TO MY PARENTS

TONE DECAY AT HIGH FREQUENCIES IN NORMALS

Register No. 8413

Yasmeen Gunja

An independent project as part fulfilment for

first year M.Sc., (Speech and Hearing) to the

University of Mysore

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All India Institute of Speech and Hearing,

MYSORE-570 006.

CERTIFICATE

This is to certify that the Independent Project entitled:

" TONE DECAY AT HIGH FREQUENCIES IN NORMALS "

Is the bonafide work, done in part fulfilment for first year M.Sc., Speech and Hearing, of the student with Register Number.8413

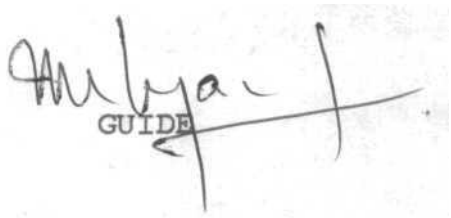
Director
All India Institute of Speech & Hearing
Mysore - 570 006

CERTIFICATE

This is to certify that the Independent Project entitled:

"TONE DECAY AT HIGH FREQUENCIES IN NORMALS"

has been prepared under my supervision and guidance.



DECLARATION

This Independent Project entitled "TONE DECAY AT HIGH FREQUENCIES IN NORMALS" is the result of my own study undertaken under the guidance of Dr. M.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.

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INTRODUCTION

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Various investigators have noted that some patients have difficulty maintaining audibility for a pure tone presented continuously at threshold. Terms most frequently used to describe this phenomenon are: abnormal adaptation or tone decay.

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.

Some modifications available of tone decay test are:

1. Schubert tone decay test
2. Hood tone decay test
3. Carhart tone decay test
4. Rosenberg one minute modification of the carhart tone decay test
5. Green modified tone decay test
6. Sorenson tone decay test
7. Modified Hood tone decay test
8. Jerger and Jerger Supra threshold adaptation test.

Carhart (1957) proposed a tone decay test and found that patients with menier's syndrome and patients with other types of sensori neural disorders demonstrated tone decay on this test.

Although abnormal adaptation is characteristic of patients with 8th nerve lesion, patients with cochlear disorders, exhibit tone decay as well, which confuses the problem of differential diagnosis.

Many case histories illustrate that high frequency audiometry contributes to a better audiological diagnosis (Darint Osterhammel 1980) and it is predicted that high frequency audiometry is of value in research studies.

In order that a system for testing high frequency threshold levels be clinically applicable, levels must be related to a 'normal' set of reference values and the device must yield reliable and valid data (Gauz, Abroon, Roberts, 1981).

One complicating factor in the interpretation of all tests is the frequency dependance of test results. In cochlear disorders the symptomatology is uniquely related to test frequency. Cochlear signs are, by and large high frequency signs. There is usually little indication of abnormality at frequencies of 250 Hz or 500 Hz. The tone decay test ordinarily shows little decay at 250 Hz or 500 Hz.

A study was done by Garcia and Hood (1972) on tone decay using Carhart method with a variation that the tone was presented at 5 dB SL rather than 5 dB below threshold.

The threshold tone decay test was administered at 500 Hz, 1 KHz, 2 KHz and 4 KHz on 41 ears. Results showed that there was no tone decay at 500 Hz.

Another study was done by Doehring and Swisher (1971). The purpose of the study was to determine tone decay in normals at 500 Hz, 2 KHz and 4 KHz, thus providing information regarding the relationship between the amount of tone decay and the sound pressure level at which the test tone was initially presented. The study also provided further evidence regarding the relationship of tone decay to test tone frequency.

'Results showed that tone decay tended to increase with increasing hearing threshold levels at all three frequencies. Tone decay was much smaller for 500 Hz. There was no systematic difference between the amount of tone decay at 2 KHz and 4 KHz.

Most of the authors agree that the higher frequencies are more sensitive therefore tone decay tends to occur 1st at the higher frequencies and extendsdown the frequency scale if progression of the disease is disclosed by subsequent testing.

It is also seen by Balas and Colo (1968) that a variety of lesions affecting the 8th nerve may cause abnormal hearing.

Reduced hearing sensitivity and acuity may result from traumatic neoplastic and vascular disorders, as well as metabolic, infections and toxic diseases. Regardless of etiology,early diagnosis of retrocochlear lesions may enhance a more effective treatment program.

NEED FOR THE STUDY:

It is known that usually the hearing sensitivity for higher frequencies is affected in different condition viz acoustic trauma, prolonged exposure to intense noise, ototoxicity, advancement of age etc. Most of the normal hearing subjects do not differ much in their hearing sensitivity for frequencies from 250 Hz to 4 KHz.

In terms of tone decay also, the normal hearing subjects do not show much difference for frequencies from 250 Hz to 4 KHz.

The fact that the hearing sensitivity of the normal hearing subjects for higher frequencies differs considerably (Fletcher et al 1967; Jacobson et al 1969, Corlus et al 1970; Downs and Northern, 1971; Osterhammel 1980) shows that if any difference in the auditory abilities of subjects is to be detected, it is better to have sufficient data on the auditory abilities of normal hearing subjects for higher frequencies.

Among the several special audiological tests, tone decay test is undoubtedly a very useful and simple.test to detect retrocochlear pathology. Since tone decay test has gained importance as a very useful test, collection of data regarding tone decay at higher frequencies in normal hearing subjects would be useful. Additionally, the 'tone decay' data at higher frequencies in normal hearing subjects may throw some light on the subject's susceptibility for noise induced hearing loss.

The present study was undertaken to final answers for the following questions:

1. Does tone decay at high frequencies depend on the frequency of the stimulus?
2. Is there any ear difference in tone decay at high frequencies?
3. Is there any sex difference in tone decay at high frequencies?
4. Does noise in the contralateral ear influence the results in any way?

REVIEW OF LITERATURE

REVIEW OF LITERATURE

Adaptation is a process by which the sensitivity of the sensory system is modified due to the continuous presentation of a stimulus at a constant level of sensitivity (Carro 1967).

One of the sensory adaptations is the auditory adaptation which is the change in the functional state of the auditory system brought about by an acoustic stimulus or merely a reduction in apparent magnitude or an increase in threshold (Sillcot and Fraser 1970).

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 for only a few seconds as the loud tone disappeared.

