A COMPARATIVE STUDY OF MLR WAVEFORM ELICITED BY TONE BURSTS AND CLICKS IN THE GERIATRICS

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AN INDEPENDENT PROJECT IN PART FULFILMENT FOR THE FIRST YEAR

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THATHA - WHO PROVIDED THE LOVE, STRENGTH
AND SUPPORT SO I COULD BECOME THE PERSON I AM.
I HOPE I HAVE IMBIBED) SOME Of YOUR WISDOM AND
STRENGTH.

JAGAH, WHO HAS GROWN INTO A PERSON WHOM
I LOVE, RESPECT AND ADMIRE.

CERTIFICATE

This is to certify that the Independent Project entitled: "A Comparative Study of MLR Waveforms Elicited by Tone Burst and Clicks in the Geriatrics" is the bonafide work in part fulfilment for M.Sc., in Speech and Hearing, of the student with Reg. No.M9021.

Mysore
1991

Director
All India Institute of
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CERTIFICATE

This is to certify that the Independent Proj ect entitled: "A Comparative Study of MLR Waveforms Elicited by Tone Burst and Clicks in the 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 MLR Waveforms Elicited by Tone Burst and Clicks in the Geriatrics" is the result of my own study undertaken under the guidance of Dr. (Miss) S.Nik am. 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

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INTRODUCTION

Indices of auditory function are many and varied. They range from simple crude tests of hearing such as observing a childs bahaviour in response to the sounds produced by toys, bells and noise makers to very sophisticated computer averaged objective methods of hearing assessment, such as electrical response audiometry (ERA).

Research into audiometric applications of electro-encephalographic(EEG) activity grew out of observations that visible changes in the BBS sometimes results from auditory stimulation (Davis, et al. 1939), These observations were interpreted as indicating that sound was heard. Marcus, Gibbs and Gibbs (1949) were among the first to report of attempts to measure sensitivity of hearing using the Eng. Development of the super imposition technique for averaged evoked responses (Dawson, 1954) led to a large number Of studies in the field of audiology. These studies enhanced oar insight into auditory physiology at the various levels of the nervous system.

One of the first auditory evoked potentials to be discovered was the "middle latency response -(MLR).

Geisler,Frischkopf and Rosenblith (1958) drew attention to a series of waves which occured in the 8-50 m.sec. time domain with an amplitude of 0.5 -3.0 /uv.

The middle latency can be slicited using tonal stimuli (tone pips,tone bursts etc), clicks and logons. It is reported that these responses approximated the behavioural thresholds by 10-30 dB HL (Madell and Goldstein, 1972).

The MLR is usally comprised of 3 positive and 3 negative peaks, which are labelled as No,Po, Na, Pa, Nb, Pb (Goldstein and Rodman, 1967).•

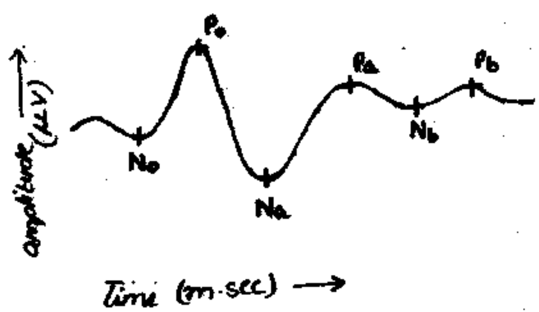


Fig . 1: Middle latency reponse for clicks.

The range of latencies within which the various peaks can be expected are:

No-	8-10	m.sec.	P_o -	10-20 msec.
Na-	16-30	msec.	Pa .	30-45 msec.
Nb-	40-60	msec	P_b -	55-80 msec.

(Goldstein and Rodman, 1967)

Several studies have shown that tonal stimuli five sensitive frequency specific information (Noushegian, Rupert and Stillman, 1973; Kupperman and Mendel, 1974; McFarland et ai. 1977; Thornton, et al.1977). Click stimuli are reported to evoke responses with greater amplitudes changes (Zerlin and Naunton, 1974; Zerlin, Naunton and Mowry, 1973).

Though there is literature on MLR in neonates, infants, children and adults. Until recently no study had been carried out on MLR in the elderly. The study by Lenxi, Chiarelle and Sumbarlaro (1939) reported of increased latency and reduced amplitude in the elderly compared to adults.

MLR has proved useful in threshold detection (Giesler et al. 1958; Goldstein and Rodman, 1967) and as an indicator of integrity of the auditory pathway. It can therefore be included as a part of the neurological test battery.

Statement of problem:

The present study was conducted to examine whether a change in the stimuli used to elicit MLR resulted in a change in the latencies of the waveform in the geriatrics. This study was carried out to answer the following questions.

1. Does change in the stimuli used to elicit MLR bring about a change in the latency of waveforms in the geriatrics?
2. Are there differences in the MLR waveforms obtained from young adults aad geriatrics?
3. How well do the MLRs approximate the behavioural thresholds?

REVIEW OF LITERATURE

The MLR vas one of the first auditory evoked potentials to be discovered. Giesler, Frischkopf and Rosenblith (1958) while studying the auditory evoked potentials observed the occurrence of a series of waves in the 8-50 m.secs time domain. They named these waves as the early waves. Mast (1963) called these the"short latency response". With discovery of the electrocochleography (EcochG) and Brain stem evoked response (BSER), whose latencies are in the 0-10 m.sec. time domain,the"early waves" were renamed "the middle latency response (MLR). (Picton, Hillyard and Krausz et al. 1974; Davis, 1976b) or the "early cortical response"• The letter term- stresses the neurogenic origin of MLR,"

Origin of middle components:

Geisler et al. (1958) on the basis of their study considered middle latency response to have a cortical origin. Bickford, Jacobson and Cody (1964); Bickford, (1972) noted that sound-evoked activity from the scalp muscles had similar latencies. They conclnded that Middle latency response may actually have a myogeaic origin.

