# THE NATURE AND UTILITY Of 40 Hz EVOKED POTENTIAL IN GERIATRICS

REG . NO.M9016

AN INDEPENDENT PROJECT AS PART FULFILMENT OF M.Sc.

(SPEECH AND HEARING) TO THE UNIVERSITY OF MYSORE.

ALL INDIA INSTITUTE OF SPEECH AND HEARING : MYSORE . 570 006

1991

**LALLI**

**A BLESSING IN MY CHILDHOOD**

**A SOURCE OF INSPIRATION DURING**

**MY ADOLESCENCE**

**AND A FRIEND FOR LIFE ... NOW AND EVER**

## CERTIFICATE

This is to certify that this Independent Project entitled : "**The nature and utility of 40 Hz evoked potential in geriatrics**" is the bonafide work in part fulfilment for the degree of M.Sc. (speech and Hearing) of the student with Reg. No,M9016.

Mysore

1991

Director

All India Institute
of Speech & Hearing
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**CERTIFICATE**

This is to certify that this Independent Project: "The nature and utility of 40 Hz evoked potential in geriatrics" has been prepared under my supervision and guidance.

Mysore
1991

Dr.(Miss)S.Nikam,
GUIDE

# DECLARATION

This Independent Project entitled: "The nature and utility of 40 Hz evoked potential in geriatrics" is the result of my own study undertaken under the guidance of Dr. (Miss) S.Nikam, Prof, and HOD, Dept. ef 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.M9016

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I thank Dr.(Miss) S.Nikam, Director, AIISH, Mysore for permitting me to do the project and the use of instrument.

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My deep appreciation and loads of thanks to *the* subjects who kindly cooperated and sat patiently through the testing.

"Pea-brained nit wit" - you are a gain. Thanks for the help and for just being there.

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My thanks are due to classmates and other friends who gave an helping hand directly or indirectly.

Amma-Appa feelings though deep fall to form words and so I simply say "Thanx".

Akka in having patiently interpreted my mumble jumble into neat script if not for which the project would have had only dots, dashes and 'U' s instead 'er' s - Thank you.

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# INTRODUCTION

"Youth is not a time of life", it is a state of mind, it is a matter of will, a quality of the imagination, a vigour of emotion, it is the freshness of deep springs of life. Yet years wrinkle the skin shrink the cells, damage the function, it is but work of nature and organ of hearing is no exception. Nature in man and animal is the psychology founded itself upon physiology and scrutiny of the brain and nervous system. Therefore it is not surprising that efforts of man is concentrated on physiology. This gave rise to rationalistic thinking empirical phenomenon and later experimental phenomenon. This progress is tree of all fields existing and hearing is non-exception. The physiology of hearing and related areas are a subject of much controversy. To the existing controversy more information is added in the hope that clarity takes birth. The evaluation of hearing was also hard which involved various measures of testing. Recent developments are giving rise to controversies which are being dealt with increasing search for the actuality. Existence of literature is a big boon for researchers and is no exception in this study.

Literature reveals that threshold of audition can be obtained basically by two methods of testing (a) subjective method (b) objective method. subjective method of estimating threshold is dependent on patient's cooperation which is not so in objective method. An objective method involves estimation of responses without the voluntary participation of the patient and majority of information is elicited by the use of instruments. One such objective method is scalp recorded auditory evoked potential. This method records electrical activity of brain in response to auditory stimuli.

Davis ot al. (1939) was the first one who noticed a change in electrical activity of brain in response to sound. This phenomenon is called electro-physiological activity end is measured in scalp recorded auditory evoked potentials. In addition to conventional audiometry, speech audiometry, this electrophysiological testing also has become a part of test battery in the past decade. Scalp recorded auditory evoked potentials being a part of the clinical armamentarium their advent has enhanced the diagnosis of difficult to test population and children of very young age.

The scalp recorded auditory evoked potentials can be divided on the basis of latency values, into three major groups. (Kilney and Shea, 1986).

(a) Early or brain stem components (ABR) (1-10 msec)

(b) Middle components (MLR) (10-100 msec)

(e) Late vertex components (LVAER) (100-1000 msec)

Though late responses and middle latency responses (MLR) were discovered earlier than brain stem evoked responses (BSER) literature reveals that BSER is widely used on clinical population. However, of late there is renewed interest in MLR. BSER has been used to estimate behavioural thresholds in difficult to test cases. BSER has been using clicks as stimuli and it predicts average behavioural threshold of 1 KHz to 4 KHz, MLR has the advantage over BSER, it gives frequency specific information as tone bursts and tone pips can be used as stimuli.

MLR was first reported by Gaister, Frishkopt, Resenblith (1958). It was called early response. Later they were renamed as MLR by Picton, Hillgard, Krauss, et al. (1974) and Davis (1976) to differentiate there from the BSER which occurs in the first 10 msec after onset of stimulus. Davis (1977) gives configuration of MLR as given below.

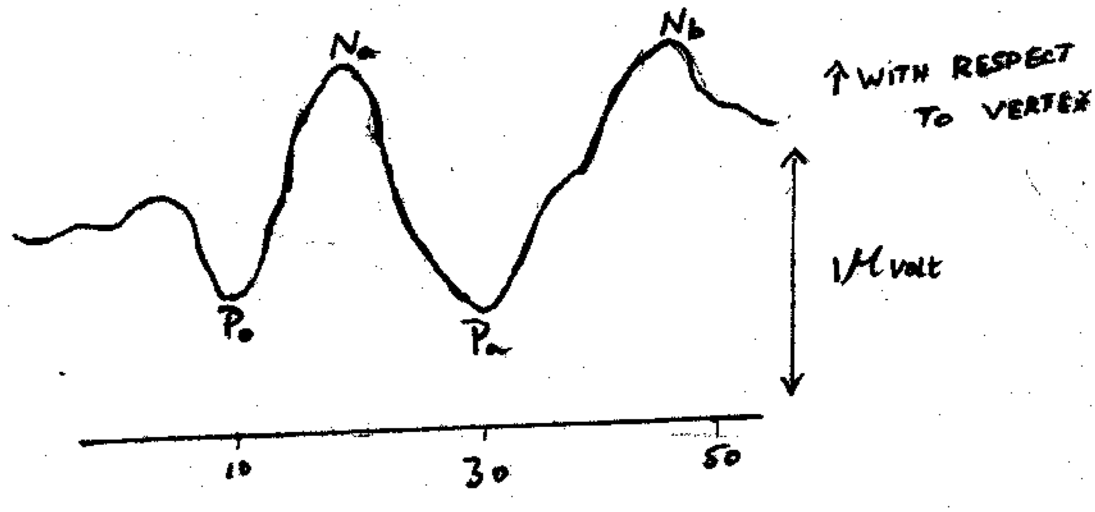


**Fig 1: Showing wave form of MLR**

Two wave form was obtained at 4 KHz with intensity of 80 dB HL and filters used were 16-320 Hz.

The wave form of MLR varies with the filter set at different cut-off frequencies. However, the wave form of the response may be described as consisting of two major positive peeks and three major negative peaks - $N_o$, $P_0$, *Na* *P*a and $M_b$ (Goldstain and Rodman, 1967). The later parts especially $P_b$ and $N_c$ are noticed with a longer time base of 10-80 m.sec. The five peaks mentioned by Goldstein and Rodman (1967) have the following range of latencies. The peak latencies is said to vary according to stimulus intensity to the recording band width limits using bond pass settings 2S-175 Hz with a slope of 6 dB/octave and a stimulus at 60 dB SL.

$N_o$ - 8 - 10 msec.

$P_o$ - 10 - 13 msec,

$N_a$ - 16- 30 msec

$P_a$ - 30 -45 msec,

$N_b$ - 40 - 60 msec.

Amongthese peaks $P_a$ is the most prominent stable peak and is said to have a latency of 30 msec in adults (Kilney, 1970) . Studies on MLR also quote $P_a$ as the most stable and prominent form and that is the peak which is often considered for further analysis (Kilney and Shea, 1986).

The over all sequence of MLR resembles the shape of a sinusoid at 40 Hz. Therefore the peak can bo enhanced toy stimulating at a repetition rate of 40 Hz. This is called 40 Hz MLR and was first described by Galamboa et al. (1981). It appears as a sinusoidal wave form which is composed of energy of both auditory brain stew response (ABR) and MLR wave form (V peak. $P_a$, $P_b$). Klein (1983a) refers to 40 Hz response as a slow wave component. A stimulus repetition rate approximating 40 Hz and a recording window of 25 msec. duration will result in super imposition of BSER and MLR components (Galambos, Makeig at al. 1981; Kilney, 1983, Stapells at al. 1984). If a recording duration of 50 msec.is used the resulting averaged auditory evoked potential will approximate cycles of a 40 Hz sine wave (Galambos et al.1981; Kilney, 1983; stapells, et al. 1984). Because of the super imposition of ABR and MLR components the 40 Hz event related potentials (BRP) exhibits an amplitude advantage.over the ABR-MLR configuration. Thus, 40 Hz ERP is MLR elicited by tone bursts delivered at the rate of 40/sec. This 40 Hz. MLR can be used to predict behavioural thresholds. A study done on infants by Maurizi et al, (1990) said that threshold

Of 40 Hz MLR in infants is 40 dB nHL increasing to 20 dB nHL ia older infant. Schafer and Bowling (1987) hare found that 40 Hz MLR can be identified seasorinural hearing impaired adult males with excellent certainity and reliability within 20 dB of the hearing threshold for 500, 1000 and 2000 Hz. MLR studies (Madell and Goldstein 1972; Mendel, Mosick, Windman et al. 1978), vivien McFarland, Molf, Goldstein,(1977) Skinner sad Glattke (1977) that MLR thresholds are within 10-30 dB HL of behavioural threshold.

**Need for the study:**

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This study deals with the nature of 40 Hz response obtained in geriatrics and adults and a comparision between both the population is made. A comparision is also made between the behavioural thresholds for pure tones and thresholds obtained by 40 Hz response.

Moreover aging process affects organ of hearing also and this is reflected through the performance of geriatrics on puretone responses, speech tests impedance and acoustic reflexes. In ABR studies have shown that there is an effect of age on latency. There is sa appreciable prolongation of latency with increasing age (Thomson et al, 1978; Rowe, 1978) while Beagley end Shelrake (1978) found only a minimal increase in latency of wave V as a function of age. Krishnamurthy (1985) has also found increase latency values in geriatrics when compared to adults. Hence it may be hypothesised expected that there would be age effects in 40 Hz MLR also. Therefore the effect of aging 40 Hz is of interest and this study would throw some light regarding it.

40 Hz evoked potentials has been carried out on 2 types of population namely adults (Galambos, 1981; Synn et al. 1984; schafer and Bewling (1987) and children (Maurizi et al (1990). The geriatric population inspite of its being a major clinical population has not been investigated for 40 Hz KRP. This instigated the curiousity of the investigator and hence the present study.

**Purpose of the study:**

1. To study the waveform and peak latencies of 40 Hz MLR obtained using 500 Hz tone bursts in normal hearing geriatrics and to compare the same with that of normal hearing adults.
2. To compare the behavioural thresholds of puretones and thresholds of 40 Hz nut in geriatric and adult group and thus detetmine its sensitivity for threshold prediction.

# REVIEW OF LITERATURE

MLR reportedly has valuable applications IN diagnosis of hearing impairment and assessment of higher auditory function, bat however, controversies surround this also. The 40 Hz MLR which was discorerad in the early 1980s a derivative of MLR holds even greater promise for threshold evaluation. Hence many issues regarding the origin of response, stimulus variation, filter characteristics repu-tition rate, sleep affects were looked into by various investigators and their contribution has been dealt with in this chapter.

**Nature of 40 Hz MLR:**

The 40 Hz MLR is classified as a steady state evoked potential (SSEP). A SSEP is elicited by stimuli presented at a rate, such that responses from successive stimuli over-lap. This results in a wave form whose peaks and troughs are the composite of different evoked potentials elicited from more than one stimulus presentation. Four prominent peaks are evident, each peak securing within 24 msec, of the preceding peak using 100 msec, recording window. The sinu-soidal wave form is obtained by presenting stimuli at the of 40/sec.

