

Trier and Levy (1965) studied the social and psychological characteristics of adult males with pseudohypacusis. The non-organic group achieved lower scores on all measures of current socio-economic status and also score significantly lower on verbal intelligence measures and showed a greater number of clinically significant emotional disturbances as hypochondriasis. These findings support earlier studies which state that such adults manifest a reliance on denial mechanisms, have a diminished sense of self-confidence and feel some gain on appearing to be hearing-impaired.

There still exists controversy over whether a non-organic hearing loss may be psychogenic at all or whether all thresholds are exaggerated towards personal gain. Beagley and Knight(1968) stated that psychogenic deafness is rare but exists and can be diagnosed by paying careful attention to the criteria. Goldstein (1966) argues that if such hearing loss exists, lower thresholds should be found on electrophysiological tests and hearing impro-ment should follow psychological treatment. Therefore he believes that all nonorganic losses are consciously simulated (malingered) and are not psychogenic. Ventry (1968) disagrees with Goldstein (1966) and feels that since the term 'psychogenesis' does not separate conscious from unconscious behaviour, if there is some psychological origin, it is by definition psychogenic. Cohen et al (1963) postulated that individuals who present inconsistent results on hearing tests may be influenced by psychodynamic factors. Gleason (1958) feel that in may cases of pseudohypacusis the problem is on an unconscious level in order to gain a favored goal, or to explain to society that the patient is blameless for inadequate social behavior. From this point of view, exaggerated hearing loss may be one symptom of personality disturbance.

Katz(1980) cautions that certain neurologic problem can appear to be nonorganic in nature. For example, one patient who initially responded on pure tone evaluation between 40 and 70 dB HL and eventually at 20 dB HL is reported to respond to spondees at 15dB. This patient was by no means a malingering nor psychogenic. Rather he was a volunteer for a study because he was terminally ill with a tumor of corpus callosum.

2.3 Pseudohypacusis in children:

A number of case reports of pseudohypacusis in children appear in the literature. Dixon and Newby (1959) reported on 40 children between ages of 6 and 18 years with pseudohypacusis. Recently McCanna and DeLapa (1981) and many other audiologists report cases with marked exaggeration of hearing thresholds for pure tones in the presence of normal speech reception thresholds.

There are also cases of apparent malingering with psychologic undertones. Bailey and Martin (1961) reported a boy with normal hearing sensitivity who manifested a great many nonorganic symptoms and deliberately attempted to create an impression of a hearing loss so as to gain admission into a residential deaf school, where his parents were teachers. Further investigation revealed that the boy was poor student in a high school for normal hearing students. Halewell et al (1966) described a 13 year old boy who revealed essentially normal hearing under hypnosis though he pretended to have a bilateral severe hearing loss.

Cases of presumed psychogenic hearing loss have also been documented. Lumio et al (1969) felt that such hearing losses may be due to family conflicts. Barr (1963) reports 32 cases whose pure tone thresholds were in the 60dB - 80dB range but speech reception thresholds significantly bettwe who were of normal intelligence but had poor school performance. Since they came from highly scholastic backgrounds, they consciously or unconsciously tended to feign a hearing loss so as to explain poor academic achievement. Such secondarygains may also be used by other such children who fail school screening tests. Several authors (Ross, 1964; Miller et al 1968) have stressed the need to uncover nonorganic hearing losses before referrals are made.

Pseudohypacusis in children appears to occur with sufficient frequency to cause concern. Performance or supervision of hearing tests on young children by an audiolcgist may serve to avert what may later develop into serious psychologic or educational difficulties. On the other hand, the audiologist should be alert to the possibility that the problem uncovered may be one of auditory perception and not true hearing loss (Wieczorek, 1979).

2.4 Indications of pseudohypacusis

2.4.1: The nontest 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 a client's sudden loss of hearing, it is only natural to suspect that nonorganicity may play a role in test results. This is also true of veterans referred for hearing tests, the results of which decide the amount of monthly pension. Pseudohypacusis must be on the minds of clinical audiologists or they may miss some of the symptoms which indicate its presence.

A case history is always of value, but is particularly valuable in compensation cases. It is obviously beneficial for examining audiologists to observe not only responses to questions but also the manner in which responses are offered. The patient may claim an over reliance on lipreading may ask for inappropriate repetitions of words and constantly, readjust a hearing aid. Exaggerated or contradictory statements of difficulty or discomfort, vague descriptions of hearing problems, volunteering of unasked for supplementary information are symptomatic of pseudohypacusis. Sometimes exaggerated action as watching every movement of the speaker's lips or cupping a hand over the ear may be evident but information should be weighted carefully.

2.4.2: The test situation;

During the hearing examination, the pseudohypacusis patient is frequently inconsistent in test responses. A certain amount of error is expected in any individual; however, when the magnitude of this variability exceeds 10 dB for any threshold measurement, one should consider the possibility of non-organicity.

Two types of patient errors commonly seen in clinical pure—tone testing are the false positive and false negative responses. When the subject does not respond at levels at or slightly above true thresholds this constitutes a false negative response. False negativeresponses are, characteristic of pseudohypacusis. Frequently the highly responsive patient will give false positive responses signalling that a tone was heard when none was presented at or above threshold. False positive responses, though often annoying are characteristic of true hearing loss. Feldman (1962) points out that the patient with pseudohypacusis does not offer false positive responses during silent periods on pure tone tests. Chaiklin and Ventry (1965a) found that only 22% of their group of adult subjects with nonorganic hearing loss gave a "false alarm" while 36% of those with organic loss gave such false responses. Thus one simple check for non-organicity is to allow silent intervals of a minute or so from time to time. A false alarm is more likely to indicate that the patient is trying to cooperate and believes that a tone was introduced. Extremely slow and deliberate responses may be indicative of a non-organic problem since most patients with organic hearing loss respond relatively quickly to the signal particularly at levels above threshold (Wood et ai, 1977).

2.4.3: The audiometric configuration:

A number of author have suggested that an audiometric pattern emerges Which is consistent with pseudohypacusis some have described this pattern as a relatively flat audiogram showing an equal amount of hearing loss across frequencies (Semenov, 1937; Fourier, 1958). Others have suggested that the saucer shaped audiogram. Similar to a supraliminal equal loudness contour is the typical curve illustrating non-organicity (Doefler, 1951; Carhart, 1958? Goetzinger and Proud, 1958). On the other hand, Chaiklin et al (1959) observed that saucer shaped audiograms can also be seen intrue organic hearing losses and that these curves are seen infrequently in nonorganic hearing loss. They concluded that there is no typical pure tone configuration associated with nonorganic hearing loss. Since the patient with non-organic hearing loss may attempt to give responses that are of equal loudness at all frequencies, ignorance of the manner in which loudness grows with respect to intensity at different frequencies does suggest that the result could be a saucer shaped audiogram.

In a study of 64 men with non–organic hearing loss and 36 men with true organic hearing loss, Ventry and Chaiklin(1965) asked a panel of three experienced audiologists to judge the configurations of the audiograms. Saucer shaped curves appeared in only 8% of the non-organic cases and were also seen in true organic losses. This research indicates, as many experienced audiologists have observed, that the saucer audiogram has limited ability in identifying pseudohypacusis.

2.4.4: Test-Retest-Reliability:

One indication of non-organicity is lack of consistency on repeated measures. Counselling the patient about his inaccuracies may encourage more accurate responses; however if this counselling is done in a belligerent way, it can hardly be expected to increase cooperation. Sometimes a brief explanation of the test discrepancies improves patient cooperation. By withholding any allegations of guilt on part of the patient the audiologist can assume personal responsibility for not having conveyed the instructions properly. This provides a graceful wayout for many patients, even if they are highly committed to nonorganic hearing loss. Berger (1965) found that some children can be coaxed into "listening harder" thereby improving results on pure tone tests.

