A COMPARATIVE STUDY OF MASKING LEVEL DIFFERENCE IN GERIATRICS

REG. NO.M9005

AN INDEPENDENT PROJECT IN PART FULFILMENT FOR THE FIRST YEAR M.SC.(SPEECH AND HEARING), UNIVERSITY OF MYSORE, MYSORE-6.

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DADDY AND MUMMY

'Who have borne all the pains
to give me the best comforts
this world can ever think of'

&

Who are responsible to make
me what I am today.

CERTIFICATE

This is to certify that the Independent Project entitled "A comparative Study of Masking Level Difference in Geriatrics" is the bonafide work in part fulfilment for M.sc., in Speech and Hearing, of the student with Reg. No.M9005.

Director
All India Institute of
Speech and Hearing
Mysore-6

Mysore
1991

CERTIFICATE

This is to certify that the Independent Project entitled: "A Comparative Study of Masking Level Difference in Geriatrics" has been prepared under my supervision and guidance.

Mysore

1991

Dr.(Miss) S.Nikam,
GUIDE

DECLARATION

This Independent Project entitled: A Comparative Study of Masking Level Difference in Geriatrics is the result of my own study undertaken under the guidance of Dr.(Miss) S.Nikam. Prof, and Head of the Department of Audiology, All India Institute of Speech and Hearing, Mysore and has not been submitted earlier at any University for any other Diploma or Degree.

Mysore
1991 Reg. NO.M9005

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Thanks to Mrs. C.s.Vanaja, for having encouraged me to take up this topic and also for her timely help and advise.

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My "Lack of words" in appreciating CSI who was eveready to comply with my "bad moods" and for giving me the right dosage of inspiration. "As a friend you leave little to be desired.

"katal" - how do I thank U? "You are some one who's more wonderful than words could ever say."

Daddy, Mummy, Anishappy and Jickumma - Thanks for everything - for loving, listening, caring, understanding, supporting and reassur.

My sincere thanks to Mrs.Rajalakshmi Akka for letting her fingers run at super speed and compiling every alphabet with a neat touch and finish.

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INTRODUCTION

Man is born into a society and has to make a living among fellow beings. This calls for an effective psycho-social interaction, which is dependent on the communication skill of the individual.

Communication is the "sending and receiving of messages both verbal and non-verbal, within, between and/or among people" (Oyer and Oyer, 1976). It is a "social glue" that bind people together, that coordinates their activities and makes organized social life possible (Woelfel, 1976). Any defect in the communication system jeopardizes the survival of the individual as well as the society.

Society is comprised of members of the all ages. The contribution of each group is important for the well being of the society; conversely each age group has a specific role to play in the society. To effectively execute these roles, the intra and inter personal communication among the member of the society is of prime importance.

The geriatric population, which forms a major selections of the society has been contributing significantly to the betterment of the society. They are a 'window' to the past, which aids in the maintenance of culture in the society. The well being of the geriatric population is important for the maintenance of integrity on the society.

The well being of the older people will be at stake, due to several changes in social, psychological and biological processes that occurs concomitantly with age. One of the types of social trauma experienced as age advances is the retirement from job. This affects the mental well being of the individual. Added to this, the biological changes occur in several body systems.

One of the most common problem is a breakdown in the communication system in the older people. The impairment in communication is brought about mainly by the changes in the sensoriperceptual and speech mechanism.

The hearing which is considered to be a temporal sense is more important for communication.

With increase in age, the hearing sensitivity deteriorates, resulting characteristically in a higher frequency loss. This condition was termed as ' presbycusis' by Zawaardemaker (1899). But presbycusis as understood now does not limit to only pure tone loss. The geriatric population showing presbycusis, most often complain of an inability to understand the speech of others, which is in compatible with their average loss in pure tone sensitivity. This phenomenon is termed as phonemic regression (Gaeth, 1848).

The findings from pure tone audiometrlc tests and findings on conventional speech and distorted speech tasks reveal the involvement of both the peripheral and central auditory system in geriatrics.

Pare tone audiometric findings will indicate the frequencies where tinere is hearing loss. Aging tends to first cause a loss in the high frequencies and later affects the low frequencies as well, but to a lesser extent. An audiogram will show the degree of loss whether slight, mild, moderate, severe or profound. With age there will likely be a slow steady progression in impairment as seen in the Fig. shown (Fig.No.1).

This gradual progression of hearing difficulty in the elderly will contribute to a tendency of these patients not to recognize that their hearing is impaired.

Speech audiometric measures can be used along with the pure tone findings to analyse the effect of hearing loss or the reception of conversation.

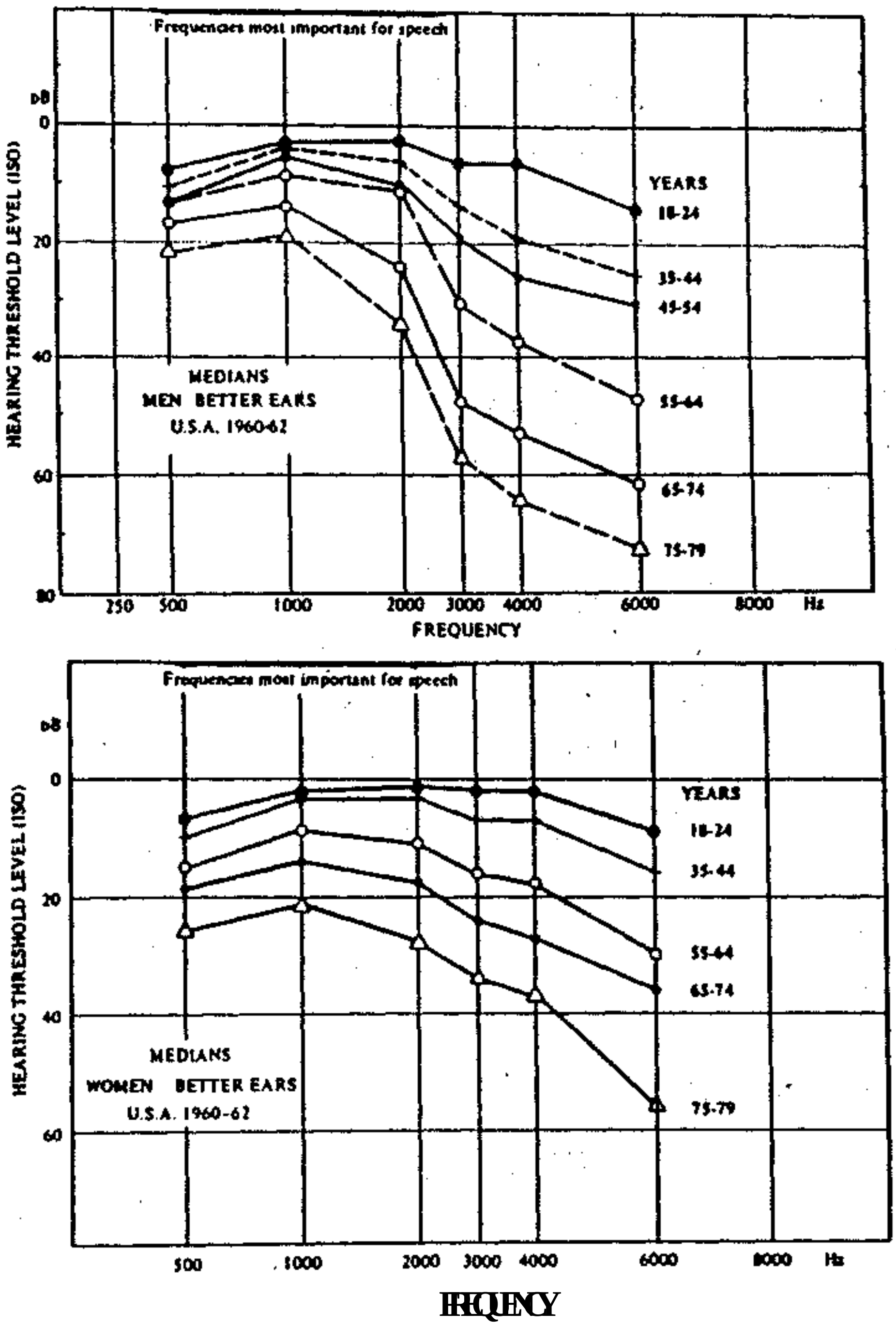

FIG:1:AUDIOGRAM SHOEING THE HEARING ACUITY ACROSS DIFFERENT AGE GROUPS OF THE TWO SEXES.

Cerebrovascular accidents (CVA)or stroke) and neural presbycusis appear to contribute significantly toward the high incidence of central auditory pathology in the elderly.

Detection of disorders within the central portion of the auditory system with the conventional audiometric battery of tests has, until recent years, been a relatively difficult task. Conventional tests were developed exclusively for the assessment of peripheral auditory dysfunctions.

Berlin (1976) presented a review of tests for the evaluation of central auditory mechanism including the Masking Level Difference (MLD).

MLD has been proposed as a potential tool to assess the integrity of the central auditory nervous system (Olsen et al. 1973).

The binaural MLD may be defined as a psychoacoustic phenomenon in which binaural auditory sensitivity for either tones or speech may be improved in the presence of masking noise by the introduction of an interaural phase difference on either the binaural signal or on the masking noise.

According to Lynn, Giiory, Leisen (1981) the MLD in normal listeners ranges from approximately 8-12 dB, varying somewhat with the type of signal being presented, response task and whether the signal or the noise is out-of-phase. Patients with hearing loss from peripheral lesions of the middle ear, inner ear or auditory nerve have MLDs that are often smaller than normals. This reduction in MLD size has been attributed to such factors as:

1. difference in threshold sensitivity between ears for the signal and the noise.
2. distortion in the signal transduction in the inner ear (IE), and
3. alteration in the coding or transmission of information from the peripheral ear to the central auditory system.

Cortical lesions have been shown to have no significant effect on MLDs for either pure tones or speech, but patients with multiple sclerosis or other brain stem abnormalities have MLD that are significantly smaller than normals (ie). A reduction in the size of the MLD when the pontemedullay region of the brain stem.

These findings would suggest that MLDs are mediated in the central nervous system some where below the auditory cortex, Where the potential exists for some form of auditory processing that correlate binaural information received from the two ears.

Carhart, Tillman and Greelis (1969) in a study, of masking of speech by others speech, found that clinically normal bat elderly individuals slowed a pattern of interference from complex maskers that differed from that observed in normal young adults. This observation led the authors to hypothesize and conclude that in the elderly subjects, the MLD for speech would be reduced relative to that observed in normal young adults.

Olsen, Noffsinger and Carhart (1976) in their study of 290 subjects found spondees MLDs smaller for elderly subjects than for normal. Schuknecht has documented the fact that sensory or neural changes in auditory system occur with aging.

Since the mechanism for the release from masking which constitutes the MLD phenomenon must be located in the central nervous system, such findings would suggest that the elderly subject has undergone some subtle if not detectable deterioration in the CNS which interferes to some extent with the binaural signal processing that produces the MLD.

This study was designed to find out whether aging has any effect on the MLD values measured for pure tones of 500 Hz both N_0 S and N s_0 conditions.