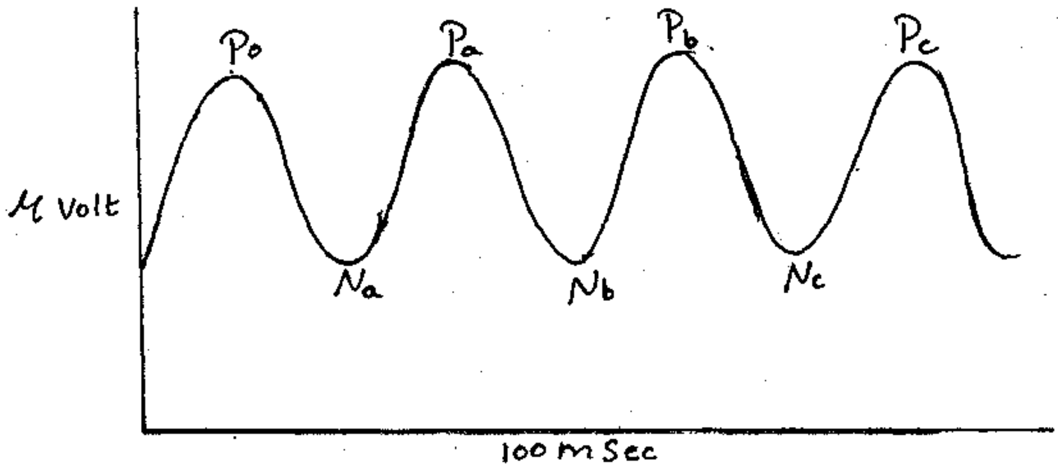



Fig 2: Showing 40 Hz wave form.

At this high rate tone pips are presented every 25 msec. Since three major peaks ($P_a$, $P_b$, $P_c$) of MLR occur approximately at 25 msec. interval there is an overlapping effect in time of these waves which enhance their amplitude. This is shown in following Fig.3:

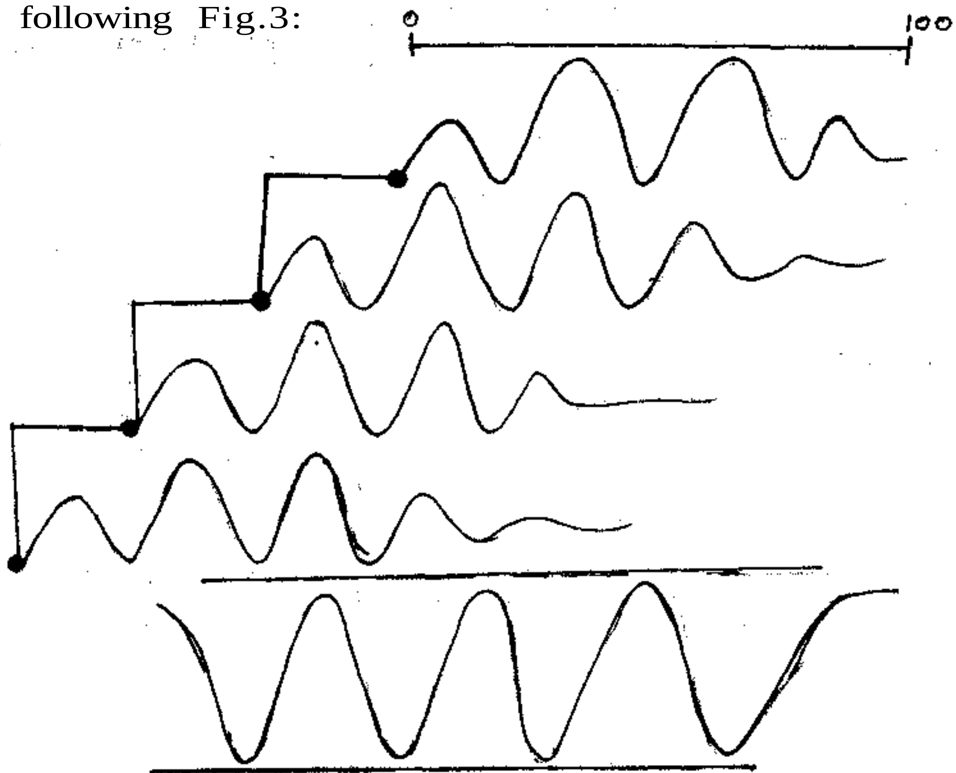



**Fig.3: The derivation of 40 Hz wave form**

This amplitude enhancement gives us a distinct sinusoidal wave form enabling easy identification of peaks. Sammeth and Barry (1985) have obtained variation in response morphology of 40 Hz MLR. Some subjects seem to have showed clear sinusoidal wave forms than others. Mendel and Goldstein (1972) have given latency values for MLR waveform.

$P_o$ - 11.3 msec.

*Na* = 20.8 msec

Pa = 32.4 msec.

$N_b$ = 45.5 msec.

These values were in agreement with Goldstein and Redman (1967). Lane et el. (1971) reported $P_o$ = 10.7 msecs. Na =19.7 msec. $P_a$ = 29.7 msec; $N_b$ = 47.2 msecs. and $P_b$ = 64.0 msec. McFarland, Vivism, Goldstein (1977) say that Pb, Nc, Pc here also been identified but because of narrow band pass used to mcord them, it is difficult to assess their relationship. Swdci, Yasiwhito, Kourucai (1981) reported tha- wave form elicited by tone pips consisted of $P_{10}$, $N_{15}$, $P_{20}$ (P - refers to posotive peak, N - refers to negative and No - represents latency). In a single channel cochlear implant cases electrically evoked NLR amplitude were found to be correlating with behavioural electrical threshold and discomfort levels. The waveform morphology includes the following peak latencies Pa - 26 msec; Pb - 56 msec; Pc - 70-60 msec, but the values are less consistent (Black, Lilly, Fowler, Stypul kowski, 1987).

**Anatomical Origin of MLR:**

The origin of MLR responses is still controversial as to whether it is neurogenic or myogenic in origin. But Majority of authors are towards support of its neurogenic origin. This controversy arose as the latencies coincided with sonomotor response. Two main theories were that the response was myogemic (Bickford et al. 1964; and Mast, 1965). They felt that Pa wave could have resulted from contracton of aural and temporal muscles. This view was changed when MLR response could bo obtained even after muscle paralysis (Horowitz et al. 1966) and was in support of neurogenic response. Ruhm et al (1967) designed a study that recorded MLRs from the scalp and from the exposed cerebral cortex of human objects and found MLRs with similar time, intensity and Morphological characteristics. Therefore the neurogenic basis had its support front other studies also (Celesia et al. 1968; Celesia and Pauletti, 1971). Marker et al (1977), Kilney (1983) recorded reliable MLRs from a suecinyl choline paralysed subject,again documenting the MLR was not myogenic. But care should bo taken as myogenic response could contaminate the neurogenic response especially if reference electrode is placed on the mastoid. (Picton et al.(1974) Davis,(1976) Streleta, et al.(1977) further said that MLR is free of myogenic component during sleep.(streletes et al (1977) Cody, Jakobsen, Walker and Bickford (1964); Code and Townsend (1975) found that inion (myogenic) response could be obtained even when acoustically deaf ear was stimulated, provided vestibular function be intact. Therefore they suggested that myogenic response was dependent on vestibular connections rather than cochlear connections. Hashimoto (1982) has shown by intra cranial recordings from humans that earliest waves of MLR ($P_o$, $N_a$) originate from mid brain region. The later MLR waves Pa, Pb are thought to be generated in the neighbourhood of the primary auditory cortex. Geisker et al. (1958); Picton, Nillyard and Krausz et al. (1974); Davis (1976b) said that earlier components of MLR ie. No, Po, Na might arise from medial geniculate body (MGB) and poly sensory nuclei of the thalamus while later portions of wave forms are found over a wide area of association cortex. Okitzu et al (1977) however said that origin of Po may be different from that of Na and Pa, Aresso et al (1975) in a study dona on rhesus monkey concluded that $P_{12}$ is originated from primary auditory cortex. Other ie. $N_{70}$ , $P_{110}$ and $N_{140}$ arise from other parts of cortex. $P_{12}$ was the only potential which was generated from supra temporal plena. Pa is localised to medial, rostral, midbrain, reticular formation and projection of thalamus, Po to primary auditory cortex (Buchwald et al. 1981).

Brasier (1972): Pieton et al (1974) tested several possible neural generator sources, thalamus and association cortex in frontal parietal and temporal lobes. They rule but significant contribution from primary auditory cortex citings a study by Celesia and Puletti (1971) who failed to detect a temporal correspondence between scalp recorded MLR sequence and responses recorded from the exposed human primary auditory cortex. Kraus et al (1982) suggested a bilateral temporal lobe contribution to the/ Pa component of MLR using a multiple coronal electrode array, the response of Pa was found to be at the level of Sylvien fissure. This was suggestive of a dlpole source to be in the superior temporal plane (Cohen, 1982).

Animal experiments showed a generator site of Pa in the anterior part of contralateral primary auditory cortex and destruction of this abolished or severely reduced Pa wave (Kaga et al 1980). Buchwald et al (1981) claim that Pa was present in cats after hemispherictony but that later MLR waves disappears.

Normal Pa has been seen in cases with temporal lobe lesion (Parving et al. 1980) . Normal Na and Pa were found in bilateral temporal lobe lesions (Kraus et al. 1982). Osdemar ot al (1982) imported that amplitude of MLR is reduced in bilateral temporal lobe lesions, Celesia (1968) gives that moat widely accepted view point is that the primary auditory cortex is the general site of some if not all MLR waves. The thalamus also has some contributions to the waves. But the exact site of origin is still to be confirmed and become an established fact.

**Factors affecting normal response:**

Normal responses parameters are affecting by the type of stimulus, recording procedure, filter band width.

**Type of stimuli:** MLRs advantage in hearing sensitivity is its frequency specificity. Zerlin and Naunton (1974) and Thornton et al (1977) reported an inverse relationship between stimulus frequency and latency of MLR waves.(McFarland et al. (1977) have shown that MLR can be obtained with tone pips of a sufficient duration to provide relatively good frequency specificity. Thus tone pips are obtained by passing a single sinusoidal wave which starts and stops at zero crossings through high and low pass filters. At the same time clicks are best for evoking responses with short latency (EcochG, MLR, action potentials etc.) by virtue of their rapid onset, and they are said to stimulate the entire length of cochlea as they contain wide range of frequencies clicks used for ERA have maximum energy lying between 2-4 KHz. But clicks are not useful in providing frequency specific information. This can be improved by filtering clicks through a high pass and low pass filters to eliminate all frequencies except those within a limited band width. But they cannot be produced at frequencies below 2 KHz.

Maurizi, Ottaviani and Paludette et al. (1984) in a study of MLR wave forms using tone pips and clicks reported tone pips to be more frequency specific than clicks. Po, Na, Pb and Nb showed greater latency but smaller amplitudes for tone pips. This they attributed to a synchrony of response evoked by tone pips.

The amplitude of 40 Hz ERP was almost twice as large as MLR amplitude for clicks and only slightly larger than MLR amplitude for 500 Hz tone bursts (Kilney and Shea, 1986). Galambos et al. (1981) Shallop and 0sterhammel (19853) showed that 40 clicks/sec MLR was 10 dB more sensitive than tone bursts. Galambos et al. (1981) reported that for tone pips with linear rise fall time of 2 m.sec. the amplitude of 40 Hz. MLR decreased as frequency increased, For tone pips with same characteristics as those used by Galambos et al (1981), DawnanseSyfter et al. (1984) reported greater differences between 40 Hz MLR and behavioural audiometric thresholds for low frequency (500 Hz) than high frequency

(1000 Hz) . The amplitude of 40 Hz ERP using clicks was slightly larger than those *evoked* by 500 Hz tone bursts.

