MOST RESPECTFULLY DEDICATED TO

MY PARENTS AND BROTHERS

AND

ALL OF WHOM I OWE. A

DEEP DEBT OF GRATITUDE.

A STUDY OF TOME DECAY AND NOISE DECAY IN NORMAL HEARING SUBJECTS AND SENSORI NEURAL HEARING LOSS CASES

Reg. No.6

An Independent Project work submitted as part fulfilment
for First Year M.Sc, (Speech & Hearing) to the
University of Mysore

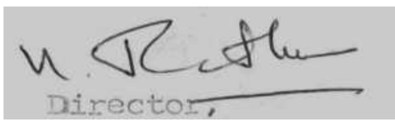
ALL INDIA INSTITUTE OF SPEECH & HEARING
Mysore 570006

C E R T I F I C A T E

This is to certify that the Independent Project entitled.

'A STUDY OF T0NE DECAY AND NOISE DECAY IN NORMAL HEARING SUBJECTS AND- SENSORI-NEURAL HEARING LOSS PATIENTS'

Is the bonafide work, done in part fulfilment for First year M.Sc., Speech and Hearing, of the student with Register Number: 6



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CERTIFICATE

This is to certify that the Independent Project entitled:

'A STUDY OF T0NE DECAY AND NOISE DECAY IN NORMAL HEARING SUBJECTS AND- SENSORI-NEURAL HEARING LOSS PATIENTS'

has been prepared under my supervision and guidance.

(GUIDE)

DECLARATION

This Independent Project entitled

'A STUDY OF T0NE DECAY AND NOISE DECAY IN NORMAL HEARING SUBJECTS AND- SENSORI-NEURAL HEARING LOSS PATIENTS'

is the result of my own study undertaken under the guidance of Shri. K.N. Vyasamurthy, Lecturer in Audiology, All India Institute of Speech and Hearing Mysore., and has not been submitted earlier at any University for any other Diploma or Degree.

Mysore,

April 1982.

Register No. 6

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Chapter_-_I

INTRODUCTION

Among all the Audiological tests used by the Audiologists, in Diagnostic Audiology, the 'Tone Decay Test' (Concomitant monaural adaptation) appears to assume a great importance for its simplicity, accuracy and usefulness, hence it has been widely used with several modifications by many investigators.

There are several modifications available. The different modifications of Tone Decay Test are briefly described here.

Schubert Tone Decay Test:

It appears that Schubert (1944) was the first to report the use of a conventional audiometer to measure tone decay. Here the case listens to measure tone decay. Here case listens to 5 dB SL tone until the tone disappear Thereafter, the intensity is raised without interruption in 5 dB steps till a plateau is reached.

Hood Tone_Decay Test

Hood (1956) reported on a more elaborate procedure. After obtaining the subjects threshold of hearing, begin the test by presenting the tone at a level 5 dB above threshold. If the signal is not audible, allow a 60 sec rest. Raise the intensity of the tone 5 dB and repeat the procedure until an intensity is reached which produces a sensation of tone 'indefinitely'.

Carhart Tone Decay Test

A tone decay test developed at Northwestern university in 1954. was reported by Carhart in 1957. Its purpose was 'to define a technique which could be conducted rapidly in the typical office situation with any standard audiometer.

After establishing the threshold of hearing begin the test with the sustained tone below the established threshold and then ascend in 5 dB steps without interruption until the subject responds, if the tone is heard for a full minute, terminate the test. If the subject indicates that he no longer hears the tone before the minute criterion is met, raise the intensity of the tone 5 dB without interrupting the tone, set the stop watch back to zero, and begin timing for a minute again. Continue raising the tone in 5 dB steps as indicated until an intensity is reached that allows the subject to perceive the tone for a full minute.

Rosenberg One Minute Modification of the Carhart Tone Decay Test

Rosenberg (1958) proposed a shortened version of the Carhart Tone Decay Test. Exploration for any given tone is limited to a total of 60 sec. No record is kept of the number of seconds the tone is audible at each intensity level. At the end of a total of 60 seconds, the tone is turned off and the amount of tone decay in dB is computed.

Green Modified Tone Decay Test (MTDT)

In 1963, Green a modified Tone Decay Test. The subject is instructed to keep the arm, perpendicular when he hears the tone lower it to 45 degree angle if the stimulus loses tonality but remains audible, and to lower his arm to the rest position if the sound becomes completely inaudible.

Sorensan Tone Decay Test

This was given by Sorensan in 1962. Instructions are same as in Carharts Tone Decay Test but he employed a 90 sec criterion for termination of the test.

Modified Hood Tone Decay Test

This was given by Owen, same as Hood's Tone Decay Test, but stop the test at the level where he hears the tone for 1 complete minute or at 20 dB SL though he will not hear for our complete minute which ever comes first

Jerger & Jerger - Supra threshold Adaptation Test

Working on the intriguing hypothesis that symptoms of abnormal tone decay first appeared only at the highest testable sound intensities. Jerger & Jerger (1975) proposed a simplified supra threshold tone decay test. A continuous 500 Hz test tone at 110 dB SPL is presented in the test ear with a white noise masking the non test ear at 90 dB SPL. Until the patient indicated that he no longer hears the tone, or until 60 seconds has elapsed whichever comes first

All the above tests show that Pure tone hasx been used for detecting Retrocochlear pathology.

It is a well established fact that positive Tone Decay is usually observed in Retrocochlear Pathology cases, and that early detection is crucial for treatment of such cases, hence, Tone Decay Test can be used as an effective tool to detect Retrocochlear pathology at an early stage.

Clinical experience shows that most of the retrocochlear pathology cases experience tinnitus. In the presence of tinnitus the results of Tone Decay Test will not be reliable. False positive tone decay or false negative tone decay results are quite common. Although Tone Decay Tests are very. Useful, the subjects with Tinnitus pose a challenge to the Audiologists and thereby the clinical utility of Tone Decay Test is restricted If the Audiologist wants to expand the clinical usefulness of Tone Decay Test to the patients with tinnitus, there is an urgent need for a modification of present Tone Decay tests to overcome the challenge posed by the patient's tinnitus.

The only solution to this problem, perhaps is to establish normative data for Noise Decay and also to have a comparitive study of Tone Decay and Noise Decay in pathological cases. Keeping this in view the present study was undertaken.

In the present study 20 normal hearing subjects (20 dB HL. ANSI 1969) with the age range of 17 years to 25 years served as subjects for the study. Carhart's Tone Decay Test was administered to all the subjects at frequencies 500 Hz 1 KHz, 2 KHz and 4 KHz to both ears.

Noise Decay for Narrow Band Noises with different centre frequency namely 500 Hz, 1 KHz, 2 KHz and 4 KHz was also determined using Carhart's procedure.

Five sensori neural hearing loss cases exhibiting abnormal Tone Decay were tested, using Carhart's procedure for comparative evaluation of Tone decay and Noise decay.

The study was carried to verify the following Null hypotheses;

1. There is no significant difference between Noise decay and Tone decay in sensorireural hearing loss cases.
2. There is no significant difference between Noise decay and Tone dec y in normal hearing subjects (2o dB HL ANSI 1969)

Implication:

whenever patients experiencing tinnitus are to be evaluated, Noise decay test can be administered instead of Tone decay test

Limitation of the present study

It would have been better if more number of hearing loss cases with abnormal tone decay were available for collecting data in the present study.

C H A P T E R - II

REVIEW OF LITERATURE

The first reference to auditory adaptation in the literature was by Gradenigo (1893). He termed this phenomena 'Functional Exhaustibility'. He reported that in acoustic tumours, the patient responded to a normally vibrating tuning fork only for a few seconds as the loud tone disappeared quickly, i.e. tone decay occured.

Threshold Tone decay may be defined as decrease in threshold sensitivity resulting from the presence of a barely audible sound.

At the onset, it is important to differentiate Tone Decay from other aspects of Adaptation.

Auditory Adaptations is a complex process. It refers to any change in the functional state of the auditory system and is manifested in a number of ways.

Classically, the phenomena included under adaptation could be distinguished in two different ways (Ward, 1973)

a) Concomitant - (observed during exposure to the acoustic stimulus) or Residual (observed after exposure to the acoustic stimulus)

b) Monoaural - (requiring One ear for its measurement) or Binaural - (requiring both ears for measurement)

The literature on Tone Decay shows considerable variations in terminology which include auditory threshold fatigue, temporary threshold fatigue (Kos, 1955) abnormal adaptations (Carhart, 1957), Pathologic relapse (Hood, 1956) Temporary threshold shift (Lierle & Reger, 1955), show adaptation (Sorensan 1962), Tone Perversion (Parka, Decker and Richords, 1968), Perstimulatory auditory adaptation (Palva, 1964) Threshold drift (Harbert and Young, 1962) and Pathologic fatigue (Flottorp,1963)

Following the 'classical classification' given above. Tone dacay is a concomitant monaural type of adaptation.

Differentiation of Tone Decay from similar Phenomena:

Differentiation of Tone Decay from similar phenomena is done interms of recovery period and method of measurement.