Need for the study:

A study of the present nature is important for the following reasons.

First, due to the advances in medical sciences, the life span of people all over the world is increasing and the death rate in decreasing drastically. The Indian census (1981) revealed that there was a decrease in death rate of about 20% during the last 70 years. Therefore, the advancement of gerontology has gained momentum during the past few years. Then the problem encountered by the aged has become the central interest in social and medical fields.

Second, 60% of the total population is over 60 years of age (1971 census). Among the people above 50 years.

57.8% have been found to have hearing loss (Gill and Sharma 1957). Thus more than half the aged population is hearing impaired. But the medical and surgical services are of limited value to presbycusis. Therefore, more effective audiological rehabilitation services are warranted.

Thirdly, several studies mentioned, earlier indicate that the question of whether the structures beyond the cochlea are involved or not in the process of aging, is completely not yet answered.

So the present study is designed to find out whether aging has any effect on the MLD values measured for pure-tones of 500 Hz in both N_OS and $N\ S_o$ conditions.

The present experiment was undertaken to study the following:

1, Is there any significant difference between MLD values $N_O S$ obtained for

a) Young adults and aged group 50-60
b) Young adults and aged group 60-70
c) Young males and young females
d) Aged males and aged females,

2. Is there any significant difference between MLD values $N\ S_O$ obtained for

a) Young adults and aged group 50-60
b) Young adults and aged group 60-70
c) Young males and young females
d) Aged males and aged females.

REVIEW OF LITERATURE

The human hearing system is a marvelous complex system. It is operationally mature even within the unborn fetus. The normal hearing mechanism provides the brain with a continuing nourishment of acoustic stimulation throughout the life. But this sensory system also changes inits structure and in its sensitivity as the age increases.

The effects of aging on man's auditory system have been noted in the literature since the late 1800s (Zwaarda Make, 1894). Various investigations have disclosed that any portion of auditory system is not immure to senscent alterations.

The decrease in auditory sensitivity with increasing age is referred to as presbycusis, that is, hearing loss securing with increasing age. The pathology of presbycusis has shown to involve all the major divisions of peripheral and central auditory mechanisms.

Whatever the etiology may be, the fact remains that substantial alterations do occur in the entire auditory system of the elderly.

Changes have been reported to occur in the following divisions of the auditory system.

a) Changes occuring in the external ear (EE) with increasing age:

The physical structure of the outer ear (0E) undergoes a number of changes. Fowler(1944) noted that changes begin to appear in individuals between 40 to 50 years of age. The skin becomes less resistant with aging, and there is shrinkage in its tissue. In addition, there might be a hair growth which proliferates along the periphery of the helix, antihelix and tragus of the pinna.

According to Tsai et al (1958) there is an increased length and width of the pinna during the process of aging. The gradual loss of skin elasticity, muscles tonicity and the longitudinal forces of gravity are reported to contribute towards the physical enlargement of pinna (Fowler, 1972; Glorig, 1973).

A number of changes such as widening of the canal has been reported by Fowler (1940), Show et al (1978). Thinning of skin lining the canal and a diminished elasticity (Senturia, 1957; Rosen Wasser, 1964) and pronounced dryness of epidermics of the canal has been reported. The cartilagenous portion of the external auditory meatus (EAM) loses its elasticity resulting in partial or rarely complete occlusion of the canal (Magladery, 1959) impede the natural path of air conducted sound more as in high frequency region.

Perry (1957), revealed that there will be a decrease in the number of wax producing cereminous glands, sweat glands and the tendency for ear wax to be somewhat drier among older people.

As, in the geriatric population the pinna and other external ear structures undergo changes, their localization ability might be affected.

b) Middle ear:

A number of age related changes have been observed within the delicate structures of middle ear (ME). These alterations nay result in some degree of auditory dys-function.

Many investigators have reported some alterations in the tympanic membrane (TM), but the exact nature of these alterations are still not known. Cove11 (1952) pointed out that there is thinning and loss of rigidity of the TM. Rosen Wasser (1964) noted the TM of the elderly to be often thin and translucent. Klots (1963) reported a sclerotic thickening or a nonreflective TM to be present to older patients having chronic rheumatism and arthritis.

Maurer and Rupp (1978) reveals that the drum is more translucent and rigid, with adjacent ossicular land marks more risible, in the aged.

Substantial evidence is available regarding the development of increased rigidity of three bones of ossicular chain. Rosen Wasser (1964) noted the presence of ossicular atrophy, particularly in the crura of the stapes, in the elderly. Belal (1974) reported the incidence and severity of involvement of the incudomalleal and incudostapedial joints to increase significantly with processing age.

owing to above changes, the ME compliance may decreases with age.

Degeneration and atrophy of tensor tympani and stapedius muscle of ME and their ligaments have been reported to occur. (Connel, 1952; Rosen Wasser, 1964; Davia, 1970). This alterations reduces operating efficiency of ME system, thereby affecting the hearing acuity.

Nerbonne, et al (1976) have reported of abnormal negative pressure in the ME of the aged persons. This has been attributed to atrophy of levator and tensor palatlni resulting in reduced patency in Eustachian tube.

Glorig and Davis (1961) observed an air-borne gap which increased with age and frequency in the older subjects of the sample ranging in age from 25 - 80 years. This type of pattern in the elderly was termed as conductive presbycusis by them. But the above finding was questioned by Staloff, Vassalo and Menduke (1965) as they failed to observe any air-borne gap in subject aged 62-86 years. Thus though ME involvement was confirmed, their effects on hearing acuity was not established.

c) Inner ear:

Numerous studies have been documented the histopathological findings in temporal bone of aged (Saxen and Von Fienelf, 1937; Jorgenson, 1961; Schuknecht, 1957).

The most important alteration in the IE with aging has been hair cell degeneration (Crowe, Guild, Polvoget, 1934; Schuknecht, 1955; Pestalozzer and Shore, 1955; Gacek, 1975). The degeneration has been attributed to the decrease in the enzymatic activity of the lysosomes in the hair cell.

The other changes which has been observed in the IE with aging are an increase in the stiffness of the baailar membrane (Mayer, 1920, Crowe, et al. 1934; Schuknecht, 1967), atrophy, rupture with thinning of the membrane at the site of rupture.

One other important structural alteration observed is the atrophy of stria vasuclaris (Crowe, et al. 1934; Von Fiendt, 1937) Schuknecht, 1964). Atrophy of stria vascularis has been considered one of the major factors in the hearing impairment of the elderly,

Hinchcliffe (1962) has summarized the alterations of the IE as follows:

a) Atrophy and degeneration of both hair cells and supporting cells of the cochlea.
b) Angiosclerotic degeneration of epithelial tissues and vessels of IE, including organ of corti, basilar membrane and stria vascularis.
c) Thinning and adhesion of tectorial membrane.
d) Reduced nutritional content of endolymph.
e) Calcification and loss of elasticity of basilar membrane.

On the basis of histopathological finding Crowe et al. and Saxen (1937) described two pathological types of deafness.

One mainly involved the organ of corti termed sensory presbycusis by Schuknecht, whereas the other primarily involved the cochlear neuron termed as neural presbycusis. In 1964, Schuknecht described two additional categories one involving the stria vascularls and termed metabolic presbycusis and other thought to be caused by stiffening of basilar membrane which changed motion of mechanics of IE (IB conductive deafness).

Types of presbycusis (with etiologies and characteristics):

Presbycusis: The word presbycusis is from the Greek word presbys meaning "old man", and akousis meaning "hearing"• Presbycusis is a communication disorder characterized by progressive degeneration of auditory function. It was proposed by Zwaardemaker(l894).

In the process of aging, the ear and its structures - like other parts of the body -undergo changes. These changes are related to whatever physical and chemical changes cause the rest of the body to age. Along with aging of auditory mechanism is deterioration of the skin and eyes (Myers and Carmel, 1968).Many types of auditory system deterioration occur. These include-

1. Loss of hearing sensitivity through chemical and mechanical changes in the lonner ear.
2. Breakdown of inner ear structures, and
3. Complex degenerative changes occurring along nerve pathways leading to the brain.

While presbycusis primarily involves the sensory-neural and central mechanism, some conductive pathway structures (in the OE, ME and IE) may also be involved.

Schuknecht (1955, 1964) has identified four types of presbycusis.

1. Sensory (cochlear) presbycusis.
2. Neural presbycusis.
3. Strial (metabolic) presbycusis.
4. Inner ear conductive (mechanical, coehlear-conductive) presbycusis.

Additionally, there is evidence suggesting that the central auditory mechanism sustain structural changes that involve the total auditory behaviour in the geriatric individual (Hinchcliffe, 1962; Kirikae, et al. 1964; Hansen and Beske-Nielsen, 1965; Fiseh, 1972; Schuknecht, 1974; and Corso, 1977).

1. <u>sensory (cochlear) presbycusis:</u>

The cause of sensory presbycusis is hair cell loss at the basal end of the cochlea (in the organ of corti). The histological identification is degeneration and atrophy of sensory and supporting cells with primary damage beginning at the basal end of the cochlea and moving towards the apex. Secondary degeneration involves the acoustic nerve.

The hearing loss is most typically an abrupt, high tone loss. Speech discrimination is generally good, but can vary. Loudness recruitment is common and hearing aid prognosis is good. This is the most common type of presbycusis. (Fig.2).

2. Neural presbycusis.

This is an advanced stage of sensory presbycusis which involves a greater loss of neurons in the central nervous system (CNS. The cause is a greater (but diffuse) loss of neural cells in the spiral ganglion or nerve fibres. There also appears to be an angiosclerotic degeneration of epithelial tissues of the organ of corti and of the basilar membrane, resulting in a loss of elasticity.