2.4.5; <u>The shadow curve</u>:

It is generally agreed that a patient with a severe hearing loss in one ear will hear a test tone in the opposite ear if the signal is raised to a sufficient level during a pure tone test. For an air conduction signal, the levels required for contralaterization range from 40 to 70dB depending on frequency (Zwislocki, 1953). The interaural attenuation, the loss of energy of sound due to contralaterization is much less for bone conduction (interaural attenuation to 20dB at higher frequencies) If a person has no hearing for air conduction or bone conduction in one ear, the audiogram taken from the bad ear would suggest a moderate conductive loss. Unless clinical masking is applied to the better ear, a "shadow curve* should be expected.

It may seem advantageous to a patient feigning hearing loss to claim that loss in only one can since normal activities can be carried on for the unilatarally hearing impaired individual without any special speech reading abilities. The naive pseudo-hypacusic patient may give responses indicating no hearing in one ear and very good hearing in the other ear. This lack of contralateral response, especially by bone conduction, is a very clear symptom of unilateral non-organic hearing loss and offers a good reason why all patients should be tested initially without masking, even if it appears obvious at the outset of testing, that masking will be required later in the examination.

2.4.6! SRT and Pure tone average disagreement;

The speech reception threshold (SRT) is generally expected to compare favourably with the best two of the three thresholds obtained at 500Hz, lOOOHz and 2000Hz (Siegenthaler and strand, 1964). Lack of agreement between the pure tone average (PTA) and SRT, in the absence of explanations such as slope of the audiogram or poor word discrimination (Noble, 1973) is symptomatic of non-organic hearing loss.

Carhart (1952) was probably the first to report that in confirmed cases of non—organic hearing loss, SRT in lower (better) than the PTA. Ventry and Chaiklin (1965) reported that the SRT - PTA discrepancy identified 70% of their patients with confirmed pseudohypacusis; in each case the SRT proved to be atleast 12dB lower than the PTA.

The lack of SRT - PTA agreement is often the first major symptom of pseudohypacusis persons exaggerating their thresholds undoubtedly use some kind of a loudness judgement to maintain consistency throughout testing. In attempting to remember the loudness of a suprathreshold signal, previously responded to one might easily become confused between pure tone and spondaic word levels.

Little research has been carried out to explain why the discrepancy generally favors the SRT. It might be that the loudness of speech primarily associated with its low frequency components. According to the equal loudness contours; the low frequencies grow more rapidly than tones in the speech frequencies. This speculation is supported by the work of McLennan and Martin (1976), who concluded that when pure tones of different frequencies are compared in loudness against a speech signal, the difference between them is a function of the flattening of the loudness contours. Ventry (1976) explain the difference between the sensation of loudness for speech and pure tones on the basis of their different sound pressure level references.

2.5 Test sequence:

Pseudohypacusic patients attempt to set a level above threshold as a reference for consistent suprathreshold responses (Hood et al, 1964; Ambrustor, 1982). For this reason, threshold tests should be performed before suprathreshold tests. Since structured tests (greater examiner participation) tend to lead to less hearing loss exaggeration than nonstructured tests (eg. Bekesy audiometry).

Armbruster (1982) suggests the following test order when examining patients with suspected pseudohypacusis:

1. SRT (including speech Stenger, if indicated)
2. Air conduction thresholds (including stenger, if indicated)

3. Word discrimination (initially done at low sensation levels)
4. Bone conduction thresholds
5. Other threshold, suprathreshold and immittance measures.

This test sequence has merit, but each clinician will develop skills and styles which will dictate alternative approaches.

Standardization of tests for detecting and quantifying functional hearing loss has been focus of attention for the audiologist. However still there exist several areas where more information is needed and quite obviously and review of different tests used in the clinic call for interesting speculation and criticism in the following sections.

2.6 Qualitative pure tone teats for detectiontof pseudohypacusis

2.6.1: Automatic audiometry:

Jerger (1960) demonstrated the usefulness of Bekesy audiometry for determination of focus of auditory lesion by comparing the threshold tracings obtained with continuous and periodically interrupted tones. Jerger and Herer (1961) added a new Bekesy pattern for nonorganic hearing loss called Type-V to the earlier four organic diagnostic types. Here the tracings for interrupted tones show poorer hearing than for continuous tones. These kind of tracings have also been reported by Resnick and Burke (1962), Stein (1963) and Peterson (1963).

Rintelmann and Carhart (1964) suggests that the type-V tracing is related to patient's own internal standard for most comfortable loudness or to his recalled loudness for a sustained tone. Hattler (1958) indicated that the type-V tracing may be attributed to differential effects of memory upon the loudness of sustained and interrupted tones. In any case, normal hearing subjects require greater intensify for interrupted tones to match the loudness of continuous tones.

Hattler (1970) altered the normal pulsed-tone duty cycle (200m.sec on, 200 m.sec off) and called this the lengthened off time test (LOT). The test has the effect of increasing the tracing level of interrupted tones for nonorganic patients but has no effect on tracings of normals or organic patients LOT identified 95% of a series of non—organic cases while Type-V tracings using the standard 50% duty cycle identified only 40%.

Rintelman and Harford (1967) feel that the type-V Bekesy classification should be based on sweep frequency rather than fixed frequency tracings. They define the type-V as a separation of pulsed and continuous tracings for at least 2 octaves with a minimum 10 dB separation between mid points. Using these criteria they found type-V tracings in no normal hearing subject, 2% of conductive loss subjects, 3% of S.N.loss subjects 76% of their non-organic group. Hence such strict criteria would help better identification of pseudohypacusis.

To add greater difficulty in Bekesy tracings for pseudo-hypacusis patients. Hood, Campbell and Hulton (1964) developed

BADGE (Bekesy Ascending Descending Gap Evaluation). This procedure involves a comparison of the differences between the following 100Hz discreto frequency Bekesy types:-

1. Continuous tone with tracing begun well below threshold
2. Pulsed tone with the tracing begun well below threshold
3. Pulsed tone with the tracing begun well above threshold

Che functional hearing loss group most commonly display readily visible gaps between the ascending and descending tracings than do the organic group. Hood considers this to happen as the patient's yardstick is destroyed.

The effects of sophistication and practice on type-V tracings were recently studied (Martin and Monno, 1975). In three groups of normal hearing subjects simulating a hearing loss, the LOT procedure was consistently superior to standard off time (SOT) in the dictation of type-V patterns. Subjects who were familiarized with the principle of the type—V pattern did better than those who were not informed. The third group with practice were able to produce organic types. The authors recommend that in case of suspected pseudohypacusis, both the continuous and pulsed pure tones should be compared to increase the efficiency of the test. The practice and sophistication may assist the motivated subject to avoid a type-V pattern when a hearing loss is simulated.

A high incidence of type-V tracings reported among otherwise cooperative listeners unaccustomed to Bekesy audiometry suggests that this type of tracing may not be a good indicator of pseudohypacusis (Hopkinson, 1965? Stark, 1966). since, Shepherd and Goldstein (1965) offer a psychological but not necessarily psychopathological explanation for the tracing. Istre and Buton (1969) report very wide pen excursions (swings) in patients with pseudolpypacusis though swing width may also be determined by factors such as reaction-time and personality.

Arguments over the usefulness of Bekesy audiometry continue but LOT and BADGE tests are of great value even though they do indicate the true threshold the type-V tracing therefore suggests non-organicity and the need for further tests.