Tone Decay and Fatigue;

The major distinction between the two is that fatigue effects last longer and can be measured after fatiguing stimulus is discontinued. Effects of Tone Decay on the other hand recover very rapidly.

Auditory fatigue, when used without explicit definition usually refers to temporary threshold shift, TTS.

Measurement of TTS;-

TTS is a residual monaural phenomenon and is measured as follows; A fatiguer is presented for a time T. Then the test stimulus of duration r is presented, at a time t after cessation of the TTS arousing stimulus. The change in detection threshold for the test stimulus, relative to the 'resting' (Pre-exposure) threshold in decibels is the threshold shift.

The duration of TTS is usually related monotonically to the intensity and duration of the fatiguer. The fatiguer may be interrupted and the TTS may be found by finding the threshold of a pure tone presented in the pauses (ultra short term TTS;

Residual Masking) or may be of a moderate level i.e., below 85 dB SPI. In the latter, the TTS persists for a couple of minutes. Another property of TTS is that it increases with exposure tine but by 1 min. has essentially reached its m.axi-mum value. TTS seldom exceeds 15 dB. Physiological fatique however, reaches values of 30 dB & recovery here may take upto 16 hours. TTS may thus be long lasting. This is seen when exposure to noise is present for several hours. This is pathological fatigue. It is also accompanied by perceptual changes in pitch. The affected ear heard the sound as 'flatter' (lower in pitch) in a general sense.

Tone decay and Perstimulatory fatigue

Tone decay is often confused with perstimulatory fatigue. Perstimulatory fatigue was the first aspect of auditory adarata-tion to be described. This confusion primarily exists because of the assuption that the 'phenomenon is based primarily on a reduction in loudness in the exposed ear' (Ward, 1973)

Dove demonstrated that if one ear were exposed to a tone for some tie, then introduction of the same tone simultaneously into the other (control) ear, resulted in the perception of a tone only in the latter.

It is difficult to decide if the loudness of the tones in the exposed ear decreased or if the characteristics of the ear shifted so that ' a tone in that ear no longer had the same lateralizing power as at the beginning of the exposure,' (Ward 1973). It is thus difficult to decide if the phenomenon is peripheral or central. A number of studies indicate that it is probaly central.

Flugel found that the two errs of a given observer often displayed different degrees of asymptotic adaptation at a given frequency. He then argued that when the tone was presented binaurally, the loudness in the more suscpetible ear should decrease. But no such shift occured, indicating a complicated central mechanism.

Mirabella et al (1967) asked the subjects to keep the loudness of a sustained tone constant and found that at 70 dB SPL, the upward drift in 10 mins, was 3.5 dB and at 90 dB there was a downward, drift, implying that loudness was increasing.

In the perstimulatory adaptation paradigm however, a 20 - 50 dB imbalance is observed (Ward, 1973). This indicated that perstimulatory adaptation appears only when both ear are simultaneously stimulated, and has nothing to do with the adaptation of the cochlear receptors. Tone Decay on the other hand is a monaural phenomenon and is measured with monaural stimulation under the following conditions;-

1. The stimulus is a pure tone instead of a noise. (irregularity helps to minimise growth, Carterette, 1965)
2. The control ear is given a pulsed instead of a continuous tone (this keeps the effect from diminishging during the process of the testing for it, Wright, 1960)
3. The adapting stimulus is continuous.
4. The instructions emphasise median,plane balance rather than "equal loudnasss' (3tockinger and Studebaker 1968)
5. When the test subjects are adults, (children between the ages of 7 to 15 years did not demonstrate much adaptation (Karjar, 1968)

This phenomenon was negatively correlated with TTS (Tanner, 1955), but has not been reduplicated.

In terms of recovery from adaptation too, Tone Decay differs from perstimulatory adaptation.

'Threshold Tone Decay recovers within a few seconds following the cessation of the signal. The recovery is too fast to be classified as perstimulatory adaptation......' (Sergeant and Harris, 1963).

Tone Decay and Fast Adaptation:-

Sergeant and Harris 1963 classified tone decay as a 'Unique category' of adaptation based on the threshold of recovery. They said that the recovery of Tone Decay following cessation of stimulus was slower than that the of fast adaptatio

Fast adaptation has a brief onset (300 m.secs or less) and recovery of and its locus which is the hair cells, as well as its insensitivity to cumulative effects. It is measured with clicks and is a function of inter-click interval.

Thus, the inconsistencies in terminology can be ruled out by differentiating between

(a) the method of measurement of the pheonomenon and the the conventional method used to measure tone decay

(b) the threshold recovery period.

As has been mentioned earlier. Tone decay can be measured at both threshold & supre, threshold level. Threshold tone decay appears as the decrease in threshold sensitivity resulting from presence of a barely audicel sound, supra threshold tone decay is a decrease in threshold resulting from a sound well above the threshold.

In this project, it is the threshold tone decay which

Tone decay measurements are usually made with a conventional pure tone audiometer and can be applied to any available frequency. The quantity of tone decay is expressed as the difference between the initial threshold and the threshold at which the test is terminated. This differenceis expressed in dB.

The methods of measure ent of Tone decay are based on the early observations made by many investigators.

After the discovery of this phenomenon, several other discoveries were made. In 1890, Corradi demonstrated that Tone decay occurs in Bone conduction. Cradenigo (1893) observed that patients with acoustic tumours responded to a ' maximally vibrating tuning fork for only a few seconds.

Dunlop reported the off-effect noted in Tone decay tests. His subjects listened to a sound emitted by telephone receiver at threshold intensity. Their task was to indicate when the signal was absent. Dunlop reported that almost half of the subject reported it to be inaudibel)

Conflicting results were also reported.

Schafer (1905) noted that not everyone experiences tone decay, even at higher frequencies. He could hear Lord Rayleigh's bird call indefinitely.

Phase (1906) found no consistent difference between normal and persons with middle ear pathology. Similarly Bleyl (1921) found no difference between persons with normal hearing, conductive losses, perceptive losses and miscellaneo s

Research on tone decay came to a standstill after these early reports.

Then in 1944, K. Schubert, used a conventional audiometer to measure tone decay. This procedure he used was as follows;

The patient was allowed to listen to a tone at 5 dB SL until it disappeared. Thereafter, the intensity was raised in 5 dB steps without interruption until a plateau was reached or the maximum limit of the audiometer. He found that for normal ears of young people (under 30 years) there was no effect at frequencies below 1 KHz. At higher frequecies, slight effects were seen.

In individuals with inner ear deafness, the effect was grossly exaggerated.

Hood (1956) reported a more elaborate procedure. The subjects threshold of hearing for an interrupted tone was obtained and the subject was instructed to raise a finger as long as he hears the tone and to lower it if it faded into inaudibility.

The test was begun at 5 dB above the threshold. When the tone was reported to be inaudible, a 60 second rest period was given and the intensity of the tone raised by 5 dB and the procedure continued until a tons was heard indefinitely.

It was not until 1957, that a formal clinical test was developed to measure tone decay.

This test is conducted to number of steps.

1. The subjects threshold of hearing is obtained for an in an interrupted tone.
2. The subject is instructed to raise his finger as long as he hears and to lower it if tne signal fades intoi inaudibility.
3. The test is begun with a sustained tone, below the

the established threshold and ascend in 5 dB steps without interruptions until the subject responds.

4.. As ssoon as the subject responds, timing is begun with a stop watch. If the tone is heard for a full minute, the test is terminated.

5. If the subject indicates that he no longer hears the intensity of the stop watch tone is raised by 5 dB without interrupting it and the watch set ,back to zero to begin timing for a minute again. A record is kept of the number of seco ds, the tone is audible at each intensity.

6. The test is continued until the tone is heard for one minute. The test is terminated at 30 dB SL and even if the tone is not perceived for one full minute.

Most testers using the Carhart procedure, begin the test at thres old or at 5 dB a ove the threshold.

This test served as a base for a number of other tests. Olsen & Noffsinger (1974) suggested beginning the test at 20 dB SL. The;; also stressed t e importance of requiring a response to 'tonality' as opposed to response to (any sound) during tone decay testi g.

This 20 dL SL tecniques was as sensitive as Carhart's procedure in identifying excessive tone decay. Carhart's method was shortened by Rosenberg (1958). He limited the exploration given to any giver tone to 60 seconds. The threshold was found similarly and the instructions were similar. If the subject indicated t a t he no longer heard the tone, intensity was raised 5 dB without interrupting stimulus, or stopping watch This was continued and at end of a total of 60 seconds, tone was turned off and the amount of decay in dB is computed.

In 1963, Green rodified instructions given with the shortened 1 minute version of the Carl-art test. He noticed that some patients with retro-cochlear lesions experienced a loss of tonality before the loss of audibility on the tone decay test.

The patient is seated in an arm chair and told to maintain elbow contact with arm rest while he signals. If the stimulus losses tonality, but is audible he is trained to lower his arm to a 45 degree angle and to lower his arm to rest position if the sound becomes in audible. The patient is cautioned against adjusting the earphones or chewing while the test is in progress, since the slightest interruption in continuity of the stimulus can impair test relaibility. A response to perception of tone is felt to enhance the sensitivity of test.