Number of stimuli: MLR requires about 400-500 individual stimulus presentations to be summed per response. Vivion, McFarland, Wolf and Goldstein (1975) obtained clear records after presenting just 125 stimuli. Lane, Kupperwan and Goldstein (1974) used 1024 stimuli to obtain a clear average response. Sammeth and Barry (1985) in this study quoted that 1024 sweeps was necessary to obtain response. In a few instances the use of 1024 sweeps appear to degrade a clear response obtain with far few sweeps. It has been reported that if the number of stimuli presented increases, there is . an/increase in the amplitude of the wave form. 40 Hz MLR also requires the same number of stimuli as MLR as it is a derivative of MLR with only an increased repetition rate of 40/sec. This enables quicker testing when compared to MLR. Usually MLR studies uses a rate of 5-10 stimuli/sec to record MLR (Mendel, 1977; McRandle, et al. 1974). MLR conducted at the repetition rate of 40/sec. enhanced the amplitude. Geisler et al (1958) commented that high repetition rates may serve to decrease the amplitude of MLRs

Intensity of stimuli: Decrease ia intensity of acoustic stimulus resulted in a decrease in amplitude and aa increase in latency of MLR waves (Geisler et al. 1958; Goldstein; and Rodman,(1967); Thornton et al. 1977; McFarland, et al 1977). Kilney and Shea (1986) have found that amplitude of 40 Hz MLR decreased and thresholds became elevated. Goldstein and Rodman (1967) also reported that though latencies appeares stable, the peak become less will defined as the stimulus intensity reaches near threshold. At higher intensity levels, the wave form may change quite suddenly and Thornton (1975) has attributed to inclusion of myogenic components. Mendel (1974); Picton, et al. (1977); Goldstein and Roonan (1967) reported that peaks appear as stable as stimuli intensity nears threshold levels. Peak latency increased as frequency decreased and there was a variation in latency with respect to sensation levels in 40 Hs MLR (Sammeth and Barry, 1985).

Rise and fall time and duration of stimulus:

MLR requires fast rise time of stimulus. But a rise time greater than 25 m.sec. was ineffective (skinner and Antinoro, 1969). Thus MLR is also called 'on' response as it depends on onset of stimulus. Lane, Kupperman and Goldstein (1971) used 1000 Hz, 50 dB SL tone burst. Rise tines of 5, 10, 15 and 25 msec. with durations of 20-40 msec.

were used. The results showed that early components were not affected by any combination but later waves showed, amplitude increase when 25m.sec. rise-decay time was used. When

Recording parameters:

Placement of electrodes: Kavanagh and Clark (1991) have reported that ipsilateral mastoid (negative) to vertex (positive) and ipsi lateral mastoid (negative) to high fomhead (positive) both have equal efficacy in recording ABR and MLA in open as well as closed conditions, Mastoid to high forehead array was preferred by several authors (Beatti, Begawalla, Mills and Boyd, 1986: Beatti and Boyd, 1984; Davis and Hirsh, 1979; Suruki Horiuchi et al. 1981). Beatti et al. (1986) say that forehead array results in 34% reduction in response amplitude. It was noticed that mean Po-Na amplitude was larger in forehead electrode array. Mean Na-Pa and Pa- Nb amplitude was larger in vertex array. The amplitude of Nb-Pb was small and ill-defined in both ears. Cohan (1982) and wood and Wolpaw (1982) have reported that maximum evoked amplitude is obtainad on the mid scalp anterior to Cz. Sazuki et al (1981) has reported very little difference. is waveform or magnitude between these two electrodes. Stimulation of VIII nerve to produce electrically evoked MLR can be accomplished via a transtympanic needle electrode placed on promontory (Kilney and Kemick, 1987) rather than a ball electrode on rounded window membrane. (Black, Lilly, Fowler, Stypulkowski, 1987).

Filter Characteristics: The band width of filters which can be used to record MLR is skill debatable. All studies which report of good stable MLR reported using sharp filters (24-48 dB/octave roll off) and narrow filtering bands (ie)less than 100 Hz). Filtering effects on the negative side leads to phase and amplitude distortions (Mandel and Kupperman, 1974). They also suggested that amplitude distortion eaa be used to estimate the threshold while phase distortion serves very little purpose. Digital phase shift filtering does not affect the waveform and latency on a large scale. But analog filtering shows how early activity of MLR is folded onto later components leading to a much longer later activity than what is present. Hence Scherg (1982) does not recommend analog filtering. A latency reduction of S msec between 500 Hz and 4 KHz was seen in 4 awake subjects for 1/3 octave clicks centered at 500 Hz, 1 KHz, 2 KHz and 4 KHz (Zerlin, et al. 1973) With low pass filtering the P wave splits Na trough into Na, and $Na_2$ (Mendel and Kupperman, 1974). Scherg (1982) has demonstrated how steep (high pass) analogue filters can distort the MLR waveform and enhance the later components

(Pb, Pc). Sprague and Thornton (1982) claimed that using wide filter band and modestly sloping filters, MLRs are seldom seen in infants and young children. Suzuki et al. (1933) related that with a 6 dB/octave roll off wide-band digital filter, the later MLR waves (Pb, Nb) were not observable in young children. They said that Pa was present is most of the children and had a latency of 35-50 msec. range at 60 dB HL which was obtained using filter band width of 20-3000 Hz. This latency was considerably longer than latencies obtained by ether investigators who used sharper, narrower filters. Shallop and Osterhammel (1983) used 30-80 Hz band pass filter in their study on 40 Hz/sec. MLR and SN-10 in new borns. A clear sinusoidal peak was obtained with tills filter setting.

Galambos et al. (1981) used band pass filter of 10-100 Hz with 50 msec. time window for 40 Hz MLR. Struzebecher ,Kuhne and Berndt (1985) used filter setting 3O-3KHz with sweep time 20 msec, in detecting 40 Hz response. A change in cut-off frequency from 30-300 Hz causes a reduction in amplitude of 40 Hz MLR..

The first low frequency energy peak of MLR is centered at 10 Hz. This is eliminated in 40 Hz since every waveform in 180° out of phase with every other waveform. Low frequency noise energy which is not time linked to the stimulus will not be diminished. High frequency response energy which is a multiple of 40 Hz will be in phase and hence augumented in the formation of steady state response while other frequencies tend to be cut off. Therefore stimulus rate is important and optical rate may vary between subjects (Kavanagh et al. 1987). These investigators stated 40 Hz response has its main energy centered at 40 Hz. The amplitude of 40 Hz response showed a progressive decrease as the filter cut-off frequency was increased. They recommend the use of minimal high pass analog filtering of 40 Hz, response (less than or equal to 12 dB/octave slope and a cut-off frequency less than or equal to 15 Hz) and a high frequency cut-off to be 100 Hz to measure 40 Hz MLR.

**Monoaural and binaural stimulation:**

Dobie and Norton (1980) found that binaural interaction for MLR is much larger than monoaural response even when elicited by 20-30 dB less intense stimuli. This was contradicted by Peters and Mendel (1974) and Becker and Howe (1982) .Wherein monoaural and binaural clicks of equal loudness yield equal response amplitudes and latency. The difference in the two studies is possibly attributed to the neural mechanism underlying the generation of middle component auditory evoked potential. The early components of MLR have larger amplitudes for binaural stimulation (Kodobayshi et al. 1934). Binaural interaction in cats is recognised for Pa-Na components bat patterns of interaction are variable (Harada, Kawamura, Ichikawa et al. 1984).

<u>Masking:</u> Presentation of contralateral masking stimuli of moderate intensity does not appear to affect component amplitude (Gutnick et al. 1978). The shift is amplitude is ±0.7 dB which is insignificant. The ipsilateral masking noise shows a peak to peak amplitude variation which varies directly with signal to noise ratio (Smith and Goldstein,1973).

There has been no report of masking or binaural and monoaural stimulation in 40 Hz MLR.

<u>Sleep effects:</u> Natural or drug induced sleep had little or no effect on MLR (Wole and Goldstein (1978): Mendel and Goldstein (1971); Mendel (1974); Kupperman and Mendel,(1974). This was contradicted by a study by Brown et al (1982) which indicated that the amplitude of the MLR waves decreased during sleep. The deeper the stage of sleep greater the effect. This was supported by 40 Hz MLR studies, Galambos et al (1981) where response is reduced in all stages of sleep more so in REM sleep. Okitsu (1984) stated that there was a decrease in the appearance of MLR response during sleep. Jones and Baxter

(1988) reported that there is significant difference in latency for sleep and wakefulness stage and also there was marked reduction in amplitude inall stages. In sleep early $N_a$ components and brain stem components contribute to 40 Hz response (Kavanagh, 1987). A study on 40 Hz MLR by Kankunen and Rosenhall (1985) show that 40 Hz MLR was obtained 40 dB higher than the behavioural thresholds obtained from same subjects when they were awake. When the patients tend to fall asleep while testing reduced amplitude was found in subjects and on waiting then up the responses cleared (Sammeth and Barry, 1985). Dauman, Szyfter, Desauvage and Cazals (1984) pointed that during deep sleep the amplitude of 40 Hz-ERP decreased and thresholds became elevated. This was contradicted by a study by Linden, Campbell, Hamel and Picton (1985). They found that while amplitude of 40 Hz ERP was lower during sleep than during wakefulness, there was no significant difference between thresholds estimated during these two states. Schafer and Bowling (1987) report that even if the patient fall asleep while testing this may not affect the ability to obtain responses.

In children, Shallop and Osterhammal (1983) state that 40 Hz MLS is affected by sleep. But they were able to obtain

40 Hz response from new born at low sensation levels. But Kankunen and Rosenhall (1985) and Maurizi et al (1990) state that sleep effect the responses obtained and thresholds are higher than the behavioural thresholds.

Sedation of the subject is also said to affect 40 Hz response (Kavanagh and Domico (1986). A study by Syfter et al (1984) supports that on sedation of subject the threshold of 40 Hz ERP increases approximately by about 15 dB. struzebecner,Kuhne, Berndt (1985) report that sedation improves conditions for detecting a near threshold response. Thus the above studies indicate that effect of sleep is still a controversy and more studies are required to confirm or negate the above reports.

<u>Clinical significance:</u>

The main advantage of MLR is the frequency specific information Which is obtained from MLR among other electrophysiological tests.

<u>Neureotological diagnosis:</u> MLR for this purpose needs an intensity not below 30 dB, is the general agreements MLR can be used as an objective index of cochlear implant function (Gardi, 1985). Indicates different arousal states of the subject (Kilney, 1983; Hall, 1985; Erwin and Buchwald, 1986). 12% of cases with multiple scleresis demonstrate abnormal

latency eventhough ABR responses were normal. These cue the active and quiescent disease states (Ruhm and Rudge, 1978). Significant latency delays but no amplitude abnormalities in response obtained from patients with multiple sclerosis are noted.(Robinson and Rudge, 1977). Harker and Backoff (1931) studied MLR in acoustic neuroma cases, there was a general decrease in latency. Also cases with large tumours showed low false negative responses compared to cases with small tumour. So they say it can be used as a predictive tool in size of tumours. The hearing impaired show a slight increased amplitude and snail reduction in latencies (McFarland, Vivion, Goldstein, 1977). MLR in mentally handicapped also does not show any significant difference in detectability of Na and Pa but ABR has better repeatability (Smith, Reed, Stein et al. 1985).

**Pseudohypacusis**: MLR can be used to detect malingering. In this regard 40 Hz MLR would be highly useful due to less time required.

**Measurement of hearing sensitivity**: A number of early reports on MLR indicated that behavioural thresholds for adults could be closely approximated to MLR thresholds (Lowell, Williams, Ballinger, et al. 1961; Zerlin and Naunton (1974); Thornton, Mendel and Anderson (1977).When several electrophysiologic techniques were compared to behavioural thresholds the best approximation to threshold was achieved by ABR and the next best was that of 40 Hz (Stappels, Picton and Smith, 1984). But on the other hand 40 Hz ERP threshold were not signif i-cantly lower than MLR. It was only less time consuming than MLR (Kilney and Shea, 1987). A study by Sammeth and Barry (1935) shows that 40 Hz ERP was obtained at behavioural thresholds in few instances. Otherwise it was obtained from 5-30 dB above behavioural threshold. The mean diffe-rence between the 40 Hz ERP and behavioural threshold was 9 dB at 500 Hz range (0-20 dB) 10 dB at 1000 $H_z$ (range 0-30 dB) 9dB at 2000 Hz (range 0.15 dB) and 16 dB at 4000 Hz (range 5-25 dB). Sturzebecher, Kuhne and Berndt (1985) were able to detect 40 Hz MLR at the level of 10 dB SPL Klein (1983) reported a mean threshold estimate of 15 dB above the behavioural threshold for frequencies 250-4000 Hz with a range of 0-35 dB SL. Fowler and Swanson (1989) detected 40 Hz potential at 70 dB Pa SPL at 500 Hz, 40 dB Pe SPL at 1500 Hz and 40 dB Pe SPL at 3000 Hz. The 40 Hz evoked poten-tials obtained from a hearing impaired population of cochlear origin is said to have under estimated behavioural thresholds (Lynn et al. 1934). In a recent study done by (Schafer and Bowling, 1937) 40 Hz evoked potential was identified in a population of sensorineural hearing impaired adult males with excellent certainity and reliability within 20 dB of hearing thresholds for 500, 1000 and 2000 Hz respectively and within 10 dB SL for 500 and 1000 Hz (85% to 88%) of the time.