2.6.2: Pure tone tests with ipsilateral masking:

(1) Modified Boerfler Stewart Test for pure tones:

Most subjects find it difficult to maintain consistent suprathreshold responses to auditory signals in the presence of several levels of noise in the same ear. This known difficulty was the principle of the Doerfler-Stewart Test (1946) which uses spondaic words in the presence of sawtooth noise Martin and Hawkins (1964) modified the Doerfler-Stewart test for use with pure tones, finding it useful in discovering non-organic hearing disorders. For the procedure to be of value the clinician must know the precise effect of noise on pure tone thresholds for pure tones of different frequencies so that he can compare the masking levels which shift the threshold of a tone on normal ears. Their research showed that effective masking levels were same for normals, conductive loss subjects and sensorineural loss subjects.

(2) Tone in noise test (TIN):

This test given by Pang-Ching Glenn in 1970 is a modification of the D-S test. The test examines an individual's ability to respond to pure tone in the presence of a masking noise and has only one criteria measurement, the difference between thresholds in quiet and noise (Pang-Ching, 1970).

Here first threshold T, is obtained in ascending method. With the intensity at T_1 + 5, wide band noise is introduced suddenly at lOdB above the (T_1+5) level. Again threshold is obtained with a interrupted tone.

(3) Sensori—neural acuity level (SAL) Test:

Designed by Jerger and Tillman (1960) to be used in lieu of bone conduction audiometry in determining sensorineural sensitivity, Rintelmann and Harford (1963) found that it also proves helpful in identifying non—organic hearing loss. They found in 10 children with pseudohypacusis, air-SAL gaps without conductive loss consistent with other test findings.

2.6.3: Miscellaneous pure tone tests for detection of Pseudohypacusis:

Most of the following tests are based on confusing the patient so that he cannot recall a previously established level at which he responded to an acoustic signal.

(1) Ascending-Descending Audiogram:

Harris (1958) suggests that a difference of greater than

10dB (25 to 30dB) between the two thresholds obtained by using the ascending and descending methods is indicative of functional hearing loss. For patients with pseudohypacusis, it is a consistent procedure and Ken, Gillespie and Eastern (1975) suggest that the test is improved if the descending procedure is carried out in 10dB rather than 5dB steps.

(2) Count and Recall Procedures:

Some tests may be carried out by presenting a number of pure tone pulses is rapid succession and asking the patient to count and recall the number of pulses he heard. The intensity of tones may be varied above and below the admitted threshold of the tone in one ear (Ross, 1964) or above the threshold in one ear and below the threshold in the other (Nagel, 1964). If the originally obtained thresholds are valid, there should be no difficulty in counting the pulses. Inconsistency should only occur if the tone pulses are above threshold and the patient has to sort out the number of louder ones from the softer ones. This can be very difficult for the patient.

(3) Gaynor (1974) suggested a procedure which requires that the patient be tested for pure tone thresholds in the normal fashion and then while humming audibly and inaudibly. The humming produces masking and elevation of the threshold in subjects with normal hearing. However such procedures need to be done for a larger number of cases with pseudohypacusis.

(4) 250Hz BC Vibrator Test:

Used for a patient who shows no response to audiometry so we use an audiometer that produces 250Hz BC tone at 50dB HL.

Place BC vibrator on finger joints. Condition the case to give response to vibration.

Place BC vibrator or elbow joint, c3avicle joint and finally on mastoid.

If no response =) Pseudohypacusis

If response + =+ pseudohypacusis still cannot be ruled out

2.7 Pure tone tests which quantify pseudohypacusis:

The following tests suggest and identify the thresholds of the pseudohypacusic patients:-

2.7.1:The Stenger test:

One of the best tests to detect and quantify unilateral functional hearing loss, it is based on the Stenger principle which states that when two tones of same frequency are introduced simultaneously into both ears only the louder tone will be perceived. Altshuler (1971) feels that with sophisticated instrumentation, the Stenger test is useful even with bilateral cases.

Methods of test presentation can be divided into the following classes (Altschuler, 1971):-

1. Involves qualitative and quantitative methods:-

Qualitative tests are mainly screening tests for non-organicity (Ballantyne, 1960; Heller, 1955 cited by Altshuler, 1971). If qualitative test is positive, many continue to test with a quantitative method (Goebzinger and Pround, 1958; O'Neill and Oyer, 1966). Here the Signal is presented to better ear at near threshold level and to the poorer ear at 20dB above level in better ear. If the subject does not respond at all, we presume that he hears the tone presented to the poorer ear. Usually the quantitative methods approximate the thresholds of the individual.

2. Involves qualitative methods and uses an ascending or descending signal presentation to the poorer ear.

Peck and Ross (1970) compared ascending and descending modes with respect to interference levels (IL). No trend was seen for either mode to yield smaller ILs and mode was not a relevant factor. When the subject does not respond to a tone in the poorer ear when it is supposed to be heard, Stenger test is said to be positive. It is suggested that by using both methods, a valid threshold can be estimated.

3. Use or lack of use of 'a fading tone':

Tone in the good ear is taken off, either suddenly or gradually, after increasing the tone in the poor ear. If the subject continues to respond, then the tone is heard in the poor ear and hence the patient is trying to beat the test.

Factors that affect Stenger test:

1. Diplacusis: Can invalidate the test. However Chaiklin and Ventry (1963) that this may be an overrated factor since, when

a critical point is passed regarding perceived loudness, small pitch differences could be observed by the Stenger effect. It is suggested to use a speech Stenger test or narrow band noise for the Stenger test as suggested by Altshuler (1971).

2. Recruitment: Can provide misleading results, but is a rare occurence in cases of strict unilateral loss though while dealing with a bilateral case, recruitment is more than a minimal consideration.

3. Intensity relations between ears: Larger the difference between ears, the more effective and valid is the Stenger test The size of the functional component in the better ear is also an important factor (Altshuler, 1971; Kenstlen et al 1972).

4. Miscellaneous factors: The three speech frequencies are probably the most valid to use with the Stenger (Heller, 1965; Altshuler, 1971). Ear pathology and contralaterization may also have effect (Altshuler, 1971).

Modifications of pure tone Stenger Test:

1. Rapid Random Loudness Judgements (RRLJ): Based on Fowler's ABLB test, it differs in purpose and presentation. Here after obtaining the patient's voluntary pure tone threshold and SRT in each ear, the patient is asked to say which of the two alternately presented tones is louder. The tones are presented in rapid succession and the sensation levels and ear of presentation varied though equal time of presentation is to be main-

tained. The evident confusion reflects functional hearing loss, both unilateral and bilateral.

2. Using automatic audiometry: The use of an automatic Bekesy type audiometer for stenger test was first suggested by Reger et al (1963). Watson and Voots (1964) modified this procedure. After establishing thresholds of the better ear, the poorer ear thresholds were traced using a Stenger variable attenuator. Signal intensity decreases or increases as the response knob is manipulated. The test was found to be of high clinical applicability.

3. Fusion Inferred Threshold (FIT): A two-channel audiometer is needed. The tone at the test frequency (eg. 1KHz) is presented to the better ear at 10dB SL and the intensity of the tone in the poorer tar is varied. The case is instructed to respond by raising the right hand if he hears in right ear, left hand if left ear and centre if he hears in the centre of the head - then the intensity of the tone in the poorer ear is increased while the tone in the better ear continues to be at 10dB SL. The level in the poorer ear at which the patient hears in the centre -10dB given the threshold of the poorer ear.

This test is based on the rationale that at equal sensation levels in both ears, the sound image is perceived at the center of the head.

The problems in using this test are that it is often difficult to lateralize the sound, hence practice is to be given and the subject may be able to best the test.