This change in quality of the tone has been called tone perversion by parker et al (1968) and a number of other investigators. Jerger and Jerger worked on the hypothesis that the symptoms of abnormal tone decay first appear only at the highest testable sound intensities. In 1975, they proposed the supra threshold adaptation test (STAT) . The test frequency are 500, 1K 2K in that order.

The subject is instructed to rignal as long as he hears the sound in the test ear. The non test ear is masked with white noise at 90 dB SPL.

The test tone is presented at 110 dB SPL until the patient indicated that he no longer hears the tone or 60 secs have elapsed (which ever comes first). The test is scored - ve if he hears it for 60 secs but +ve otherwise. To ensure that he has understood the task, a pulsed tone is given at same level

If he responds, he is responding to the test in a relaible manner. The 110 dB SPL are roughly 100 dB HL at 500 Hz and 2 KHz and 105 dE HL at 1 KHz

Owens (1964) modified the Hood tecnique, incorporating a 20 sec rest period between stimulus presentations. He provided both tre amount of tone decay upto 20 dB SL and the pattern in seconds, at succeeding levels for categorzation into normal, cochlear and retro cochlear types.

The tone decay patterns he obtained are given below;

Levels above threshold	patterns of Decay						
	Type I	Type II					Type III
		A.	B	C	D	E	
dB							
6	60	25	7	12	15	5	14
10		60	34	26	23	14	16
15			60	40	30	18	12
20				60	39	21	14

The number in the table represent the seconds of time tone was heard at intensity level irdicated be ore fading to inaudibility.

Other variations were reported by Sorenson 1962 who used a 90 sec criterion for terminating test and confined his test to a single frepuency - 2KHz.

These are the conventional rethods of measuring tone Decay. Despite their wide spread use, systems of classification are few.

Rosenberg 1968 devised a gradation based on the number of dB of tone decay resulting from application of his procedure.

0 to 5 dB - Normal 20 - 25 dB Moderate.

1C to 15 dB - Mild 30 to or more marked.

The type I category of Owens is considered normal. Number of authors agree that 5 to 10 dB of tone decay is seen in normals, Jerger and Jerger 1975 state that tone decay as high as 15 to 20 dB is sometimes seen even in normals.

In the pathological grour, Owens found that Types I and II are characteristic of Meniere'd disease and type III characteristic of a cranial nerve VIII lesion. Types I II and III he said could be correlated to Pekesy audiograms.

Morales - Gracia and Hood, 1972, used a 4 type classifica-tions system based on Carhart tone decay test results Type I was normal minimal and did not exceeed 15 dB.

Type II slightly greater tone decay.

Type III More that 20 dB at 500 Hz, at 25 1 KHz, 30 at 2KHz and 35 at 4KHz.

Type IV similar to type III, but more rapid in decay.

There is no standard system of classification, but marked tone decay is characteristically found in patients with retrocochlear lesions. The data does not provide much information about the pheonmenon in the normals. Due to the paucity of literature available, the investigator has been forced to supplement information known about normals and with that gathereed from pathological cases.

Mechanism of Tone decay:-

Tone decay is a normal pheonomenon. The mechanism of tone decay is not exactly known, but many speculators have been made. All these speculations are based mostly on studies on pathological groups.

Marked decay was found in patients with retro cochlear pathology; Abnormal tone decay can be caused by neural degeration, inflammation, trauma, as well as space occupying lesions like tumors which press against VIII nerve.

The etiologies that can nanifest tone decay are acoustic primary tumour, cholesteatoma, meningoma (Johnson, 1966) thermal injury to nerve VIII (Harbert and Young, 1962), Multiple scelerosis, mumps, neuritis, Von Recklinghausen's disease acquired genetic deafness, Ramsay Hunt syndrome, intra cranial aneurysr, head trauma, (Harbert and Young) Pinealoma (Kos 1955) Nerve IX Neuroma (Naunton et al 1968) Cerebellar atrophy (Miller and Daly, 1967) Extra axial brain stem lesion (Jergar and Jerger, 1974)

Reversible tone decay has been described in nerve VII neuritis, multiple scelerosis, pineacoma and cerebellar atrophy or cerebellar tumour (Stroud and Thalamann, 1969). Such a wide array of etiologies causing abnormal tone decay has caused a number of speculations about the mechanism and locus of the tone decay.

Mechanism of Tone Decay in pathological ears;-

Tone decay is associated with both decrease in loudness as well as a change in tonality. Any therapy about mechanism of tone decay must explain both those factors.

The underlying physiological correlate the tone decay is generally assumed to be an absence of neural elements to fire continuously.

They first normally at the onset of a tone or in response to a sudden change in level, but if the level is sustained, then activity ceases.

This initial burst of auditory excitation or On effect is followed by adaptation, i.e. progr essive reduction in excitation to sustained stimulation was observed in number of cases. Hallpike and Hood 1951) emphasised this on effect, this is analogous to the Wedensky inhibition of peripheral nerves. It was found that if a short stretch of nerve was partially narcotized, the first impulse of a series of a entire series of impulses would pass through, successfully, but a rapid sequence would fall after the first impulse or first few impulses.

Davis (1962} based his hypothesis on this phenomenon. He said that Wedenshy's narcotically induced block was similar to the partial dysfunction of a large number of nerve fibres from a retro cochlear lesion. The gradual slowing of recovery and failure of complete rec very during continued stimulation would cause 'programme failure of more and more of the impaired fibres'

This model accounst for the simultaneous loss of tonality and audibility.

Another condition exists in wich the fatiguing signal loses tonality but not audibility. It is postulated that there is less impairment of function when tonality but not audibility is lost.

This statement is borne out by some observation on a case with sudden deafness with complete recovery. Harbert and Young 1964 found that while the patient began to recover, tone decay tests with subjects responding to any sound, showed, a reduction in amount of tone decay, but when instructed to respond to tonality, little improvement was seen until further recovery took place.

This phenomenon may be explained from the travelling wave: and Volley theories (Gree, 1978) If the place of maximal stimulation on basilar membrane and adjacent areas is 'served' by a large number of defective fibres, the stimulating tone will fail to be sustained and the adjacent areas to which signal spreads, will exhibit a lack of time and so audibility but not tonality would be ppreserved.

The off effect is often seen in tone decay. The tone loses both audibility and tonality, but the patient becomes aware that the tone has been with drawn, as soon as it is discontinued.

This effect is due to the neural off fibres found in the vertebrates ears and eyes, which are activated when sound or illumination ceases. (Harbert and Young, 1962)
This is the mechanism of tone decay in pathological ears; what then is the mechanism in normal ears? For, tore decay is seen in normals also but to a certain extent.

Tone Decay_in Normal Ears;

It cannot be denied, that what is seen in pathological ears, probably exists in normal ears in a different degree, pathologies, as has bean found earlier, often help to determine the normal function.

To understand what happens in tone decay, a parallel may be drawn between tone decay and the disappearance of a steadily fixed visual target. If the target stimulated precisely the same area of the retina at all times by what ever means, then, after a few seconds, the target disappears.

Matthew's (1931) work demonstrates this effects clearly. He found that w.en a stimulus is applied to ear and end organ the Action potential response consists of an initial high frequency discharge known as on effect. The duration of this initial burst of impulses is brief, in the order of o-2 seconds, and is followed by a slow decline in the discharge frequency with time. This decline is independent of intensity of the stimulus and can thus occur at either threshold or supra threshold levels.

Tone Decay and Threshold:

Hood noticed that a tone presented to low or near threshold intensity decayed, but with higher intensities, the persistence of sensation is indefinite.

This suggests that the auditory system requires a certain level of stipulation to maintain its response at onelevel, indefinitely. This level is the same, regardless of whether the tone is initially presented at threshold or at any other value. (olsen and Noffsinger, 1974).

This may be as in pathologies of VIII nerve, where a certain number of the fibres are under continuous stimulation and may be in an absolutely refractory stare. (Sung, et al 1967)

These fibres probably respond to low intensity. As the intensity increased, fibres whic required a higher level of intensity were brought into action and since were larger in number would then sustain the perception. This critical level of intensity were brought into action and since were level of stimulus above the threshold of it is what is found when the Tone Decay tests are administered. In normals it has beeen found that at a level 5 to 10 dB above threshold, a tone is sustained for one minute at least. (Willeford, 1960 and others). This indicates that duration for which a tone is sustained at threshold level increases very rapidly for every dec'bel increase of presentation upto this critical point, i.e. 5 to 10 dB SL generally.

Thus, the accuracy with which the hearing threshold is established will affect the result, (Langenbeck 19)

Thus, the most common index of adaptation is time, and in the tone decay tests, the time for normalcy, (upto a certain sensation level of presentation of course) is fixed to 60 seconds. Beyond 30 dB SL, decay is pathological.