In the new born (Maurizi et al. 1990) found that 40 Hz ERP is 40 dBnHL in new born decreasing to 20 dB nML in older children In a study by Kankunen and Rosenhall (1985) identical thresholds between 40 Hz MLR and puretone thresholds were obtained in 34% of determinations. The MLR thresholds were judged to be lower in 18% and higher in 48% of the determinations than the pure tone thresholds in infants.

Sturzebecher, Kuhne and Berndt (1935) have summarised the clinical utility of 40 Hz response. They say the response shows all essential properties required for objective estimation of hearing threshold :

1. good detectability at hear-threshold level stimulus.
2. short time needed for averaging the response.
3. frequency specificity also in the range below 2 KHz.

Review of literature indicates that 40 Hz MLR has not been explored that extensively as MLR with respect to/ stimulus parameters, sleep effects, age effects on normals and also on hearing impaired population. Any electrophysiological tests main utility is the capacity for prediction of threshold in subjects. We find that studies have been attempted on all populations in MLR but not so in 40 Hz MLR. Therefore this study was taken up to see the efficacy of 40 Hz MLR to measure the hearing sensitivity in geriatrics and also to aote the differences between 40 Hz MLR of adults and geriatrics.

# METHODOLOGY

This topic deals with -

1. Subjects
2. Instrumentation
3. Test environment
4. Stimulus
5. Procedure.

Subjects:

a) 10 subjects with normal hearing sensitivity at 500 Hz and within 40 dB HL at other frequencies above the age of 50 years were selected for the study.

b) 10 adult subjects (18-22 years) with normal hearing sensitivity at all frequencies (ie below 25 dB) were selected to establish norms.

The subjects selected fulfilled the following criteria the information for Which was obtained through case history taking.

1. They should not have had any history of chronic ear discharge; tinnitus, giddiness, earache or any other otological complaints.
2. They should not have had any history of neurological or psychological disorders.
3. They should not be chronic alcoholic ie an addict.
4. They should be able to relax and feel comfortable with electrodes on, within 10-15 minutes after their placement.

5. General health should be adequate for his age.

Instrumentation:

The instruments used were :

a) A 2 channel clinical audiometer (Madsen OB 822) with facilities for air conduction and bone conduction testing, free field testing, speech testing facilities was used. Objective calibration was ensured before the experiment was started. Subjective calibration was done everyday. In this the audiometer was primarily used for air conduction and bone conduction testing. The earphone used along with this instrument for air conduction testing was TDH-50P supra aural earphones enclosed in audiocups.

b) An instrument for electrophysiological testing (Nicolet Compact Auditory System) was used. This equipment uses TDH-39P earphones with supra aural ear cushions. The instrument has the facilities for measuring BSERA, MLR, 40 Hz,ERP; P300 with a variety of stimuli such as tone bursts, logon, clicks. This instrument was used primarily for 40 Hz testing.

Test environment:

Testing was carried out in a sound treated room wherein, the ambient noise levels were within specified limits.


*NICOLET COMPACT AUDITORY SYSTEM*

**STIMULUS:**

The stimulus used was tone bursts with centre frequency at 500 Hz. The rise and decay tine is 4 m.sec with an entime of 2 m.sec. The rate of presentation was 39.1 tone bursts/sec. and the sample was 1000 bursts/4OHz wave form. The impedance of the electrodes were within 25 KΩ.

Procedure:

The test procedure started with eliciting information from the subjects regarding their general health, neurological and psychological problems through case history. On satisfying the requirements of the subject they underwent airconduction and bone conduction testing by using the clinical audiometer. Then the subjects were seated comfortably on a chair, 3 feet away from the console.

Equipment set-up: The instrument was started by inserting programme disks and data disks.

Test selection:

Step-I: From the master mean which had all data, on the test available, 40 Hz evoked potential was selected and then the ear to be tested was selected. Any required parameter changes were dene at this point. For the purpose of recording an amplifier with the sensitivity of 100μ volt was used. A time window of 10 m.sec. with low pass filter at 10 Hz and high pass filter at 100 Hz was used.

Step-II Electrode placement was as follows. (Appendix I)

| Site | Headbox connection |
|---|---|
| Forehead (FPz) | COM |
| Vertex (Cz) | 1+ and 2+ (linked) |
| Left ear (Al) | 1- |
| Right ear (A2) | 2- |

Step-III: After the placement of electrodes, impedance testing was commenced. The impedance value of positive and negative electrode are referenced to common electrode. On obtaining individual electrode impedance within 25KΩ and impedance difference between the electrodes were 3 KΩ of each other. The earphones were placed with the centre of the earphone diaphragm placed directly over the ear canal opening.

Step- IV: Tone bursts were delivered via the earphone and by averaging process the wave fora was displayed. This was started at as intensity of 75 dBnHL and continued for 60 dB, 45 dB, 30 dB, 20 dB, and 10 dBnHL. The delivery of stimulus was stopped at that intensity which could not bring about a clear waveform. Only one ear was tested aid the ear to be tested was selected at random.

Step-V: Once the waveforms were obtained a patient record was created which included details of name, age, relevant history. Then all the waveforms of the subject were stored under their respective record.

Step-VI: Whenever required the patient's data file could be recalled. At a later date the waveforms were recalled and latencies were measured with the use of cursor. Thus latencies for peaks, Na, Pa, Nb, Pb, Nc, Pc were measured and recorded. All the peaks were tagged with '+' mark. A permanent visual recording was obtained by means of a print out.

## RESULTS AND DISCUSSION

The aim of the present study was to determine the nature of the 40 Hz evoked potentials in adults and geriatrics and to compare their waveforms.

40 Hz wave forms weae obtained at seventyfive dBnHL, sixty dBnHL, forty five dBnHL, thirty dBnHL and twenty dBnHL for both the above mentioned groups.

The wave form obtained was sinusoidal in nature. The latencies of each peak of the waveform was measured. Peaks Pa-Na, Pb, Nb, Pc, *Nc* were identified in all waveforms. Latency values were measured by taking the peak point. If the peak was not clearly defined the midpoint was considered. For certain wave forms, double peak was obtained. This is obtained due to the presence of a muscle reflex and is said to disappear on relaxation (Kavanagh, 1937). In such a case latency of the highest peak was considered. If the wave form did not have clear peak or slope or double peak and if it was fuzzy then the peak was not considered for the study.

The latencies were measured for the obtain able peaks for all wave forms and the values were tabulated. The data obtained was statistically analyzed*

Among the 10 geriatric subjects one geriatric subject could not tolerate 75 dBnHL. Hence latency values could not be obtained at that intensity.for that subject.

**Patient: GOWRAMMA** ID:

**Today: 04/87/:** **Birth day: 58**

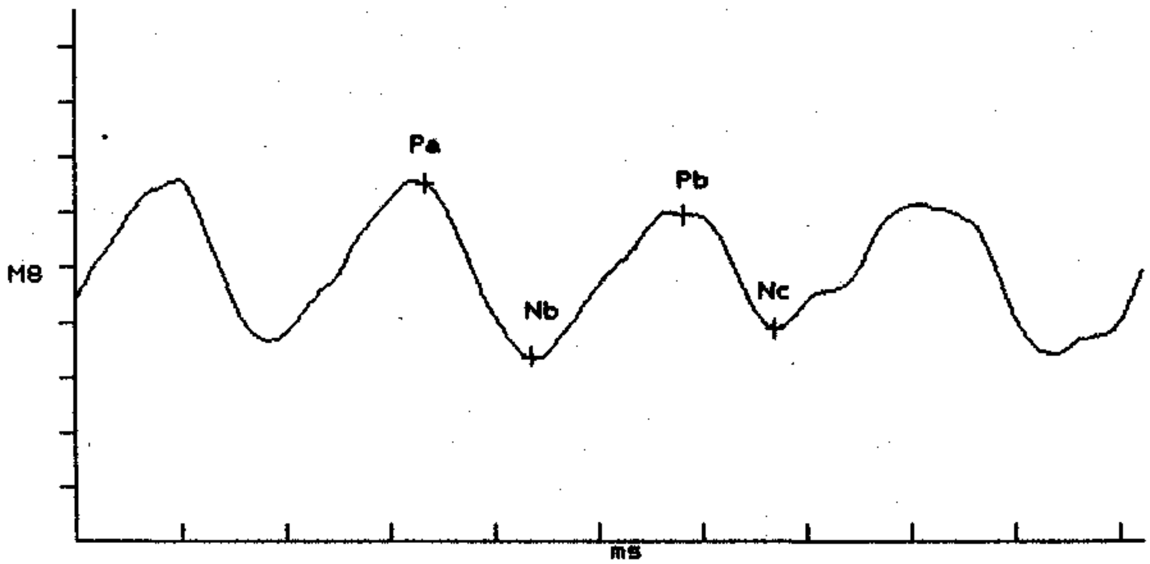
**Case History** **Examiner: 4**

**N**

**N**

**Diagnostics:** **N**

**N**




| | MLR |
|---|---|
| | Time mS |
| Pa | 33.40 |
| Nb | 43.60 |
| Pb | 58.20 |
| Nc | 67.00 |

| N | AMP/DIV | ms/DIV | TESTTIME | REMARK | OFFLINE ROUTINE |
|---|---|---|---|---|---|
| 0 | 0.61 uV | 10.0 | 17:42:0 | | /BLC |

| | ART | | STIM | | AMP | | | AUD LEFT | | | | | | | AUD RIGHT | | | | | | | AUD NOISE | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| N | TIME | SWP | RATE | DUR | SNS | LFF | HFF | TYPE | POL | CAL | LEV | MAN | PLA | FREQ | TYPE | POL | CAL | LEV | MAN | PLA | FREQ | TYPE | DEV | LEV |
| | ms | | /s | us | uV | Hz | Hz | | | | dB | | | | | | | dB | | | | | | dB |
| 8 | 100 | 1000 | 39.1 | 100 | 100 | 10 | 100 | OFF | ALT | nHL | 0 | | | | TONE | ALT | nHL | 75 | 4ms | 2ms | 500 | OFF | OFF | 0 |

*Fig :- 40Hz MLR WAVEFORM OF GERIATRIC*

The mean and standard deviation at each intensity was tabulated. At 75 dBnHL the mean latency obtained was 19.33 m.sec. for geriatrics and 18.33 m.sec for adults. The range of latency values obtained for adults was 16.4 msec. to 24.4 msec. and 17.4 msec. to 22.4 msec. in geristrics,at 75 dBnHL. The above values are in agreement with Goldstein and Hodman (1967) study who obtained a range of 16-30 msec. The mininal intensity level at which clear Na peak was obtained was 30 dB nHL. As the intensity decreased from 75 dBnHL to 30 dB N*HL* nean latencies were found to increase but the difference was not statistically significant.

Statistical measures was used to find out if there is significant difference between latency of adults and geriatrics at 75 dBnHL. It was found that there was no significant difference between the latencies of adults and geriatrics at 75 dB nHL at .05 level of significance.

Table-II: states the latency values of peak Pa at 75 dB nHL, 60 dB nHL, 45 dB nHL and 30 dB nHL and 26 dB nHL. Of the above intensities for only one/adult subject could a Na waveform be obtained at 20 dB nHL end 4 subjects showed a clear wave fora at 20 dB nHL. for geriatrics.