Following Lord Ray Leigh's (1882) discovery of tone decay, considerable effort was expanded in an effort to find out what it meant. Jacobson (1883) observed that in some patients a weakly strung tuning fork may actually be heard longer than one struck more vigorously. Huijsman (1884) later treated tone decay at some length, showing that it occured much more often at high frequencies. Carradi (1890) demonstrated that tone decay also

occurs in bone conduction, if, after the tone disappears the fork is taken off the mastoid and replaced, it can again be heard by some patients, Carradi (1890) therefore used as diagnostic measurement the duration of perception at the 1st application of the fork, than at the second reapplication and so on. Schafer (1905) insisted that not everyone expresses tone decay even at high frequencies. He could hear loud Rayleigh's bird call indefinitely. Phone(l906) found no consistent difference in the degree of tone decay between normal ears and persons with middle ear pathology. Bleyl (1921) tested persons with normal hearing, conductive losses, perceptive losses and 'miscellaneous', but found no consistent differences among the groups. K.Schuberts (1944) rediscovered tone decay as a diagnostic tool.

DIFFERENTIATION OF TONE DECAY FROM SIMILAR PHENOMENA

A tone of steady intensity presented through a standard pure tone audiometer to a pathologic ear near threshold is often perceived as fading in loudness. In describing this phenomenon, investigators have used various terms including perstimulatory fatigue, threshold shift, abnormal adaptation, relapse and tone decay.

The terms are confusing and must be differentiated from tone decay.

Tone decay and fatigue:

The major difference between fatigue and tone decay is that fatigue effects last longer and can be measured after the fatiguing stimulus is discontinued. Whereas effects of tone decay recover very rapidly.

Tone decay and perstimulatory adaptation:

Tone decay is often confused with perstimulatory adaptation which appears only when both ears are simultaneously stimulated and has nothing to do with the adaptation of the cochlear receptors. Tone decay on the other hand is a monoaural phenomenon and is measured with monoaural stimulation. Even though tone decay recovers within several seconds, it can hardly be perstimulatory adaptation which has a recovery period nearer one minute.

Tone decay and fast adaptation:

Sergeant and Harris (1963) said that tone decay is differentiated from fast adaptation as the recovery of tone decay following cessation of stimulus was slower than that of fast adaptation. On the other hand fast adaptation has a brief onset (300 m.sec. or less) and recovery of its locus is the hair cells. Also it is measured with clicks and is a function of inter click interval.

MEASUREMENT OF TONE DECAY:

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

The advantages of the threshold tone decay test is its simplicity. No special equipment is required other than an audiometer and a watch. The high correlation between the threshold tone decay and the Bekesy comparison of interrupted and continuous tone suggests that if one does not have access to a Bekesy audiometer, he may still classify patients as to presumed Bekesy types II and III on the basis of threshold tone decay.

There are several modifications available of the tone decay test. Some of them are:

1) Schubert tone decay test:

It appears that Schubert (1944) was the first to report the use of a conventional audiometer to measure tone decay. In his procedure, the patient was allowed to listen to a 5 dB tone until the tone disappeared. Thereafter the intensity was raised in 5 dB steps without interruption until a plateau was reached or the maximum limit of the audiometer prohibited follow ing the receding tone.

2) Hood tone decay test:

Hood (1965) reported a more elaborate tone decay procedure where the subject's threshold of hearing is determined. Then the test is begun by presenting a tone 5 dB above threshold. If the subject stops hearing the tone, it is switched off and the subject allowed rest of 60 sec. Then the intensity is further raised by 5 dB and the procedure repeated until an intensity is reached which produces a sensation of tone 'indefinitely'.

3) Carhart tone decay test:

In 1957 Carhart proposed as a formal clinical test an adaptation of the procedure proposed by Gradenigo (1893).

Carhart's procedure involved presenting a continuous tone at 5 dB below a patient's previously determined hearing threshold level and checking the patient's response with a stopwatch. If the patient maintains the tone at an audible level for 60 secs, the test result is negative i.e. there is no tone decay. If the patient 'looses' the tone short of 60 secs the examiner increases the intensity by one or more 5 dB steps until the patient again signals that he hears the tone. The timing then commences a new. Additional increases are made if necessary until a hearing level is reached at which the patient can respond to the tone for a full 60 seconds. The amount of tone decay is expressed as the dB change from the original threshold to the final hearing level required to meet the 60 secondscriterion.

4) 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 seconds. 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 switched off and the amount of tone decay in dB is computed.

Several variations of the Carhart test such as the Rosenberg modification, have been proposed to reduce the time of test administration in the interest of the patient and of the examiner.

Using Rosenberg modification it was seen that when the tone decay was measured,at the end of 60 seconds, a total of 12.5 dB decay is noted. This could be classified as a cochlear pattern, whereas continuation of the test uhder the Carhart technique produced a total tone decay of 85 dB (Parker et al 1971).

5) Sorenson Tone decay test:

This tone decay test was given by Sorenson in 1962. The instructions are the same as the Carhart tone decay test, but he employed a 90 second criterion for termination of the test.

6) Modified Hood tone decay test:

This test was given by Owen and is the same as Hood's tone decay test except that the test has to be stopped at the level. Where he hears the tone for the complete minute or at 20 dB SPL whether he hears the tone for one complete minute or not, whichever comes first.

In the tests discussed, one is concerned primarily with the total amount of threshold shift produced within a given time reference. Owens stresses a different parameter in his variation of the tone decay test, namely the time required for complete fade out of the tone within a specified range of threshold shift. In addition to this, a 20 second rest period between each intensity increment is given. It is believed that, the 20 second rest (recovery) period may have a modifying effect i.e. tending to make the test less sensitive by interrupting the stimulus duress.

7) Green Modified tone decay test:

In 1960 Green modified the instructions given with the shortened one minute version of the Carhart test (Green 1960). The subject is instructed to keep the arm perpendicular when he hears the tone and to lower it to 45 degree angle if the stimulus looses tonality, but remains audible and to lower his arm to the rest position if the sound becomes completely inaudible

8) Simplified Suprathreshold tone decay test:

The conventional tone decay test has two basic limitations i.e. it may consume an unusual amount of testing time, especially at high frequencies where 15 to 20 dB of decay is not unusual in normal ears. Also coupled with its extreme sensitivity to 8th nerve disorder seems to be an unusually high positive rate. Thus a hypothesis was formed (Jerger and Jerger 1975) that symptoms of abnormal tone decay first appears only at the highest testable sound intensity. Later as the 8th nerve disorder progresses, they will be manifest at systematically lower and lower test levels. In the early stages however, they are not likely to appear at or near threshold. Indeed, in these early stages, cochlear symptoms will usually predominate. Only when abnormal adaptation has moved well downward on the intensity scale will it begin to mask the otherwise dominant cochlear signs to produce a classic retrocochlear configuration of test results

Working on the above hypothesis Jerger and Jerger proposed a simplified suprathreshold tone decay test. The test frequencies are 500 Hz, 1 KHz and 2 KHz. The technique is that 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 secs, has elapsed whichever comes first.