It would be interesting to findout, how long the auditory system can sustain the sensation of hearing at threshold level. Tone decay was found to increase with threshold (Morales Garcia and Hood, 1972)

Tone Decay and the SPL of the test tone in Sensori-neural and and conductive hearing loss:

In 1971, Doehring and Swisher, studied the relation of tone decay as a function of the SPL, of the test tone in SN loss. They found that Tone decay, tended to increase with increasing threshold level whenboth Rosenberg test and Bekesy audiometry were used, at all frequencies. The tendency of tone decay to increase as the threshold increased to 80 dB confirms Owen's finding that tone decay seldom occurs with threshold levels below 35 dB for frequencies below 2 KHz. This relation does not hold good in conductive loss. Sorenson found essentially no tone decay present in persons with conductive loss.

It is agreed that persons with sensori-neural loss that is cochle r, do exhibit some decay, that is a little more than normals, but this is stabilised with increasing sensation levels, Eg. Meniere's Disease.

At 20 to 30 dB SL, persons with cochlear loss perceived a . tone indefinitely (Hood) Types I and II categories as described by Owens (1964) are characteristic of Meniere's disease.

Rosenberg (1967) indicated that mild to moderate levels of tone decay were seen in pathology involving the organ of corti, but marked tone decay, alrost always indicated retrocochlear pathology.

Tone Decay and Frequency;

Available data on normal ears show a definite frequency effect. Carles Morale Garcia and J.D. Hood 1972 found no tone decay was markable at the test frequency 500 Hz. At the test frequency 1 KHz. 10 out of 41 ears had a slight threshold shift of 5 dB, at KHz, 2KHz and between hearing levels and the amount of tone decay, it was found that at 4 KHz, the proportion of ears with some delay clearly exhibited increased thresholds. It may thus be concluded that tone decay was no greater than 5 dB at 500 Hz and 1 KHz and no more than 10 and 15 dB at 2 KHz and 4 KHz. The magnitude of tone decay increased with frequency, but one must not forget the additional factor of hearing threshold involved.

The frequency effect is more clear in pathological ears. Generally, tone decay in retrocochlenr pathology is marked in the higher frequencies. This, however, is due to the organisation of nerves in the auditory nerve, with fibres, from the base of. the cochlea on the outside and entering the cochlea in the moral position (Neff at al)

Doehring and Swisher (1971) also report that higher tone decay was seen at 4 KHz and on the modified Rosenberg, as compared to other frequencies.

Tone decay, was smaller for 500 Hz at hearing threshold levels below 60 dB and their increased to the level of other frequencies above 70 dB. They report no difference between 2 KHz and 4 KHz at any threshold level.

Owens found that tone decay seldom occurs for frequencies below 2 KHz and when thresholds are below 35 dB. Katinsky et al (1972) Silman et al (1978) report a similar effect. Low frequencies are rarely affected. Impairment in the pons or higher levels may cause a pronounced decay at aone frequency (Morales - Gracia and Hood 1972).

Tone Decay and Masking;

Contra lateral masking influences the measurement of tone decay. Shimizu 1969 measured tone decay at 500 Hz, 1000 Hz, 2000 Us in 11 normal hearing subjects and in 34 with moderate unilateral conductive loss with 40 dB SL of contra lateral masing a level low enough to avoid over masking, there was an incesase in tone decay. At 2 KHz without masking, only 7% of subjects had 10 dB of tone decay, but with masking 77% had 10 to 40 dB of tone decay.

One patient with unilateral sensori neural loss, showed 10 dB of tone decay at 1 KHz without masking. With 40 dB SL Noise in the contra lateral ear, there was 30 dB tone decay and with 60 dB SL, there was 50 dB of decay.

Snashall (1974), Blengal 1972 also report that contra lateral noise affects tracing with contra lateral noise and this was frequency dependent. -

Snashall reports that greatest masking effect was seen on Carhart's tone decay test. 10% of normals showed less tone decay on Owen's test and 20 % showed less decay with Bekesy. He found however, that adaption tests at 20 dB SL showed similar effects to noise at the other levels. Since these levals of masking were not high enought to cause over masking, central factor was attributed as cause for this effect.

The effect of masking on tone decay cannot be ignored.

Interaction of Tone Decay with special Tests;

Tone Decay and Bekesy;

The most obvious manifestation of tone decay is in Bekesy audiometry, when the test tone is continuous. This effect is seen in both fixed frequency and sweep frequency tracings. Fixed frequency is more sensitive. Reger and Kos 1952 noted that the indicated threshold gradually shifted to a higher and higher intensity.

The magnitude of tone decay is dependent on stimulus parameters. Attenuators with step sises of 1 ard or 2 dB bring about the on effect. Tone decay is manifested in type III and type IV Bekesy tracings.

The Critical off tine is very-imrportant. Harbert and Young 1962 showed that for an interrupted tone, the Bekesy tracings are sharply dependent on the off-time. With decreased off time the thresholds increased and the tracings were similar to the tracings obtained for continuous tone. Jerger and Jerger 1966 report critical off times ranging from 200 m secs to 40 m sec

Dallos and Tillman 1966 found that frequency modulation with a slow modulation rate (less than 10 per second) and a frequency range of 40 Hz was needed to prevent tone decay in the continuous tracing at 500 Hz. Bekesy audiometry however, is not very sensitive to abnormal tone decay.

Tone decay and Difference Limen;

Plath 1973 believes that the difference limen for intensity is an indicator for adaptation and fatigue in the auditory function. He believes that with the SISI test, adaptational charges of hearing are also measured. This is evidenced by the fact that the 6 th and 20 th increments are heard often than the first 5 increments. He justifies this assumption on the fact that adaptation of the sensory cells of corti occurs in milliseconds. Thus, the described adaptation time of 30 seconds of tone stimulation, forintensity DL must be influenced by a more central adaptation process, with a longer time constant.

Jerger 1955 reports high SISI scores in a patient with retrocochlear pathology. Because of the decay of carrier tone, the 1 dB increment pips, appearto emerge from silence. The 5 sec interval between the pips, allows or sufficient recovery to take place.

Even cars exhibiting moderate tone decay, 20 dB either with cochlear or retrocochlear pathology, exhibit this phenomenon Hughes 1968. This effect is possibly be demonstrated in normal if the contralateral ear is masked.

Tone Decay and ABLB

Masked tone decay impairs loudness growth with increasing intensity loudnoss growth, that is less than normal is termed decriment. (Fowler, 1965) or reverse recruitment (Dix and Hallpike, 1960)

Tone Decay and Acoustic Reflex;

Tone decay is associated with elevated reflexes as well as abnormal reflex decay.

Tone Decay and Word Discrimiration;

Since many fibres are needed for the effective transmission of speech signals, marked tone decay often affects speech discrimination. Thus, word discrimination is much worse than the pure tone thresholds indicate.

Patients fitted with hearing aid, may complain that the hearing aid losses its clarity after using it for some time. After resting for several hours the hearing may again seem clear. (Goldberg, 1964). This also affects language development significantly. (Costello and Mc Gee, 1976)

Tone Decay and ERA:

Retro cochlear lesion causes longer latency and smaller amplitude in the acorstically looked response, (Schinnizu, 1968). This may be due to the fact that the passage of nerve impulses was disturbed by pressure on or destruction of the 8th nerve.

Tone Decay - Decay or Peripheral:

Through much is known about tone decay, there are many gaps in our knowledge of the phenomenon that are yet to be filled in.' For instance, the question, whether the tone decay is a central or. peripheral phenomenon has often plagued audiologists.

The wide range of etiologies that cause tone decay to be manifested, only added to the corviction that tone decay is a complex process. Most studies implicate the 8 the nerve as a locus of tone decay, but other factors point to higher centres in the auditory system.

Peripheral factors in Tore Decay;

Sorensen observed a per stimulatory and post-stimulatory depression of the activity of the VIII nervar after low intensity stimulation. Harbert and Young observed that abnormally rapid threshold tone decay was related primarily to lesions affecting dendrites and slower decay was related to widespread, partial damage to axons.

They thus hypothesise that threshold tone decay results from, ionic changes in interstitial fluids affecting conductivity of dendritees.

This hypothesis may be further explained in terms of the critical off time. Jerger and Jerger found that the patients with VIII nerve pathology, for an interrupted tonethe threshold is sharply dependent on the off time. As critical off time is decreased, the results became indistinguishable from the indicated threshold for a continuous tone. Jerger and Jerger related this to a specific and apparently critical rest period between successive stimuli. This rest per.'od between successive stimuli may be called the refractory period; a polarised neuron, excited fires a series of impulses. Once it has fired, a neuron is depolarised so that it returns to its resting stage (The firing of the neuron charges the chemical environment in and around the neuron making it no longer polarised)

Once the neuron is depolarised, it reaches a state of exhuastion called the refractory period. The refractory period may be differentiated into two stages.

Absolute Refractory Period:

During this nerve cannot be excited and si cethere is an exchange of ions in and out of the cell and

Relative Refractory Period:

During which the cell membrane goes back to its resting state and the neuron is capable of being excited but only with intense stimulation.