Table-1: Latency values of peak Na for adults and geriatrics.

| | Adults | | | | | Geriatrics | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Intensity in dBnHL | | | | | | | | | |
| | 75 | 60 | 45 | 30 | 20 | 75 | 60 | 40 | 30 | 20 |
| | Latency in Msec. | | | | | | | | | |
| | 23.2 | 23.6 | 24.2 | 25 | - | | 22*2 | 23.2 | 24.6- | |
| | 24.2 | 27.6 | -- | | | 21.4 | 22.8 | 22.2 | -- | |
| | 21 | 21 | -- | | | 18.2 | 25.2 | 27 | -- | |
| | 24.4 | 24.6 | 24.6- | | | 170.6 | 19.2 | 18.4- | | 23.4 |
| | 21 | 21.2 | 24.8- | | | 18.2 | 18.6 | 26.2 | 26.4- | |
| | 17.2 | 18 | - | 18 | - | 19.8 | 20 | 22.6 | 26.8- | |
| | 16.4 | 18.8 | 24.8 | 26.8 | - | 17.4 | 19 | 20.2 | 19.4- | |
| | 22.8 | - | 23.2 | | | 20.2 | 22.8 | 21.4 | 20.8- | |
| | 22.6 | 22.2 | 22.2 | | - | 19.2 | 19 | 18.4 | -- | |
| | 19.4 | 20.4 | 23.4 | 24.4 | - | 22.4 | 24.8 | 26 | -- | |
| . Mean | 18.80 | 21.93 | 23.8 | 23.55 | - | 19.33 | 21.36 | 22.56 | 23.6- | |
| S.D | 3.58 | 2.76 | 0.99 | 3.33 | - | 1.63 | 2.30 | 3.45 | 3.03- | |

Table-1 shows the latency values of the peak na At 75 dB nHL, 60 dB nHL, 45 dB nHL, 30 dB nHL and 20 DB nHL for both adults and geriatrics. na Peak was not obtained at 20 dB nHL for any of the adults subjects and also the geriatric subjects except for one.

MEAN LATENCIES OF PEAK Na

FOR YOUNG ADULTS AND GERIATICS

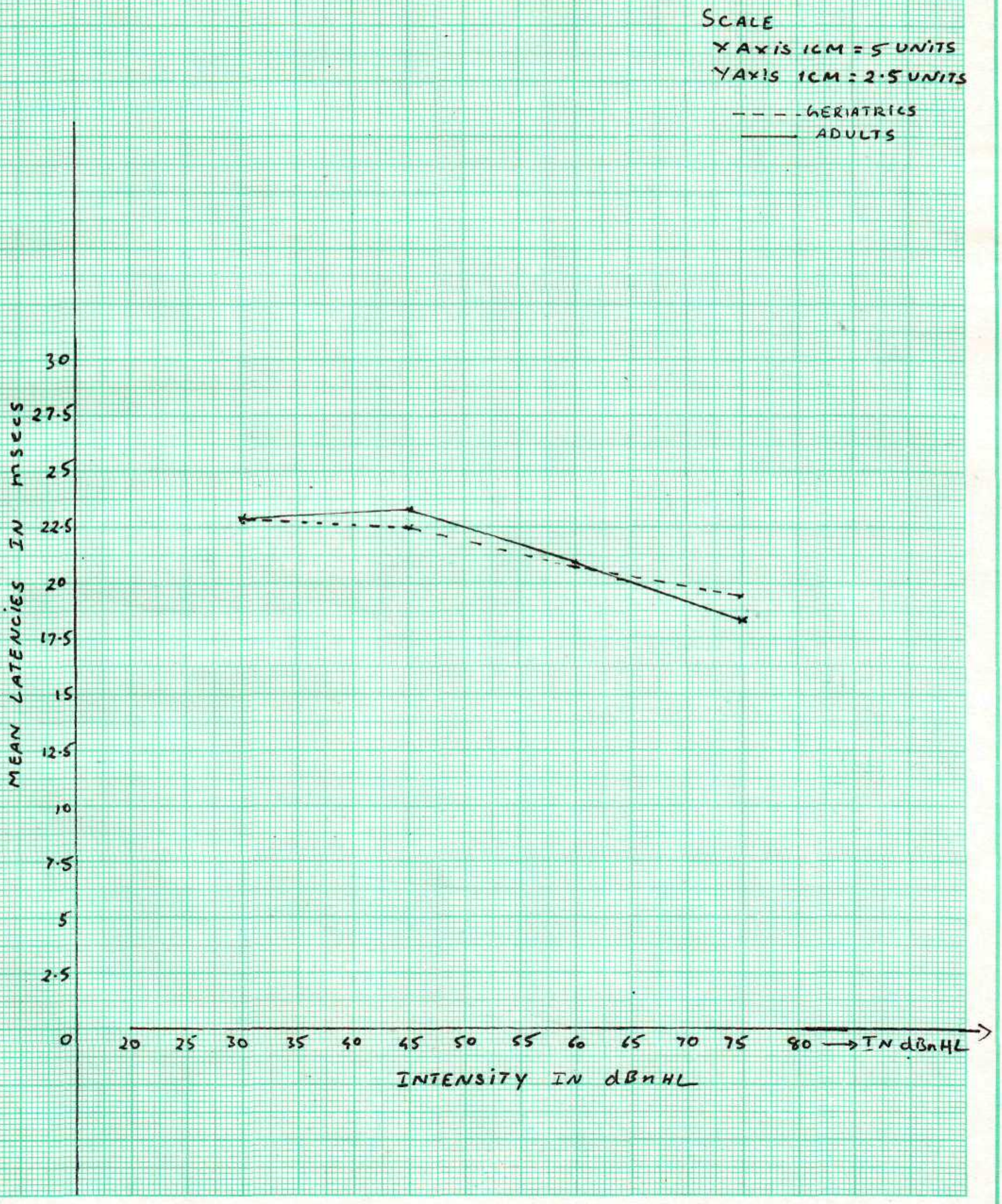


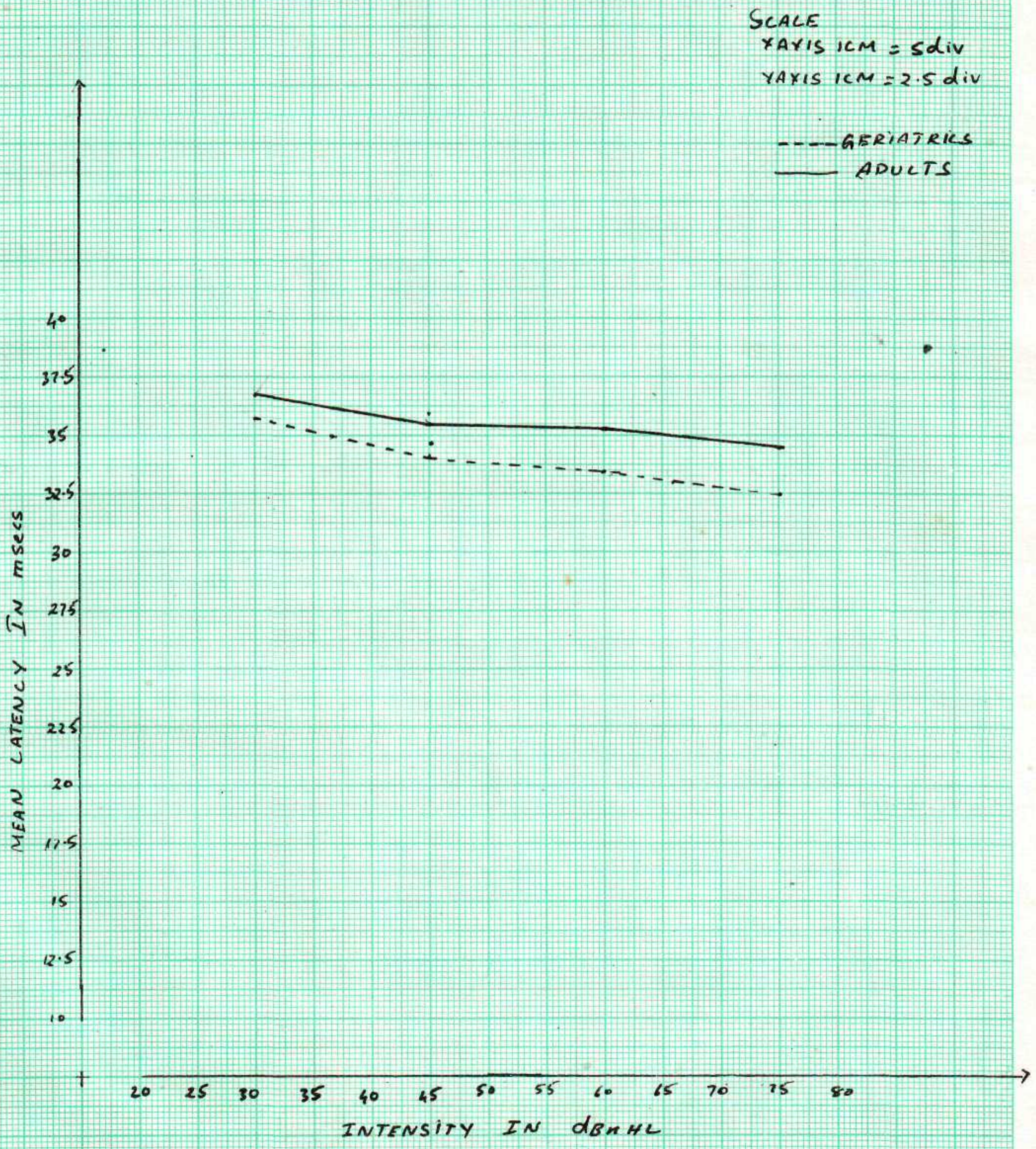
Table-II: Latency values of peak Pa for' adults and geriatrics.

| | Adults | | | | | Geriatrics | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Intensity in dBnHL | | | | | | | | | |
| | 75 | 60 | 45 | 30 | 20 | 75 | 60 | 45 | 30 | 20 |
| | Latency in m.sec. | | | | | | | | | |
| | 35.2 | 35.4 | 35.8 | 36.2 | - | 34 | 34.4 | 34.8 | 36.4 | - |
| | 37.2 | 39.8 | 40.4 | 45.2 | - | 33.8 | 34. | 35.9 | 37.4 | - |
| | 34.4 | 35 | 34.6 | 34.6 | - | 34.8 | 35.8 | 36.6 | 39.8 | - |
| | 35.4 | 35.8 | 36.4 | 36.8 | 37 | 30.8 | 31 | 32.4 | 34.6 | 38.2 |
| | 34.8 | 35.6 | 36.8 | 39.2 | - | 32.4 | 33.4 | 33.8 | 36.8 | - |
| | 31.6 | 31.6 | 32 | 31.4 | - | 32 | 34.6 | 35.2 | 39 | 40.2 |
| | 34.6 | 34.8 | 36.2 | 36.2 | - | 29.6 | 32.4 | - | 33.2 | 33.6 |
| | 34.6 | 35 | 34.6 | 36.2 | - | 31 | 33 | 33 | 33.6 | - |
| | 34.6 | 34.4 | 34.2 | 36.2 | - | 33.4 | 33.2 | 34 | 34 | - |
| | 33 | 35 | 35.8 | 36 | - | - | 33.2 | 35.2 | 36.4 | 38.4 |
| Mean | 34.54 | 35.24 | 35.68 | 36.84 | - | 32.42 | 33.58 | 34.27 | 36.12 | 37.6 |
| S.D. | 1.40 | 1.80 | 2.05 | 3.34 | - | 2.5 | 1.2 | 1.56 | 1.98 | 2.68 |

The mean and standard deviation has been tabulated for all the latency measures at the intensities mentioned above. The mean latencies for Peak Pa obtained at 75 dB nHL was 32.42 m.sec. and 34.54 msec. for adults and geriatrics respectively.. The latency range of peak Pa for adults was 31.6 to 37.2 msec. and for geriatrics was 29.6 to 34.8 msecs. This was in agreement with Goldstein and Rodman (1967)

MEAN LATENCIES Vs INTENSITY OF PEAK Pa

FOR YOUNG ADULTS AND GERIATRICS



range for Pa was 30-45 msec. The minimal intensity at which all the subjects obtained a clear waveform was 30 dB nHL. As the intensities decreased from 75 dB nHLto 35 dB nHL the mean *latencies* was found to increase in both the groups though the difference was not statistically significant /at.50 and .01 level in adults. The statistical measure employed was ANOVA which showed a statistically significant increase in latency as intensity decreased ia geriatrics at .0l level.

Statistical measure employed to detect the significant difference for latency values between the two groups, adults and geriatrics at each intensity level from 75 dB nHL to 30 dB nHL, showed ao statistically significant difference between the two groups at .05 level.

Table-III: Lists the latency values obtained for the peak Nb for both admits and geriatrics at 75 dB nHL, 60 dB nHL, 45 dB nHL aad 30 dB nHL and 20 dB nHL. Among all the subjects only one subject of geriatric group showed a clear wave form at 20 dB nHL. The mean values and standard deviation of latencies at each iatensity 75 dB nHL. 60 dB nHL, 45 dB nHL, 20 *dBnML* were calculated.