The hearing loss is a high frequency sensorineural hearing loss ranging from mild to severe. A distinguishing factor is that speech discrimination is much poorer than

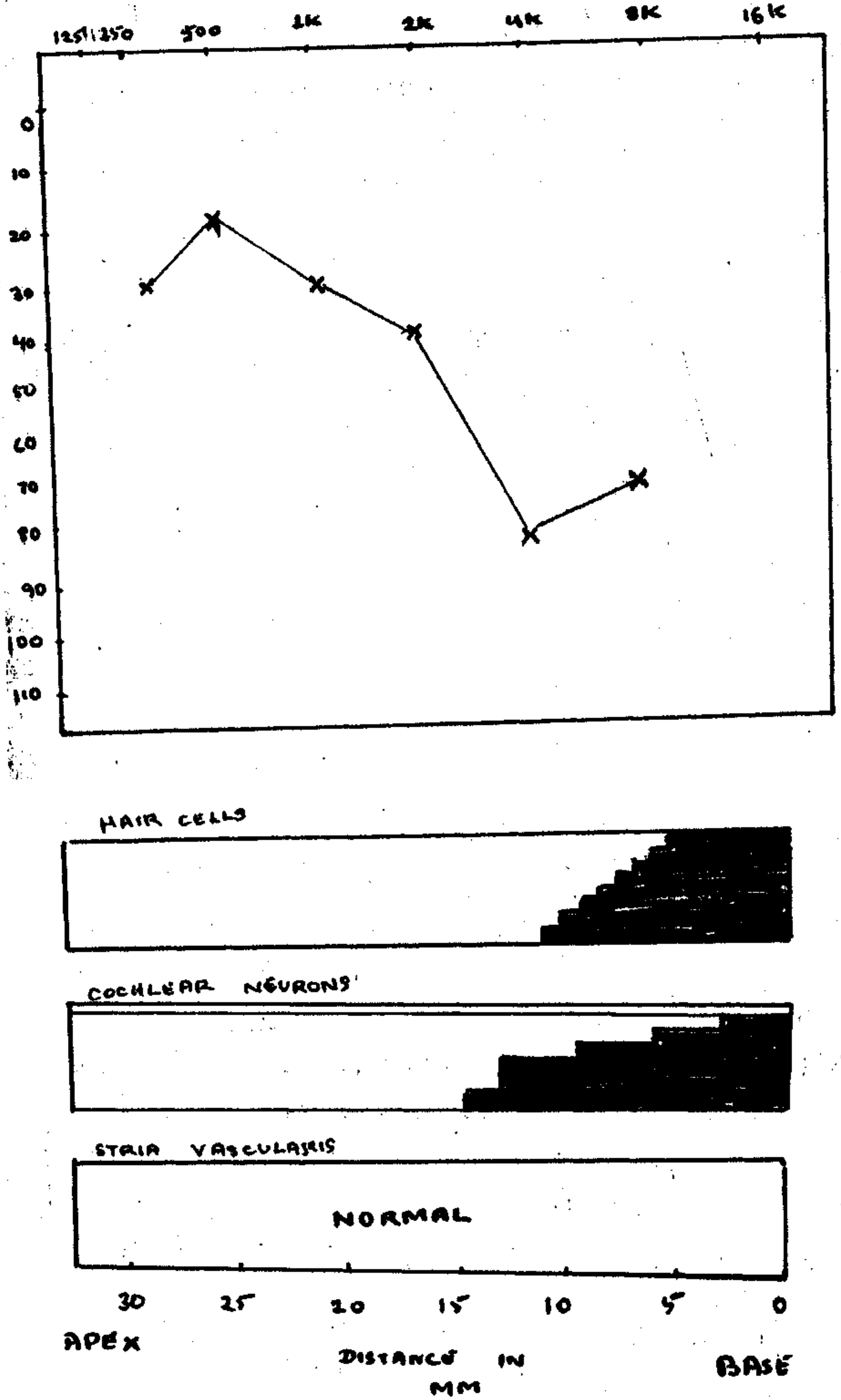

FIG : 2 : SENSORY (COCHLEAR) PRESBYCUSIS.

pure tones would indicate - a condition labelled "phonemic regression" by Gaeth (1948). Hearing aid prognosis is not good for this type of pathology and the hearing impaired usually requires rehabilitation and counselling. This condition is oftea seen in persons with severe arterio-sclerosis. (Fig.3).

3. Strial (metabolic) presbycusis:

The cause of strial presbycusis appears to be partial atrophy of the stria vascularis along the entire length of the cochlear duet. Believed to be the site of endo-lymph production, changes in the blood vessels of the stria vascularis cause a biochemical alteration of endo-lymph potential throughout the entire cochlea (reduced nutritional content).

The resultant hearing loss is generally flat, with speech discrimination good (80-90%). Hearing aid prognosis is good (Fig.4).

4. Inner ear conductive presbycusis:

This type of presbycusis is conjectured to be sensori-neural hearing loss with an IE conductive components cause (Mayer, 1919; Nixon, Glorig and High, 1962). No recognizable

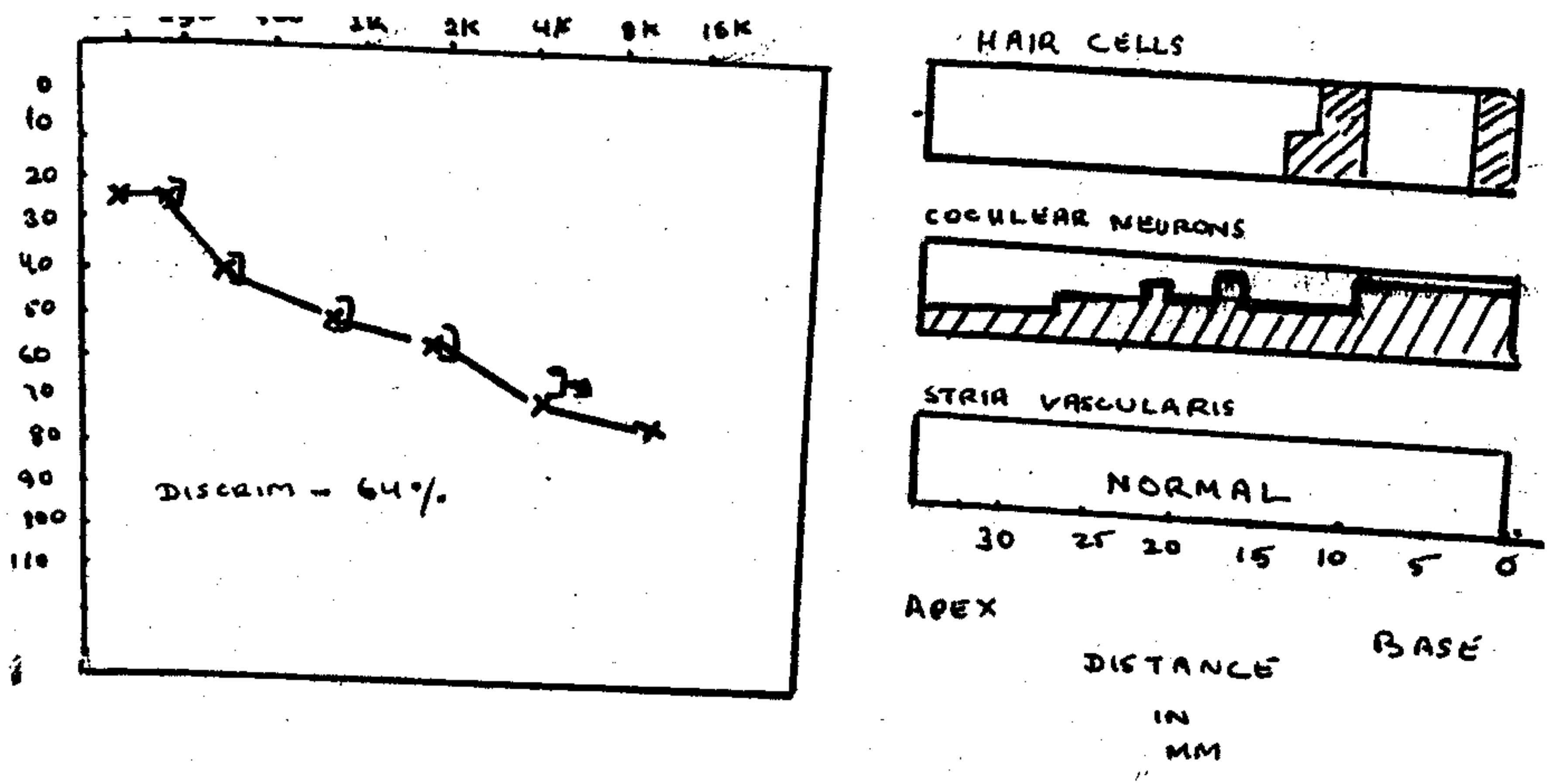

FIG: 8: NEURAL PRESBYCUSIS.

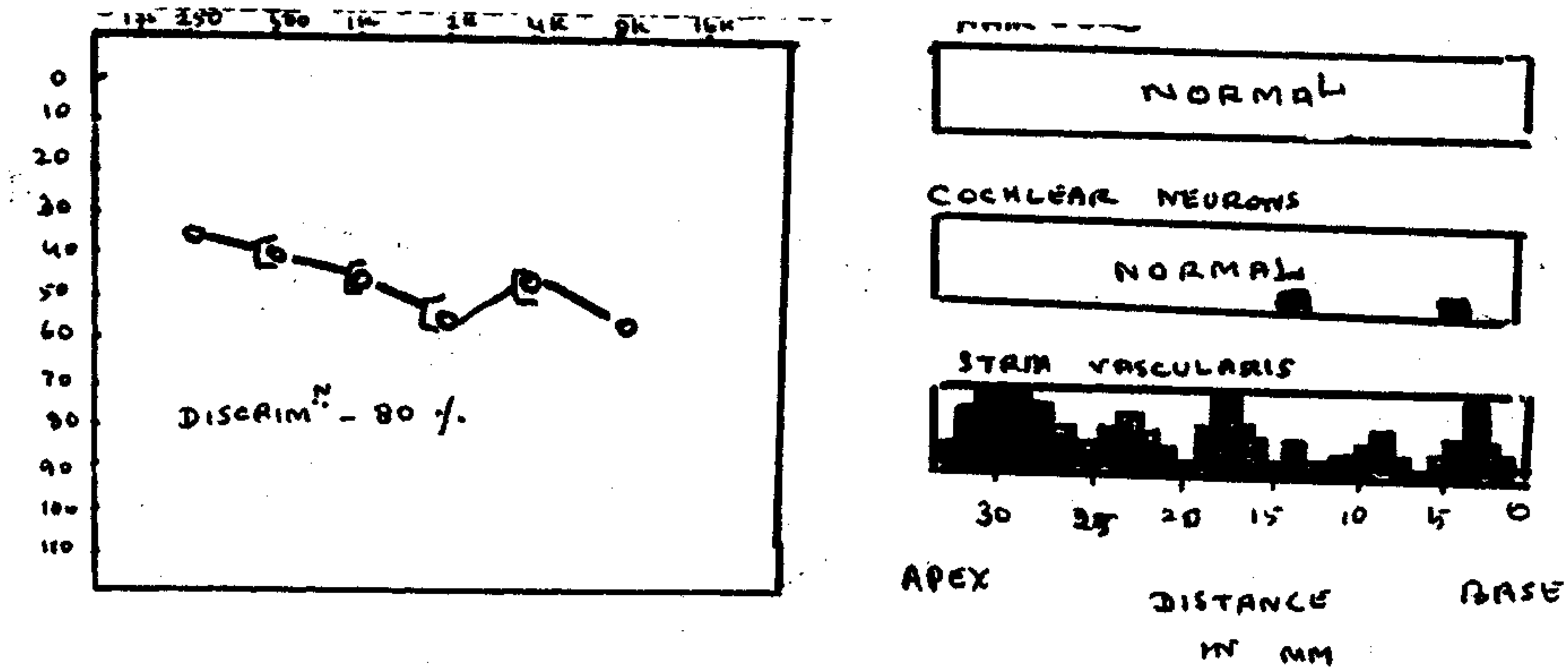

FIG: 4: STRIAL (METABOLIC) PRESBYCUSIS.

pathological correlate has been identified. It is speculated that it is a disorder of notion of the mechanics of the cochlear duet caused by a stiffening or calcification of the basilar membrane - which would be consistent with a loss of elasticity and increase of the internal friction in the basilar membrane.

The hearing loss gradually descends (high-frequency) with a conductive component. Speech discrimination is reduced to varying degrees and hearing aid prognosis is good (Fig. 5).