Lesions affecting the dentrite or the 8th nerve would naturally affect refractory period. Kupperman 1971 hold that adaptation results from the hyper polarisation of nerve fibre membrane.

Central Factors in Tone_Decay;

Yet experimental evidence points to other factors which wholly or partly influence tone decay.

Hernandez-peon et al de onstrated marked adaptation in the electrical potentials recorded from the more central pathways i.e.the Dorsal cochlear nucleus.

Galambos 1951 and Pfalz 1964 showed that tie effecent cochlear bundle controls input coming from ear, reducing it by varying amounts.

Leibratndt 1965 demonstrated that procaine hydrochloride when injected into internal acoustic meatus blocked the efferent bundle and this resulted in less adaptation.

Hahn and De Michelis 1960 investigated the length of time a tore at or near threshold intensity could be heard. They found that a simultaneous intermittent light markedly reduced the period of audibility. They concluded that tone decay is not exclusively a peripheral phenomenon. They suggested that Rasmussen's efferent tract plays an important role by inhibiting VIII nerve but do notstate how it is activated by light.

They thus opine that the efferent neural system's influence on adaptation is unlikely . The affect of masking on tone decay also implicated a central factor. With each scantly data, it is difficult to speculate where tone decay lies. Adding to the confusion is the wide variety of lesions that can manifest abnormal tone decay, from the VIII nerve to the cerebellum to even the cortex.

Mencher and Rupp 1969 found that there was a slight suggestion of tone decay in 4 out of 10 unilateral brain damaged persons at 2 KHz. They attribute this to poor perception in the ear's contra lateral to lesion.

The need for Research;

Marked tone decay is not always manifested in the pathologies described. Johnson 1965 is thus of the opinion that while positive tone decay indicates a strong probability of retrocochlear pathology, absence of it does not always rule out the possibilites of such a lession. He found that 46 %

of 110 cases of surgically confirmed retrocochlear lesions had inconsistent results. He attributed this inconsistency to differences in tumour size, but it indicates that our testsaare not sensitive enought to indicate the sites of lesion. Brand and Rosenberg 1964 believe that 'bizarre findings' in cases of acoustic neuroma indicate 'weakness' in many of tests and feel that in the diagnosis, a team approach was useful.

It has been found that Tone Decay is sensitive to procedural differences. Tests which e ploy long periods of sound stimulation like Carhart's Tone Decay test are relaible because they afford maximum opportunity to obtain positive results (Mercher and Rupp, 1969)

Obviously, our tests need to be modified, but this cannot be done without more knowledge as to thenatures of Tone Decay.

Available evidencepoints out to the fact that Tone Decay isgoverned by a complex process or a series of processes which may be situated at various levels in the auditory system.

In the last few years, practically no work has been done or this phenomenon and much investigation is needed so that we may have a more thorough knowledge about the locus and mechanism of Tone Decay.

CHAPTER III

METHODOLOGY

Subjects:-

20 normal subjects with age range of 17 to 23 years of whom 12 were females and 3 males. All the above subjects ware under graduates in the field of speech pathology and audiology. These subjects had no history of ear aches or any other compliant. All had normal ear structures otologically and normal hearing audiologically (20 dB HL ANSI.1969)

5 subjects (4F + 1M) with age range of 13 to 48 years, having abnormal tone decay were also tested in the present study.

Equipment;-

A dual channel diagnostic audiometer Maico MA - 22 with TDH 39 earphones placed in MX - 41 AR cushions, was used for testing. Using this audiometer, it was possible to test the frequencies from 125 Hz to 8000 Hz. Hearing level range from -10 to 110 dB HL for puretones and, -5 to 105 dB HL for narrow band noise.

Narrow Band Noise Specifications: Filtered white noise (equal energy per cycle noise); Maximum level was 105 dB 3EM, Band width dependent on frequency setting of the audiometer.

An Omega Stop Watch was used to record the duration for which a tone or Narrow Band Noise was heard, for full one minute.

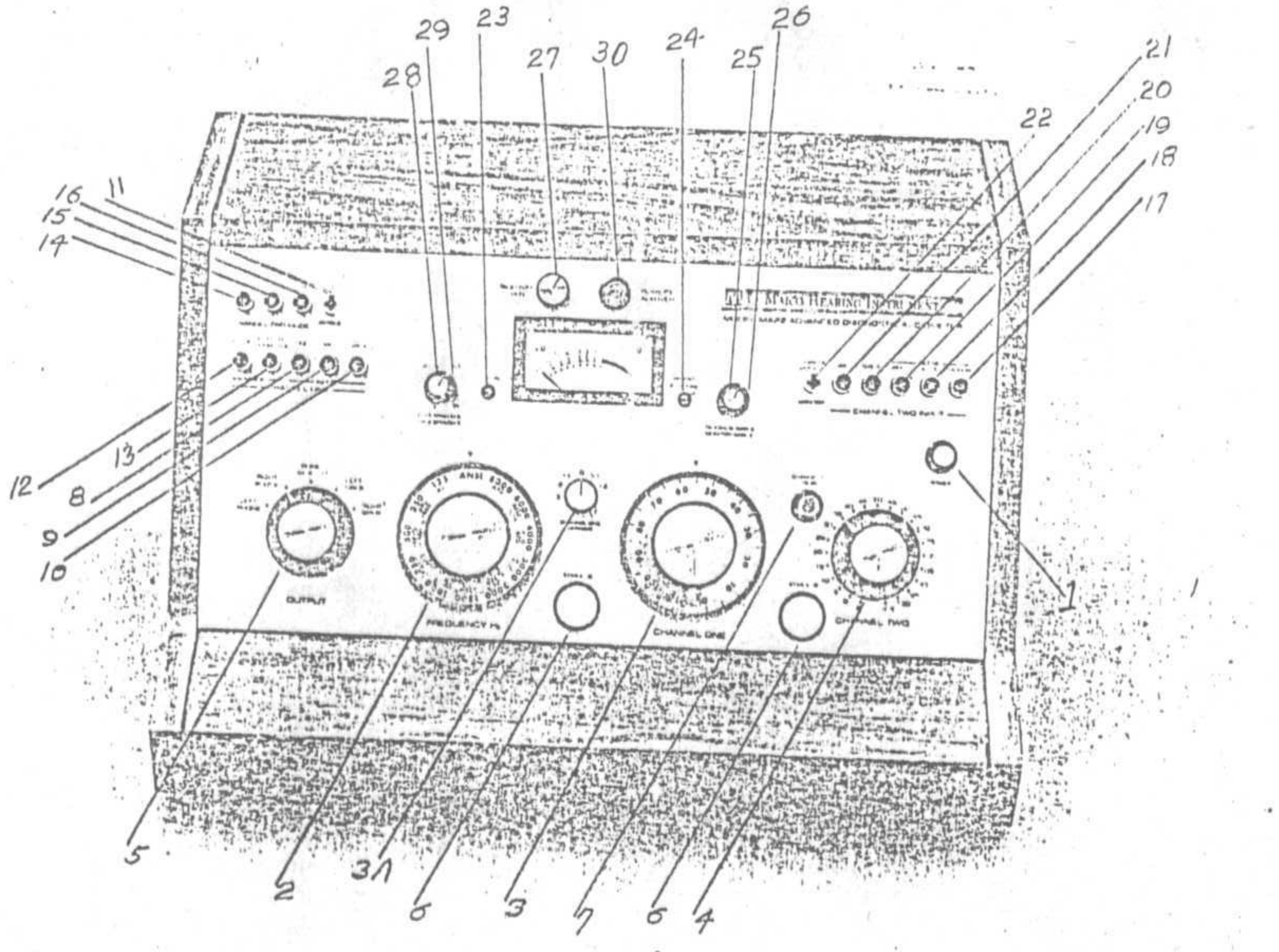

Fig. 1 : Audiometer - Maico MA-22

CONTROLS - MAICO MA 22.

1. Power
2. Frequency.
3. Channel one (Hearing level cortrol).
4. Channel two (Hearing Level control),
5. Output (Left phone, Right phone, Bone)
6. Stimulus (Interrupter)
7. Channel one - 10 dB.
8. Tone
9. Mic.
10. Tape A

CHANNEL ONE MODE PUSH BUTTON.

11. Warble.
12. Pulse.
13. Norm off - Norm on.
14. Cont (continuous).
15. Alt (Alternate).
16 Sim (Simultaneous).

CHANNEL TWO INPUT PUSH BUTTONS.

17. Narrow Noise.
18. White Noise.
19. Speech Noise.
20. Tape B
21. Channel 1.
22. Channel 1 & 2 monitor & VU adjust.
23. Channel 1 on.
24. Patient Response.
25. Talk rack gain.
26. Monitor gain.
27. Talk over gain .
28. Volume control. (Tape or Mic)
29. Volume control Tape B.
30. Talk over switch.
31. Vernier.