2.7.2: <u>acoustic impedance measurements</u>: Concerning pseudohypacusis, the greatest value of acoustic impedance measurements is the determination of middle ear muscle reflex threshold. Since it is generally agreed that this reflex is produced by the loudness of an acoustic signal rather than its physical intensity, the ellcitation of this reflex at low SLs may suggest a cochlear lesion. If the difference between the reflex threshold and the voluntary pure tone threshold is extremely low (5dB or less) it is difficult to accept ever an explanation of quick loudness recruitment as an explanation for this sudden increase in loudness (Lamb and Peterson, 1967). As an example of this, Feldman (1963) cites a case with an unilateral non-organic hearing loss, with acoustic reflexes observed with the best tone in the 'poor ear' at levels below the patient's voluntary threshold. Tf the audiologist is certain that no artifact contaminates the readings the suggestion that the acoustic reflex can be achieved by a tone which cannot be heard must be rejected and a diagnosis of pseudohypacusis may be made.

More than merely identifying paaudohypacusis, acoustic reflex measurements may be useful in actual estimation of thresholds. Jerger et al (1974) describe a procedure based on the work of Niemeyer and sesterhener (1972) in which the middle ear reflex thresholds for pure tones are compared to those for broad band noise and low and high frequency filtered broad band noise. This procedure called SPAR(Sensitivity Prediction by Acoustic Reflex) may be useful in predicting the degree and configuration of hearing loss.

Reflex measurements alone may not be useful indicators in cases where nonorganic problems overby the mildest conductive problems because of which reflexes may be absent. In such cases tympanometry may prove to be of value. It is often better to perform middle ear measurements as the first test on adults and cooperative children.

2.7.3: Electrodermal audiometry (EDA):

Once the most popular test for pseudohypacusis, EDA has new fallen into complete disuse. Its primary function is to determine pure tone thresholds on patients with suspected pseudohypacusis (Martin and Forbis, 1978).

It is possible for the patient who is knowledgable about the EDA to confound the test in several ways. eg. moving about squirming or coughing will increase the activity of the stylus on the psychogalvanometer, requiring that the sensitivity be decreased causing the actual changes in skin resistance to be more difficult to discern.

Another reason for the abandonment of EDA is the necessity of noxious stimuli such as electric shock as the unconditioned stimulus which is paired with pure tones or speech as the conditioned stimulus.

Unlike the earlier proposed model, EDA is no more accurate and its popularity has shown a steady decline (Knox, 1978).

2.7.4: Evoked Response Audiometry (ERA):

Unlike the EDA, ERA involves no electric shocks or other noxious stimuli and appears a useful tool for determining pure tone thresholds for noncooperative patients (Beagley, 1973) It has been recommended that ERA can be used for all cases of noise induced hearing loss (Heron, 1968) and has even been called the 'crucial'test' in diagnosis of pseudohypacusis (Knight and Beagley, 1970).

As an example of the enthusiasm generated by ERA, Alberti (1970) called the cortical audiometer the most important instrument in detection of pseudohypacusis. He finds that the results obtained from this technique and from voluntary pure tone testing agree within 10dB and recommends the procedure for uncooperative and illiterate patients. Examination of the earlier components of the response by means of BSERA (Brain Stem Evoked Response Audiometry) has the advantage of easy application of surface electrodes plus the fact that the response is stable and repeatable(scharlleman - Galambos and Galambos, 1975). Disadvantages include the necessity of using clicks or transients as stimuli and the fact that the cochlear portion of responses are rarely elicited below 60dB HL. Berlin(1973) feels that BSERA, in combination with electrocochleography; tympanometry and acoustic reflexes, forms a powerful test for noncooperative patients as small children. It seems logical to extend this conclusion to pseudohypacusic patients.

The development of modern techniques for digital averaging allows the recording of synchronous findings in response to low frequency tones, minimizing the disadvantages of BSERA and Electrocochleography that clicks be used as stimuli. This procedure called the frequency following response (FFR) by Marsh and Worden, 1968 may have the potential to be one of the procedures to be used in diagnosis of pseudohypacusls.

ERA has the effect of eliminating or detecting the presence of nonorganic overlays on true organic losses. The mere elaborateness of the procedure along with the suggestion that hearing be measured without patient cooperation may have a determing effect on the malingerer.

Caution should be used in interpreting ERA data by audiologists skilled in its use. Not all audiological centers are provided with such expensive equipment and hence more feasible procedures should be used it such situations.

2.7.5: Electrocochleography (ECochG):

A procedure which has drawn considerable attention in recent years is electrocochleography, the recording of cranial nerve VIII action potentials. The obvious advantage of BcochG in dealing with pseudohypacusis is that actual measurements can be determined with fewer contaminating artifacts that are seen with either EDA and ERA.

Like EDA and ERA, ECochG may be categorized as "Objective" since determinations of hearing may be made without the conscious cooperation of the patient. Until recently the procedure was limited to those patients who could be anaesthetized so that the tympanic membrane could be surgically reflected, exposing the round window. More recently the intratympanic needle electrode has been used to obviate the need for surgery. It is obvious that either procedure could be refused by the patient as being painful or dangerous which could be avoid using suture impregnated cotton with metal disc electrodes (Cullen et al, 1972).

In addition to the fact that responses during ECochG lack frequency information because clicks on transients are the stimuli, limitations are placed by cost of equipment, time required for the test and the skill and training of the examiner.

2.7.6: Delayed feedback audiometry (DFA):

This procedure has its drawback of not revealing the 'true' threshold of the patient with non-organic hearing loss. Ruher and Cooper recommend the following pure tone DFA test for non-organic hearing loss.

Pure tone DFA requires the use of a special apparatus, some variations of which are commercially available. The patient is asked to tap out a continuous pattern such as four taps, pause, two taps, pause etc. After the patient has demonstrated that he can maintain the tapping pattern and rhythm, an audiometer circuit is added so that for each tap, a tone pulse is introduced into an earphone worn by the patient. The tone has a duration of 50 m.sec at maximum aplitude but is delayed by 200 m.sec. from the time the key is tap ed. If the tone is audible its presence causes the subject to vary his tapping behaviour in several ways, such as loss of tapping rythm, a change in the number of taps or an increase in finger pressure on the key.

Ruhen and Cooper (1963) have demonstrated that changes occur in tapping performance at sensation levels as low as 5dB and are independent of test tone frequency and manual fatigue. Once a subject has shown any alterations in key-tapping ability after introduction6f a delayed pure tone must be interpreted as meaning that the tone was heard. Alberti (1970) found tapping rythms was disturbed in general at 5 to 15 dB above threshold but has observed variations as great as 40dB. Though, requiring practice, the pure tone DFA procedure is considerably less time consuming and involves use of no noxious stimuli.

2.8.1 Qualitative speech Tests:

2.8.1: Doerfler - Stewart test (D-S Test):

The DS test compares responses to speech versus noise. Most listeners will continue to respond even when noise is presented at a level 10 to 15 dB more intense than speech. The nonorganic patient tends to stop responding even when the noise is less intense than speech.

While several kinds of noises have been used in the D-S test, the essential element is that the greatest energy is found in the 125Hz to 500Hz range in order to be an effective marker for speech (Hopkinson, 1978). The procedure is as follows:-

1) Obtain a binaural spondee threshold using an ascending method (SRT_1).
2) Raise the level of speech by 5dB to allow for 100% discrimination of spondees (SRT_1+5).
3) Starting at OdB HL, raise the level of the noise in both ears in 5dB increments, each time a spondee is spoken until the patient stops repeating the spondees. This is the noise interference level (NIL).
4) Continue to raise the level of the noise in 5dB steps to a level 20dB above the NIL, presenting one spondee at each level.
5) Lower the level of the spondees in 5dB steps, presenting one word for each decrement until a level below 15dB below the SRT_1 is reached.
6) Decrease the level of the noise in 10dB steps each time a spondee is spoken until NIL isreached and then in 5dB steps until the lowest hearing level dial setting.

7) Determine a second spondee threshold in the same manner as Step(l) - SRT_2 .