9) Albreicht Effect:

Albreight effect is a phenomena concerned primarily with the time required for complete fade out of the tone at threshold. The test differs from Carhart tone decay test (1957) in three respects (a) tone was presented at threshold level istead of at below threshold,(b) duration for which tone was heard was recorded, (c) subject was to indicate if there was reduction in loudness.

A study done (Madhuri 1981) showed that the duration of decay reduced with increasing frequency (i.e. tone decay increased with increasing frequency).

CLASSIFICATION OF TONE DECAY:

Although abnormal tone decay is characteristic of patients with 8th nerve lesions, patients with cochlear disorders exhibit tone decay as well, which confuses the problems of differential diagnoses.

It seems reasonable to assume that the amount and the type of threshold shift on tone decay, by whatever method they are measured, depend on the severity of involvements of the neural elements and that the concept of an arbitrary dividing line on one side of which we call the results negative and on the other positive is unrealistic. There have been cases in which there

was little threshold shift by any method on first testing, but in whom total threshold shift developed at all frequencies over a period of time with subsequent tests.

Despite the widespread use of tone decay tests, system of classification appears infrequently. Rosenberg (1958) devised a clinically useful scale of gradation based on the number of dB of tone decay resulting from application of his procedure. He used the following criteria 0 to 5 dB normal.

10 to 15 dB mild

20 to 25 dB moderate

30 dB or more marked.

Rosenberg (1969) indicated that mild to moderate levels of tone decay were frequently seen in pathology involving the organ of corti, whereas marked tone decay almost always indicated retrocochlear pathology.

Glasscock (1968) using the same testing technique agreed that a positive tone decay test was one in which there were atleast 30 dB of decay.

Tillman (1969) advocated the longer Carhart procedure, but agreed that patients with retrocochlear lesions typically had tone decay exceeding 30 dB.

Owens (1964) derived 3 major tone decay types:

Type-I - There is no evidence of decay i.e. the tone remains audible for 60 seconds at 5 dB SL

Type-II - There is progressively slower decay with each 5 dB increments. The amount of decay is measured only upto the 20 dB SL. Five categories of Type-II tone decay are delineated on the basis of amount and rate of tone decay.

Type-III - There is progressive decay with little or no change in rapidity with each 5 dB intensity increment upto 20 dB SL.

Morales Garcia and Hood (1972) used a four type classification system to indicate increasing amounts and rates of tone decay in patients who were given the Carhart tone decay test Records were kept of amount of decay as a function of time. Tone decay type-I was minimal and did not exceed 15 dB. Slightly greater decay was called type-II. Patients were classified as type-III if they had more than 20 dB of decay at 500Hz, more than 25 dB at 1 KHz, more than 30 dB at 2 KHz or more than 35 dB at 4 KHz. Type-IV was distinguished from type-III primarily by rapidity of the decay.

INTERACTION OF TONE DECAY WITH SPECIAL TESTS:

When tone decay is present, its influence can often be seen in tests other than the formal tone decay test itself.

Tone decay and Bekesy audiometry:

The most obvious manifestation of tone decay is in Bekesy audiometry when the tone is continuous.

Comparison of Carhart tone decay test and Bekesy audiometry shows that in Carhart tone decay test an uninterrupted pure tone stimulus starting at threshold intensity is continued for 60 seconds.

In Bekesy sweep tracing difference between the threshold measured by the continuous tone tracing and the interrupted tone tracing is a measure of the tone decay. In this test, there are two added factors that are not present in tone decay test which could influence the result. First the frequency is continually chaning from the above to below threshold and back and also the intensity is continually shifted.

It might be anticipated that continuously changing intensity alone (fixed frequency) might influence the measurement of tone decay.

Roger and Kos (1952) noted that when one tested at a single frequency in a person with acoustic neuroma, the indicated threshold gradually shifted toward a higher and higher intensity. Even when the frequency is continually shifted, the tone decay induced by the threshold level tone may be considerable, so that in such cases larger separation between Bekesy audiograms gathered using continuous and using interrupted tone emerges.

The modified Bekesy audiometer can easily be used to track tone decay,at discrete frequency for the Carhart and Rosenberg tests. The subject is merely instructed to press the button as soon as he hears the tone, to keep the button pressed for as long as he hears the tone, and to release the button when the tone fades away. As soon as the patient releases the button, the tone will automatically increase in intensity until the patient once again presses the button. This is continued for 60 seconds (Rosenberg) or until the tone is heard at one level for a full 60 seconds (Carhart). The Bekesy audiometer is somewhat more difficult to use for the Owens procedure because this procedure requires a 20 second rest period after the tone fades away, as well as several 5 dB increments.

Tracking tone decay with the modified Bekesy audiometer offers two advantages over the procedures routinely employed for

measuring tone decay. First and most important is that we can obtain not only an accurate measurement of tone decay, but also a precise picture of the interaction between intensity and time. We can also note the time and/or intensity required to reach audibility once the tone fades away, which is important in the differential diagnosis of lesions of the auditory system.

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 changes of hearing are also measured. This is evidenced by the fact that the 6th and 20th increments are heard more 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, for intensity difference limen 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 one dB increment pips, appears to emerge from silence. The 5 second interval between the pips, allows for sufficient recovery to take place.

Even ears exhibiting moderate tone decay, 20 dB either with cochlear or retrocochlear pathology, exhibit this phenomenon (Hughes 1968). This effect is possibly been demonstrated in normals if the contralateral ear is masked.

Tone decay and ABLB:

When the ABLB recruitment test is performed at a frequency where there is marked tone decay, loudness growth with increasing intensity is less than normal. This result has been termed decruitment (Fowler 1965, Davis and Goodman 1966) in contrast to recruitment where loudness growth with increasing intensity is greater than normal.

Tone decay and Evoked Response Audiometry:

In cases with nerve VIII lesions every average evoked response on the impaired side revealed longer latency and smaller amplitude than those obtained from the normal side. On the other hand, the Menier's cases revealed shorter latency or very little difference in latency and increase in amplitude on the impaired side.

Tone decay and word discrimination:

In cases where there is marked tone decay, presumably from damage to fibres of nerve VIII, word discrimination may be much worse than the pure tone thresholds would ordinarily indicate.

Tone decay and acoustic reflex:

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

Tone decay and pseudohypacusis:

Little is known at this time about characteristic responses of functional patients to the standard tone decay test.