Calibration Procedure Used:-

The audiometer used in this study was calibrated ' periodically during the study according to the guidelines given by Wilber (1978). The exact procedure was:

The audiometer Maico MA - 22 was turned 'on' and was allowed to warm up. The Sound Level Meter (B & K 2203) was set to the following settings. The meter switch was turned to 'external filter' and to 'slow'. The weighting switch was in the 'off' position. The signal ear phone (TDH 39 with MX 41-AR cushions) of the audiometer was removed fron the head band and was placed over the coupler of the artificial ear (B & K type 4152) Condenser Microphone of one inch B & K type 4145 was used. The ear phone was held in place by means of a tension of the artificial ear and it was adjusted to 0.5 Kg of weight. After initial placement of the earphone on the coupler, a low frequency tone (250 Hz) was introduced and the ear phone was readjusted until the Sound Level Meter needle read the highest intensity. This is said to ensure best placement according to Wilder (1978). The frequency selector of the audiometer was set to 500 Hz. The Octave Filter (B & K 1630) of the Sound Level Meter was set to 500 Hz. The intensity dial was set to 60 dB HL for the frequency chosen. The reading on the Sound Level Meter was noted. Similarly other frequencies (1KHz, 2KHz and 4KHz) was checked. The earphone output levels were found to be within the permissible limits (ANSI 1969).

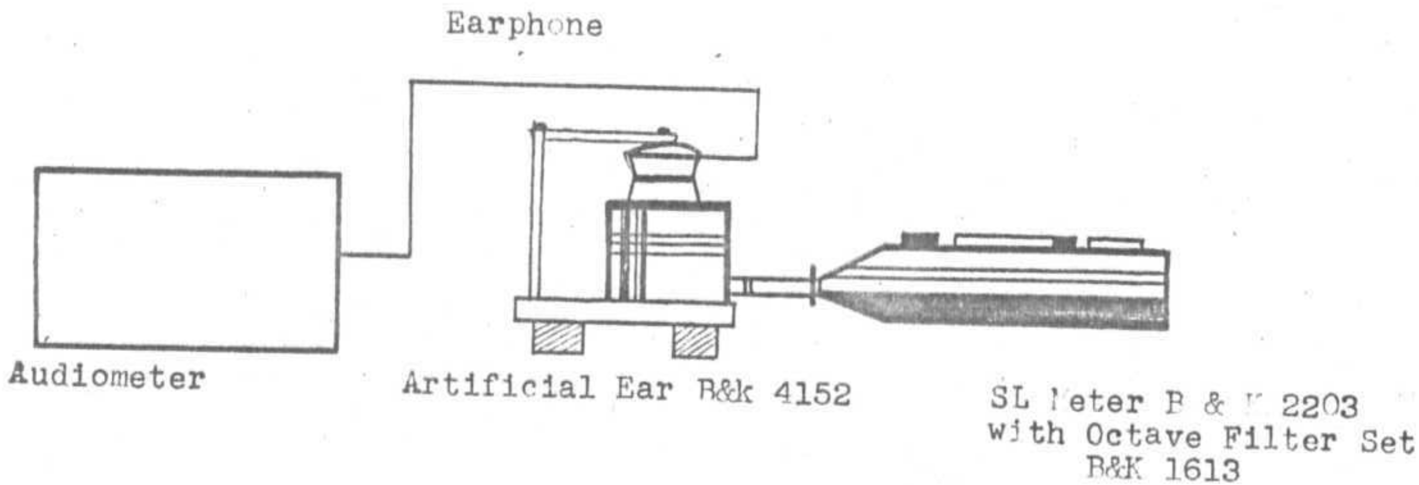

Fig. 2: Block Diagram of Pure Tone and Narrow Band Noise Calibration

To check the linearity of the attenuator of the audiometer, a similar set up was used. The range finder was set to 120 dB. The intensity dial was sat at maximum and the output of the Sound Level Meter was noted. The intensity dial was dropped in 5 dB stops and the reading on the Sound Level Meter showed that the audiometer linearity satisfactory.

The earphone output level for narrow band noises at different centre frequencies were checked in the same way as pure tone, the only difference being, instead of pure tones narrow band noises were introduced and the hearing level dial was adjusted to 85 dB HL to avoid interference from extraneous noise. The Sound Level Meter was set to centre frequencies namely 500 Hz, 1000 Hz, 2000 Hz and 4000 Hz respectively, in accordance with that of the audiometer's settings. The reading on the Sound Level Meter was within expected levels.

The band width of narrow band noise at different centre frequencies Viz. 500, 1000, 2000 and 4000 Hz were checked. The block diagram of the instruments used for checking the band width is shown in Fig 3.

The signal from the Pre-amplifier B & K type 2619 was the input signal for the Audio Frequency Analyser B & K type 2107. The Frequency Analyser drove the'Graphic Level Recorder B & K type 2305 by means of a shaft B & K type 0041 UT and the signal was fedfrom the frequency analyser to the Grapbic Level Recorder.

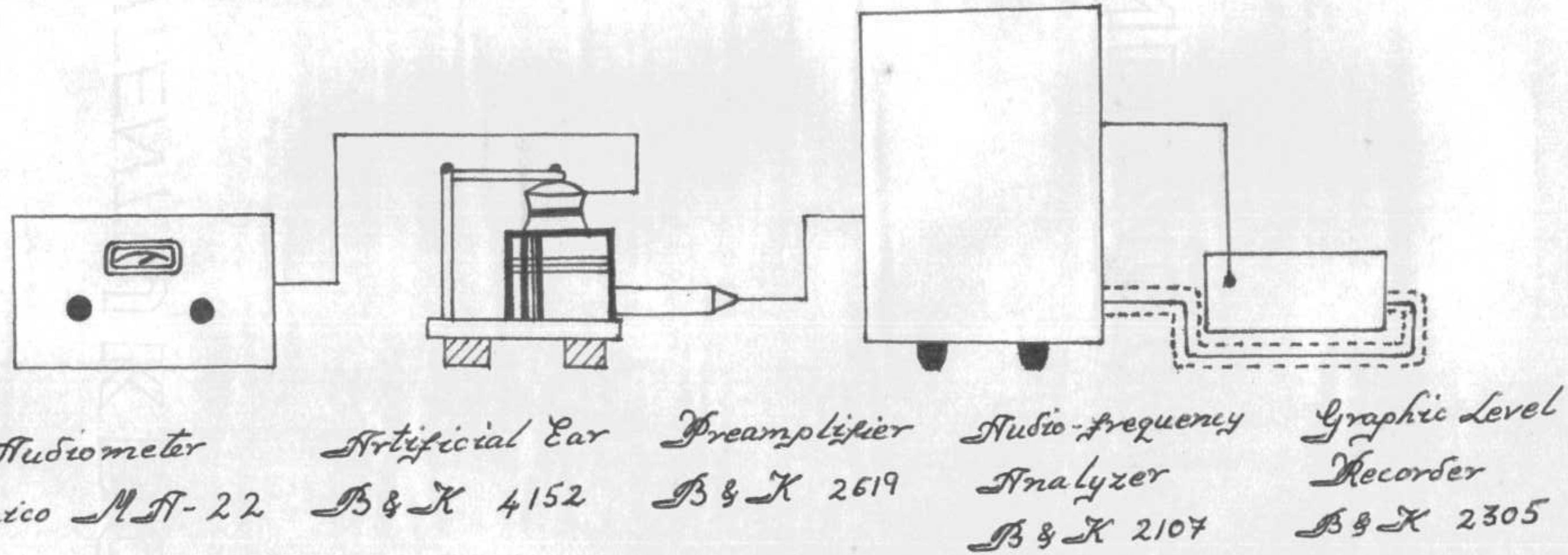

Fig. 3: Block Diagram for Determining the Bandwidth of Narrow Band Noise.

The audiometer's frequency dial was set to 5G0 Hz and signal was narrow band noise, intensity dial reading was set at 80 dB HL. The Frequency Analyser was set to the frequency range 200 Hz to 630 Hz. A calibrated paper was used on the Graphic Level Recorder. The band widths of the remaining other band noises were also determined in the same manner.

All these measurements were done in a Sound Treated Room of All India Institute of Speech and Hearing, Mysore.

Environment:-

The audiometric tests were performed in a Sound Treated Room of All India Institute of Speech and Hearing. The ambient noise levels in these rooms were within the maximum allowable noise levels.

Procedure:-

Testing was done in a Sound Treated Two Room situation. The Subject was seated in an arm chair so that the control panel of the audiometer was out of his/her line of vision. The following data was collected:

1. Pure tone thresholds at frequencies 500 Hz, 1000 Hz, 2000 Hz and 4000 Hz for both ears.
2. Narrow band noise thresholds for different centre frequencies Via. 500, 1000, 2000 and 4000 Hz for both ears.

Instruction to subject;

'You will hear a tone in either your right or left ear, Rest your elbow on the arm chair, make a fist and raise your index finger when you hear. Even if you hear it softly, raise your finger, and hold it up as long as you hear. "When you no longer hear it, bring your finger down. If you hear the tone in your right ear lift your right finger.' The instructions were accompanied by appropriate gestures. Thresholds were established using the Hughson-Westlake procedure.