8) 'Find' the binaural threshold for noise using an ascending 5dB method. This is the noise detection threshold (NDT).

The D-A test must be performed by an examiner experienced in rapid live voice audiometry. Date should be recorded on a special form as mentioned below. At the completion of the test, comparisons are made among the results and the D-S test is considered positive for pseudohypacusis if the norms are exceeded on two measures.

FORMS FOR USE IN D-S TEST

A. Test results	SRT_1	SRT_1+5	NIL	SRT_2	NDT
B. Test differences	SRT_1-SRT_2	SRT_1-NDT	SRT_2-NDT	SRT_1+5-NIL	NDT-NIL
Normal values	-4 to +5	-7 to +15	-7 to+15	-18 to +3	-31 to -2

Using the D-S test, Ventry and Chaiklin (1965) considered the absence of positive (suspicious) difference scores as a negative result; one positive difference score equivocal. Based on their findings, they suggest that the value of the measures is only when there is an overall classification of positive or negative outcome. Menzel (1960) described the efficiency of the D-S test when used early in the battery of tests.

The Doerfler-Stewart test has universality because of the norms. Within the clinic, normative data make classification possible while outside, normative data make possible a communication with the referral source.

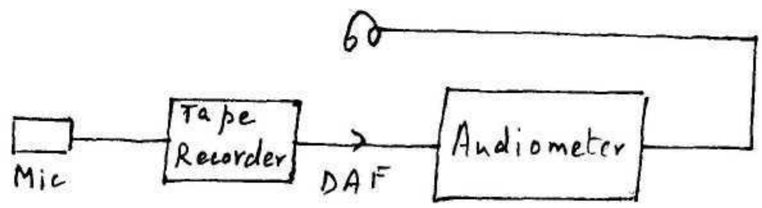
2.8.2: <u>Delayed Auditory Feedback Test (DAF):</u>

Black (1951) found that if there is a 1/8 sec delay between time of reading aloud and hearing the playback, the effects of side tone on the speaker-reader were quite marked? at ¼ sec, effects were still present but at 1/15 of sec. delay, little or no effect was noted. This he described as changes in vocal rate and intensity as a result of the subject's hearing his own voice delayed in time.

A tape-recorder reproduce is necessary to give the test The spacing of the recording and play back heads makes it possible to insert a delay between what the speaker monitors from his kinesthetic movements during oral reading and what he monitors from his speech through earphones. A variety of delay times makes the instrument more versatile. A monitor meter to observe change in vocal intensity and a stop watch to record the reading rate add objectivity.

Most studies have been done on subjects with normals or on persons pretending to have nonorganic losses (Chaiklin and Ventry, 1963). Investigators reporting on DAF have stressed that a great deal of individual variations have been shown inresponse to feedback and in general, the test is not helpful in obtaining a quantifiable threshold.

<u>Procedure:</u> Hanley and Tiffany (1954) suggest a procedure which makes use of the following instrumentation for a 0.68 sec delay.



The microphone is adjusted so that the patient cannot readily more away from it. Instructions to the patient are brief. He is to read the passage again and again, when told after the earphone are put on. The first reading rate is noted without feedback. A second baseline reading without feedback but with the recording device on is noted so that he can see it operating. A Volume - Unit (VU)meter is useful too monitor volume. A third pretest reading is obtained in the same way as the first reading. The next time the patient needs the passage, the equipment is set 10dB above the normal OdB intelligibility level with a feedback delay of 0.18 sec. This reading is followed by the noise by lOdB steps until the patient experiences obvious difficulty in reading. Each time the VU meter reading should be noted for comparison.

Next delay time should he switched to a different value if there is a doubt, that control of reading rate at low feed back levels occurs. Also simultaneous feedback may be used to compare with the delayed reading. Using the above procedure, a change in reading rate of 3 sec. or greater is considered a significant effect of the delay when the base line for comparison is an average of the first three pretest readings. Other report a change of 3.5 sec. as significant for a threshold measure when a speech-line analyzer is used (McGranahen et al, 1960).

If the reader did not show facility with the reading passage at the beginning of the test and the clinician believes that the post test reading without delay is a more accurate indicator of his reading ability the final reading may be used as the basis for comparison. The reading rate is usually slower under a delayed condition than under the base condition.

2.8.3: Modifications of conventional speech tests:

1. Three spondaic words: The patient is instructed that two syllabled words will be said in groups of three, after which the clinician will wait for all three to be repeated. Emphasis should be placed on remembering and repeating all three of the words. The method is begun at approximately 4dB above admitted threshold. The cooperative patient will repeat all three spondees at each level until he is not able to hear them. The less cooperative patient responds in a variety of ways. The most frequent response is to say one spondee of the three. At the beginning the clinician should take some time to ask the patient, if he could not remember all three words. Under these conditions, the

clinician may become aware of the range below the admitted threshold, in which the patient continuousto find speech intelligible. He may then initiate a retest of SRT beginning at a lower level.

2. Monosyllables at low sensation level: When the SRT's are discrepant from other threshold measures, phonetically balanced monosyllables may be prescribed at 5 or 10 dB above admitted thresholds. Theoretically a listener with OdB HL will score 25% on PB lists at 5dB SL, 50% at 10dB SL, 75% at 20dB SL, 88% at 28dBSL, 92% at 32 dB SL and 100% at 40dB SL. If a patient has admitted to hearing speech at a level of 40dB, but other tests in the battery of tests show evidence of hearing levels less than 40dB, a repeat test of discrimination for speech using live voice may be attempted.

3. Repeat discrimination measures; Used to find consistency of responses and not consistency of score eg. the score may be the same but a totally different set of words may be missed each line. This reflects but does not confirm nonorganic hearing loss.

2.8.4: Lombard Test:

The Lombard test is well known as a screening test for pseudohypacusis. The principle of this test is that the listener speaker's own vocal intensity is regulated by him to accommodate the noise in his environment. Unless one does not hear noise in his surroundings, he will not noise his vocal intensity to compensate for the level of noise.

The audiologist uses the Lombard effect by having a patient need a passage aloud, and gradually increasing masking noise through the patient's earphones to determine, whether vocal output changes. If the patient raised his reading volume while the noise is being increased and lowers it While the noise is being decreased, the intensity changes. If the vocal reflex occurs at levels of intensity less than the patient's admitted thresholds then the threshold is in error but the magnitude is not known.

The patient reads aloud into the microphone input of a live voice speech audiometer. The talk back and attenuator dial are left at one position so that VU meter peaks it zero. Masking noise is then introduced into both ears and is slowly increased until the VU meter is observed to increase peak value Reading the level brings the VU meter back to zero (Harris, 1965).

Neither normative nor pathological data is available because of the wide variations observed among individuals.

2.9 Quantitative speech tests:

2.9.1. Speech Stenfer Test:

Development: A test using spondaic words as speech signals has been used to verify monaural hearing loss based on the classical pure tone Stenger test. Both ears, as in pure tone Stenger are stimulated with different sensation levels in each ear the patient with normal hearing or a binaural hearing loss is conscious of hearing speech in the louder ear. A two-channel speech audiometer is necessary, so that the speech signal can be presented to both ears simultaneously with intensity levels in each ear controlled independently (Newby, 1972).

Advantages: The results of this test provide quantitative information and unlike the pure tone Stenger there is no beats phenomenon or diplacusis interfering.