Controversy over the neurogenic vs myogenic origin of MLR led to a number of studies in this area. Goff, et a1 (1977) reported that MLR had neurogenic origin at least for low to moderate stimuli. This finding was supported by Goff et a1 (l977): Goldstein and Rodman (1974). Mast (1963- 1965);Picton et al (1977) claimed that middel latency components were of neurogenic origin when electrode was not overlying the inion processe.

Picton et al (1974) reported that the myogenic response had a latency value similar to that of wave P of the neurogenic response. They also reported that the response was highly variable.

Unilateral reflex of post-auricular muscle can be elicited by stimulating the cochlea. Bilateral reflex can be recorded from the mastoid process at the level of the external auditory canal (Yeshi et al. 1969; Douek, et al 1973: Streltz, et al. 1977).

On acoustic stimulation myogenic response has been obtained ia deaf ears (Cody, at al. 1964; Cody and Tomnsend, 1971). This led to the suggestion that myogenic response depends upon vestibular connections rather than cochlear upon vestibular connections. Ruhm and Flanigan (1967) added that there is a cochleoneurogenic response to low intensity and vestibuloneuregenic response to high intensity.

The myogenic response can distort MLR (Davis, 1976b) Picton et a1. 1977). During sleep, middle latency components are uncontaminated by the myogenic response (Streltz, 1977). Picton, et al (1974) reported that contribution of muscle/myogenic response was not significant.

A large number of studies have been carried out on humans (Wood, and Woolpaw, 1952 s Vaughn and Ritter, 1970; Picton, et al 1974; Celesia, 1976, Goff et al. 1977; Cohen, 1982; Ozdamar and Stein,, 1982; Ozdamar et al, ,1982) and on animals, (Arezzo et al 1975; Kaga et al. 1980a; Norman et al. 1981) to determine the area of origin of MLR However, a general consensus is still lacking.

Based upon animal studies an assumption has been made that MLR are of neurogenic origin and are generated in the primary auditory cortex. The primary auditory cortex seems to be the general site of some if not all the middle latency waves (Celesia, 1966).

In pre-operative temporal lobe recording, Ruhm et al (1976) found evidence indicating that temporal lobe is the generating site of the middle component.

Geisler et al (1958; Picton et al (1974); Davis (1976b) said that No, Po, and Na, that is, the early components of MLR arise f rom the medial geniculate body and polysensory nuclei of thalamus, while later portions of the waveforms are found over a wide area of association cortex. Okitzur et al (1977) however said that origin of P_o may be different from that of Na and Pa. Origin of No, Po and Na has been attributed to post synaptic activity frominferior colliculus (Hashimoto, 1982).

Arezzo et al (1975) in a study done on rhesus monkeys concluded that P_{12} originated from the primary auditory cortex, while others - N_{10} ,P_{110} and N_{140} arise from other parts of the cortex. P_{12} was the only potential which was generated from supra temporal plane.

Pa is localised to medial rostral, midbrain, reticular formation and projection of thalamus, Po to primary auditory cortex, by Buchwald et al (1981). Using a multiple coronal electrode array Pa was localised to level of sylvian fissure. This was suggestive of a dipole source in the superior temporal plane (Cohen, 1982). Animal experiments have indicate the anterior part of contralateral primary auditory cortex as the generator site of Pa (Kaga et al. 1980a).

Uchida, et al. (1979) reported that Na originated from centralateral medial geniculate body while Pa is a compound response from a wide area. They concluded that MLR was generated at upper level of superior colliculus. Davis and Hirsch(1979) suggested that N_{15} may represent the electrical output of dendrites and cell bodies in the grey natter of one or more of the brain stem nuclei of the auditory system. Pacioretti, et al. (1987) said that amplitude of Na and N_o are evenly distributed across the surface of the head.

Results obtained in cases with temporal lobe lesions have been mixed. Parving et al (1980) reported of normal Pa in bilateral temporal lobe lesions. Kraus et al (1982) report of normal Na and Pa in unilateral temporal lobe lesion cases. Ozdamar et al (1982) however reported of absence of Pa in bilateral temporal lobe lesions.

There is a general agreement that middle evoked potential components reflect activation of the cerbral.

cortex and the thalamus. However, there is no consensus to the precise origins of waves P_{10}, N_{15} and P_{20} (Rowe, 1981).

Middle larency response waveform morphology:

The MLR waveform is seen to consist of 5 major peaks - 2 positive and 3 negative peaks (Goldstein and Rodman, 1967). These peaks are labelled as No, Po , Na ,Pa and Nb a sixth peak - Pb may also be obtained.

Latency values as given by different investigators are given below:

Researchers	Year	No	Po	Na	Pa	Nb	Pb (in msec).
Goldstein & Rodman	1967	8-10	10-13	16-30	30-55	40-60	55-80
Mendel & Goldstein	1972	-	11.3	20.8	32.4	45.5	-
Lane, et al	1974		10.7	19.7	29.7	47.2	64.0

Suzuki et al (1981) reported that waveforms elicited by tone pips consisted of P_{10}, N_{15} and P_{20} (Within 0-25 msec).