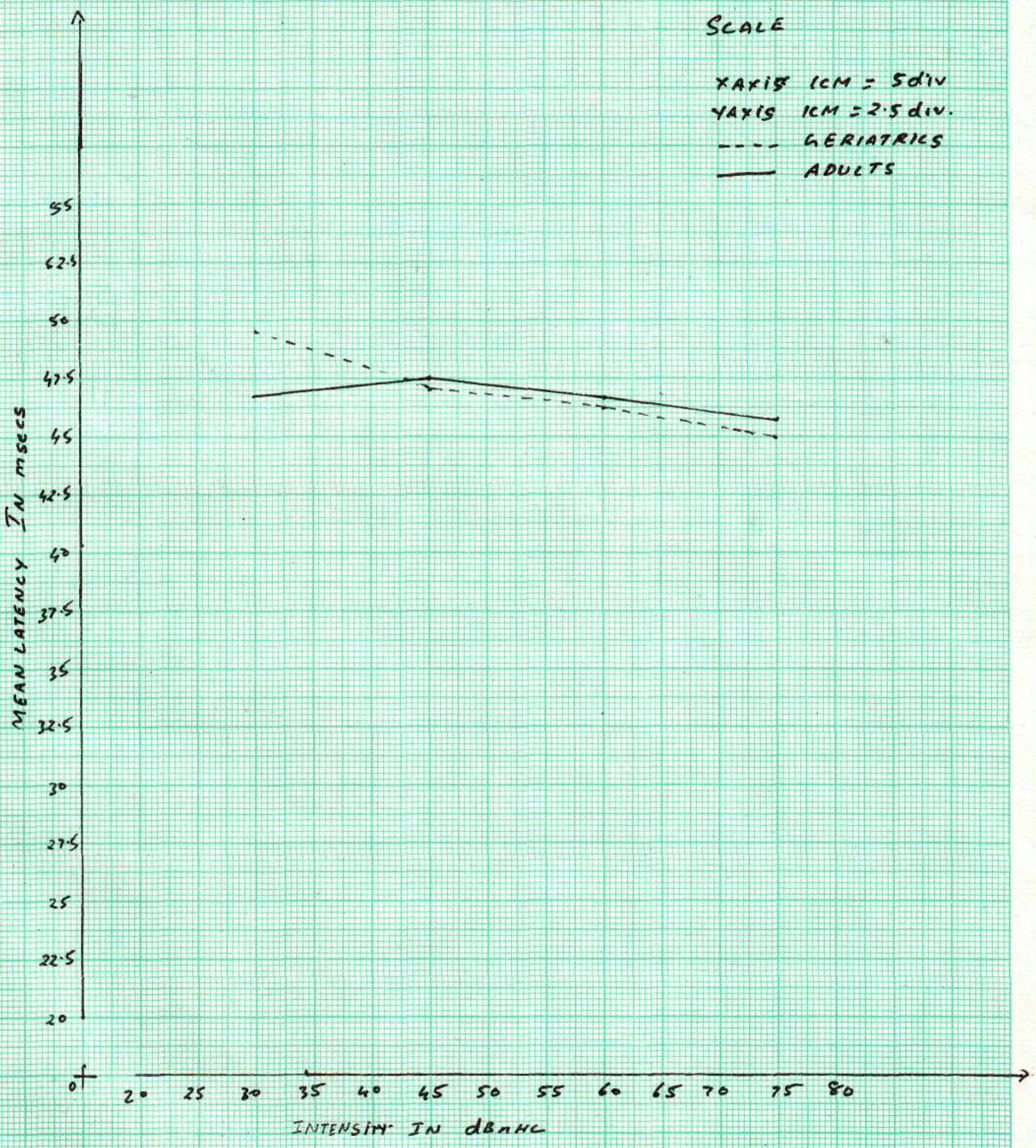
Table-III: Latency values of Peak Nb for adults and geriatrics.

| | Adults | | | | | Geriatrics | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Intensity in dBnHL | | | | | | | | | |
| | 75 | 60 | 45 | 30 | 20 | 75 | 60 | 45 | 30 | 20 |
| | Latency in msec. | | | | | | | | | |
| | 48.2 | 47.8 | 49 | 51.2 | - | 46.8 | 48.6 | 49.4 | 49.6 | - |
| | 48.2 | 49 | 51.6 | - | - | 46 | 46.6 | 47.2 | 48.2 | - |
| | 45.6 | 45.8 | - | 45.8 | - | 49.8 | 50 | 50.6 | 51.8 | - |
| | 49 | 50.4 | - | 51 | - | 42.6 | 43.2 | 44 | - | - |
| | 46.8 | 46.2 | 49.4 | - | - | 44 | 45.2 | 48.6 | 48.6 | - |
| | 42 | 42 | 42.6 | 43.2 | - | 44 | 46 | 45.8 | 50.6 | - |
| | 41.6 | 44.2 | 46.6 | 46 | - | 42.2 | 43.4 | 45.6 | 45 | - |
| | 47.4 | 47.6 | 47.6 | .47 | - | 45.8 | 46 | 47 | - | - |
| | 47.4 | 47.4 | 47.6 | 46.8 | - | 44 | 45.4 | - | 49 | - |
| | 45.2 | 48.2 | 48 | 46.2 | - | - | 46.8 | 49 | 45.4 | 52.2 |
| Mean | 46.14 | 46.86 | 47.8 | 47.15 | - | 44.93 | 46.12 | 47.44 | 49.77 | - |
| S.D. | 2.43 | 2.29 | 2.42 | 2.5 | - | 2.25 | 1.9 | 1.9 | 2.52 | - |

At 75 dB nHL mean latency values for adults was 46.14 msec. and geriatrics was 44.93 msec. which was again in accordance with Mentel and Goldstein (1972) value of 45.5 msec. The range of latency values at 75 dB nHL for adults was 41.6 msec. to 49 msec. and geriatrics was 42.2msec.

MEAN LATENCIES Vs INTENSITY OF PEAK $N_6$

FOR YOUNG ADULTS AND GERIATRICS



to 49.8 msec. This was in agreement with Goldstein and Rodman (1967) data who gave a range of 40-60 msec. The minimal intensity at which a clear peak was obtained for all subjects was 30 dB nHL. As the intensities decreased the latencies was found to increase ia both the groups but the increase in latency was not statistically significant.

At 75 dB nHL on using 't'-test to calculate the significant difference for latencies between adults and geriatrics it was found that there was no significant differeace between the latencies of both groups at 0.05 level .of significance.

Table-IV shows latency values obtained for peak Pb at 75 dB nHL, 60 dB nHL, 45 dB nHL, 30 dB nHL and 20 dB. nHL. At 20 dB nHL only one adult and three geriatric subjects showed a cle ar peak.

At 75 dB nHL mean latency obtained for adults was 59.02 msec. and the range of latencies was 56.6 to 59.6 msec, and for geriatrics mean was 57.8 msec. and range was 55. 2 msec. to 60.6 msec. These values were within the range specified by Goldstein and Rodman (1967) whose values for Peak Pb was 55-80 msec.Statistical significance was not obtained in increase of mean latencies when intensities decreases from

Table-IV: Latency values of Peak Pb for admits and geriatrics.

| | Adults | | | | | Geriatrics | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Intensity in dBnHL | | | | | | | | | |
| | 75 | 60 | 45 | 30 | 20 | 75 | 60 | 45 | 30 | 20 |
| | Latency lit en.sec. | | | | | | | | | |
| | 59.2 | 60 | 60.6 | 61 | - | 60.6 | 59.8 | 60.6 | 59.2 | - |
| | 58.4 | 63.6 | 64.2 | - | - | 58.6 | 60.6 | - | 61.2 | - |
| | 59.4 | 60.2 | 60.2 | 61 | - | 60.4 | 61.2 | 61.2 | 65.6 | - |
| | 61.4 | 61.2 | 61.2 | 62.4 | 64.2 | 56 | 56.8 | 56.6 | 61.4 | 61 |
| | 59.6 | 60.2 | 62.6 | 63.4 | - | 57.8 | 58.2 | 60.4 | 61.4 | - |
| | 56.6 | 57.8 | 56.8 | 57.2 | - | 56.2 | 57.8 | 59.2 | 62.4 | 62.6 |
| | 59 | 60.2 | 61.6 | 62.8 | - | 55.2 | 57.6 | 57.8 | 57.8 | - |
| | 59.2 | - | 60.6 | - | - | 58.2 | 58.4 | 57.6 | 59.2 | -. |
| | *51.8* | 59.6 | 60 | 60.9 | - | 57.8 | 69.6 | 59 | 58.8 | - |
| | 59.6 | 61 | - | - | - | - | 58.2 | 59.8 | 59.6 | 63.2 |
| Mean | 59 .02 | 60.42 | 60.86 | 61.24 | - | 57.8 | 58.82 | 59.13 | 60.64 | 62.26 |
| S.D. | 1.11 | 1.44 | 1.80 | 1.89 | - | 1.76 | 1.33 | 1.39 | 2.08 | 0.92 |

75 dB nHL to 30 dB nHL in both adults and geriatrics. The 30 dB nHL was considered as it was the minimal intensity at which a clear peak was obtained for all subjects.

Statistical measures used for the data to calculate the significant difference between the latencies of admits and geriatrics at 75 dB nHL showed no significance difference at 0.05 level of significance.