TCNE DECAY AND MASKING:

It is well known that even minor alteration in test conditions may significantly change the outcome of audiological tests. Masking of the non test ear is necessary in testing adaptation at threshold in many patients with a unilateral hearing loss.

The adaptation tests performed with a starting level of 20 dB SPL masking do, however show masking effects to those at other levels, and were found to be statistically significant for the Carhart test. Shinija (1969) found a greater degree of tone decay effect with the Carhart test than had been observed with Bekesy recordings.

The mechanism of masking effects on tone decay are obscure. It could be argued that cross masking occured with the higher

levels of masking used. A further possibility is that the tone decay assessment without masking was due to cross hearing.

Bleguad and Turkildren (1966) argue that the effect of central masking is not due to stapedius contraction and Bleguad (1972) has also demonstrated in one patient that the cochlear efferent fibres were not responsible. Shinizu (1969) was of the opinion that central adaptation might be responsible. Hopkinson (1971) found that patients with brainstem lesion were more susceptible to central masking than those with peripheral pathologies.

Beleguad and Josephsen (1971) have recommended that contralateral masking should always be used with tone decay test in order to avoid false negative results.

MECHANISM OF TONE DECAY:

Tone decay is a normal phenomenon. The mechanism of tone decay is not exactly known, but many speculations are based mostly on studies on pathological groups.

Marked decay was found in patients with retrocochlear pathology. Abnormal tone decay can be caused by neural degeneration, inflammation, trauma, as well as space occupying lesions like tumours which press against the eighth nerve.

The etiologies that can manifest tone decay are acoustic primary tumour, cholesteatoma, meningoma (Johnson 1966), thermal injury to nerve eight (Harbert and Young 1962) multiple sclerosis, mumps, neuritis. Van Recklinghausen's disease, acquired genetic deafness, Ramsay hunt syndrome, intracranial aneurysm, head trauma (Hartbert and Young) Pinealoma (Kos 1955). Extra axial brain stem lesion (Jerger and Jerger 1974).

Reversible tone decay has been described in nerve VII neuritis, multiple sclerosis, pineacoma, 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.

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

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

According to Mathew's work, when a stimulus is applied to the end organ, the action potential response consists of an

initial high frequency discharge known as the 'on-effect'. The duration of this initial burst of impulses is breif, being of the order of 0.2 second and is followed by a slow decline in the discharge frequency with time. This decline is termed adaptation.

Davis (1962) contended that the mechanism of tone decay was probably analogous to the Wednesky inhibition to peripheral nerves. The essence of this phenomenon is that if a short stretch of nerve is partially narcotized, the first impulse of a series or perhaps an entire series of impulses with long intervals between them will pass through successfully, but a rapid sequence will fail after the first impulse or first few impulses.

Assuming a similarity between "Wedneskey's narcotically induced neural block" and the partial dysfunction of a large number of nerve fibres from a retrocochlear lesion. Davis postulated that the gradual slowing of recovery and failure of complete recovery during continued stimulation should cause the progressive failure of more and more of the impaired fibres. This would obtain in any condition of retrocochlear lesion, whether pressure from a tumour, inflammation or atrophy of nerve VIII fibres. The simultaneous loss of tonality and audibility would be accounted for on this basis.

Another condition exists in which the fatiguing signal looses tonality but not audibility. This phenomenon may be explained from the travelling wave and volley theories. 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 the signal spreads will exhibit a lack of response and so audibility but not tonality would be preserved.

The off effect is often seen in tone decay. The tone looses 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 vertebrate's ears and eyes which are activated when sound or illumination caeses (Hubert and Young 1962). This is the mechanism in pathological ears.

Tone decay is seen in normals also, but to a different degree.

To know whether tone decay is at least partially a central nervous system effect, Hahn and De Michelis investigated the length of time a tone at or near threshold intensity

could be heard. Their results showed that a simultaneous intermittent light markedly reduced the period of audibility. In agreement with Sorenson, they concluded that threshold tone decay is not exclusively a peripheral operation. They suggested that Rasmussen's efferent tract plays an important role by producing an inhibitory effect on the 8th nerve. It is not known how the tract of Rasmussen could be activated by a light. The possible importance of the efferent auditory system to adaptation was pointed out also by Portmann, and Pertalozza.

Harbert and Young observed Bekesy tracings in a study of the threshold tone decay. They found abnormally rapid decay related to a widespread partial damage to axons. They hypothesised that threshold tone decay results from ionic changes in interstitial fluids affecting conductivity of dendrites.

TONE DECAY AND THRESHOLD:

Hood noticed that a tone presented at 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 stimulation to maintain its response at one level,

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 eighth nerve, where a certain number of the fibres are under continuous stimulation and may be in a absolutely refractory stage. These fibres probably respond to low intensity. As the intensity is increased, fibres which required a higher level of intensity larger brought into action and since were larger in number would then sustain the perception. In normals it has been found that at a level of 5 to 10 dB above threshold, a tone is sustained at least for one minute (Willefored 1960). This indicates that duration for which a tone is sustained at threshold level increases very rapidly for every decibel increase of presentation upto the critical point i.e. 5 to 10 dB SL generally.

It is of interest whether the amount of tone decay varies systematically as a function of the sound pressure level of the test tone in S.N. (sensorineural) loss. Since, the initial test tone is given at or near threshold, in tone decay tests, the sound pressure level which reaches the cochlear will increase with increases with SN loss.

Doerhing and Swisher(1971) concluded that amount of tone decay is related to the initial threshold level of the test tone in S.N.loss.

Owens (1964) reported that there tended to be less tone decay in patients with mild SN loss, but did not specify the amount of decay at each sound pressure level.

TONE DECAY AND FREQUENCY:

Available data on normal ears show a definite frequency effect. Morale Garcia and Hood 1972 found no tone decay at the test frequency 500 Hz, At 1 KHz, 10 out of 41 ears had a slight tone decay of 5 dB. At 4 KHz it was found that the proportion of ears with some decay exhibited increased thresholds. It can be concluded that tone decay was no greater than 5 dB at 500 Hz and 1 KHz and no more that 10 to 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 is pathological ears. Generally, tone decay in retrocochlear 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 dorsal position (Neff et al).

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

Tone decay was smaller for 500 Hz at hearing threshold levels below 60 dB and increased to above 70 dB for higher frequencies between 2 KHz and 4 KHz at threshold level.

Owens found that tone decay seldom occurs for frequencies below 2 KHz and when thresholds are below 35 dB. Impairment in the pons or higher levels may cause a pronounced decay at one frequency. (Morales, Garcia and Hood 1972).