Studies on animals have shown that MLR can be elicited ia animals also. MLR evoked from vertex of anaesthetized rats showed presence of 2 positive peaks which unified at 30 msecs. with increasing age, and presnce of 2 negative peaks (Iwasa and Potsic, 1982).

In cats the MLR was seea to consist of 2 positive and 2 negative peaks. The latencies of these peaks fell within 20-50 msec, time domain (Walsh et al 1986, a & b). Kraus et al (1985b) obtained a negative component at 7-13 msec, latency and a positive component of 25-35 m sec.in 6 months old orangutangs 0.15 months old macaguils. In adult gerbils the middle component obtained from centralateral temporal lobe showed 2 positive and 1 negative peak (Kraus et al (1987a). They further said that wave B appeared first followed by wave C in young gerbils.

Black et al (1987) carried out a study of MLR in a cochlear implant eases. He reported that electrical MLR amplitudes in this case,with a single channel cochlear implant,correlated with behavioural electrical threshold and discomfrt levels. The waveform morphology showed t P_a - 26 msec, P_b - 56 msec, P_c - 70-8Omsec. However, these responses were not consistent.

Mendelson and Salamy (1981) reported that latency of P_b was shorter than P_b but longer than reported by other researchers. The differences in latency reported by various researchers may be a result of brief duration of stimuli or wide band pass filters or a combination of both.

Stimuli parmeters afecting MLR:

Type of stimuli - The differ eat stimuli that can be used to elict MLR are:

Clicks - Clicks are electrical and acoustical waveforms having rapid onset times. They stimulate the entire length of the cochlea as they contain a wide range of frequencies. Clicks used for evoked response audiometry, however, have maximum energy between 2-4 KHz. Because of their rapid onset they are best used for evoking responses with short latency , Eg. Action potentials, EcochG, MLR etc. Disadvantage of using clicks is that they do not provide frequency specific information.

Filtered clicks - Filtered clicks are obtained by passing clicks through a high pass and a low pass filter to eliminate all frequencies except those within a limited bandwidth. They have fast rise time bat cannot be produced at frequencies below 2 KHz.

Tone burst - Tone burst when used for evoked response audiometry usually have a rise-fall time of 2-3 msec, and a duration of 2 msec. Duration varies with frequency of tone burst. The spread of energy is approximately 1 octave in tone burst. Tone burst are useful in eliciting cortical responses and middle components. Chief advantage is their ability to provide frequency specific information.

Tone Pips - Tone pips are obtained by passing a single sinusoidal wave which starts and stops at zero crossings, through high and low pass filters. It is also a good stimuli for obtaining frequency specific information.

Logan - These stimuli are derived from Gabson' s (1947) concept of acoustic quantum. Basically it is a sine wave modulated by a Gausian probability pulse.

The initial studies of MLR were carried out using clicks age stimuli. Zerlin et al (1971) adversed the use of l/3rd octave filter clicks. They reported that filtered clicks elicited clearer waveforms than tone bursts.

Kupperman and Mendel (1974) preferred use of gated tone bursts with a rise time of 2.5 msec. and a duration of 2msec. Using either of these stimuli, that is, filtered click, or gated tone bursts, it was possible to obtain frequency specific stimuli in the range of 500-800 Hz.

It is difficult to produce stimuli which are frequency specific at lower frequencies without loosing the fast rise-time necessary to evoke early responses.

Maurize et al (1984) compared MLR waveforms of tone pips and clicks. They tested 20 normal subjects in 26-32 years age range. The results indicated that tone pips provided more frequency specificity than clicks, pa,Na, Pa and Nb, showed greater latency but smaller amplitude for tone pips. This they attributed to asynchrony of response evoked by tone pips.

Zerlin and Naunton (1974): Zerlin, et al (1973); have reported that clicks evoke greater amplitude changes compared to tone burst. Kilney and Shea (1986) found that clicks evoked well defined and easily identifiable MLR. Also the amplitude of Na and Pa were larger than when tone bursts were used.

Tonal stimuli are found to give frequency specific responses compared to clicks (Moushegian, et al 1973; Kupperman and Mendel, 1974; McFarland, et al 1977; Thomson et al. 1977). Low frequency tone bursts are found effective in obtaining response from adults who are awake (Museik and Geurkink, 1981).

Tonal stimuli is preferred over clicks when frequency specific information is sought.

MLR can also be obtained using electrical stimulation. Electrical stimulation can be accomplished via a trans-tympanic needle electrode placed on the premontary (Kilney and Kemink, 1987) or a ball electrode on the round window membrane (Black et al 1987). Burton, et al (1989) reported of no significant differences between latencies of electrically and acaustically evoked waveforms in guinea pigs. In profounndly deaf ears MLR has been elicited using electrical stimulation. Latency of the most prominent peak obtained was 26-30 msec. (Kemink, et al. 1989).

Number of stimuli:

MLR requires around 400-500 individual stimuli presentations per response to be summed. An averaged response can be obtained if 200-400 stimuli are given (Horowitz, et al 1966). Vivion et al (1975) obtained clear recordings after presentation of just 125 stimuli. Lane, et al (1974) used 1024 stimuli to obtain a clear averaged response. A few investigators have used upto 2000 stimuli presentations per MLR waveform. As the number of stimuli presented increases there is an increase in the amplitude of the waveform and the response smoothens out.