MEAN LATENCY Vs INTENSITY OF PEAK $P_6$

Fo YOUNG ADULTS AND GERIATRICS

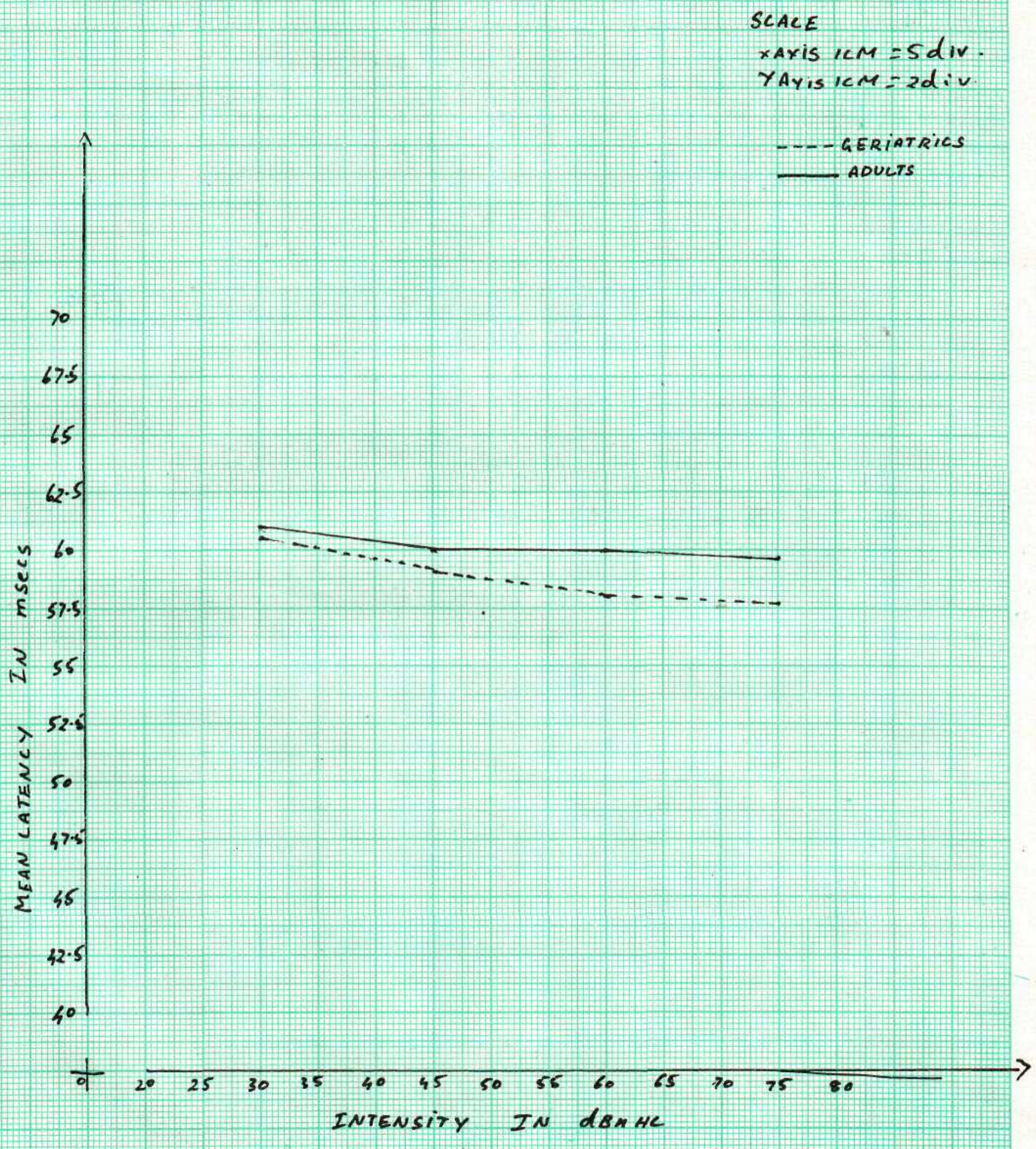
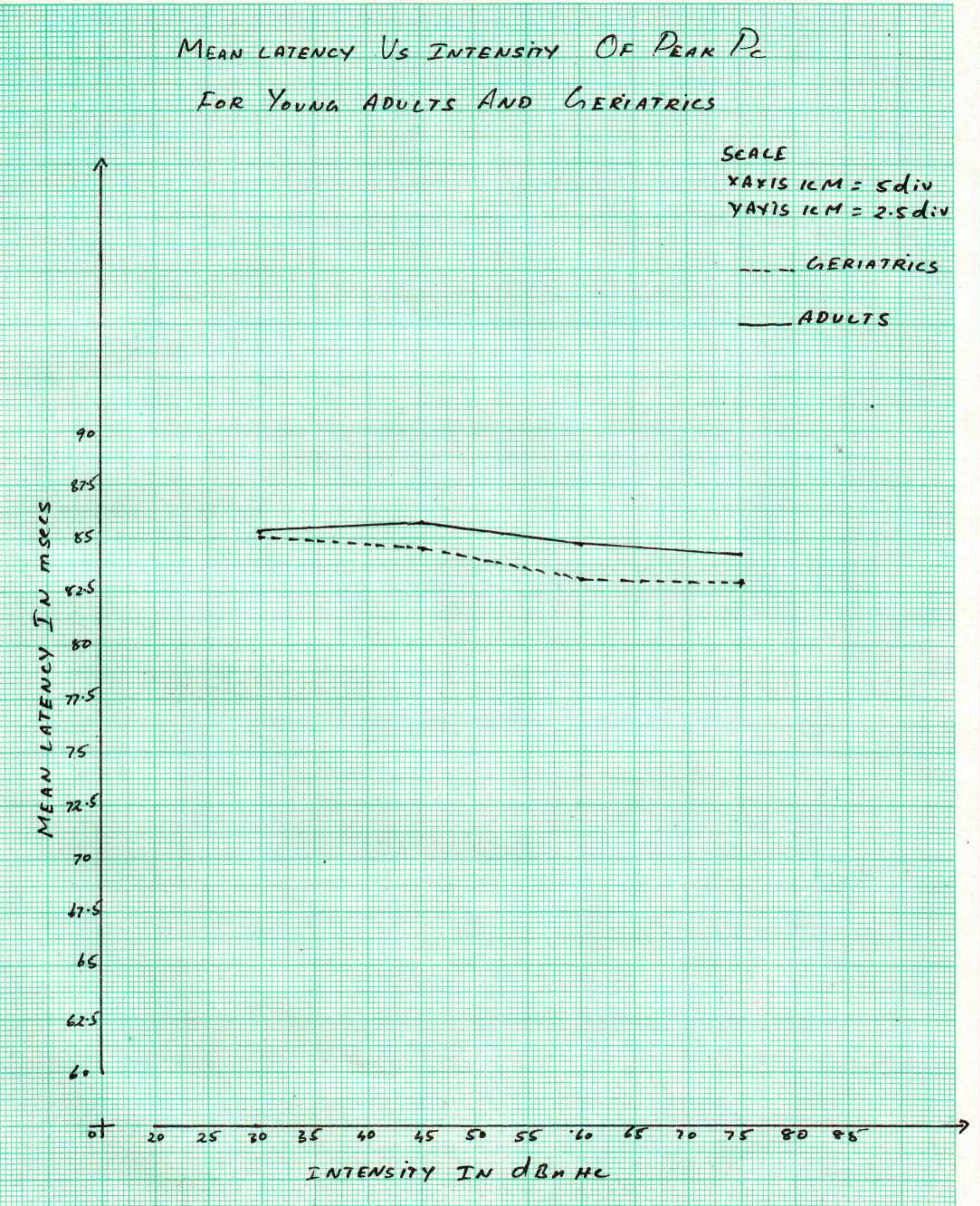


Table-V: Latency value of peak Nc for adults and geriatrics.

| | Adults | | | | | Geriatrics | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Intensity In dBnBL | | | | | | | | | |
| | 75 | 60 | 45 | 30 | 20 | 75 | 60 | 45 | 30 | 20 |
| | Latency in m.sec. | | | | | | | | | |
| | 73.2 | 73.8 | 73.4 | 75.8 | | 69 | 73.8 | 74.8 | 74 | - |
| | 75.2 | 75.6 | - | - | - | 72.6 | 72.4 | - | - | - |
| | 69.8 | 70 | 71.8 | 72.2 | | 71.8 | 75.2 | 76 | 75.4 | - |
| | 73.8 | 74.4 | 74.6- | | 74.2 | 67.8 | 67.8 | 67.8 | 68.4 | 70.4 |
| | 72.2 | 73.6 | 73.8 | - | | 67 | 69.6 | 70.4 | 72 | - |
| | 67.2 | 67 | 68 | 68.8 | | 70.8 | 70.8 | 72.4 | 77 | |
| | 67.6 | 70.4 | 71.4 | 76.6 | | 67.4 | 68.4 | 71 | - | - |
| | 72.2 | 71.4 | 72.2 | 71.8 | | 72 | 72.4 | - | M | - |
| | 72 | 72.8 | 73.4 | 73.6 | | 68.8 | 71.2 | 70.6 | 71.6 | |
| | 76 | 73.2 | - | - | | | 73 | 74 | 74.2 | 74.4 |
| Mean | 71.32 | 72.22 | 72.33 | 73.13 | | 69.68 | 71.46 | 72.12 | 73.22 | 72.2 |
| S.D | 2.45 | 2.45 | 1.92 | 2.60 | | 2.14 | 2.24 | 2.33 | 2.55 | 1.41 |

Table-V: Lists the latency -values of peak Nc at 75 dB nHL, 60 dB nHL,45 dB nHL, 30 dB nHL and 20 dB nHL for 10 subjects of both adults and geriatrics. Except for two geriatric subject and one adult subject no other subjects gave waveform at 20 dB nHL. The mean and the standard deviation valves were calculated at each intensity and tabulated.


MEAN LATENCY VS INTENSITY OF PEAK Pc
FOR YOUNG ADULTS AND GERIATRICS
SCALE
X AXIS 1CM = 5div
Y AXIS 1CM = 2.5div
GERIATRICS
ADULTS
MEAN LATENCY IN msecs
90
87.5
85
82.5
80
77.5
75
72.5
70
67.5
65
62.5
60
0
20
25
30
35
40
45
50
55
60
65
70
75
80
85
INTENSITY IN dBnHL

The mean latency at 75 dB nHL for peak Nc was 71.32 msec. and range was 67.2 to 73.8 msec for adults and mean latency for geriatric was 69.68 and range was 67 msec, to 72.6 msec. McFarland, Vivien, Goldstein (1977) reported that though Kc can be identified it is difficult to assess due to narrow band pass filter used in obtaining MLR. As this study was done with a band pass filter of 10 Hz -100 Hz and a 100 msec, time window is probable that a clear peak of Nc could be obtained. But with the same parameters studies on MLR (Rashmi, 1991; Bhuvana, 1991) on tone bursts and a study on MLR using clicks and tone bursts (Sujatha, 1991) did not show a clear peak of Nc. The peak was not distinct enough to be identified. Therefore, the amplitude advantage of 40 Hz MLR over MLR could have been the contributing factor in eliciting a clear peak of Nc in this study on 40 Hz MLR.

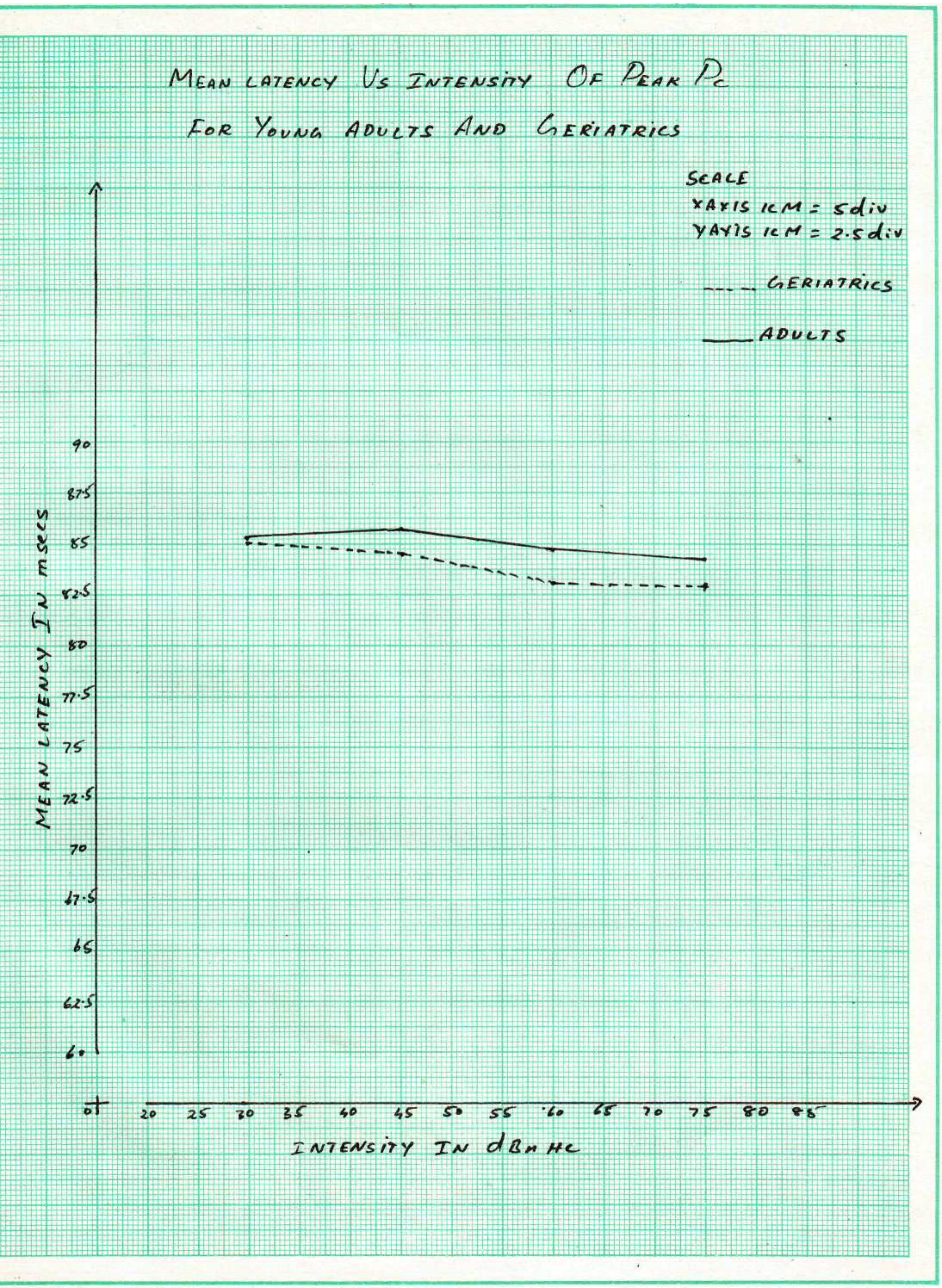
At 75 dB nHL it was found that there was no statistically significant difference between latency values of admits and geriatrics at .05 level of significance. The statistical measure used for the above is t-test.

Table-VI: shows the latency values of peak Pc at 75 dBnHL, 60 dBnHL, 45 dB nHL, 30 dB nHL and 20 dBnHL for both adults and geriatrics, Only two subjects from each group had a peak at 20 dB nHL.