The tone decay test seems to be a valuable test as to the diagnostic separation of eighth nerve disease, but not in the differentiation between the other groups. Tone decay in 500 Hz, 2 KHz and 4 KHz definitely suggests an expansive angle tumour (Gjaevines and Sohoel 1969). At 4 KHz tone decay may be present in all diagnostic groups. This test frequency therefore has little diagnostic value and could possibly be dropped to simplify the audiometric examination. Although a pathological outcome at the test frequency 2 KHz may be found in all the diagnostic groups except the normal

hearing group and the group of conductive hearing loss, the results in the angle tumour group differ distinctly from the other ones. Therefore, it is recommended that tone decay test be carried out at two frequencies i.e. 500 Hz and 2 KHz. The application of the lower test frequencies however, should be necessary only in cases with significant decay at the higher frequencies (Gjaevenes and Sohoel 1969).

HIGH FREQUENCY AUDIOMETRY:

A routine pure tone audiometric assessment usually is restricted to the range from 250 Hz to 8 KHz, possibly because most of the important sounds of everyday life fall within this range, and also because normative threshold data with this range are less affected by acoustic factors of the pure tone signal itself. Yet although it has long been known (Wegel 1932) that the total range of human hearing is approximately 16 Hz to 24 KHz relatively little clinical work has been done with frequencies were of relatively little importance for most practical purposes in diagnostic assessment as in therapeutic environment.

Zislis and Fletcher (1966) suggest that if high frequency hearing efficiency is affected, then perhaps a hearing deficit which appears only at very high frequencies can serve as an indication of possible further hearing loss at the more important lower frequencies.

Histologic observations of the extreme base of the human cochlear have indicated that degeneration may be common by early adulthood. Thus a normative survey for hearing sensitivity above 8 KHz may include subjects who have, for unknown reasons already undergone physiologic changes that affect high frequency audition. In this group it was seen that hearing sensitivity above 12 KHz was highly variable and neither history, information nor conventional audiograms adequately explained the hearing sensitivity difference.

The normal hearing estimate revealed mean threshold from 500 Hz through 12 KHz were less than 20 dB SPL rising steeply to 82 dB at 20 KHz in normals from 18 to 27 years.

Thus it is seen that testing tone decay at high frequencies can help in early diagnosis. Before a case can be said to have abnormal tone decay, it is important to have norms for tone decay and from the review of literature on tone decay one can see that no pertinent literature is available regarding norms for tone decay at high frequencies and therefore this study has been taken up.

METHODOLOGY

METHODOLOGY

SUBJECTS:

30 subjects of whom 15 were males and 15 females were tested in this study. The subjects were selected from the student population of T.N.Medical College.

The subjects had to satisfy the following criteria:

1. No history of any ear discharge, ear ache, tinnitus, giddiness, headache, brain damage or exposure to loud sounds.
2. No family history of hearing loss
3. Age range from 18 to 25 years
4. Hearing sensitivity within 25 dB HL (ANSI 1969) in the frequencies 500 Hz, 1 KHz, 2 KHz, 4 KHz, 6 KHz and 8 KHz.

INSTRUMENTS USED:

An Arphi 700 MK IV Serial No.275 audiometer with TDH-39 earphone and circum aural cushion MX-41/AR was used. The audiometer was calibrated for both intensity and frequency for pure tones and for noise as per the specifications given by ANSI 1969.

TEST ENVIRONMENT:

The study was carried out in an acoustically sound treated room at T.N.Medical College. The ambient noise levels present in the test room were below the proposed maximum allowable noise levels.

PROCEDURE:

The subject was seated in an arm chair so that the control panel of the audiometer was out of his line of vision.

First, thresholds were obtained for pure tones at frequencies 500 Hz, 1 KHz, 2 KHz, 4 KHz, 6KHz and 10 KHz.

The subject was instructed as follows: "you will hear a tone in either your right or left ear. Rest your elbow on the arms of this chair, make a fist and raise your index finger when you hear the tone. Even if you hear it softly, raise your finger and hold it up as long as you hear the tone. When you no longer hear it, bring your finger down. If you hear the tone in your left ear lift your left finger and if you hear 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 tone was reduced in 10 dB steps following each positive response, until he failed to respond. The tone was then 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 again heard.

Thus the thresholds were established for 500 Hz, 1 KHz, 2 KHz, 4 KHz, 6 KHz, 8KHz and 10 KHz.

The right ear thresholds were obtained from 7 male and 8 female subjects. Left ear thresholds were obtained from 8 males and 7 females.

Tone decay at frequencies 4 KHz, 6 KHz, 8 KHz and 10 KHz was determined for the same ears. Carhart's (1957) method was used to determine tone decay.

The test began with the sustained tone 5 dB 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 one minute the test was terminated.

If the subject indicated that he no longer heard the tone before the one minute criterion was met, the intensity of the tone was raised by 5 dB, without interrupting the tone and the stop watch was set back to zero and timing begun for one minute again.

The same test was repeated using 60 dB SPL white noise in the contralateral ear.

Tone decay was determined at the different frequencies in the following order: 6K, 10K, 4K and 8KHz. 5 min rest was allowed between the test frequencies.

The data collected were statistically treated and analyzed using appropriate statistical measures.

RESULTS AND DISCUSSIONS

RESULTS AND DISCUSSIONS

The present study was undertaken to find out norms for tone decay at high frequencies viz. 4 KHz, 6 KHz, 8 KHz and 10 KHz and to find answers for the following questions:

1. Does tone decay at high frequencies depend on the frequency of the stimulus?
2. Is there any ear difference in tone decay at high frequencies?
3. Is there any sex difference in tone decay at high frequencies?
4. Does 60 dB SPL noise in the contralateral ear difference the results in any way?

The study was performed on 30 normal subjects in an age range of 18 to 25 years. Tone decay was determined using Carhart procedure (1957).

Pure tone thresholds of 8 female subjects for the right ear are given in Table-1.

Pure tone thresholds of 7 female subjects for the left ear are given in Table-2.

Pure tone thresholds of males for the right ear are given in Table-3 and for the left ear in Table-4.

Table-1: Pure tone thresholds of females for the right ear in dB HL

Sl.No.	4 KHz	6 KHz	8 KHz	10 KHz
1	5	20	20	0
2	5	5	0	0
3	0	15	5	5
4	20	15	15	-
5	10	10	5	0
6	15	20	15	0
7	15	15	10	0
8	5	5	5	0

Table-2: Pure tone threshold of females for the left ear in dB HL.