Repetition rate :Mendel (1973) has reported that a change in repetition rate has little effect on the amplitude of the response. A change in repetition rate from 1-16 stimuli per second has no effect on middle latency response amplitudes (McFarland et al (1975). However, when repetition rate is increased beyond 16/sec. a reduction in the overall amplitude may be seen (Goldstein, etal(1972); McFarland, et al(1979). When clicks rates were reduced from 1/63 second to 1/100 sec, amplitude increased. When repetition rate was slower than 10/sec amplitude did not increase (Lowell et al, 1960).

McRandle et al (1974) reported that a repetition rate of 4.5/second and 256 stimuli was enough to evoke a clear middle component waveform. For 512 stimuli a repetition rate of 9/sec. was required.

Jerger et el (1987) reported that MLR may undergo rapid adaptation sad augmentation at rates of 1/sec and 2.5/sec.

Most studies have used repetition rates of 9/sec. (Mendel, 1977). Mendel (1976) has suggested use of 10/sec for clinical purposes.

Galambose et al (1981) used a slightly different procedure to obtain MLR for low frequency stimuli. They presented tone pips at a rate of 40/sec/. This procedure has popularly become known AS THE 40 Hz evoked potential. Presentation of stimuli at such a high rate results in overlapping of the responses of succesive stimuli. We obtain a periodic response which has a constant phase relationship with the repeating stimuli. The resultant recording is of a sinusoidal waveform which approximates a 40Hz sinusoid and is composed of energy from both the auditory brain stem response and middle latency component, Morae so of the latter.

Amplitude of 40 Hz AEP are almost twice as large as the amplitude for waves of MLR elicited using clicks and only slightly larger for waves elicited using tone bursts (Kalney and Shea, 1986).

40 Hz potentials are a viable procedure for threshold estimation.

Intensity of stimuli:

Amplitude - intensity function-As the stimulus intensity increases, amplitude of the MLR waves increases (Goldstein and Rodman, 1967; Mendel 1974; Thornton, at al 1974; Picton etal. 1977). Ozdamar and Kraus (1983) reported that amplitudes of middle component levles off at about 50-60 dB.

Goldstein and Rodmen (1967) found that though the latencies appeared stable the peaks become less well defined as the stimulus intensity reached threshold. Kupperman and Mendel (1974) reported of absence of systamatic growth in amplitude with an increases in intensity of tone pips.

At higher intensity levels, the waveform may change suddenly. Thernton (1975) has attributed this to inclusion of myogenic components.

-Latency- intensity function-With increase in intensity latency decreases slightly upto moderate levels (Mendel, 1974). Picton et al. (1977) ; Goldstein and Rodman, (1967) reported that the peaks appeared stable as stimuli intensity neared threshold level.

<u>Stimlus frequency:</u> Latency for the peaks reduce with increase in stimuli frequency (Thornton, Mendel and Anderson (1977). Further, linear changes la amplitude are noted for early peaks with increase in stimulus frequency. Kupperman (1970) demonstrated that the middle component was more dependent on the stimulus than the stimulus frequency.

<u>Rise-fall time and duration:</u> MLR is considered an"onset" response, ie it depends upon the onset of stimulus. Use of faster rise time gives more consistent and clearer response. Skinner and Antinoro (1971) found that rise time greater than 25 m.sec. did not produce suitable response.

clicks have a faster rise time than tone pips or tone burst. They elicit waveforms which have larger amplitudes (Zerlin et al. 1973; Zerlin and Naunton, 1974)

There is no effect on MLR waveform with change in decay time as it is a 'on' response.

Kupperman and Goldstein (1974) used a 1000 Hz tone burst at 50 dB SL. Rise time used by them were - 5, 10, 15 and 25 m.secs. Durations were 20-40 msec. Early components of MLR were not affected but later waves showed an increase in amplitude when 25 m.sec. rise-decay time was used.

An increase in rise decay time or equivalent duration results in increase of latency by 1-3 msec,for *all peaks* and an overall reduction in amplitude at a11 intensity levels (Weber et al 1982).

Kupperman (1970); Skinner and Antinoro (1971) found no consistent change in MLR as duration of stimuli was varied from 1.5 msec. - 4.0 msec.

Recording parameter:

- Filter characteristics - Lane, et al (1974) found that filtering lead to distortions of MLR waveform in terms of phase and amplitude. They suggested that amplitude distortion could be used to estimate threshold.

Most studies have the low f requency end set at 20-30 Hz and high frequency end set at 100-250 Hz.

Power spectral analysis and digital filtration of MLR shows frequency components located in 30-50 Hz range. If activity is present below 30 Hz, detection of Na and P_a is difficult. If a high pass filter is used then Na, Pa,Nb and a positive peakat 60-70 msec, latency can be recognised. If high pass filter is set at 40 Hz, positive peak disappears and Nb is followed by 2 positive peaks at 50-55 m.sec.latency and 80-85 m.sec. after onset of stimuli (Susuki, 1982).

Mendel (1977) reported that latency of individual peak, are prolonged by reducing low pass filter setting.

He recommends use of a band pass filter of 25-175 Hz. with a slope of 6 dB/octave.

A latency reduction of 5 m.secs between 500 Hz and 4000 HZ was noticed in 4 subjects who were awake, for 1/3 octave clicks centred at 500 Hz, 1000 Hz, 2000 Hz and 4000 Hz (Zerlin, et al 1974). Mendel and Kupperman (1974) observed that with low pass filtering the P wave splits Na trough into N_{a1} and N_{a2}. P wave corresponds to SN_{10} (Kavanagh, 1979).