Procedure: Instructions for the test are delivered over the earphones to the better ear as follows:-

"Please continue to say words after me. Most of the words will be heard in your right (better) ear. Sometimes I will ask a question. Along with the answer raise the hand in the ear in which you are hearing and repeating after me". The speech signals are then delivered only to the better ear at a level l5dB SL. Several spondees should be presented until the patient feels comfortable repeating spondees and raising his hand. To stop the malingerer from awareness of the poorer ear also getting involved in the test, interrup the presentation after each word. Then the first binaural presentation is made with the poorer ear receiving a level 20dB above the dial reading in the better ear. Hence assuming that the non-organic patient hears in the poorer (left) ear, three types of responses will occurs:-

1) Stops repeating which implies functional hearing loss in poorer ear.
2) Continues to respond: Then the tester should stop presenting spondees to the better ear without knowledge of the patient. Again two types of responses are:
   a) stops repeating implying organic loss in poorer ear.
   b) continues to respond implying pseudohypacusis in poorer ear.
3) Repeats the word and tells that he hears in the left ear (poorer ear) thus confirming pseudohypacusis. This test is routinely used in the clinic.

2.9.2: <u>The story tests:</u>

Although stogy tests are no longer considered part of the stylish repertoire of nonorganic tests, they still may be used to verify a monaural loss of hearing and quantitative results can be obtained if the technique is controlled for that purpose A two channel audiometer with facility for switching the speech from one ear to the other and binaurally.

The patient is instructed that he will hear a story over the earphones. He should listen to all of it and repeat as many parts of the story as he remembers carefully.

The choice of level for presenting the test signals is very important. The level will be same for both ears but it should be chosen so that it is slightly above the threshold of the better ear or else cross hearing will occur if level for the poorer ear is more than 35dB greater than level for the better ear (Newby, 1972).

Parts of the story are delivered to the better ear, parts to the poorer ear and parts to both ear. If the level has been effectively chosen and if patient repeats parts of the story delivered to that ear hearing is at least at that level. The story should be designed so that it is wholly integrated and makes sense. Hence an approximate idea of the actual sensitivity of the poorer ear is obtained. The threshold for speech, if lower than the admitted threshold is determined by presenting parts at a level 10 dB below the admitted threshold. If a response is forthcoming, the audiologist is encouraged to seek better SRTs. If a response does not occur, one may choose to accept the initially admitted thresholds.

2.9.3: <u>Falconer's lipreading test:</u>

This test was given by Falcone in 1966. The test contains auditory as well as visual stimuli and consists of monosyllabic homophenous words, which are nearly impossible to perceive by lipreading alone. The patient however does not know this and responds in the usual way to sound and vision and hence he becomes a victim of lipreading. Because most of the correct responses are aresult of audition, the patient inadvertently reveals some degree of functional hearing loss. This technique is also effective with patients who demonstrate a much smaller degree of functional hearing loss. The exact methodology is discussed in detail in the next section.

Goldman (1971) used the same test in his study and commented, that the test helps to determine the organic levels definitively. The SRT predicted from the test relates closely to standard pure tone and speech measures and is remarkable in exposing the functional problem without obviously indicating to the subject that he has been caught.

Besides the above advantages, Goldman (1971) has also pointed out that this test can be used either monaurally or binaarally. It requires no special equipment for its administration. Also the functional hearing loss patient falls a victim to his own overreliance on lip reading. Thus, Falconer's lip-reading test should be a must in a battery of qualitative and quantitative tests for pseudohypacusis. In Indian languages, where there is need of normative data, Subba Rao (1981) and Sadia Saher (1982) have developed the lip reading test in Kannada and Hindi.

3.0 Functional Involvement Battery:

(From O.Haug, Personal Communication)

Cheek each item + or -

- Severe to total loss claim from accident, blow foreign body, noise.
- Seeks compensation from industry, government or insurance company for alleged hearing loss.

- Military service or draft an imminent possibility.
- Complaint of charges following surgery.
- Poor school performance
- Failure on school hearing test with subsequent increase in parental concern and attention
- Other apparent advantages associated with establishment of hearing loss.

General Behaviour (in conversation or interview):

- Very exaggerated speech comprehension difficulty even when watching speaker.
- Exaggerated listening attempts: hand cupping, pointing ear a face very close to speaker.
- Discrepancy between informal, unguarded, conversational efficiency and perported loss on formal tests or observations.

Auditory test behaviour:

- Exaggerated body and head leaning listening
- Exaggerated facial grimacing, struggling and listening
- "Phonefiddling" - frequent moving, shifting, pressing phones
- Nervous, restless,fidgeting in chair
- Perspiration and other signs of tension
- Vague descriptions of peculiar auditory sensations of interferences during test
- Many complaints about personal discomfort and fatigue during test.
- Concern with length and termination of tests.

- Says 'no' or shakes head negatively as soon as the tone or speech comes on.
- Eyes follow the change or shift of the signal to the other ear but does not acknowledge it.

Basic auditory test results;

- Inconsistencies in response intratest.
- Inconsistencies in response inter test.
- Discrepencies between PTA and SRT (SRT better)
- No shadow curve on alleged unilateral severe/total loss
- Gives half-word or one syllable responses to SRT spondaic word stimulation.

Advanced auditory test results:

- Stenger, pure tone
- Stenger, speech
- Speech interference level
- Delayed auditory feedback, speech
- Delayed auditory feedback, pure tones
- Bekesy, Pattern V
- Bekesy, very large swing pattern
- Bekesy, BADGE (Bekesy Ascending-Descending Gap Evaluation)
- GSR
- BSERA
- Impedance

- Falconer lipreading
- FTT
- Lombard
- Doerfler-Stewart
- Others

Summary:

Behaviour and test results indicate

- Legitimate organic hearing loss
- Pseudohypacusis with normal hearing
- Exaggeration of some authentic hearing loss.

Apart from the above plethora of tests, the audiologist remains the most efficient agent in diagnosis of pseudohypacusis.

METHODOLOGY

3.1 Introduction;

The study involved two main phases;-

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

The development of the test material was in accordance with the method used by Falconer (1966), Subba Rao (1981) and Sadia Sehar (1982) who developed the test material in English, Kannada and Hindi languages. However while Falconer used homophenous monosyllabic words only, this test, like those developed by Subba Rao (1981) and Sadia Sehar (1982) involves the use of both monosyllabic and polysyllabic homophenous words, owing to the relative scarcity of monosyllables in Indian language. Attempt was also made to see that all such words were most often used and hence familiar to the Tamil speaking population.

3.2 Development of the test material:

It was aimed at preparing a test with 80 words. These 80 words were divided into two forms A and B, each of which had 40 homophenous words. Form A was further divided into 2 lists L_1 and L_2 each of which had 20 homophenous words such that every word in list L_1 had a homophenous counterpart in list L_2

eg. |naḍI| (நடி) in L_1 had its homophenous counterpart |taḍI| (தடி) in L_4. Similarly, Form B further divided into two more lists - L_3 and L_4 with 20 homophenous words each eg. |muttu| (முட்டு) in L_3 had its homophenous counterpart |puttu| (புட்டு) in L_4.

To construct the material, the sounds of the Tamil alphabet were first grouped according to their place of articulation. Since homophenous words involve sounds that look alike but sound different eg. the bilabials /p/ /b/ /m/ were grouped together, the alveolars /t/ /d/ /n/ together velars /k/, /g/ /n/ together, netreflexes /t/ /d/ /n/ together etc. owing to the lack of voiced-voiceless contrast in Tamil language, only 2 homophenous counterparts instead of 4 such counterparts in other tests could be used.

All the words selected were chosen with guidance from a Tamil speaking phonetician such that they would be equally familiar and meaningful to a Tamil speaking population in general. An attempt was also made to see that the two forms A and B were equal in terms of difficulty by equating the phonemic distribution. The words in each list were randomized by using Fisher's random number tables.

3.3 Subjects and presentation levels:

In order to develop norms for the lipreading test, 10 students of the All India Institute of Speech and Hearing constituted the subjects for the study. Their age range was 18 years to 21 years with the mean age of 19.5 years. The group consisted of 5 males and 5 females. The criteria for the selection of subjects was that they (1) should have Tamil as a second language during schooling and mother tongue (2) pass a screening test for hearing at 20dB HL (ANSI, 1969) between the frequencies from 250Hz to 8KHz and should possess normal vision.