Sl.No.	4 KHz	6 KHz	8 KHz	10 KHz
1	10	10	5	—
2	10	20	10	20
3	5	0	10	10
4	20	10	20	20
5	0	0	10	0
6	10	15	15	25
7	15	15	15	0

Table-3: Pure tone thresholds of males for the right ear in dB HL.

Sl.No.	4 KHz	6KHz	8 KHz	10 KHz
1	20	20	20	15
2	5	15	15	25
3	25	20	10	5
4	10	10	20	10
5	25	10	10	0
6	15	20	20	10
7	0	20	15	20

Table-4: Pure tone thresholds of males for the left ear in dB HL.

Sl.No.	4 KHz	6 KHz	8 KHz	10 KHz
1	10	20	15	10
2	20	15	15	25
3	20	25	25	25
4	15	5	20	5
5	10	20	10	20
6	20	15	15	15
7	20	20	20	25
8	20	25	25	25

Mean, Standard deviation and range of pure tone thresholds for right and left ears at different frequencies viz. 4 KHz, 6 KHz, 8 KHz and 10 KHz for females and males are given in tables 5 and 6 respectively.

Mean, standard deviation and range for combined data of the pure tone thresholds at different frequencies are shown in table-7. In combined data, the mean, standard deviation and range do not vary greatly at different frequencies.

Table-5: Mean, Standard Deviation and range of the pure tone thresholds at different in females in the right and left ears.

	Right			Left		
Frequen-cies	Mean	S.D.	Range	Mean	S.D.	Range
4 KHz	9.375	6.781	0-20	4	5.982	0.20
6 KHz	13.125	5.938	5-20	6.470	7.127	0.20
8 KHz	9.375	6.781	0-20	12.142	4.879	5.20
10 KHz	0.769	1.877	0-5	15	9.428	0.25

Table-6: Mean, S.D. and range of pure tone thresholds at different frequencies in males in the right and left ear.

	Right			Left		
Frequencies	Mean	S.D.	Range	Mean	S.D.	Range
4 KHz	14.705	9.265	0.25	15.108	7.187	10.20
6 KHz	15.208	8.139	10.20	15.555	7.115	5.25
8 KHz	15.322	7.408	10.20	15.887	6.926	10.25
10 KHz	14.736	7.618	0.25	18.75	7.905	10.25

Table-7: Mean, S.D. and range of pure tone thresholds at different frequencies in combined data.

Frequencies	Mean	S.D.	Range
4 KHz	12.33	6.91	0.20
6 KHz	14.5	6.74	0.25
8 KHz	14.16	6.45	0.25
10 KHz	13.202	7.769	0.25

Tone decay was determined under two conditions viz. A (without 60 dB SPL noise in the contralateral ear) and B (60 dB SPL noise in the contralateral ear) at different frequencies.

The amount of tone decay at high frequencies in females for the right ear under the two conditions is given in table-8 and for the left ear under the two conditions in table-9.

Table-10 shows tone decay at different frequencies in males under the two conditions for the right ear.

Table-11 shows tone decay at different frequencies in males under the two conditions for the left ear.

Table-8: Tone decay at different frequencies in females for the right ear.

	Without noise in the contralateral ear				60 dB SPL noise in the contralateral ear.			
No.	4KHz	6KHz	8KHz	10KHz	4 KHz	6KHz	8KHz	10KHz
1	5	5	15	10	15	5	15	15
2	5	20	20	15	10	25	25	20
3	10	5	20	5	5	15	25	25
4	15	35	35	-	15	45	45	-
5	15	15	15	5	15	20	20	30
6	10	35	25	25	10	35	30	15
7	5	5	10	5	5	10	5	15
8	10	15	25	45	10	10	20	30

Table-9: Tone decay at different frequencies in females for the left ear.

	Without noise in the contralateral ear				60 dB SPL noise in the contralateral ear			
No.	4KHZ	6KHz	8KHz	10KHz	4KHz	6KHz	8KHz	10KHz
1	30	5	10	-	10	5	15	-
2	10	5	10	5	10	15	20	5
3	25	30	5	20	15	30	15	5
4	5	5	5	10	5	20	20	20
5	10	30	25	15	20	15	5	15
6	5	10	10	10	10	15	30	25
7	10	15	10	-	15	15	5	-

Table-10: Tone decay at different frequencies in males for the right ear.

	Without noise in the contralateral ear				60 dB SPL noise in the contralateral ear			
No.	4KHz	6KHz	8KHz	10KHz	4KHz	6KHz	8KHz	10KHz
1	15	25	10	5	35	25	25	35
2	10	5	5	10	15	40	20	20
3	10	20	10	10	15	25	40	35
4	5	10	15	5	10	20	20	15
5	15	10	35	20	20	10	20	15
6	10	20	35	15	25	20	40	15
7	10	15	10	35	10	20	50	35

Table-11: Tone decay at different frequencies in males for the left ear.

	Without noise in the contralateral ear				60 dB SPL noise in the contralateral ear			
No.	4KHz	6KHz	8KHz	10KHz	4KHz	6KHz	8KHz	10KHz
1	5	5	5	5	5	5	5	5
2	30	15	20	15	20	45	45	45
3	20	30	40	35	15	45	55	40
4	5	10	5	10	15	25	50	50
5	15	15	30	35	35	50	60	--
6	5	5	10	10	10	5	25	25
7	15	5	30	15	15	10	35	35
8	15	25	20	30	20	5	45	40

Mean, S.D. and range of tone decay at different frequencies were computed.

Table-12 gives the mean, S.D. and range of tone decay in females for the right ear and table-13 for the left ear under the 2 conditions viz A(without 60 dB SPL noise in the contralateral ear) and B(60 dB SPL noise in the contralateral ear).

Table-14 gives the mean, S.D. and range of tone decay in males for the right ear and table-15 for the left ear under the 2 conditions.

Table-12: Mean, S.D., and range of tone decay at different frequencies in females for the right ear.

	Without noise in the contralateral ear			60 dB SPL aoise in the contralateral ear.		
Frequencies	Mean	S.D.	Range	Mean	S.D.	Range
4 KHz	9.375	4.170	5.15	10.625	4.172	5.15
6 KHz	15.625	13.211	5.35	20.625	13.741	5.45
8 KHz	20.625	7.761	10.35	23.125	11.628	5.45
10 KHz	15.714	14.819	5.45	21.428	6.991	15.30

Table-13: Mean, S.D. and range of tone decay at different frequencie in females for the left ear.

	without noise in the contralateral ear			60 dB SPL noise in the contralateral ear		
Frequencies	Mean	S.D.	Range	Mean	S.D.	Range
4 KHz	13.57	9.88	5.30	12.142	4.879	5.20
6 KHz	14.28	11.34	5.30	16.428	7.493	5.30
8 KHz	10.71	6.728	5.25	15.714	9.885	5.30
10 KHz	12	5.70	5.20	14	8.944	5.25

Table-14: Mean, S.D. and range of tone decay at different frequencie in males for the riaht ear.