Large portions of MLR energy is produced by phase shifting the response energy from other portions of time bases (Izumi, 1980, Scherg and Volk, 1983). Phase shift reduces amplitudes of wave P_o-N_a complex with augmentstion of MLR waveforms P_a and P_b . But peak P_b can be noticed only on analog filtering and not on digital filtering (Kavanagh and Domico, 1987; Suzuki et al. 1989). scherg (1982) in his study said that digital phase shift filtering did not affect the waveform and latency a lot. Use of analog filtering however led to a much later latency activity than what is present physiologically. He therefore advises against use of analog filtering.

Using lowpass filtering with a cut off frequency of 100Hz, Po has a latency of 11.7 msec. If open recording filter is used, Po shows a reduction in latency and will be recorded in ABR time domain (Kavanagh,and Domico, 1987).

Barajas, et al (1985) said that use of different filter settings did not result in difference in threshould.

Electrode placement: Basically there are 2 kinds of electrode arrays - ipsilateral mastoid (-) to vertex (+) and ipsilateral mastoid (-) to high forehead (+) • Kavanagh and Clark (1989) found that both arrays have equal efficacy in recording ABR and MLR in open as well as closed filter conditions.

Beattie et al (1986) reported that forehead placement resulted in 34% reduction la the MLR amplitude. Mean Po-Na amplitude was larger ia forehead electrode array. While mean Na-Pa and Pa-Nb amplitude was larger ia vertex array. The amplitude of Nb-Pb was small and ill defined for both arrays however.

Cohen (1982): Wood and Woolpaw (1982) reported that maximum amplitude was obtained on the midscalp. While difference between the 2 placements in terms of magnitude and morphology.

Mastoid to high forehead array has been preferred by several investigators - Davis and Hirsh (1979);Susuki,1981 Beattie and Boyd (1984); Hall et al. 1984; Baattie, et al /1986.

Forehead placement is preferred because-

- it eliminates placement of electrode get and adhesive on the hair.
- it moves electrode away from earphone head band,which can cause discomfort and dislodgement of electrode.
- allows easy achievement of low electrode impedance.

<u>Masking</u> - Goldstein et al (1978) reported of no significant effect on amplitude of MLR components when masking stimuli of moderate intensity was presented contralaterally. Ipsilateral masking noise brings about a peak to peak amplitude variation which varies directly with signal to noise (S/N) ratio (Smith and Goldstein, 1973).

<u>Monoaural vs. binaural stimulation</u> - Mendel and Peters (1974) reported that MLR wereform obtained using monoaural and binaural clicks of equal loudness had similar amplitude and latency. Denker and Howe (l982) supported this finding.

Early components of MLR have larger amplitude for biaural stimulation (Kodobayashi et al. 1984). Under binaural stimulatio when intensity of presentation is aore than 70 dB nHL a reduction in amplitude is noticed (Dobie and Morton, 1980). Latency differences can also be seen (Wolf and Goldstein, 1978).

In cats binaural stimulation caa be recognised within 20 m, sec. time domain. For humans the interaction is noticed for Pa-Na component, but patterns of interaction are variable (Narada, et al 1982).

Subject parameters

Subject attention - MLR waveforms are essentially unchanged with change in degree of attention given to stimuli. No changes are observed in MLR waveform when patient is reading, sitting and eyes closed, sitting with eyes open, etc. (Mendel and Golstein, 1971; Mendel and Kapperman, 1974; Pictor, Hillyard,1974).

Muscle tone - Gibson (1978) reported of the effect of muscle tone on MLR. Mast (1965) reported that parietal MLR was not altered by head movements.

No change has been reported in waveform configuration, latency and amplitude for temporarily induced muscle paralysis (Marker, et al. 1977). Complete anaesthesia is reported to eliminate MLR (Goff, et al 1977).

Meadel and Goldstein (1969 a) claimed that MLR was a sensitive indicator of increases stress. This observation was based on increased latency and reduced amplitude as a result of conditions such as hypoxia, hyperventilation and body acceleration through space.

Subject state of consciousness: - Light sedation has been found to hare little effect on MLR (Mendel and Goldstein, 1969a; Kupperman, Mendel, 1974; Mendel and Hosick, 1975; Mendel, et al. 1977).

Ho change is noticed in the middle components in terns of amplitude or latency after medication (Mendel and Goldstein, 1969: Goldstein et al l972; Thornton and Mendel, 1974).

Amplitude of P_b and P_c are reduced during sleep (Brown end Shallop, 1982). During wakefulness N_{a2} - can toe obserred. During sleep N_{a1} one of the double peaks of N_a is noticed.

MLR is fairly stable during early stages of sleep (Mendel and Hosick, 1975). As sleep deepends latencies

of all peaks excepts Po gradually increase and amplitude reduces- Deep sleep effects childrens waveforms more than adults waveform (Okitsu, Shibhara, 1981). MLR threshold was 40 dB higher in children who were asleep than whan they were awake (Kankumen and Rosenhal, 1985).

Mendel and Goldstein (1971) reported that latencies of major peaks remain constant across different stages of sleep. Amplitude was larger during stage 1 and 2 of REM sleep than during stages 3 and 4.

P_a can easily be detected when subject is awake and in stage 1 of sleep. During stage 4 detectability of Pa is poor (Kraus et al. 1985).