The tone was initially presented at 40 dB HL and the intensity of the test tone was reduced in 10 dB steps following each positive responses, until he failed to respond. The tone was thus raised by 5 dB. If the subject heard this increment, the tone was reduced by 10 dB and raised in 5 dB steps until it was heard again, and thus the threshold for Pure tones and narrow band noises were established.

3. Tone decay at frequencies Vis. 500, 1000, 2000 and 4000 Hz was determined for both the ears.

4. Decay for narrow band noises with different centre frequencies Viz 500, 1000, 2000 and 4000 Hz, was also determined for both the ears.

Instructions to the subjects were same as before, Carhart's (1957) method was used to fine the tone decay and narrow band noise decay.

After obtairirg the thresholds for pure tones and narrow band noises at various centre frequencies, tone decay and narrow band noise decay were determined.

The test begin with the sustained tone below the established threshold and the intensity was increased in 5 dB steps without interruption until the subject responded. As soon as the subject responded timing was noted with a stop watch. If the tone was heard for ore minute the test was terminated.

If the subject indicated that he no longer heard the tone before the minute criterion was met, the intensitv of the tone was raised by 5 dB, withort interrupting the tone the stop watch was set back to zero, and begun timing for a rinute again. This was continued till the subject responded for one full minute. Narrow band noise decay values at centre frequencies 500, 1000, 2000 and 4000 Hz were also established using the same procedure.

The ears were tested alternatedly i.e. 500 Hz tone decay of left ear, followed by 1000 Hz tone decay for right ear, again 2000 Hz tone decay of left ear and 4000 Hz tone decay for right ear.

The thresholds and decay established for pure tones and for narrow band noises at various centre frequencies were noted down in the data sheet as shown over leaf.

Test - Retest Reliability

7 subjects out of 20 were selected randomly for test - retest reliability. After a month, thresholds for pure tones and narrow band noises were established.

Also tone decay and narrow band noise decay were established for the frequencies 500, 1000, 2000 and 4000 Hz

There was no significant difference between the test and retest results. The obtained data were statisticallv analysed.

DATA SHEET

	Right Ear				Left Ear			
Test	500	1000	2000	4000	500 Hz	1000 Hz	2000 Hz	4000 Hz
Pure tone threshold								
H.D.N. threshold								
Tone decay								
N.B.N Decay								

Pure Tone Thresholds				Narrow Band Noise Thresholds			
500Hz	1000H2	2000Hz	4000Hz	500Hz	1000Hz	2000Hz	4000Hz
11.5	12	9	19.5	20	19	23	13
16.5	12	9	19.5	20	14	28	13
16.5	17	14	14.5	15	19	18	13
16.5	17	14	19.5	20	14	18	13
21.5	7	14	14.5	10	19	18	23
21.5	7	9	14.5	20	14	18	13
16.5	17	19	19.5	20	19	23	18
16.5	12	14	14.5	20	19	18	13
26.5	17	9	9.5	25	19	23	8
21.5	17	9	14.5	20	19	23	13
16.5	12	14	24.5	20	19	23	13
16.5	12	29	24.5	15	24	18	33
21.5	17	14	9.5	20	19	13	13
26.5	22	9	29.5	25	14	23	13
26.5	22	14	29.5	20	19	13	18
31.5	17	14	29.5	25	14	18	13
21.5	17	14	19.5	20	19	13	18
16.5	12	14	14.5	15	14	13	13
16.5	7	19	14.5	15	19	13	13
11.5	7	14	14.5	15	19	13	13
26.5	12	9	14.5	25	14	18	8
26.5	17	9	9.5	20	9	18	8
26.5	12	14	19.5	25	14	23	18
16.5	7	29	14.5	20	19	18	13
21.5	22	14	14.5	25	19	18	23
21.5	12	14	14.5	20	19	18	18
26.5	17	9	9.5	20	14	18	8
26.5	17	24	9.5	20	19	18	18
26.5	17	29	14.5	20	14	18	18
31.5	22	19	24.5	30	14	33	13
16.5	12	14	9.5	20	19	13	13
16.5	12	14	14.5	20	19	13	13
11.5	17	14	14.5	15	19	23	18
11.5	12	9	9.5	15	14	23	18
21.5	12	14	14.5	20	9	23	8
21.5	12	14	9.5	20	14	18	8
21.5	12	34	19.5	25	14	18	13
21.5	12	19	14.5	20	14	13	8
16.5	12	14	19.5	20	14	13	18
21.5	12	19	9.5	20	14	13	18
M=20.5	M=14.00	M=15.00	M=16.5	M=20.00	M=16.50	M=18.50	M=14.5
σ 5.27	σ 4.15	σ 5.72	σ 6.44	σ 3.71	σ 3.16	σ 4.58	σ 4.90

<u>Table 1</u>

Pure Tone Thresholds and Narrow Band Noise Threshold for 20 Normal Hearing Subjects.

CHAPTER - IV

RESULTS AND DISCUSSIONS

The present study was undertaken to find the difference between thresholds of hearing for pure tones and the thresholds for narrow band noises centreed around test frequencies 500, 1000, 2000 and 4000 Hz.

Further difference between tone decay and narrow band noise decay was computed. The test tones included for finding tone decay were 500, 1000, 2000 and 4000 Hz. The different narrow band noises used for finding noise decay were having different centre frequency namely 500, 1000, 2000 and 4000 Hz.

Pure tone thresholds and Narrow band noise thresholds for the 20 normal hearing subjects are presented in Table I Mean thresholds with Standard Deviation for frequencies namely 500, 1000, 2000 and 4000 Hz. for pure tone are 20.5 (S.D. 5.27), 14.0 (S.D. 4.15), 15.0 (S.D. 5.72) and 16.50 (S.D. 6.44) respectively. Mean thresholds with standard deviations for narrow band noises of different centre frequencies namely 500, 1000, 2000 and 4000 Hz are 20.0 (S.D. 3.71), 16.5 (S.D. 3.16) 18.5 (S.D. 4.58) and 14.5 (S.D. 4.9).

The comparison of the Mean Thresholds obtained for pure tones and Narrow Band noises s ows that there is a very little difference between them. The Range of the thresholds for the pure tones with Mean and Standard Deviation are presented in Table 2, The Range of thresholds for narrow band noise with Mean & Standard Deviation are presented in Table 3.

The Mean Standard Deviations and Range of Pure Tone Thresholds at various test frequencies.

Frequency	Mean S.D.	Thresholds in dB SPL	Range
500 Hz	KL- S.D.	20.50 5.27	11.5-31.5
1000 Hz	M S.D.	14.00 4.15	7.0-22.0
2000 Hz	M S.D.	15.00 5.72	9.0-34.0
4000 Hz	M S.D.	16.50 6.44	9.5-34.50

TABLE - 2

The Mean Standard Deviations with Range of Narrow band noise thresholds at various centred frequencies.

0 Centre Frequency	Mean S.D.	Thresholds in DB SPL	Range
500	M S.D	20.00 3.71	10.30
1000 Hz	M S.D.	16.50 3.16	9.24
2000 Hz	M S.D.	18.50 4.58	13.33
4000 Hz	M S.D	14.50 4.90	8.33

TABLE - 3

The Mean Difference between Pure Tone Thresholds and Narrow Band Noise Thresholds with- 't' value.

Frequency	$\bar{D}$ t	Mean Difference in dD SPL.	
500 Hz	$\bar{D}$ t	.63 .37	**
1000 Hz	$\bar{D}$ t	4.5 7.69	*
2000 Hz	$\bar{D}$ t	7.05 6.24	*
4000 Hz	. $\bar{D}$ t	6.24	*

TABLE - 4

* Not significant at 0.01

** Significant at 0.01 .

At 0.01 level of significance 2.423

At 0.05 level of significance 1.684

TONE DECAY				NARROW BAND NOISE DECAY			
500Hz	1000Hz	2000Hz	4000Hz	500Hz	1000Hz	2000Hz	4000Hz
10	0	10	5	0	0	0	0
0	0	O	5	0	5	0	0
0	0	0	5	5	0	0	0
0	0	0	5	0	5	0	0
5	5	5	0	5	0	5	0
5	0	5	5	0	0	5	5
5	5	0	5	0	5	0	0
5	10	0	5	0	5	0	5
0	0	0	5	0	0	0	5
5	0	0	0	5	5	0	5
O	5	5	5	0	5	0	5
0	5	5	10	0	0	5	5
5	0	5	5	0	0	5	0
0	5	5	5	5	0	0	0
5	5	0	5	10	0	5	0
0	5	0	5	10	5	0	0
0	5	0	0	0	0	0	O
0	5	0	5	5	0	0	0
10	0	0	0	5	O	0	5
10	O	0	0	5	5	0	0
5	0	5	5	5	0	0	0
5	0	5	5	5	0	5	0
e	0	5	5	0	5	O	0
5	5	0	5	5	0	5	0
0	0	5	0	0	10	0	0
5	0	5	5	0	5	0	0
5	5	0	0	0	0	5	5
5	5	5	5	5	0	5	0
0	5	5	0	5	0	0	0
0	5	5	O	5	0	5	0
0	0	0	5	5	5	5	0
0	0	0	5	5	5	5	0
5	0	5	O	5	0	0	0
5	0	5	O	5	O	0	5
0	5	0	0	0	5	0	0
0	10	O		5	5	0	0
5	0	5	0	0	5	0	5
5	0	5	0	0	5	5	5
5	0	O	0	5	5	10	5
0	5	O	0	5	5	5	0
M= 3	M= 2.5	M =2.5	M = 3	M = 3	M =2.5	M =2	M = 1.5
σ 3.12	σ 2.96	σ 2.74	σ 2.69	σ 2.92	σ 2.74	σ 2.69	σ 2.29

<u>Table 5</u>

Tone Decay and Narrow Band Noise Decay for 20 Normal Hearing Subjects.