Krampotic and Nenanic (1971) reported narrowing of auditory nerve structures attribute due to progressive deposits of connective tissue, osteoid and bone at the base of the internal auditory meatus. This nay compress fibre of auditory nerve and thus atrophy of fibre.

d) <u>Central auditory mechanise (CAM):</u>

The loss of neurons throughout the entire central nervous system (CHS) must been shown to begin early and to continue throughout life. This loss of neurons becomes vigorous in old age. Brody (1955): Neff (1947) reported that the partial section of the auditory nerve in roan

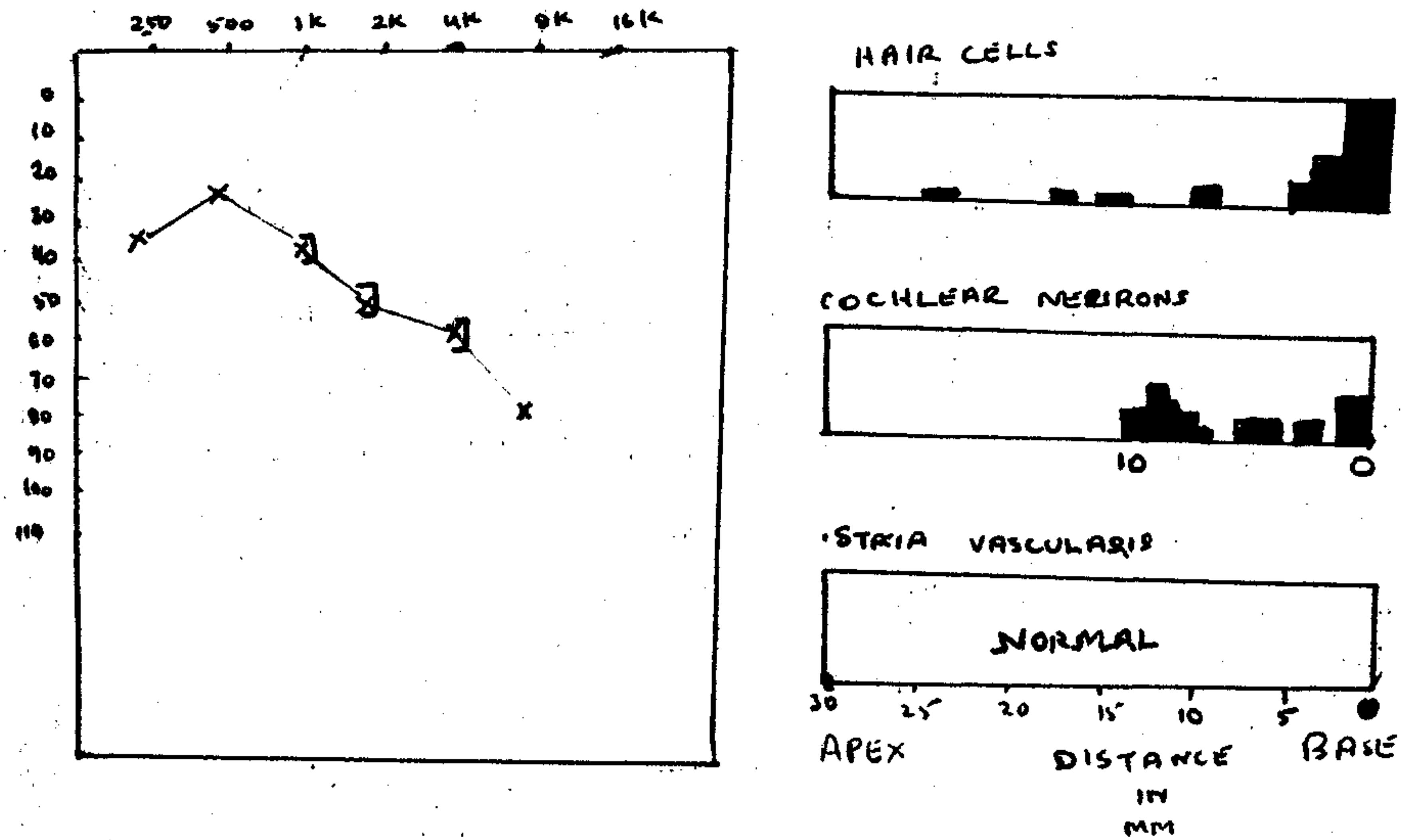

FIG: 5: INNER EAR CONDUCTIVE PRESBYCUSIS.

results in a high frequency hearing loss. However, there is no parallelism between nerve fibre population and pure tone threshold. Schuknecht and Woelliner (1953) and Citron et al. (1963) found a normal threshold for pare tones despite severe degeneration of the cochlear nerve.

Crowe et al (1934) and Hansen and Reske Nielsen (1965) reported only slight degeneration in the peripheral part of the auditory nerve, but severe vascular alterations in the internal auditory meatus. Covell and Rogus (1957) and Sercer (1958) report a narrowing of the openings of the tractus spiralis foraminosus by hyperostotic deposits. They would exert a continuous pressure and thus cause an atrophy of the acoustic nerve fibers, resulting in pure 'ideiopathic presbycusis.'

As one cochlea is represented bilaterally, extirpation of one hemisphere does not cause threshold loss for pure tones in man (Dandy, 1933). Bilateral temporal lesions, result in severe to total loss of hearing. Kirkae, Sato and Shitara (1964) found atrophy of neural structures in the ventral cochlear nuclei, the superior olivary complex (SOC), the lateral lemniscus the inferior collicular and medial geniculate body and in the auditory cortex itself. Scheidegger (1963) mentions how in old patients the central pathways and nuclei are affected by general diffuse atrophy. Hansen and Reske-Neilsen (1965) found severe degeneration in the glial part of the acoustic nerve as well as in the white matter of the brain stem and in the hearing centers.

Alterations were most pronounced in the White matter of the hemisphere, next in the brain stem and finally in the nuclei and the cochlea.

The structural changes described above alters the functions of the auditory system.

Audiological manifestations of aging:

It has been known for many ears that the hearing acuity is diminishes in the old age, particularly for high frequencies. The aging process produces systematic changes in each of the two critical dimensions of hearing impairment - loss in the threshold sensitivity and loss in the ability to understand suprathreshold speech.

Pure tone thresholds:

Zwaardemaker (1899) was the first to investigate hearing acuity quantitatively in the elderly and he noticed that high frequency threshold diminished with the increasing age of the patient and this process starts as early as the second or third decade of human life. Benzold (1894); Struyken (1913); Cicocco (1932); and schober (1962) have confirmed above findings.

Carhart (1958) described Bernero effect and he suggested that reduced bone conduction response at 500 Hz more likely a reflection of the central auditory dysfunction. Glorig and Devis (1961) described a high frequency air-borne gap that they ascribed to an age-related increase in stiffness of the eochlear partition. Air-borne gap was in evidence at 4 KHz increased from 10 dB at 50 years to 4 dB by 80 years of age. Nixon, Glorig and High (1962) found air-borne gap at 4 KHz only and it was not due to noise exposure and they suggested pathological change in the connective tissue of ME.

Speech Discriminations:

It is a well known clinical fact that in presbycusis the intelligibility of speech is seriously affected and speech discrimination in the aged is frequently much poorer than is suggested either by pure tone audiometry or by speech reception threshold.(Cawthorne, 1951; Konig, 1957; Sataloff and Meadake, 1957; Koltz and Milbane, 1962).

According to Bocca (1958) discrimination difficulties of the aged are mainly of a cortical nature. Calvi and Finzi (1957) explain the poor discrimination as a diminished integrative capacity of the aged. The reduced ability to hear and to repeat common words at all supra threshold levels as found in the aged was named "phonemic regression" by Gaeth (1946).

The performance of the aged on various other audiological tests is given in the following table•

Table-1: Summarizes the finding of the following tests used with the aged:

I. 1) Impedance audiometry

2) Bekesy audiometry

II. special tests

1) SISI

2) Adaptation

III. Binaural hearing ability

1) Directional hearing,

Localization vs. lateralization.

IV. Tests of brainstem lesion

1) Brain stem respone eudiometry

2) Masking level difference.

Investigator 1.	Sample and Methodology 2.	Findings 3.
I. IMPEDANCE AUDIOMETRY:		
Beathi, and Leany (1975) (Cited in Marshall, 1982)	: Admittance value in two groups : of individuals elderly group (60-78 years) and young (17-29 years).	Admittance value was higher in the elderly group as compared to the young adults.
Blood and Greenberg (1976)	Dynamic compliance of the middle: ear system among the aged.	A significant increase in impedance in population aged 50 and above.
Nerborne Bliss and Ronald (1978)	Mean static compliance as a function of age and sex in 3 groups 20-29; 60-69, 70-79 years.	Slight but no significant tendency for the static compliance value to decrease with age the acoustic impedance value increases with age particularly above 70 years. This is due to increased stiffness of the conductive mechanism as the age advances.

1.	2.	3.
Hall (1979)	: The effects of age on static compliance la 336 subjects in age range 6-91 .	: Both la men and women the static compliance value are maximum between 31-40 years aad then decreases systematically as age increases.
Jerger (1972)	: Evaluated the age variation of the reflex thresholds amoag children less than 6 years and adults above 65 years.	: The intensity of the sound to elicit reflex diminishes as the age increases.
Habenuar and Sayder (1974)	: 64 normal persons from 3-68 years of age.	: Poorer reflex thresholds in the younger age groups.
Seaverton and Lennor (1976)	: The subjects of the study formed 3 age range groups 20-30; 40-50; 60-70 years.	: While the reflexes in 3 age groups were elicited at equivalent SL, the supra acoustic reflex amplitude were reduced.

1.	2.	3.
Jerger (1978) (cited in Osterhammel,1979)	: Compared thresholds for pure-tones and noise as a function of age.	: Decrease in aeoustic reflex threshold for pure tone while no change in acoustic reflex threshold for white noise with increasing age.
Osterhammel and Osterhammel (1979)	: 268 persons in the age 10-80 years tested the effect of age/sex on compliance and stapedial reflex.	: The absolute compliance has no dependences on sex or age. The stapedius reflex threshold expressed in dB SPL decreases systematically at a rate of 3.5 dB/decade.
Quaranto and Cassaso(1980)	: Relation between crossed and uncrossed acoustic reflex threshold in presbycusis subjects.	

1.	2.	3.
Thompson and sills : (1980)	Studied the growth of the acoustic reflex to filtered noise and tone of 500 Hz, 1 KHz and 2 KHz in 30 persons between 20-70 years.	: The rate of growth in amplitude decreased linearly with the increase in age. The size of this decrease in growth of amplitude for tone ranges from 2-5 between the youngest and the oldest. The monotonic decrease in conductance and susceptance with increase in stimulus level seen mainly in 60-70 years.
Hall (1982)	92 subjects grouped according to age as 20-30; 60-69; and 70-80 years. The crossed end uncrossed reflex amplitude was measured.	Uncrossed reflex amplitude decreases with increasing age. Decrease in the amplitude of reflex with age is appa-rent only at the maximum signal inten-sity level (11OdB SPL) over the range of 20-80 years, maximum reflex ampli-tude of the average decreased by 56%.