Subjects age - Differences have been documented between the MLR wavefoms of neonates, inf ants, children and adults.

Engel (1971); Davis, et al (1974); Skinner and Glattke (1977) reported that it was difficult to obtain reasonably clear waveforms in neonates. Mendel et al. (1976)were able to estimate thresholds in only one of the 28 infants they studied (1 Month 2 years) using MLR, Rotteveal, et al (1986a) howerer reported that they were able to identify P_o, N_a and P_a peaks in MLR waveform obtained from 64 premature infants as early as 25 weaks (CA).

Based on these findings they concluded that the auditory pathway had attained functioning structure early. They also noticed significant changes in latency and amplitude, before and after term date,

Attempts to obtain normative data for new borns and infants have been made by Engel (l972); McRandle et al. (1974); Mendel (1977):/Goldstein (1978); Wolf and and Ozdamar and Kraus (1983).

MLR waveforms in adults and young children are reported to be stable and insensitive to changes in state of vigilance and age (Mendel, 1980 and 1982; Goldstein and Madell, 1972).

Significant differences have been noted between adult and infant MLR waveforms (Mendel, 1977). significant reduction in P_o was noticed in infants by Mendel son and Salamy (1981).

Very little difference is there between adult and infant MLR waveform Morphology as a function of intensity and rate of presentation (McRandle, Smith et al,1974; McRandle and Goldstein, 1974; Mendel and Adkinson, and Harker, 1977; Frye-Osier, Goldstein, et al. 1982).

Neonates, however, exhibit shorter latency and smaller amplitudes than adults, with no signif i-cant activity beyond 60 msec. Also la both groups ipsilateral stimulation evoked clearer and more well defined waveforms compared to contralateral stimulation (Goldstein and McRandle, 1976; Mendel and Adkinson et al. 1977;Wolf and Goldstein, 1978 and 1980). In neonates an increase in latency of P_a is seen from 1-8 months (Mendel, et al. 1977).

Difference in latency of P_o and N_a are noticed, though they way not be significant (McRandle, et al. 1974; Madell et al 1977; Hendelson and Salamy, 1981). This can be attributed to variability in filter characteri-stics used in different studies (Lane et al. 1974; Goldstein et al 1971; Scherg, 1982).

From birth to adolescence the detectability of P_a increases systematically (Kraus, et al. 1985). Mendelson and Salamy (1981) have reported of amplitude differences between age groups. They also reported of increase in amplitude of P_o P_a and P_b till 3-4 years of age and a reduction in adults.

MLR waveform in geriatrics is an area which has not received much attention, Lenzi, Chiarelle and Sumbalaro (1989) have made an attempt to study MLR in the geriatrics. They studied the MLR waveforms in the age group of 70-90 years and compared them with adult waveforms. Morphology, lateney and amplitude differences were found. They observed increased latency of the various peaks, and reduced amplitude in the elderly.

The shorter latencies shown by 30 year old males as compared to 30 year old females was not exhibited in the elderly. Reproducability in the elderly was reportedly poor.

As the MLR is of neurogenic origin, it will reflect the structural aad physiological changes the nervous system undergoes with age.

Clinical utility:

Clinically MLR can be used in the following areas:

- Test for hearing acquity: MLR thresholds are reported to closely agree with behavioural thresholds (Goldstein, aad Rodman (1967); Madell, aad Goldstein, 1972; Kupperman Mendel, (1974); Mendel et al. (1975)), Horowitz et al

(1966) have reported of greater difficulty in identifying responses in normal hearing than in partial hearing subjects.

Goldstein et al (1967) reported that using clicks, MIA thresholds were obtained within 30 dB SL of behavioural threshold. While other studies reported that MLR thresholds were within 10-30 dB HL of behavioural threshold (Madell and Goldstein, 1972; Mendel et al.1975; Vivion, 1977; Skinner, and Glattke, 1977; Vivion et al, 1979; Prye-Osier, Vivion et al. 1980).

At near threshold levels N_a, Pa and N_b are consistantly recorded (Ozmadar and Kraus, 1983; Scherg & Volk, 1903). Vehara, Ichikawa, et al. (1932) reported that P_o, N_a and P_a were stable at 20 dB SL.

A recent study by Maarizi et al (1984) has supported the idea/that a just detectable wave P_a is a more significant measure of auditory threshold than latency of the components.

MLR provides frequency specific information within a range of 500 Hz - 8000 Hz, In this frequency range thresholds can be obtained within 10-20 dB of psychoacoustic threshold in adults (Mendel, 1077) .

Clinically its use at 500 Hz and 1000 Hz have been reported (Musiek, Geurkink, 1981; Scherg, Volk, 1983; Zerlin and Naunton, 1974; Maurizi, et al 1984; Kavanagh, et al. 1984) . A study on the hearing impaired reported of increased amplitude and a small reduction in latency of MLR waveforms, (Goldstein, et al 1975).

Overall, MLR is considered a good tool for measuring low-frequency threshold.

Pseudohypacusis: Electrophysiological procedures have for some time been utilised la cases of pseudohypacusis. MLR seems ideally suited for use in case of functional hearing loss because of its stability, sensitivity and frequency specificity.

-Neurootological diagnosis: MLR has been useful in diagnosis of neuro-otological disorders like acoustic neuroma and cerebral lesions.