Table-VI: Latency values of peak Pc for adults and geriatrics.

| | Adults | | | | | Geriatrics | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Intensity in dBnHL | | | | | | | | | |
| | 75 | 60 | 45 | 30 | 20 | 75 | 60 | 45 | 36 | 20 |
| | Latency in m.sec. | | | | | | | | | |
| | 85.2 | 85.2 | 85.2 | 86.2 | - | 84.2 | 84.2 | 85.8 | 84.4 | - |
| | 88 | 87.4 | 93 | - | - | 83.8 | 85 | - | 85.8 | - |
| | 84.6 | 84.6 | - | 84.6 | - | 85 | 84.4 | 85.2 | 88 | - |
| | 85.4 | 85.6 | 86.8 | - | 87.2 | 81 | 81 | 80.8 | 82.4 | - |
| | 84.6 | 85.6 | 86.4 | 88.4 | - | 81.8 | 82 | 83.6 | 86 | - |
| | 81.0 | 81.8 | 81.6 | 82.2 | - | 83.8 | 84 | 85.6 | - | - |
| | 83.6 | 86 | 86.4 | 86.4 | - | 80.4 | 82 | 83.8 | 83.4 | - |
| | 83.4 | 84.4 | 84.2 | 85 | - | 83 | 84 | 83.2 | - | - |
| | 83.4 | 84.2 | 84.4 | 84.4 | - | 82.8 | 83.6 | - | - | - |
| | 84.4 | 85 | 85.8 | 87.4 | - | - | 84 | 85.5 | 86 | 88.2 |
| MEAN | 84.38 | 84.98 | 85.97 | 85.57 | | 82.86 | 83.42 | 84.17 | 85.14 | - |
| S.D | 1.76 | 1.38 | 2.90 | 1.8 | | 1.5 | 1.2 | 1.5 | 2.0 | - |

The mean latency value at 75 dBnHL was 84.38 msec, and the range was 81 *msec*, to 88 msec, for adults and mean latency was 82.86 msec, and range was 80.4 to 85 msec, f or geriatrics. MLR studies do not site the presence of Pc waveform or its latency. This McFarland, Vivion and Goldstein (1977) attribute to use of narrow band pass filters used in MLR recording. As 40 Hz MLR


MEAN LATENCY Vs INTENSITY OF PEAK Pc
FOR YOUNG ADULTS AND GERIATRICS
SCALE
X AXIS 1CM = 5 div
Y AXIS 1CM = 2.5 div
GERIATRICS
ADULTS
MEAN LATENCY IN msecs
90
87.5
85
82.5
80
77.5
75
72.5
70
67.5
65
62.5
60
0
20
25
30
35
40
45
50
55
60
65
70
75
80
85
INTENSITY IN dBnHL

uses a 100 msec, time window with band pass filter of 10-100 Hz, as was used in this study it is a possibility that this contributed to the appearance of Pc. But with the same band pass filters, as was used in this study. Sujatha (1991) obtained MLR waveform using clicks and tone bursts in geriatrics, Rashmi (1991) and Bhuvana (1991) obtained MLR waveform using tone bursts in both adults and geriatrics. Their studies did not report of identification of peak Pc. It is a possibility that the amplitude advantage of 40 Hz MLR over other MLR is a main contributing factor for the appearance of Pc.

As the intensities were decreased from 75 dB nHL to 30 dB nHL for a few and to 45 dB nHL for a few subjects there was an increase in mean latency across intensities though the increase was not statistically significance.

Statistical measures(t-test) showed no statistical significant difference at .05 level of significance, between the latency value of adults and geriatrics at 75 dBnHL.

Few subjects of the geriatric groups did not have a clear peak Pc at 30 dBnHL also which was not so in other peaks of 40 Hz MLR.

Table-VII Behavioural thresholds and electrophysiological thresholds of 40 Has MLR in adults.

| | Behavioural | 40 Hz MLR |
|---|---|---|
| 1 | 15 dB | 30 |
| 2 | 20 dB | 30 |
| 3 | 15 dB | 30 |
| 4 | 15 dB | 20 |
| 5 | 15 dB | 30 |
| 6 | 20 dB | 45 |
| 7 | 15 dB | 30 |
| 8 | 5 dB | 30 |
| 9 | 10 dB | 30 |
| 10 | 10 dB | 30 |

The 40 Hz MLR shows a relatively large amplitude and clear peaks which may prove advantages in detecting audiometric thresholds (Bauch, 1982; Brown, Shallop, 1982; Kilney, 1983). Four peaks are clearly evident in a waveform of 40 Has MLR. Among these Pa is the most prominent stable peak (Poulkiney, 1970; Sprague and Thornton et al. 1982). Therefore in this study the minimal intensity at which a clear peak of Pa could be obtained was taken up coapare with the puretone behavioural thresholds. A study by

Schafer and Bowling (1987) shows that 40 Hz MLR can be identified in a population of sensorineural hearing impaired adult males with a reliability within 20 dB of behavioural thresholds for 500, 1000, 2000 Hz and within 10 dB SL for 500, and 1000 Hz (85% to 88%) of the time. Maurizi et al (1990) found that 40 Hz MLR in 40 dB nHL in new born decreasing to 20 dB nHL in older children.

Table-VII shows the pure tone behavioural thresholds and also the minimum intensity at which a clear Pa peak could be identified for adults. Comparision of the Ist column (puretone thresholds) with Had column (the minimum intensity at which clear peak Pa was identified for 40 Hz MLR) showed that 40 Hx MLR was identified anywhere from 5-25 dB nHL above the behavioural threshold in admits is the present study.

Of the 10 subjects two subjects showed 40 Hz MLR at 25 dB SL 4 subjects at 15 dB SL; two subjects at 20 dB SL; one at 10 dB SL and oae at 5 dB SL,

Table-VIII shows puretone behavioural thresholds and also the minimum intensity at which clear Pa peak could be obtained for the 10 geriatric subjects.

Table-VIII: Behavioural thresholds and electrophyslological thresholds for 40 Hz-MLR in geriatrics.

| | Behavioural | 40 Hz MLR(dBnHL) |
|---|---|---|
| 1 | 20 dB | 30 |
| 2. | 10 dB | 30 |
| 3. | 15 dB | 30 |
| 4. | 20 dB | 20 |
| 5. | 15 dB | 30 |
| 6. | 20 dB | 20 |
| 7. | 10 dB | 20 |
| 8. | 25 dB | 30 |
| 9. | 25 dB | 30 |
| 10. | 15 dB | 20 |

On an observation the 40 Hz MLR thresholds were any where from 0 to 20 dB nHL above the puretone behavioural thresholds. Of the 10 subjects one subject obtained 40 Hz MLS at 20 dB SL two subjects at 15 dB SL and 10 dB SL and three subjects at 5 dB SL aad two subjects at 0 dB SL.

## SUMMARY AND CONCLUSION

The present study was carried out to study the waveform patterns and latencies in geriatrics and also its capacity to predict: the behavioural threshold. The above results were compared to adult responses also.

The study was conducted on 10 normal hearing adults (13-25 Years) and 10 geriatrics (50 years - 65 years). Their hearing thresholds were determined using a diagnostic audiometer (Madsen OB 822), These subjects were tested for 40 Hz MLR using Nicolet Compact Auditory System for 500 Hz tone burst. This was carried out in sound treated room. The latencies in msecs. was measured for each 4 peaks of the wareforms at intensities 35, dBnHL,60 dBnHL, 40 dBnHL, 80 dBnHL, and 20 dB nML.

The data was statistically analysed for mean and standard deviation and also significant differences between adults and geriatric values ( latency).

Therefore a comparision was made between admits and geriatrics in teams of 40 Hz MLR and also the threshold estimation, capacity was compared.

The following conclusions may be drawn.

1. The waveform morphology and clarity of peaks remain the same in both young adults and geriatrics.

2. There is an increase in the mean latencies of all the peaks of the waveform as the intensities decreased from 75 dB nHL to 30dB nHL. This increase was not statistically significant in the ease of admits but it was statistically significant in ease of geriatrics for peak Pa. Peak Pa was subjected to maximum statistical analysis as studies quoted it as most stable peak (Kilney, 1970; Sprague and Thornton, 1982).
3. There is no statistically significant difference between the latency values of young adults and geriatrics at 75 dB nHL and at all intensities with reference to the peak Pa.
4. The 40 Hz MLR is obtained with a variation of 5-25 dBnHL above the behavioural threshold in young adult and 0-20 . dB nHL above the behavioural threshold in geriatrics.

Recommendations for further study:

1. This study can be carried out using a different stimuli (clicks) and the variation could be noted.
2. The study can be carried out in larger population to determine its potential for predicting thresholds.
3. studies can be done on infants to enhance early identification procedures.

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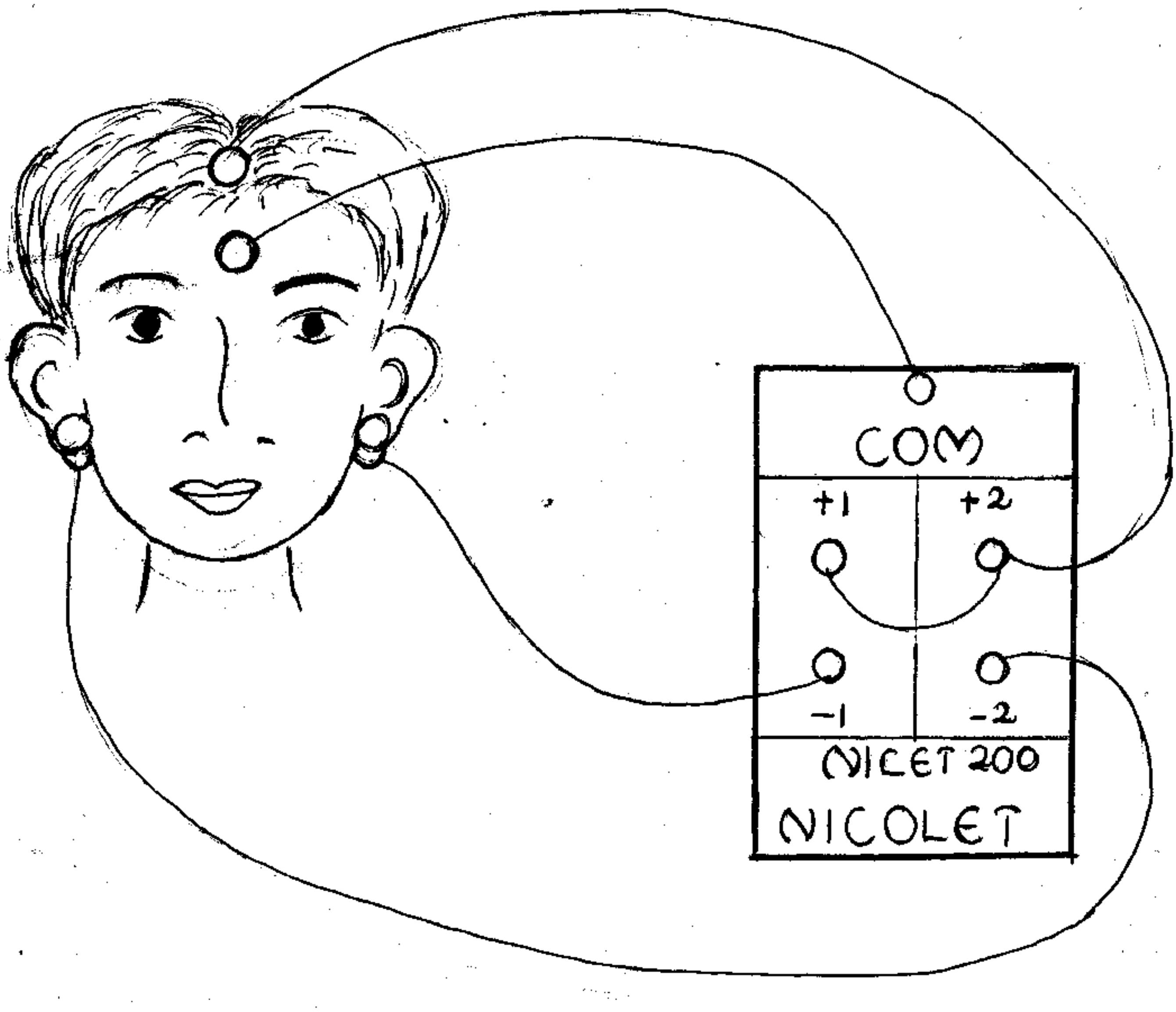
# Appendix.




Electrode placement.