The presentation levels of the test were SRT + 0dB and SRT - 10dB respectively. The following presentation combinations were used (L refers to list, I refers to intensity level).

Form A: L_1 I_1, i.e. List L_1 presented at I_1 (SRT + 0dB)
L_2 I_2 i.e. List L_2 presented at I_2 (SRT -lOdB)
Form B: L_3 I_1 i.e. List L_3 presented at I_1(SRT + OdB)
L_4 1^ i.e. List L_4 presented at I_2(SRT -lOdB)

The normal hearing subjects were divided into two groups - Group-I and Group-II. Group-I received the Form A of the test in presentation combinations L_1I_1 and L_2I_2 while Group-II received form B of the test in presentation combinations L_3I_1 and L_4I_2. The manner of testing was maintained across the group i.e. in terms of lists and presentation levels. Besides, the same order was maintained for both forms and care taken not to select same presentation combination for both groups.

A random selection of the ear to be tested was done and only one ear of each subject was tested. Mean scores of the different groups at different levels for the different lists as mentioned above were computed.

The average hearing threshold levels and forms A and B are given in Appendix-I.

3.4: Instrumentation:

GSI-16, a two channel audiometer with matched TDH-39 ear phones and MX-41/AR ear cushions was used throughout the test. Channel one of the audiometer was used for speech audiometry. Live voice testing monitored by the VUmeter on the audiometer was carried out and the talk back system used to note the subject's responses. A special lighting arrangement so as to allow light to fall on the speaker's face for adequate lipreading was also used.

3.5: Test Environment:

Testing was carried out in the sound treated audiometric room. If the Audloiogy Department of the Institute. Testing was carried out in a two room situation with the test room totally isolated from the control room in order to rule out the possibility of leakage of stimuli across the two room. The noise levels in the test room were well within the recommended noise levels in dB SPL.

To facilitate lipreading, the tester's face was adequately illuminated by proper light arrangements. Care was taken to see that the examiner's head and subject's head were at the same level and the lipreading was clearly possible. Further glass reflection from the observation window was illuminated.

3.6: Testing procedure:

Initially the subject was instructed for obtaining SRT without visual cues. For this the SRT spondee list in Tamil by Kapur (1971) was used. Then the instructions for lip-reading test as given below were given and the test administered at the mentioned presentation levels.

3.6.1: Instructions for SRT:

"You are going to hear words like '" mainto:L" etc etc. Each item will follow the carrier phrase
Try as far as possible to concentrate on these test items. Repeat them loudly, wherever you are doubtful try to guess the word". These instructions were used in Tamil language.

3.6.2: Instructions for Lipreading test:

"You can see the examiner's face very clearly from the observation window. You will hear different words as well as you can read them on the examiner's lips. Use both cues and try to repeat exactly the word given to you. Let us see how good you are at lipreading. Be alert, as soon as you hear the carrier phrase "idu sollunga!" you will hear the word. In case, you fail to follow, ask for a repetition. Instructions were made clear before commencing the test.

3.6.3: Obtaining initial SRT:

The Tamil spondee list given by Y.P.Kapur (1971) was used for determining SRT.

The test was started at 20dB above the pure tone average of thresholds obtained at 500Hz, 1000Hz and 2000Hz. 2 words were presented at each level and the level was decreased in 5dB steps until no spondee words were repeated correctly. At the level the intensity was increased in ldB steps and 4 words were presented at each level. The level at which the subject repeated 50% of the words i.e. 2 words was taken as the SRT. This level served as reference for further testing.

3.6.4: Administering lip reading test:

1. Once the subject was comfortably seated in the test room, the room was darkened and the door closed to prevent any sound leakage. After this, the examiner's face was illuminated in the control room and the line of vision between the subject and examiner adjusted to prevent any reflection from the observation window.

2. The microphone was placed close to the subject's mouth so as to pick up his speech. Care was taken not to keep the microphone too close to the mouth, so as to avoid any distortions that would arise in the feedback and in turn could affect the examiner's discrimination.

The audiometer microphone was placed about 6* from the examiner's mouth and was placed below the chin so as to avoid any obstruction, in the subject viewing the examiner's face.

3. The earlier mentioned instructions, stressing that the tester intended to know the subject's capacity of lipreading complementing his hearing were given.

4. Before every word in the test list was spoken, the lips were brought to an abnormal position by the carrier phrase. "idu sollungal" which preceded the word. The VU meter was constantly adjusted to maintain speech level while testing.

5. The whole test required about 10 minutes to administer. After presentation of each item, the subject's response was noted down. Care was taken not to exaggerate the articulatory movements during presentation.

6. An articulation gain function was drawn for the above levels of presentation.

RESULTS AND DISCUSSIONS

The performance of the two normal hearing groups for the four lists of the two forms at the two different levels: -10dB and OdB (reference:SRT) was used as data for analysis. The data is presented in Table-1.

The average SRT for the normal group was 17.5dB HL (OdB HL = 19.5 dB SPL for speech). The most suitable criterion found to predict SRT from the lip reading test was the level at which 12 words were repeated correctly. This criterion varied slightly with the criteria established in earlier studied. The criterion given by Falconer (1966) to establish SRT on his test was the level at which 5 words were repeated correctly. This was supported by Goldman (1971). Subba rao's (1981) criterion was the level 5dB below the level at which 10 words were repeated correctly while Sadia sehar (1982) found the criterion to be the level at which 11 words were repeated correctly on the test. This variability may be attributed to the difficulty of items and linguistic variability involved in the test.

Table-1 indicates the individual and mean scores of the number of words repeated correctly on the lip reading test. Mean age of the normal group = 19.5 years.

From the Table-I and the articulation gain function drawn for responses at the two levels of presentation, it is evident