Harker and Backoff (1981) reported of increased latency of the MLR waveform in cases of acoustic neuroma. They also said that ABR was more sensitive to detect acoustic neuroma than MLR. MLR waveforms had greater latency for large tumors and a significant interaural latency difference compared to small tumors. Therefore, it was suggested that MLR could be used to derermine size of acoustic neuroma.

A prerequisite to carry out MLR evaluation of cortical lesions is obtaining basic audiological data as well as normal ABRs bilaterally. This is because peripheral brainstem dysfunction contaminates MLR waveforms.

Most cases of cortical hemispheric lesion have yielded essentially flat or highly distorted bilateral MLRs (Musiek, et al.1984).

Parving et al (1980) reported of normal P_a in bilateral temporal lobe lesions. Ozdamar et al (1982) reported that P_a was absent in bilateral temporal lobe lesions. Kraus et al (1982) report of normal N_a *and* P_a in unilateral temporal lobe lesions.

Significant latency delays bat no amplitude abnormalities are reported in multiple sclerosis patients (Robinson, Rudge, 1977),

MLR in mentally retarded do not exhibit any changes in detectability of N_a and P_a but ABR has better repeatability (Smith, Reed, stein, et al 1985).

MLR in cases with neurologic involvement is best suited to determine the function rather than threshold or specific site of lesion (Kileny and Berry, 1983).

METHODOLOGY

Methodology of this study is described under the following headings:

- Subjects
- Equipment
- Test environment
- Procedure.

Subjects:

Twelve subjects in the age range of 18-22 years (meaa age 20 years; 6 males and 6 females) were selected to obtain normative data for MLR in adults. All subjects had pure tone thresholds within normal limits (ANSI, 1969).

Ten subjects in the age range of 50-62 years (mean age 56 years; 5 male and 5 female) were selected for this study. All subjects had near normal hearing. The geriatric subjects were chosen based on the following criteria:

1. The subject should be above 50 years.
2. The subject should not have had any history of chronic ear discharge, tinnitus, giddiness, earache or any other otological complaints,
3. The subject should not have any history of epilepsy or other neurological complaints.

4. Subject should not have any psychological problems.
5. General health at time of testing should be good.
6. The subject should be able to relax with electrodes in place for duration of testing.

Equipment:

Instruments used in this study were -

- Diagnostic audiometer (Madsen OB 822).
- Electrophysiological test equipment (Nicolet Compact Auditory System).

Hearing thresholds wore obtained for one ear at all test frequencies front 250 Hz to 8000 Hz using Madsen OB 822. For all subjects ear to be tested was chosen randomly.

The audiometer was caliberated for air and bone conduction once in a month till the study was completed. Subjective calibration was done everyday prior to testing.

Nicolet Compact Auditory System was used to obtain the middle latency response.

Test environment :

The experiment was carried out in a sound treated room which met the ISO-1969 requriments.

NIC0LET COM PACT AUDITORY SYSTEM

The instrument was placed inside this sound treated room where humidity and temperature were maintained at a comfortable level. It was kept away from bright lights, noisy and drafty areas. It was also kept away from areas of excessive vibrations.

Procedure:

Instructions: The subjects were instructed to sit as comfortably as possible on the chair and relax. They were briefed with the information that the electrodes would be placed and then earphones. From the earphones they could hear tone bursts or clicks in one ear only. The subjects were further instructed to avoid movements of head, neck, and jaw for duration of the test. The subjects were aot sedated, They were asked to be la a relaxed state but aot fall asleep.

Electrodes: Four electrodes were used in this study. All were checked for continuity. They were cleaned with cotton soaked in rectified spirit aad then plugged into the sockets.

Cotton soaked in rectified spirit was briskly rubbed on the skin areas where electrodes were to be placed,

till pinkish colour indicative of increased vascularity appeared. This area was then wiped with dry cotton.

Sufficient quantity of electrolyte gel was placed on electrodes to fill the recess in the electrodes to the slightly rounded condition. Electrodes were placed on the cleaned areas, by pressing slightly. Johnson adhesive tape was used to hold the electrodes la place. Excess paste which oozed out was wiped with dry cotton.

Electrode placement was as follows:

- Channel 1 (Al) - left ear
- Channel 2 (A2) - right ear
- Common(F_{pz}) - forehead
- Jumper (C_z) -vertex

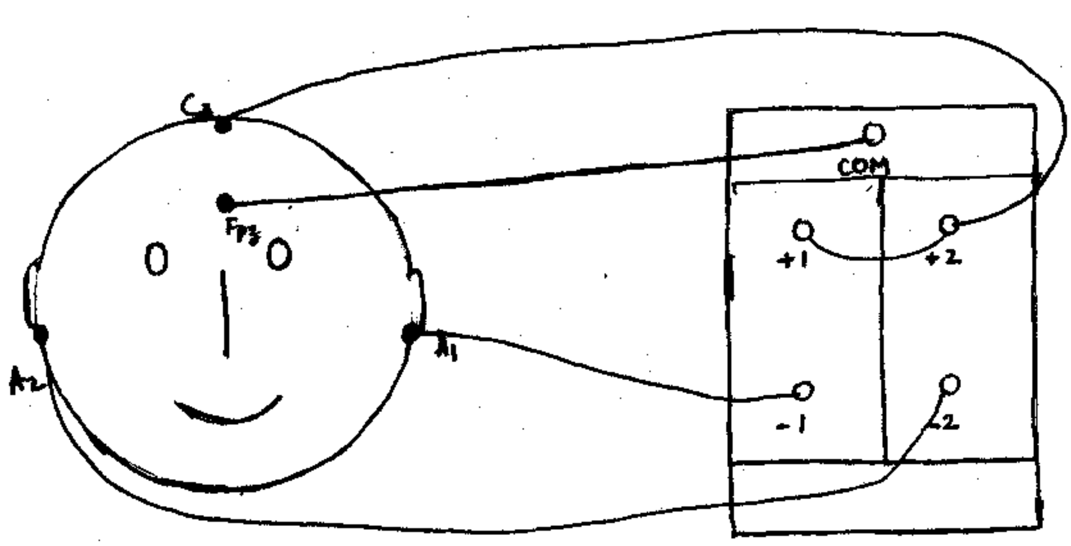


Figure: Electrode placement for MLR.