1.	2.	3	
II. BEKESY AUDIOMETRY:			
Jokinen and Kaiya (1970)	s: 60 prasbycusis ears were studied with forward and backward sweep frequency.	: The sweeps with the continuous tone gave slightly better threshold values in forward than in reverse direction at middle and high frequency and the situation being the opposite at low frequency.	

Investigator 1.	Sample and methodology 2.	Findings 3.	Explanation 4.
III.LOUDNESS FUNCTION			
a) SISI Tests			
Pestalossa and Shone (1955)	: Reger' s technique of mono aural bifrequencies loudness balancing was used to assess recruitment in 20 elderly individuals.	They found that 20% of the patients had complete recruitment, 30% had partial recruitment and 50% had none.	Since the presence of recruitment is indicative of cochlear pathology absence of it in majority of the elderly suggest the higher centers.

1.	2.	3.	4.
Goetzinger (1961)	: He tested 80 males and 40 females in a population of the aged subjects.	: Among the male population 34% showed complete recruitment 51% incomplete recruitment. Among females they found that 25% complete recruitment 40% incomplete recruitment and 39% no recruitment.	
Jerger (1973)	: Two groups of elderly individuals, one group exibiting recruitment and other with no recruitment and one control group 12 normal young persons.	The effect of loudness recruitment on auditory discrimination ability among the elderly. The results of the study indicated no difference between the 3 groups.	

1.	2.	3.	4.
		: Thus the disproprotionate loss in speech understanding in aging is not strongly related to the loudness recruitment phenomenon.	
Traynor (1975)	: Subjects ranging from 78 to 92 years using the impedance audiometry to detect recruitment.	60% of the subjects did not show acoustic reflexes that would be indicative of recruitment while 40% demonstrated reflexes at normal or near normal intensities.	
Marshall (1981)		Since the SISI test would be greatly affected by a conservative criterion, this test may be especially inappropriate for the elderly.	

1.	2.	3.	4.
b) Adaptation			
Goetzinger (1961)	: Tested subjects with age range 60-79 years and 80-89 years.	: No correlation between the presence of presbycusis and tone decay. Hone of them exhibit significance decay at 1 KHz, 2KHz and 500 Hz.	
Milen and Peterson(1972) (cited in Mainer and Rapp, 1979).	: Studied the normal and sensorineural hearing loss ears among the elderly and compared with the normal young adults.	: They found that the tone decay pattern for their older population were not different from those of their young population.	
IV. FREQUENCY DISCRIMINATION AUDIOMETRY:			
Mermauram (1955)(cited in Marshall 1982)	Difference limen for frequency (DLP) at 20 dB SL across the frequency 125 Hz-4000 Hz.	DLF at this frequency range larger than normal but lesser than pathological condition such as Menieres disease.	Impaired auditory diseximination due to the degeneration changes that occur in the brain with age.

1.	2.	3.	4.
Konig(1957):	DLP for pulsed sinusoidal at 40 dB SL for 125 Hz - 4000 Hz 10 listeners per decade through 20-89 years.	: Poor discrimination as a function of age.	: Degeneration of sensory cells in the vicinity of the helicotrema and in the first coil of the cochlea.
Ross(1965)		At the age of 70 years. the DLF fs 2-3 times the value at the age of 25 years.	
Zwicker & Senon(1978) (cited in Marshall 1982)	72 hearing impaired subjects 10 of Whom had presbycusis.	This group showed greatly reduced frequency selectivity results compared with normal young adults.	

1.	2.	3.	4.
V. DIRECTIONAL HEARING AND LOCALIZATION VS. LATERALIZATION AMONG AGED:			
Matyker (1958) and Springbon (1959)	: Localization of phantom source.	: The ability decreased steadily after the age of 30 years.	: This implied a defective integration of the stimuli received from the 2 ears. Integration being the process that takes place at the brainstem, the defect indicates a degeneration that occurs in brainstem.
Kirikae (1969)	: Two groups of subj ects(1)subj ects between 50-75 years 2) younger groups between 20-30 years. Tests used were a) directional hearing (b) time vs. intensities trade.	Minimal interaural time differences necessary to lateralize the sound image (TDL).TDD for the aged was 0.082 whereas for the young it was 0.05. Thus greater for the aged. The young people perceive the lateralization events with a slight difference in time.	Changes in pinna size affect the sound directionality as age advances.

1.	2.	3.	4.
Bostaro and Russoto (1982)	: Used three central tonal lifts like auditory later alization temporal order and auditory pattern answering 50-88 years. This result was compared with the sensi- tized speech.	: Results shows a considerable reduction of the performance intensity function with age whereas tonal test remains within the value of younger subjects.	: This can be explained based on the fact that central tonal tests are of low frequency dominated which usually are affected little by presbycusis.
VI. BRAIN STEM RESPONSE AUDIOMETRY:			
Corti and Arpine (1978)	Studied later potentials in 60 subjects of diffe- rent age groups children with mean age 6.2 and adults with mean age 76.8 years.	Ho CNV is recorded in children 36% of the elderly exhibited CNS.	under the age of 5 years

1.	2.	3.	4.
Spink and Johannsen and Pinsing (1989).	: Slow component of the acoustically evoked potentials for 1000 Hz tone was compared between two groups. One with mean age of 22 years and the other with mean age of 63 years.	F_2 latencies of the older group was significantly shorter at 60, 75 and 80 dB HL than those of the younger group. This is due to a decreased efferent inhibition of severalnuclei of the auditory pathway as the age advances. No significant differences in the latencies of P_1 and N_1among the 2 groups.	
Hall and Jerger(1980)	Studied the amplitude and latencies of the ABR as a function of age in 182 males and 137 females.	The age had a slight effect on both latencies and amplitude of the wave V. Latencies increased, about 0.2 m.sec. over the age range from 25-55 years but the amplitude of wave V decreased about 10%.	
Fatihaeoa and Weber(1980) (cited in Hall et al. 1980) •	Tested 3 groups of eight subjects each infants. young adults and geriatric population using 3 rates of c lick presentation(0,13/sec. 0.33/sec, 0.50/sec.& 0.67/sec)	Greater shifts for infants and geriatrics than were present for the young adults.	

1.	2.	3.	4.
Tillman, Carhart Nicholas(1973) Quaranta and Cervellera (1974).	: Measured Masking level difference for speech /under 27, binaural condition in presence of 1-3 competing maskers for 2 groups, (l) 10 normal young adults (*2)* 55 elderly adults (63-88 years) .	: The older group exhibited a smaller MLD of 1-8 dB during antiphasic as compared to 8 dB for the young adults in the same condition.	: This difference probably indicate the reduced hearing, efficiencies in the complex testing situation as the age advances.

1.	2.	3.	4.
Findlay & Scherman, (1976)	MLD for speech was compared under 2 conditions $S_m N_m$ and $S_m N_o$ for 3 groups of subjects (1) 20 normal children 5-6 years; (2) 40 normal young adults; (3) 20 aged adults between 60-76 years.	No interaural difference appearance for children. Mean MLD for right ear exceeded than for left ear in $S_m N_m$ condition - more significantly for the' young adults.	The mechanism for MLD recedes in CNS, Thus the reduced MLD suggests that the elderly subjects has undergone some subtle - if not detectable deterioration in CNS which interfere with binaural processing.

The gradual progression of hearing difficulty in the elderly will contribute to a tendency of these patients not to recognize that their hearing is impaired.

Cerebrovascular accidents and neural presbycusis appear to contribute significantly towards the high incidence of central auditory pathology in the elderly.

Detection of disorders with in the central portion of the auditory system with the conventional adiometric battery of tests has, until recent years, been a relatively difficult tasks, conventional tests were developed exclusively for the assessment of peripheral auditory dysfunction.

Berlin (1976) pesented a review of tests for the evaluation of central auditory mechanism including the maskinglevel difference (MLD).

Masking Level Difference(MLD):

The MLD is a procedure for assessing the integration of binaural temporal information. There are several version of this procedure, but typically masked thresholds for binaural signals that are in phase in the 2 ears are compared with masked thresholds for signals that are binaurally out of phase. It has been proposed that normal performance on the MLD task requires normal transmission of temporal information from both ears, and this task is a sensitive measure of binaural temporal processing in the central auditory system (Mustillo, 1984).

A binaurql MLD may be defined as the improvement in masked threshold sensitivity for a signal that occurs on transition from a homophasic listening condition to an antiphasic one. Homophasic listening occurs when each of the 2 stimuli, signal and masker is either interaurally in phase (N_oS_o) or interaurally out of phase ($N\pi S\pi$) with itself. Antiphasic listening occurs when either of the stimuli, signal or masker in interaurally out of phase with itself, while its companion is in phase ($N_oS\pi$) or ($N\pi S_o$)(o1sen, Noffsinger and Carhart, 1976). Thus MLD is the difference between the binaural threshold obtained in an antiphasic condition (Eg. $S\pi N_o$ or $S_o N\pi$) and the binaural threshold obtained in a homophasic masking condition ($S_o N_o$)The magnitude of the MLD is expressed as the change in dBs between the homophasic condition and one of the other conditions. The largest occurs in the antiphasic condition ($N_oS\pi$), where the masker'is diotic while the signal is reversed in phase interaurally. The MLD for $N_oS\pi$, 500 Hz gated tones in a narrow band noise mask is about 15 dB.

The detectability of a tonal signal presented binaurally in a background noise is heavily dependent onthe interaural amplitude and phase relations of both signal and noise. Experiments have shown that signal detectability is enhanced if the signal and the masker noise are not in the same interaural relation.

Some people have tried to define binaural masking level differences in terms of the time delay differences than through specified phase shifts. Lockner and Burger (1961) have emphasized the role of interaural time delays in achieving release from binaural masking for pure tones, palses and narrow band noises.

The binaural masking level difference resulting from binaural analysis requires a peripheral mechanism to preserve and transmit the temporal information in stimulus received at each ear and also a central location mechanism where the 2 stimuli interact and are compared. It is this processing of binaural temporal information which allows localisation and permits the exceedingly important procews of selective listening in noise environments.

It is known that due to binaural analysis there is dramatic improvement in detection of dichotlc signals.

Binaural analysis is the improvement in hearing that results where there are interaural discrepancies in the signal and masking at the 2 ears. The binaural analysis experiments demonstrate that vastly superior detection performances are possible in many conditions in which some intersural discrepancy exists between the signal or maskers at 2 ears.

Various researches have been denoted to investigate those differences in interaural stimulus parameters that lead to improved detection performance. Many interaural differences in the signal S and in noise N have been investigated and various notations have developed.

To make the notations specific and more complete the following symbols for the various combination of noise and signal are adopted using N for noise and s for signal. The subscript 0 - indicates that there are no interaural differences between the masker or signal arriving at the ears. to indicate a phase reversal at one ear relative to the other, U to indicate that the noises at the 2 ears are uncorrelated (ie arise from separate sources) and m to indicate that the noise or the signal is raonaural When the stimuli to both ears are the same in all respects - level, frequency and phase - the stimulus condition in diotic

The diotic condition is one of the homophasic condition. If the phase (or time) at one ear either for the signal or for the noise (but not for both) is altered relative to the other ear the condition is called antiphasic. Any binaural condition which is not diotic is dichotic.