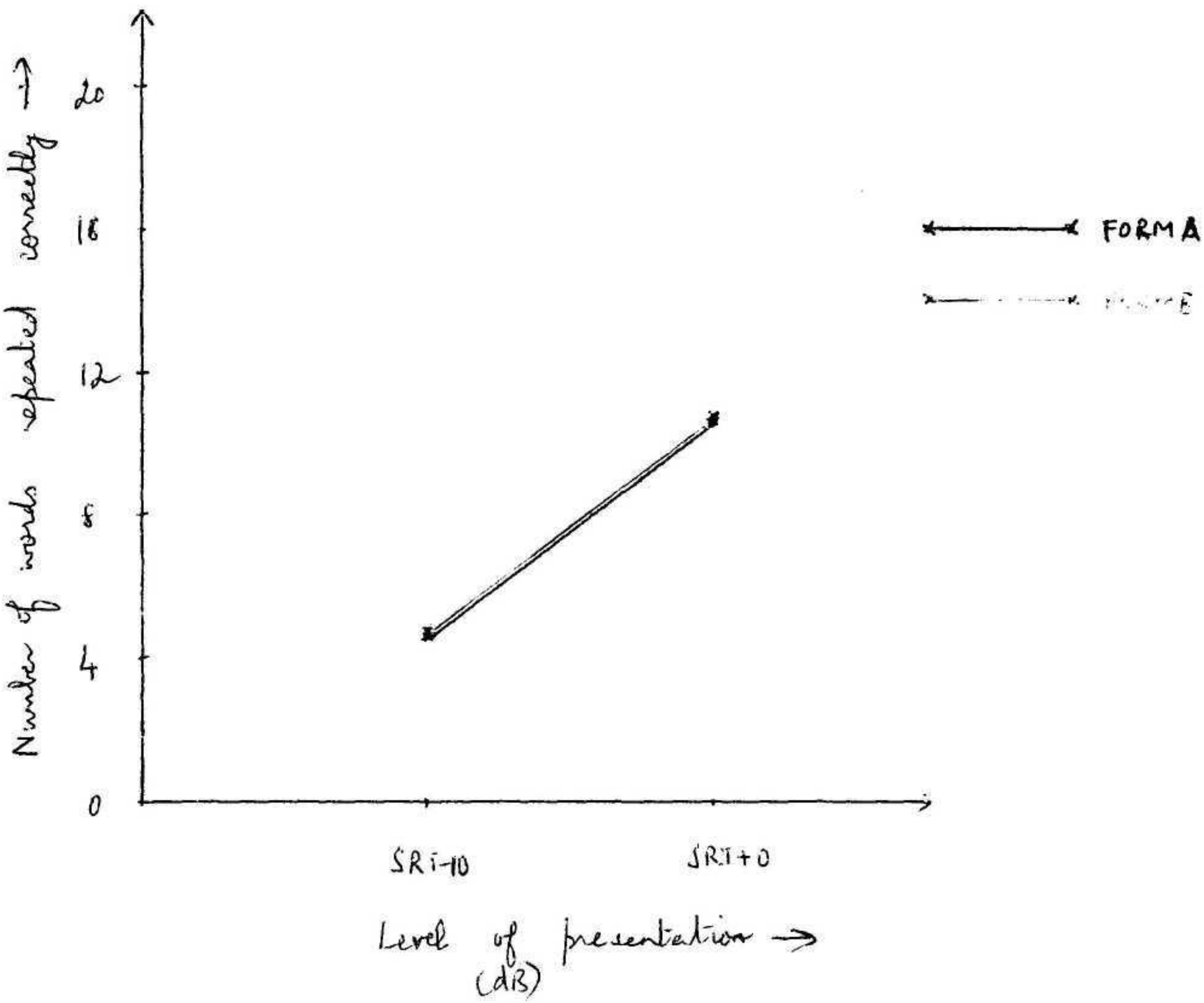
TABLE-I

Form-A - Group-1				Form-B - Group-2			
S.No.	SRT	L_1 SRT + 0 dB	L_2 SRT - 10dB	S.NO.	SRT	L_3 SRT - 0 dB	L_4 SRT - 10dB
1	20dB	12	5	1	20dB	14	5
2	15dB	12	4	2	15dB	12	6
3	15dB	12	5	3	20dB	13	4
4	20dB	14	4	4	20dB	13	5
5	15dB	15	5	5	15dB	12	4
	Mean	12.6	4.6		Mean	12.8	4.8

Combined $(L_1 + L_2)$ Mean $= \frac{12.8 + 12.6}{2} = 12.7$

Combined $(L_3 + L_4)$ Mean $= \frac{4.8 + 4.6}{2}$ 4.7

ARTICULATION - GAIN FUNCTIONS FOR FORMS A & B



Average SRT = 17.5 dB

the scores for forms A and B are very close to each other, indicating that the forms are equally balanced in terms of difficulty.

From the Table-I and the Articulation gain function, it can also be seen that there was a steady increase in scores obtained as the level of presentation was increased. Also the obtained and predicted. SRT are closely correlated, indicating that this lipreading test can be used successfully to predict SRT in normals and pseudohypacusic patients. These results are also in accordance with earlier studies.

Falconer (1966) found the worth of the test as a clinical tool by establishing true organic hearing thresholds even when subjects demonstrated very little nonorganic component.

Both Falconer (1966) and Goldman (1971) have suggested that the test be administered monaurally or binaurally depending on the test situation.

From the results of the study it can be concluded that the lipreading test can be used to predict SRTs of normal and pseudohypacusics.

SUMMARY AND CONCLUSIONS

Falconer (1966) developed a test to evaluate the lip-reading capacity of an individual. This teat was used to established organic hearing threshold levels in pseudohypacusic caaes. Goldman (1971) conducted a study to test the usefulness of Falconer start and concluded it was practically applicable and useful in predicting organic hearing thresholds with methodical efficiency.

Subba Rao (1981) and Sadia Sehar (1982) working on the lines of Falconer, developed lip reading tests in Kannada and Hindi languages respectively and concluded that the SRT predicted from this test was closely related to organic hearing thresholds.

In this study, lipreading test was developed in Tamil language using 80 homophenous (Monosyllabic + Polysyllabic) words which were organized into 2 forma A and B. These two forms were further divided into 2 tests each with both lists in each form having 20 homophenous counterparts each. The forms and lists were balanced in terms of familiarity and usage and equated in terms of phonetic distribution.

Before commencing the test, it was emphasized that the subject's ability, to lipread was being measured and screening for normal hearing and vision carriedout. The test proper was carried out in two room situation in a sound treated room of predict speech reception thresholds in pseudohypacuslc patients.

2. Either form A or B or then combination can be used for testing.
3. The recommended criterion for predicting SRT is the level at which 12 words correctly repeated.
4. If this 12 words criterion is not met, any score, nearest to 12 can be considered for predicting SRT.

Limitations:-

1. More normative data for this lipreading test is needed, since only 10 normals were used as subjects in the study.
2. There is a need to validate the test in the clinical population with organic and nonorganic hearing loss.
3. Some normal hearing subjects used for the study were familiar with the test procedure.

Recommendations:-

1. The lipreading test should be a routine tool in any special test battery to detect pseudohypacusis.
2. More normals and clinical population need to be tested to validate this study.
3. On lines of the present study, similiar lipreading testa may be constructed in other Indian languages.

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FORM – A

LIST-1 (L_1)

பணம்	paṇam
நடி	naḍI
பை	paI
கப்பல்	kʌppʌl
படம்	paḍam.
மயிர்	mʌyir
பட்டம்	paṭṭam
மாலை	ma:lai
பார்	pa:r
பின்னல்	pinnʌl
படி	pʌḍI
தரை	tarai
பாசி	pa:sI
நரி	nʌrI
பல்லி	pallI
நண்டு	naṇḍu
மொட்டு	moṭṭu
நாகம்	na:gam
நார்	na:r
நாய்	na:y

LIST-2 (L_2)

கம்மல்	kʌmmʌl
நரை	narai
மாசி	ma:sI
மை	maI
தடி	taḍI
தார்	ta:r
மல்லி	mallI
மடி	mʌḍI
தண்டு	tʌṇḍu
மட்டம்	maṭṭam
பாலை	pa:lai
தாய்	ta:y
தாகம்	ta:gam
மின்னல்	minnʌl
பொட்டு	poṭṭu
மணம்	maṇam
பயிர்	pʌyir
தரி	tʌri
மடம்	maḍam
மார்	ma:r

FORM – B

List 3 (L_3)

நட்டு	nattu
மணி	manI
தேர்	te:r
பூட்டு	pu:ttu
அம்மா	amma
பட்டை	pattai
மாடம்	ma:dam
தோட்டம்	to:ttam
போர்	po:r
திரும்பு	tirumbu
நாக்கு	na:kku
முட்டு	muttu
தொங்கு	tongu
பொந்து	pondu
தூள்	tu:l
முத்து	muttu
விந்தை	vindai
கள்	kal
ஞானம்	ña:nam
வளை	valai

List – 4 (L_4)

பூண்டு	pu:ndu
நொங்கு	nongu
பணி	panI
புள்ளி	pulli
தாக்கு	ta:kku
நேர்	ne:r
கானம்	ga:nam
கண்	kan
தூண்	tu:n
மட்டை	mattai
நோட்டம்	no:ttam
வடை	vadai
வித்தை	vittai
திருப்பு	tiruppu
புத்து	puttu
தட்டு	tattu
பாதம்	pa:dam
பொத்து	pottu
அப்பா	appa
மோர்	mo:r