	Without noise in the contralateral			60 dB SPL noise in the contralateral ear		
Frequencies	Mean	S.D.	Range	Mean	S.D.	Range
4 KHz	10	3.52	5.15	17.5	8.618	10.35
6 KHz	15.6	6.343	5.25	23.5	8.434	10.40
8 KHz	17.5	11.649	5.35	30.6	11.160	20.50
10 KHz	14.4	9.797	5.35	23.8	9.543	15.35

Table-15: Mean, S.D. and range of tone decay at different frequencies in males for the left ear.

	Without noise in the contralateral ear			60 dB SPL noise in the contralateral ear		
Frequency	Mean	S.D.	Range	Mean	S.D.	Range
4 KHz	15	8.017	5.30	18.6	8.997	5.35
6 KHz	15	8.864	5.30	25.7	20.163	5.50
8 KHz	21.4	10.926	5.40	42.2	17.471	5.60
10 KHz	20.7	11.473	5.35	44.2	18.389	5.50

Table-16 shows Mean and S.D. of tone decay under the two conditions (A & B) for the total combined data (Data of light ear, left ear, male and female are combined).

(Left and right ear combined) in males and females are given in tables-17 and 18 respectively.

Mean and S.D. of tone decay under the two conditions (A & B) for the combined data (Males end Females combined) in the right ear and left ear are shows in tables-19 and 20 respectively.

Table-16: Mean and S.D. tone decay at different frequencies for combined data.

	Without noise in the contralateral ear		60 dB SPL noise in the contralateral ear.	
Frequencies	Mean	S.D.	Mean	S.D.
4 KHz	11.833	7.007	14.660	7.535
6 KHz	15.166	9.955	21.666	13.086
8 KHz	17.666	10.462	27.833	15.518
10 KHz	15.926	11.269	24.4	12.609

Table-17: Mean and S.D. of tone decay at different frequencies in females (right and left combined)

	Without noise in the contralateral ear		60 dB SPL noise in the contralatecal ear	
Frequencies	Mean	S.D.	Mean	S.D.
4 KHz	11.3	7.43	11.333	4.418
6 KHz	15	11.952	17.272	11.098
8 KHz	16	8.701	18.421	10.678
10 KHz	14.185	11.645	18.387	9.694

Table-18: Mean and S.D. of tone decay at different frequencies in males (right and left combined) under the 2 conditions

	Without noise in the contralateral ear		60 dB SPL noise in the contralateral ear	
Frequencies	Mean	S.D.	Mean	S.D.
4 KHz	12.33	6.778	18	8.618
6 KHz	15.333	7.898	22.857	11.259
8 KHz	18.654	10.715	28.571	14.835
10 KHz	16.333	9.553	28.929	13.612

Table-19: Mean and S.D. of tone decay at different frequencies in the right ear (males and females combined)

	Without noise in the contralateral ear		60 dB SPL noise in the contralateral ear	
Frequencies	Mean	S.D.	Mean	S.D.
4 KHz	12.742	7.285	14.062	7.576
6 KHz	13.773	8.198	21.875	11.086
8 KHz	13.870	9.672	24.375	11.482
10 KHz	14.752	9.346	22.666	8.200

Table-20: Mean and S.D. of tone decay at different frequencies in the left ear (males and females combined)

	Without noise in the contralateral ear		60 dB SPL noise in the contralateral ear	
Frequencies	Mean	S.D.	Mean	S.D.
4 KHz	13.928	9.236	15.357	7.712
6 KHz	16.025	10.648	18.392	12.40
8 KHz	16.538	11.794	21.473	15.544
10 KHz	16.8	11.075	25.909	17.002

Difference between the 2 conditions viz. A (without noise in the contralateral ear) and B (60 dB SPL noise in contralateral ear), was determined by computing t values. The difference in the left ear is presented in table-21 and it can be seen that in the left ear of males there was significant difference at 6 KHz at 0.05 level and at 8 KHz and 10 KHz at 0.05 and 0.01 levels.

The females in the left ear showed no significant difference in tone decay between the 2 conditions.

The difference in the right ear is presented in table-22 and it can be seen that females showed significant difference at 0.05 level at 6 KHz whereas in males there was significant difference at 4 KHz, 6 KHz, 8 KHz and 10 KHz at 0.05 and 0.01 levels.

The difference in the total combined data is presented in table-23 and it can be seen that there is significant difference at 6 KHz and 10 KHz at 0.05 level and 8 KHz at 0.05 and O.O1 levels.

The difference in the two conditions (right and left combined) is given in table-24, from which it can be seen that females showed no significant difference, whereas males showed significant difference in tone decay at 4 KHz and 10 KHz at 0.05 level between the two conditions.

Table-21: Difference in tone decay between the two conditions in the left ear.

	Female			Male		
frequencies	t	Level of significance at 0.05 level	Level of significance at 0.01 level.	t	Level of significance at 0.05 level	Level o signifi cance a 0.01 level
4 KHZ	0.642	2.18	3.06	1.480	2.18	3.06
6 KHz	0.783	2.18	3.06	2.405*	2.18	3.06
8 KHz	2.072	2.18	3.06	4.935**	2.18	3.06
10 KHz	0.779	2.20	3.11	5.367**	2.20	3.11

* : Significant at 0.05 level

** : Significant at 0.05 and 0.01 level

Table-22: Difference in tone decay between the two conditions in the right ear.

Frequencies.	T	Level of significance at 0.05 level.	Level of significance at 0.01 level.	t	Level of significance at 0.05 level	Level of significance at 0.01 level
4 KHz	1.198	2.14	2.98	4.261**	2.14	2.98
6 KHz	2.671*	2.14	2.98	4.246**	2.14	2.98
8 KHz	1.013	2.14	2.98	4.549**	2.14	2.98
10 KHz	1.726	2.18	3.06	3.889**	2.14	2.98

* Significant at 0.05 level

** Significant at 0.05 and 0.01 level

Table-23: Difference in tone decay between the two conditions in combined data.