A number of conditions can be listed:

Monaural (monotic)

N_m S_m : Noise and signal both monaured (same ear)

Homophasic

N_oS_o : Noise and signal in phase at the ears diotic

$N\pi$ $S\pi$: Noise and signal reversed in phase at one ear relative to the other (dichotic)

N_o S_m : Noise in phase, signal monaural

$N\pi$ S_m : Noise reversed in phase, signal monaural

Antiphasic

N_o $S\pi$: Noise in phase Signal s/reversed in phase (at one ear)

$N\pi$ S_o : Noise reversed in phase, Signal in phase.

Hetero-phasic

N_uS_o : Noise uncorrelated, signal in phase

N_uS : Noise uncorrelated, signal reversed in phase

A MlD hierarchy demonstrates that When a signal and masker are presented to both ears identically (N_oS_o) the signal is as easily detected as when the signal and noise are presented to only one ear ($N_m.S_m$). However, if the interaural phase of the shift is changed from 0°-180° ($N_o S\pi$) Then the signal is easier to detect by 15 dB.

Factors influencing MLD performance:

MLD is defined in terms of detection and not in some other psychological dimensions such as loudness. Thus, it is necessary to investigate those parameter and conditions Which lead to an improvement in detection.

The precise amount of release from masking obtained by transferring from a homophasic condition to an antiphasic condition is dependent upon the various characteristics of the signal, the masker and psychophysical procedure used.

1. Signal frequency:

The amount of binaural improvement measured in MLD experiments greatly depends oa the frequency of the signal. MLD is known to be primarily a low frequency effect.

An MLD of greater than 15 dB may be obtained for certain binaural masking condition when the signal frequency is 500 Hz. The MLD for the same condition is not more than about 3 dBs, however, when the signal frequency is above 1500 Hz.

Between 300 Hz and 200 Hz, the MLD is inversely proportional to frequency, but for frequencies below 300 Hz, it is somewhat capricious in nature. Some investigators have reported small MLDs as frequency decreases below 300 Hz (Hirsh, 1948; Webster, 1951) while others have found larger MLDs with decreases in frequency (Durlach, 1963; Rabiner, et al. 1966). These discrepancies may have arisen from the dependence of MLD on the noise spectrum level (Dolan, 1968; Wilbanks and Cornelius, 1969). Relatively large MLDs have been obtained for low frequencies when the noise spectrum level was fairly intense (50 dB or above) and the MLD decreases as noise intensity was reduced.

2. Signal band width:

Several experimenters have used clicks (Zertin, 1966), short duration, sinusoids and pulse train, as signals in the MLD paradigm. All of these stimuli have energy spread over a wide range of frequencies. The largest MLDs occur when the signals contains energy in the frequency region below 1 KHz and when in this spectral regions there is an interaural phase reversal of signal but not of the masker.

3. Signal separation:

Rabinson (1971) has investigated the effect of using different frequencies for the signal in the Sπ conditions. in general, the maximum improvement occurs when the signals are the same frequency and there is a little differences in the Sπ and S_m conditions.

4. Noise signals:

When the noise is the signal as well as the masker, the MLDs ($N_o S\pi$) tend to vary over a considerable range 15-30 dBs. Rilling and Jeffress argued that a crucial variable in the noise-signal experiments is the phase relation between the signal and the masker. Largest MLDs were found when the phase angle between the signal and the masker was less than 90°, the MLD decreased as the phase angle was increased beyond 90.

5. Signal Phase:

The first systematic study of how signal phase affects the MLD was made by Hirsch who varied the phase of a 200 Hz. signal in 30 degrees steps in both Mo and Mπ configurations and found that largest MLDs appear when the interaaral phase of the signal is 180° difference from that of the masker ie when the configurations are M_o $S\pi$. Here the signal can be detested at a level on the order of 15 dB lower than when both are in phase. Jeffress (1952) Colburn and Durlach (1965) confirmed these results concerning signal phase using a 500 Hz signal.

Its also concluded that by altering the phase angle reflections between the 2 ears, the intelligibility of speech in noise seems to improve. This may be due to interaural phase angle sensitivity at the level of the inferior colliculi. Thus the effect of interaural signal phase is pround.

6. Signal duration:

The duration/of the signal changes the MLD very little. As the signal duration is shortened, the signal becomes more difficult to detect which is true for monotic, diotic and dichotic conditions. For very short durations of less than 50 m.sec, the MLD for some conditions may increase somewhat being 1-2 dBs larger. This effect has also been confirmed by Green.1966).

Soderquist and John W. Lindsey (1970) have studied the character of MLD with the different duration and found a non-significant effect for duration.

Hennig and Zwicker (1984) also found that binaural MLD is not markedly dependent on signal duration ie. they found that binaural MLD scarcely differ for signal duration of 20 and 200 ms.

For longer duration signals, there is an inverse relation between signal duration and the magnitude of the MLD in a continuous noise. Jeffress et al (1956) reported a larger 500 H_z MLD with a 150 ms tone than Hirsch (1948) had observed with a 1000 m.sec.

Blodgett (1958) investigated the effect on the 500 Hz MLD of varying signal duration from 5-500 ms. The MLD, although somewhat irregular varied from 17 dB (5 ms) to 13 dB (100 ms) to 15 dB (300-500 ms). Similarly -

a) a 3 dB larger 500 Hz MLD was noted for a 25 ms signal than for a 500 ms signal (Jeffress et al 1956); and

b) a 2.3 dB larger 500 Hz MLD was observed for a 32 ms. signal than for a 250 ms signal (Robinson and Trahiotis (1972). Green (1966) reported that the 250 Hz MLD was 2 d^B larger for a 10 ms signal than for a 100 ms signal.

According to Brown et al (1983), the 500 Hz MID increased significantly (1.4 dB) as the signal duration was shortened from 100 to 10 ms. The above representative studies using continuous noise demonstrated that the MLD increases by 2-4 dB as the signal duration decreases from greater than 100 to ~10 MS. In contrast MLD decreased significantly 19 dB as the signal was shortened from 10-2ms.

Wilson and Fowler, (1986) conducted 2 experiments to study the MLD for 2-128 ms. 500 Hz tones in 32 dB pressure spectrum level, continuous broad band noise. The data of this study indicated that as the signal duration was shortened from greater than 100 to ~ 10 ms. the S_o N_o and $S\pi$ N_o threshold integrate function diverged thereby producing an increase in MLD. For signal duration less than 10 ms. however, the S_o N_o and $S\pi$ N_o threshold function converged and the MLD decreased.

7. Masker level:

Schweny (19) has found that the level of the noise used in the listening condition is also an important.variable in determining the amount of unmasking. In general the greater the masker level the larger the MLD, There is some evidence that the size of the MLD asymptotes at a noise spectrum level of 40 dBs.

Hirsh and Blodgett (1952) showed practically no difference in detection of a signal monaurally ($N_m S_m$) and detection of a signal in binaural noise (N S) until the spectrum level of the noise exceeded about 20dBs. From that point, there was a reliable increase in the MLD until the spectrum level of the noise was about 40 dBs.

The spectrum level of the noise at which the maximum MLD occurs probably depends on the signal frequency.

8. Interaural intensity:

Hirsch (1948) reported that maximum advantage of the binaural system could be achieved when the masker were equal in level at the 2 ears.

Blodgett et al (1962) have shown that the effect upon the size of the MLD is gradual but a reduction is apparent even for a 10 d^B asymmetry in the level of the noise at the 2 ears.

According to Hirsch (1948) datectability reaches to peak when the level of the external noise at 2 ears is equal and steadily decreases as the masker at non-signal ear is attenuated.

9. Tnteraural correlation:

As the MLD hierarchy shows the maximum advantage of binaural listening depends on the degree to which the noise is correlated at the 2 ears while the signal is inverted (Sπ).

Licklider (1948) varied the correlation of the noise at the 2 ears by using 3 noise sources. He used speech as the signal waveform. His results showed that the correlation had little effect until it was greater than about 0.70. Robinson and Jeffress (1963) also studied the effect of noise correlation on the detection of sinusoidal signals and their results showed a systematic change in the size of the MLD ($H_u S_o$ and $N_u S$ condition) as the correlation was changed from -1 to + 1.0.

Thus various researchers condluded that the size of the MLD at a given frequency may be expected to vary with interaural correlation.

10. Interaural time:

The release from binaural masking for pure tone, pulses and Narrow band noise have also depends upon the interaural tine delay.

Short interaural time delays do not appear to have any important influence on the reception of speech heard *in* a guiet environment. It is seen that MLDs produced by varying the interaural timing of either the masker or the speech signal became larger as the time differences was increased from 0.1 to 0.8 m.sec.

Jeffress et al (1952) were the first to investigate how the MLD depended on a time delay between the noise masker at the 2 ears. The signal in their study was a 500 Hz tone. They found that as the noise was delayed, detection performance improved to about 10 dBs until the delay reached the value of about 1 m. sec.half the period of 500 Hz tone* From that point detection performances deteriorated until the delay was 2 m.sec. at which the results were essentially the same as those obtained with no delay.

Jeffress et al (1962) studied a delay in the noise when the signal was 167 Hz, The results showed that the MLD increased slightly to a value of about 4 dB at 1 m.sec. and remained there for all longer delays.

Interaural Phase:

Since the noise is composed of many frequencies a phase shift in the noise produces differential time shifts in the components at the different frequencies.

Thus the detectability of a tonal signal, presented binaurally in a background of noise is heavily dependent on various parameters of both the signal and masker.

MLD in normala and pathological ears:

A. MLD in normals

In order to have an increased insight regarding MLDs in normal subjects. Many studies were carried out.

Dierecks and Jeffress (1962) on the basis of their own work and earlier studies presented hierarchy of MLD conditions in the order of increasing signal detectability in normals. The 3 conditions that produce the poorest detection are $N\pi S\pi$, $N_o S_o$ and $N_m S_m$. These were reported to produce about equal masked thresholds and are used as the reference condition in most MLD studies. The best detection is obtained in the anti-phasic condition. The general size of the antiphasie MLDs about 15 dB at low frequencies, decreasing in size, through the mid-frequency range.

Quaranta and Cervellera (1973) in their study with different groups of subjects namely normals, conductive symmetrical, conductive asymmetrical, sensorineural hearing loss, mild and severe meniere's disease found a MLD values of 8.2 dBs in normals which was taken as reference and the results of the pathological group were compared with that of the normals.

Study done by Quaranta, Cosseno and Cervellera (1974) to investigate the clinical value of the tonal MLD examined 184 subjects among which normal subjects were 20• Average MLD obtained for normals was 8.2 dBs and the range was 7 to 9,3 dBs.

Uisen and Noffsinger and Carhart (1976) encountered MLDs in clinical populations. The results of investigation into MLDs for 500 HZ and spondees among those with normal hearing in this investigate are Similar to results reported by numerous other investigators. *The* value of MLD was found to be 8 dBs in this study in normals.

B. MLD in symmetrical conductive hearing loss cases

Quaranta and Cervellera (1974) found that a similar MLD average was obtained for symmetrical conductive hearing losses ie. 8.1 ± 2dBs as seen in normals.