Hear Difference between Pure Tone Thresholds and Narrow Band Noise Thresholds with 't' value are shown in Table 4. It can re seen from the Table 4 that there is significant difference between the Mean Thresholds of Pure Tone and Narrow Band Noises except at 500 Hz. Thus it is observed that the thresholds for Narrow band Noises are higher than the thresholds for the Pure Tones. This observation is in contrast to earlier studies reported.

Table 5 shows the Tone Decay and Narrow Band Noise Decay values obtained for 20 normal hearing subjects . Mean Tone Decay with Standard Deviation at 500, 1000, .2000 and 4000 Hz are 3 (S.D. 3.12), 2.5 (S.D. 2.96), 2.5 (S.D. 2.74) and 3 (S.D. 2.69) respectively.

Mean Narrow Band Noise decay with Standard Deviation at Center frequencies 500, 1000, 2000 and 4000 Hz. are 3 (S.D. 2.92) 2.5 (S.D. 2.74), 2 (S.D. 2.69) and 1.5 (S.D. 2.29) respectively.

Mean, Standard Deviation and Range for Tone Decay are shown in Table 6. Similar information regarding Narrow Band Noises are giver in Table 7.

Mean Difference between Tone Decay and Narrow Band Noise decay with 't' values are presented in Table S. It can be seen from the Table 8, that there is no significant difference between Tone Decay and Nrrrow Band Noise Decay. At all the frequencies of pure tones and centered frequencies of narrow band noises tested.

Myers (1957) was one of the first persons to have compared Narrow Band Noise and Pure Tone Threshold and concluded that two signals were inter-changeable at low frequencies but tended to differ at higher frequencies. Simon and Northern

The Mean Standard Deviation and Range of Tone Decay at various Test Frequencies

Frequency	M S.D.	Tone Decay in DB	Range
500 Hz	M S.D.	3 3.12	0-10
1000 Hz	M S.D.	2.5 2.96	0-10
2000 Hz	M S.D.	2.5 2.74	0-5
4000 Hz	M S.D.	3 2.69	0-10

TABLE 6

The Mean Standard Deviation and Range of Narrow Band Noise Decay at various centre frequencies.

Frequency	M S.D.	N.B.N. Decay in dB	Range
500Hz	M S.D.	3	0-10
1000 Hz	M	2.5 2.74	0-10.
2000 Hz	M S.D.	2 2.69	0-10
4000 Hz	M S.D.	1.5. 2.29	0-5

TABLE - 7

Mean Difference between Tone Decay and Narrow Band Noise Decay with 't' values

Frequency	$\bar{D}$ t	Mean Difference* in dB
500 Hz	$\bar{D}$ t	0 0
1000 Hz	$\bar{D}$ t	0 0
2000 Hz	$\bar{D}$ t	.5 .35
4000 Hz	$\bar{D}$ t	1.60

Level of Significance. 0.0l 2.423

level of significance 0.05 1.684

TABLE - 8

T.

Tone Decav and Harrow and Noise Decay in 5 sensori-neural hearing loss cases.

Patients		500 Hz	1000 Hz	2000 Hz	4000 Hz
patient 1	Rt	60 (5)	65 (20)	45 (0)	20 (25)
	Lt	60 (10)	40 (20)	25 (f)	30 (15)
patient 2	Rt	35 (45)	60 (45)	70 (20)	55 (15)
	Lt	-	-	-	
patient 3	Rt	15 (10)	10 (5)	25 (5)	25 (5)
	Lt	15 (10)	10 (5)	20 (5)	25 (5)
patient 4	Rt	-	-	-	
	Lt	25 (50)	40 (45)	.O (20)	15 (30)
patient 5	Rt	30 (40)	40 (40)	45 (45)	40 (55)
	Lt	30 (r.5)	35 (30)	30 (35)	65 (5)

Table 9

( ) Figures in parenthises indicates Narrow Land Noise decay value at respective centre frequencies.

' (1966) found adults with normal hearing showed no significant differences between Narrow band noise and Pure Tone thresholds. In the study done by Stephens and Rintelmann (1973) they have indicated that audiometer configuration may influence pure tone and Narrow Band Noise agreement, and Narrow band Noise thresholds were more sensitive than pure tone thresholds in persons with sloring audiometric configurations. As the 't' values obtained for the difference mean between puretone threshold and narrow band noise threshold are significant, it clearly rejects the first hypothesis that there is no significant difference between thresholds for pure tone and narrow band noise So if narrow band noise is utilised as an alternative stimulus thus difference should be considered.

A thorough review of literature shows that there is no study with regards to the difference between Narrow band noise decay and Tone decay. The present study has revealed that in normal subjects there is no significant difference between Tone decay and Narrow band noise decay.

Table 9 s:ows Tone Decay and Narrow Band Noise decay for 5 cases having serscri neural hearing loss. In the case of 3 patients both the ears were tested. The remaining 2 patients, one ear of each was tested. These five patients were selected because they had exhibited Tone decay onOlsen's Tone Decay Test. It is obvious from the Table 9 that there is not much relationship between Tone Decay and Narrow band noise Decays in all the patients at all the pure tone frequencies tested. However the relationship between narrow band noise decay and tone decay appears to be satisfactory at 1000 Hz.

At 1000 Hz , the data show that, if there is positive Tone Decay, positive decay for narrow band noise are also be expected. However, here also there are some exceptions. The fact that there is some relationship between the Tone Decay at 1000 Hz and Narrow band noise decay centred around 1000 Hs, indicates that the idea of using the Harrow band noise for assessing decay in cases who, exhibit abnormal Tone decay and tinnitus nay not be rejected. More number of patient having Sensori neural hearing loss exhibiting positive tone decay at 1000 Hz will have to be tested to find out whether they also show Decay for Narrow band noise centred around 1000 Hz. This information will be useful for developing 'Noise Decay Test' for asessing Retrocochlear pathology.

C H A P T E R - V

SUMMARY & C0NCLUSI0NS

The purpose of the present study was to explore the relationship between pure tone thresholds and the narrow band noise threshold in normal hearing subjects. Additionally with a view to develop 'Noise Decay Test' for asessing abnormal decay for continuous auditory stimulation (concomitant monoaural adaptation) in sensori-neural hearing loss patients who exhibit tinnitus, the Tone decay test can not be administered. Hence, there is a need for 'Noise decay test'.

A sample of 20 subjects with normal hearing (20 dB HL ANSI 1969) with an age range of 17 to 23 years (12 F + 8 M) served as subjects. Pure tone thresholds at 500 Hz, 1000 Hz, 2000 Hz and 4000 Us were established using Hughson Westlake procedure. Thresholds for narrow band noises varying in central frequencies namely 500, 1000, 2000 and 4000 Hz were established.

Tone decay and Narrow band noise decay, were determined using Carhart's procedure. (1957)

Five subjects with age range of 12 to 42 years (4F + 1'*) exhibiting abnormal tone decay on Olsen tone decay test were also tested using narrow band noises and pure tones.

The present study has revealed that there is significant difference between pure tone thresholds and the narrow band noise thresholds in normal hearing subjects. No significant difference was noticed, between tone decay and narrow band decay in normal hearing subjects. Thus the null hypothesis (there is no significant difference between tone decay and narrow band noise decay) is accepted.

The relationship,between narrow band noise decay and tone decay in senscri-neural hearing loss cases appears to be satisfactory at 1000 Hz. The fact that there is some relationship between the Tone decay at 1000 Hz and narrow band noise decay centred around 1000 Hz, indicates that idea of using narrow band noise for assessing decay in cases who, exhibit abnormal tone decay and tinnitus may not be rejected. More number of patient having senscri-neural hearing loss exhibiting positive tone decay at 1000 Hz will have to be tasted to find out whether the also show decay fcr narrow band noise centred around 1000 Hz . This inforration will be useful for developing noise decay test for assessing Retrocochle r pathology.

Suggestions for further research;

1. narrow band noise with very narrow bands should be used instead of wider bandwidths.

2. A large sample of sensori neural hearing loss patient exhibiting varying amount of tone decay will have to be tested.

3. It would be desirable if, confirmed Retrocochlear pathology cases are used for this type of study.

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