Frequencies	t	Level of significance at 0.05 level	Level of significance at 0.01 level
4 KHz	1.565	2.00	2.66
6 KHz	2.138*	2.00	2.66
8 KHz	2.992**	2.00	2.66
10 KHz	2.616*	2.01	2.68

* Significant at 0.05 level

** Significant at 0.01 level

Table-24: Difference in tone decay between the 2 conditions in the two ears (right and left combined)

	Female			Male		
Frequencies	t	Level of significance at 0.05 level	Level of significance at 0.01 level	t	Level of significance at 0.05 level	Level of significance at 0.01 level
4 KHa	0.013	2.05	2.76	2.06*	2.05	2.76
6 KHz	0.53	2.05	2.76	1.74	2.05	2.76
8 KHz	0.67	2.05	2.76	1.83	2.05	2.76
10 KHz	1.00	2.07	2.82	2.639*	2.05	2.76

* Significant at 0.05 level

** Significant at 0.05 and 0.01 level.

Sex differences were also computed by finding out t values at individual frequencies (represented in table-25). It can be seen that in the left ear there is significant difference at 0.05 and 0.01 level at 8 KHz and 0.05 level at 10 KHz in tone decay between males and females.

In the right ear there was no significant difference in tone decay between males and females at all the frequencies tested.

Table-26 represents t values which were computed to see if there is any ear difference at all the frequencies tested. It

can be seen that there is significant difference at 0.01 level between the right and the left ear with regard to tone decay at 8 KHz in females.

There was significant difference at 0.05 level between the right and the left ears with regard to tone decay at 4 KHz and 10 KHz in males.

Difference between the frequencies 4 KHz, 6 KHz, 8 KHz and 10 KHz were computed under the two conditions viz. A(without noise in the contralateral ear) and B(60 dB SPL noise in the contralateral ear) for the combined data represented in table-27. It can be seen that for condition. A, there was significant difference at 0.05 level between 4 KHz and 8 KHz.

For condition B, the frequency of the stimulus had significant effect on the tone decay.

Table-25: Sex difference in tone decay

Frequencies	Left ear			Right ear		
	t	Level of significance at 0.05 level	Level of significance at 0.01 level	t	Level of significance at 0.05 level	Level of significance at 0.01 level
4 KHz	0.556	2.18	3.06	0.521	2.14	2.98
6 KHz	0.248	2.18	3.06	0.009	2.14	2.98
8 KHz	4.124**	2.18	3.06	1.262	2.14	2.98
10 KHz	2.954*	2.20	3.11	0.385	2.16	3.01

* Significant at 0.05 level

** Significant at 0.05 and 0.01 level

Table-26: Ear difference in tone decay

Frequencies	Females			Males		
	t	Level of significance at 0.05 level	Level of significance at 0.01 level	t	Level of significance at 0.05 level	Level of significance at 0.01 level
4 KHz	2.019	2.16	3.01	2.948*	2.14	2.98
6 KHz	0.792	2.16	3.01	0.335	2.14	2.98
8 KHz	5.121**	2.16	3.01	1.291	2.14	2.98
10 KHz	0.603	2.23	3.17	2.19*	2.14	2.98

* Significant at 0.05 level

** Significant 0.05 and 0.01 level

Table-27: Difference between the frequencies under the two conditions for combined data.

	Without noise in the contralateral aar			60 dB SPL noise in the contralateral ear		
Frequency	t	Level of significance at 0.05 level	Level of significance at 0.01 level	t	Level of significance at 0.05 level	Level of significance at 0.01 level
4 KHz & 6 KHz	1.504	2.00	2.66	2.492*	2.00	2.66
4 KHz & 8 KHz	2.532*	2.00	2.66	4.235**	2.00	2.66
4 KHz & 10 KHz	1.679	2.01	2.68	3.586**	2.01	2.68
6 KHz & 8 KHz	0.946	2.00	2.66	1.660	2.00	2.66
6 KHz & 10 KHz	0.275	2.01	2.68	0.784	2.01	2.68
8 KHz & 10 KHz	0.605	2.01	2.68	0.911	2.01	2.68

* Significant at 0.05 level

** Significant at 0.05 and 0.01 level

Studies on the hearing sensitivity of normal subjects for higher frequencies 8 K to 20 K (Fletcher et al 1967, Jacobson et al 1969, Corlus et al 1970, Downs and Northern 1971, Osterhammel 1980) show that the hearing sensitivity differs considerably.

The hearing sensitivity of normals subjects did not differ considerable for frequencies 4 K, 6 KHz, 8 KHz, and 10 KHz in this study. Also the amount of tone decay of the normal hearing subjects did not differ considerably.

It was also seen that the amount of tone decay was not dependent on the hearing sensitivity.

SUMMARY AND CONCLUSION

SUMMARY AND CONCLUSION

The present study was undertaken to find norms for tone decay at high frequencies viz 4 KHz, 6 KHz, 8 KHz and 10 KHz in normal hearing subjects. The study was also designed to find if there is any ear difference, sex difference, frequency dependence or if noise in the contralateral ear affects tone decay at high frequencies.

A sample comprising of 30 subjects with normal hearing and an age range of 18 to 25 years (15 males and 15 females) was tested.

Pure tone thresholds at 500 Hz, 1 KHz, 2 KHz, 4 KHz, 6 KHz, 8 KHz and 10 KHz were established using Hughson Westlake procedure. Tone decay was determined using Carharts Procedure (1957) under two conditions viz. A (without noise in the contralateral ear) and B (60 dB SPL noise in the contralateral ear) for frequencies 4 KHz, 6 KHz, 8 KHz and 10 KHz

The present study has revealed that the frequency of the stimulus has significant effect on tone decay for the condition B (60 dB SPL noise in the contralateral ear). Also significant difference in tone decay for the condition. A (without noise in the contralateral ear) at 0.05 level between 4 KHz and 8 KHz was observed.

With regard to the question (does noise in the contralateral ear influence the results in any way? - it was found that there was significant difference at 6 KHz and 10 KHz at 0.05 level and 8 KHz at 0.05 and 0.01 levels in tone decay between the two conditions viz. A (no noise in the contralateral ear) and B(60 dB SPL noise in the contralateral ear).

Also it was observed that there was significant ear difference at 0.01 level with regard to tone decay at 8 KHz in females.

In males there was significant ear difference at 0.05 level with regard to tone decay at 4 KHz and 10 KHz.

It was seen that in the left ear there was significant difference at 0.05 and 0.01 level at 8 KHz and at 0.05 and 0.01 level at 8 KHz and at 0.05 level at 10 KHz in tone decay at high frequencies between males and females whereas the right ear showed no significant difference in tone decay between males and females.

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