In the study done by Boeca and Antonelli (1976) where a group of symmetrical conductive hearing loss cases were tested, they found that MLD size in this group was the same as that of the control group which consisted of normals.

C, MLD la asymmetrical conductive hearing loss Cases

In 1971 01sen reported the results of 118 patients with various types of hearing loss, grouped into 6 hearing loss categories and he found that MLDs were least reduced for patients with asymmetrical conductive hearing losses and labyrinthine otosclerosis.

Quaranta, Cassanp and Cervellera (1974) studied MLD in 15 cases with chronic otitis media and found average MLD to be 7.9 dBs, and the range was from 5 to 10,8 dBs, they also took up 12 cases with otosclerosis and found MLD of 7,2 dBs and the rangewas from 5 to 0.8 dBs, Earlier they had found MLD in normals to be 8.2 dBs, They found out that only if MLD was less than 6 dBs it was considered to be pathological. So they concluded that binaural unmasking is normal in patients suffering from symmetrical and asymmetrical conductive impairment,

Bocca and Antenelli (1976) in their study reported that MLD is signifieantlyreduced in asymmetrical hearing loss cases when compared to normals especially when the good ear is heading and the poor ear is lagging,

Olsen, Noffsinger and Carhart (1976) in their study have found that 2/5 patients with conductive hearing loss yielded S_{π} N_{o} MLDs at 500 Hz smaller than that found in normals. These findings suggests that the reduced MLDs in this groups are attributable to interaural differences in the signal and noise level reaching the cochlea.

The detrimental effect of large interaural differences on MLB size has been demonstrated for normal hearers also.

D. <u>MLD in seposorineearal hearing loss cases</u>

Study done by Quaranta and Cervellera (1972) of MLD in sensorineural hearing loss patients revealed a smaller MLD than that obtained for normal subjects. They found a MLB of 5.7 ± 2 dBS in sensorineural hearing loss cases,

Quaranta, Cassare and Cervellera (1974) collected 50 cases with sensorineural hearing loss their MLB value was found to be 5.2 dBs and ranging from + 1.8 to + 10.2 dBs and so they concluded that binaural unmasking was significantly reduced in patients with sensorineural hearing loss.

But Jerger and Jerger (1965) tested in a series of 3 patients with sensorineural hearing loss and it was shown that the MLB was not significantly different from that found with normally hearing subjects.

Results of study done by Bocca and Antonelli (1976) indicated that MLD is small in sensorineural unilateral deafness when good ear is leading.

B. MLD in Noise Induced Hearing Loss cases:(NIHL)

Olsen, Noffsinger and Carhart (1976) found MLDS for 500 Hz and for spondees. Their results indicated that the behaviour of patients with NIHL was unique, because the MLDs for 500 Hz were usually normal, whereas a substantial fraction of the spondee MLDs were smaller than normal.

F. MLD, in Meniere's disease cases: (MD cases)

Olsen, Noffsinger and Carhart (1976) studied MLD in 12 unilateral MD cases. Their results are as follows:

-MLD for 500 Hz S_{π} N_o was 4.8 dB and S_o N_{π} 2.9 dB.
-MLD for spondees S_{π} N_o was 3,0 dB and S_o N_{π} 2.9 dB.

More than 50% of the MD group had smalll MLDs for 500 Hz. and all but 15% of them had abnormally reduced S N_o speech MLDs. This reduction is an outcome of distortion in signal transaction occuring at the cochlea on affected side.

Quaranta, Cassano and Cervellera (1976) studied MLD in 27 MD cases and found average MLD to be 3.7 dB and range to be 0-7 dB.

Bocca and Antonelli (1976) found that for MD group. MLD was very small when the good ear was leading. MLD effect disappeared when the poor ear was leading.

Thus it is seen that binaural release from masking was reduced considerably for the group of patients having unilateral MB. It is apparent that low frequency sensori-neural hearing loss such as associated with unilateral MD does alter the input from one side sufficiently to diminish release from masking,

G. MLD in vestibular neurinitis cases

Quaranta and Cervellera (1974) studied MLD in 6 cases of vestibular neurinitis and found an/average MLD to be 4.6 dB and the range was 5 to 9 dB.

H. MLD in VIIIth nerve tumour cases

Carhart, Olsen and Noffsinger (1976) have reported reduced MLDs for 500 Hz and speech among the 20 patients with 8th nerve tumour despite the findings that 13 of them had normal hearing sensitivity at 500 Hz and bilateral inter-aural threshold differences of greater than 15 dB. This reduction indicates that unilateral involvement of auditory nerve can reduces the size of the binaural MLDs, Qaranta, Cassano and Cervellera (1978) tested 5 cases with acoustic neuroma and found that average MLD was 2.7 dB range extending from 1.2 to 4.5 dB.

I. MLD in brain stem lesion cases

Noffsinger (1976) took up brain stem lesion cases and measured speech MLDs and MLD at 500 Hz. The results showed that

- MLD for 500 Hz 1) normals had a shift of 11 dB
  2) These patients had a shift of only less than 6 dB.
- MLD for spondees 1) Normals had a shift of 9 dB
  2) These cases had a shift of 4 dB and sometimes OdB.

The reduction in MLD size for these patients cannot be attributed to hearing loss, Since their speechreception thresholds were normal and also 250 - 4000Hz thresholds. Therefore. reduced MLD for these patients is more logically tied to some disruptions in central auditory nervous system integration of binaural input than to peripheral auditory image.

Olsen, Hoff singer and Carhart (1976) have reported that the average MLD in 12 centralnervous system disordered patients were 9.8 dB in S N_o and 7.3 dB in S_o N_π for MLD at 500 Hz and for spondees was 5.0 dB for S_π N_o and 3.8 dB for s_o N_π.

In 1974 Quaranta, Cervellera and Cassaro found average MLD to be 6 dB and the range is from 2-10 dB in 29 cases of centralnervous system disorder. Thus there is a reduction in tonal MLD. So its hypothesized that in such cases the centers responsible for the cross correlation are directly impaired.

J. Multiple sclerosis and MLD

Noffsinger, Olsen and Carhart (1976) studied the effect of Multiple sclerosis (MS) on the size of MLD, Subjects were 61 patients with MS age 20-64 years and found that patients with MS had MLDs at 500 Hz of 7 dB or less and sponoee MLDs of 5 d^B or less. The reduced MLDs exhibited by this population were the result of lesions in central nervous system.

Thus they concluded from their data that many of the patients with MS had normal peripheral auditory functions but had lesions that interferred with central binaural processing as revealed by MLD

K. MLD in cortical lesion cases

Noffsinger and 01sen (1971) studied MLDs in a series of two hemispherectomized patients and achieved large MLDs,

Cullen and Thompson (1971) and 01sen (1973) have also reported patients with cortical lesions who achieved large MLDs.

Bocca and Antonelli (1976) carried out MLD tests on a group of patients with unilateral cerebral lesions of vascular origin and apparently normal puretone audiograms. He found the pure tone audiogram was within normal limits on both sides, a tendency with interaural delay to produce larger MLD when the ear leading in time was ipsilateral to the normal hemisphere.

Carhart, Noffsinger and Olsen (1976) in their study of 290 subjects found that MLDs were not affected by cortical lesions. Findings suggest that unmodified partici pation of both cortical hemispheres are unnecessary for normal release from masking and therefore that MLDs are mediated at levels below the auditory cortex. Hence reduced MLDs with normal hearing is indicate of damage at lower levels of central auditory nervous system and small MLDs in MS patients implicate lesions in brainstem or mid brain or both.

L, MLD in aphasic children

Rosenthal and Wohlert (1973) explored fhe MLD in developmentally aphasic and normal, age matched children. The aphasic children showed slight but consistently lower pure tone MLDs than normal children.

M. MLD in elderly persons

In a study of masking of speech by other speech, Carhart, Tillman and Greetis (1973) found that clinically normal but elderly individuals showed a pattern of inference from complex maskers that differed from that observed in normal young admits, which led them to conclude that in the elderly subject, the MLD for speech would be reduced relative to that observed in normal young adults. And they also suggest that since MLD resides in central nervous system, the elderly subject has undergone some subtle, if not detectable, deterioration in the centralnervous system which interferes to some extent with binaural signal processing that produces MLD.

Tillman, carhart and Nicholis (1973) measured masked thresholds for spondees in 27 binaural conditioncoverlng homophasic, antiphasic, parallel time-delayed and opposed time delayed listening in the presence of one to three competing maskers. One of the maskers was white noise modulated 4 times per second by 10 dB with 50% duty cycle, the other two were sentences spoken by different male talkers. Subjects were 10 young adults, 23 women aged 70-85 years and 22 men aged 63 - 88 years. MLD were observed in every instance of dichotic presentation. MLDs for the young adults were usually somewhat larger than those for the elderly subjects. Both groups showed (l) somewhat larger MLDs when the competing background included 2 talkers.

2) Somewhat smaller MLDs during time delay modes and

3) smaller MLDs in opposed time-delay than in parallel/ time delay.

Tillman et al (1973) have observed a release from masking for spondee thresholds among a group of elderly listeners. "They have suggested that the smaller MLDs for elderly 1isterns may be related to increased difficulty separating surgical and noise in intr acranial space; possibly as a result of central nervous system degeneration interfering with signal processing.

Jerger, Brown and Smith (1984) carried out analysis Of the effect of age on MLD on 270 subjects (10-69 years) with normal hearing and they observed a systematic decline in the average MLD with age from 11.4 dB in the 10-19 years decade to 10.3 d[B] in the 60-69 years decade. An analysis of variance demonstrated, however, that the age effect was not statistically significant.

Bocca and Antoneli (1976) studied effects of MLD in a group of presbycusis cases found that Whilst under S_mN_m and S_oN_o condition, intelligibility was definitely poorer than in the central group, but MLD obtained under binaural condition with interaural delay reaches the same values as in control group.

01sen, Noffsinger and Carhart (1976) in their study of 290 subjects found spondee MLDs smaller for elderly subjects than for normals. Schuknecht (1955) has documented the fact that sensory or neural changes in auditory system occur with aging.

Quaranta, Cassaro and Cervellera (1974) tested 20 cases of presbycusis and found average MLD to be 7 dBs and theange 5-9 dBs.

Tillman (1973) have suggested that the smaller MLDs for elderly listeners may be related to increased difficulty separating signal and noise in intracranial space, possibly as a result of central nervous system degeneration.

Thus in the absence of hearing loss due to lesions of the peripheral auditory system on one or both sides, abnormal findings (significantly decreased scores) would indicate involvement of the auditory system at the ponto-medullary levels of the brain stem.

normal MLD scores would not rule out the possibility of central auditory involvement, but could be interpreted as an indication of non-involvement of the auditory system at the pontomedullary level. Thus, either abnormal or normal MLD test findings may aid in the localization of central nervous system lesions/degeneration especially when used as part of a battery of other behavioural and electrophysiological tests. The MLD tests may also reveal unsuspected brain stem, involvement in many patients with clinically silent lesions, such as in MS.

METHODOLOGY

The purpose of the present study was to find the change in masking level difference values as a function of age.

The binaural release from masking exhibited by a control group of normally hearing young adults and by an experimental group of elderly subjects with normal hearing was determined.

Subjects:

The control group consisted of 20 normally hearing adults aged from 18-23 years (both males and females) . Each was required to have hearing levels bilaterally within 15 dB (ANSI 1969) in the frequencies 250 Hz, 500 Hz, 1000 Hz , 2000 Hz, 4000 Hz and 8000 Hz,

The experimental group consisted of 20 elderly subjects who were randomly selected from the general population. The sample included literate as well as illiterate people. The age range of the subjects were from 50-70 years. These subjects were categorized into two age groups 50-60 years; and 60-70 years; based on their chronological age. The age was determined from the date of birth. But when this data was not available, the age of the subject was derived from the time of occurrences of certain important events in their life, such as their age at the time of marriage, the age of the Ist child, the time of retirement etc.

A screening criteria, based on the background information like medical history, history of noise exposure, history of ototoxicity, and results of impedance, audiometry, was set-up, for the selection of subjects to the study.

The following criteria was employed for selection of subjects:

1. A negative history of any kind of ear abnormalities, structural and functional, prior to, as well as at the time of testing.
2. A negative historyof head injury.
3. A negative history of systemic diseases like diabetes, cardiovascular abnormalities and central nervous system infections.
4. A negative history of the consumption of high doses of streptomycin, kanamycine and neomycin.
5. A negative history of upper respiratory tract infection at the time of evaluation.
6. A negative family history of hearing loss.

7. A negative history of noise exposure, meeting the : damaged risk criteria given by OSHA was used as the guidelines.

Equiment:

An impedance bridge (Madsen ZO 174) equipped with earphones (TDH-39) set in supra aural cushions (MX 41/AR) was used for impedance screening.

For obtaining pure tone thresholds and MLD values, Grason-Stadler audiometer (GSI-10) with TDH-39 earphones mounted in MX-41/AR supra-aural cushions was used for all the subjects.

The instruments was calibrated according to the specifications given by ANSI 1969.

Test Environment:

The study was carried out in an acoustically sound treated room. The ambient noise levels present in the test room were below the proposed maximum allowable noise levels i.e. the noise level was found to be sufficiently low as not to interferes with threshold testing.

Test procedure:

Impedance Screening:

For each subject, tympanometric and reflexometrie measurements were done to rule out middle ear pathology.

Tymapanogram was obtained with a 220 Hz probe tone for both the ears of a subject. Then, the contralateral reflex thresholds were measured, for frequencies, ranging from 250 H_z to 4000 Hz at octave intervals.

Subjects who had a normal pressure peak ($\pm$ 50 mm H_20) and reflexes atleast at any three frequencies in both ears, were included for the study.

Pure tone testing:

The conventional procedure was used for pure tone testing and thresholds were obtained using the Modified Hughson and Westlake procedure. The pure tone thresholds were obtained for seven frequencies ranging from 250 Hz to 8000 Hz at octave intervals. Both ears of the subjects were tested once at a time. Similarly bone conduction thresholds were also obtained.

Procedure for masking level difference:

For obtaining MLD values each subject was presented binaurally a narrow band noise of 60 dB SPL, centered around 500 Hz and 500 Hz pulsed tone which had on and off time of 200 m.sec, under the following conditions:

1. Homophasic - $S_o H_o$ ie when both the noise and signal are in phase at the 2 ears.
2. Antiphasfcc- S_π N_o ie. when the phase of the signal is reversed 180° at the 2 ears.
3. Antiphaaic - S_o N_π ie. when the phase of the noise is reversed 180° at the 2 ears.

Thus the MLD values for 500 Hz pure tones were obtained for both the normal young admits and elderly subjects. The data was then analysed statistically using the non-parametric Mann Whitney U Test.

ANALYSIS,RESULTS AND DISCUSSIONS

The data of MLD values were subjected to statistical analysis.

Descriptive statistics was applied to find the mean and standard deviation of MLD values of each of the three groups.

Mann Whitney U Test was carried out between each of 3 groups.

The statistical analysis of the data on MLD values obtained is given in Table *2*, 3, 4.

Table-2: BLD values obtained for normal young adults 18-23 years.

Variables	NO.Of subjects	Mean	Standard deviation	Minimum	Maximum
Age	20	18.8	4.63	18	23
Sex	20	0.5	0.51	0	1
MLD_1	20	13.63	1.28	12.5	15
MLD_2	20	10.38	0.92	10	12.5

Table-3: MLD values obtained for normal aged group 50-60 years.

Variables	No.Of subjects	Mean	Standard deviation	Minimum	Maximum
Age	10	56.6	3.06	51	60
Sex	10	0.5	0.53	0	1
MLD_1	10	13.5	1.29	12.5	15
MLD_2	10	10.75	1.21	10	12,5

Variables	No.Of subjects	Mean	Standard deviation	Minimum	Maximum
Age	10	65.1	3.08	61	70
Sex	10	0.5	0.53	0	1
MLD_1	10	11.25	1.32	10	12.5
MLD_2	10	8.25	1.21	7.5	10

MLD_1 - MLD values obtained for the antiphasic condition $N_o S_\pi$

MLD_2 - MLD values obtained for the antiphasic condition $N_\pi S_o$

The analysis of the data reveal that -

I.a) There is no significant difference between MLD_1 values ($N_o S_\pi$) obtained for young admits and aged group 50-60 years.

b) There is a significant difference between MLD_1 values (N_o S_π) obtained for young adults and aged group (60-70 years) at 0.01 level.

c) There is no significant difference between MLD_1 values (N_o S_π) obtained for young males and young females.

d) There is no significant difference between MLD_1 values (N_o S_π) obtained for aged males and aged females.

II.a) There is no significant difference between MLD_2 values (N_π S_o) obtained for young adults and aged group 50-60 years.

b) There is a significant difference between MLD_2 values (N_π S_o) obtained for young adults and aged group 60-70 years at 0.01 level.

c) There is no significant difference between MLD_2 values (N_π S_o) obtained for young males and young females.

d) There is no significant difference between MLD_2 values (N_π s_o) obtained for aged males and age females.

Several investigators (Eg.Teal et al (1958) Fowler (1972), Glorig (1973), Snow et al (1978), Perry (1957), Covell (1952), Rosen Wasser (1964), Maurer and Rupp (1978), Crowe, Guild, Polvoget (19 34); Sehuknecht (1955), Gacek(1975)

Mayer, (1920), Von Fiendt (1937), Hinchcliffe (1962) reported that the aging involves only peripheral end organs.

On the other hand the existence of central influence on aging has been observed by many authors (eg. Brody (1955); Neff,(1947), Woelliner (1953), Citron et al (1963), Hansen and Reske Nielsen (1965), Sercer (1958) Kirkae, Sato and Shitara (1964) Scheidegger (1963).

Recently Hannley et al (1983) Lynn et al (1981) and Vyasamurthy et al (1985) have shown that MLD one of the psychoacoustic phenomena to be mediated by superior olivery complex a structure beyond the cochlea.

The results of the present study which was undertaken to test whether aging has any effect on the MLD values for pure tone of 500 Hz show that binaural release from masking was reduced for the geriatric group (50-70 years) as a whole. These results are also in agreement with other reports on MLD for geriatrics. Carhart, Tillman and Greelis (1969) in a study of speech by other speech on clinically, normal but elderly individuals showed a reduced MLD for speech in the elderly subject relative to that observed in normal young adults and they concluded that, elderly subject has undergone some subtle, if not detectable, deterioration in the central nervous system with aging. Tinman et al (1973) have suggested that the smaller MLDs for elderly subjects stay be related to increased difficulty separating signal and noise in intracranial space. possibly as a result of central nervous system degeneration interfering with signal processing. According to Olsen and Hoffsinger (1976), the 500 Hz MLD results obtained from presbycusis subjects revealed smaller mean MLDs than for normal young hearers. Schuknecht (1955, 1960) has documented the fact that sensori orneural changes or both in the auditory system occur with aging. And effects of such changes or signal transduction or transmission or both produces the small MLDs that frequently are found in patients with pre-sbycusis.

It is apparent that changes during aging does alter the input from one side sufficiently to diminish binaural release from masking.

The reduction in MLD size of these subjects cannot be attributed to hearing loss since their 250 - 4000 Hz thresholds were normal; on only a few instances were there mild losses at 6000 Hz And 8000 Hz. Therefore, reduced MLD for these geriatrics is more logically tied to some disruptions in the central auditory nervous system integration of binaural input than to peripheral damage.

In other words, reduced MLDs in tandem with normal hearing sensitivity are indicative of damage at lover levels of central auditory nervous system and implicate lesions* in the brainstem or mid brain or both.

In the present study a low MLD in 60-70 years group itself should not be interpreted as an indication that this group has brain stem changes or lesion with aging. Conversely, a normal MLD in 50-60 years group should not be interpreted as a proof that this group does not have an auditory processing problem. A wide sampling of central auditory function is needed to describe the integrity of central auditory nervous system of a geriatric and this can only be accomplished by using a test battery approach.

SUMMARY AND CONCLUSION

In India there is no study conducted to determine the effect of aging on MLD. The few available studies on geriatrics or presbycusis subjects do not provide any information on the relationship between age and the MLD values. Therefore, this study was designed to obtain information regarding effect of aging on MLD values measured for puretones of 500 Hz in both $N_o S_\pi$ (MLD_1) and $N_\pi S_o$ (MLD_2) conditions.

The results of this study on 20 normal young adults (18-23 years) and 20 normal aged admits (50-60 and 60-70 years) showed that:

I a) There is no significant difference betwen MLD_1 values ($N_o S_\pi$) obtained for young adults and aged groups(50-60 years)

b) There is a significant difference between MLD_1 values ($N_o S_\pi$) obtained for young adults and aged group(60-70 years) at 0.01 level.

c) There is no significant difference between MLD_1 values for young males and young females.

d) There is no significant difference between MLD_1 values ($N_o S_\pi$) obtained for aged males and aged females.

II a) There is no significant difference between MLD_2 values ($N_\pi S_o$) obtained for young adults and aged group (50-60 years).

b) There is a significant difference between MLD_2 values ($N_\pi S_o$) obtained for young adults and aged group 60-70 years at 0.01 level.

c) There is no significant difference between MLD_2 values ($N_\pi S_o$) obtained for young males and young females.

d) There is no significant difference between MLD_2 values ($N_\pi S_o$) obtained for aged males and aged females.

Thus there is a reduction in MLD values as age increases.

Although a test battery approach and a wide sampling of central auditory function is needed to describe the integrity of central auditory nervous system of a geriatric, in subjects with normal hearing, pathological tonal MLD indicates the existence of central hearing pathway lesions.

Thus the present study shows that age-related changes involve not only the end organs but also the brain stem structures.

<u>Implications for further research:</u>

1. To carryout similar study on large number of normal adults and geriatrics.

2. To vary other parameters like duration of the masker and signal, intensity of the masker and frequency of the signal, carry out similar experiment.
3. To carry out studies on MLD in the handicapped population like Meniere' s disorders, acoustic neuroma, multiple sclerosis, learning disability etc.

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