After electrode placement, the instrument was switched on. The program disc and data disc were inserted into their respective slots. Impedance matching was carried out as stipulated in the manual by the manufacturers. Impedance was accordingly adjusted to within 5kΩ left in each channel.

Earphone placement: Earphones were placed after electrodes were in position. Care was taken not to displace the electrodes. The blue earphone was placed over the left ear and red earphone over the right ear. The earphone diaphragm was placed directly over the ear canal so that accurate stimulus intensity levels were delivered to the ear.

The procedure followed for testing was as described la the manual. Each subject was tested for one ear only. Same ear was tested for both tone bursts and clicks.

The presentation level was decreased from 60 dB nHL till the level at which a clear MLR Have form was obtained.

The stimuli parameters used in this study were, as shown below:

Parameters	Stimuli	
	Tone bursts	Clicks
Frequency	500 Hz	-
Rise time	Instantaneous	-
Plateau	2 m sec.	-*
Decay	Instantaneous	-
Rate	9.7/sec.	9.7/sec.
LLP	10 Hz	10 Hz.
HFF	100 Hz	250 Hz.
Sample number	2000	2000
Polarity	Alternating	alternating
Impedance	to < 5 KΩ	to <5KΩ
Artefacts permissable	20%	20%

While testing the following observations were made.

1. Motor movements and subsequent effects on the waveform
2. Rejection rate should not exceed 200. If it did the waveform was rejected.

Latency of P_o, N_o, P_a, N_a and any other peak identifiable were noted for all intensities tested.

Later data obtained for geriatric subjects was compared with the data obtained for normal hearing subjects.

RESULTS AND DISCUSSION

In the present study MLR waveforms were obtained for all subjects (young adults and geriatrics) using tone burst and clicks separately". The same ear was tested for both stimuli at intensity levels of 60 dB nHL, 40 dB nHL and 30 dB nHL. He clear waveform was obtained at 20 dB nHL for any subject. Peaks were identified and their latencies were noted. Criteria used to determine letency of peaks in this study were -

- for sharp waves latency of peak was noted.
- for relatively flat waves latency of midpoint was noted,
- for waves with gradual slope, midpoint of slope was considered.
- for waves with double peaks, midpoint was considered.
- fussy waveforms were rejected.

Tone bursts of 500 Hz was used in this study as it is reported that they provide frequency specific response (Brown and Shallop, 1981; Maurizi, et al. 1984).

Testing was started at 60 dB NHL as Ozdamar, and Kraus (1983) report that amplitude of MLR waveforms level off at moderate intensities.

Data obtained from young adults and geriatrics was subjected to statistical and descriptive analysis.

Statistical analysis was done using Wilcoxon test for matched pairs to determine the significance of difference between tone burst and clicks at 60 dB nHL and 40 dB nHL for Na and Pa.

Only peaks Na and ^{P}a were subjected to statistical analysis as they were the only peeks which were obtained in all subjects at both 60 dB nHL and 40 dB nHL.

Descriptive analysis was done for the entire data.

Table 1 and 2 show the pure tone threshold at all test frequencies from 250 Hz to 8000 Hz for young adults and geriatrics (respectively).

Table-3 aad 4 show the latency values for the peaks obtained using tone bursts and clicks (respectively) for young adults. Table 5 and 6 show the same for geriatrics.

Effect of stimuli on waveform :

In this study it was found that clicks evoked early peak N_o more frequently than tone bursts. Tone bursts however evoked later peaks Nb and P_b more frequently than clicks. This was observed in both young adults and geriatrics. (Table-7).

In Table-8 it can be seen that peaks N_a and P_a were obtained in all subjects at intensity of 60 dB nHL and 40 dB nHL. This supports the findings of Scherg and Volk (1933) and Ozdamar and Kraus (1983). They reported that N_a and P_a were present consistently in their subjects near threshold level.

Musiek and Geurkink (1981) reported that N_a and P_a had larger amplitude when clicks were used as stimuli than when tone bursts were used, In this study it was observed that N_a and P_o had a larger amplitude when clicks were used.

All these observations were true for both young adults and geriatrics. Peak N_c was seen la only one subject in the entire study. Its latency was 67.0 -69.0 m.sec.

<u>Effect of stimulus on latency:</u>

Means of peak latencies at 60 dB nHL, 40 dB nHL sad 30 dB nHL were obtained for teas burst and clicks is young adults and geriatrics. (Table-8).

Clicks evoked waveforms with snorter latencies than tone bursts. This was noticed la both young adults and geriatrics.

In this study clicks and 500 Hz tone burst (low frequency stimulus) were the stimuli used. Literature reports that high frequencies peak near the base of the cochlea while low frequencies peak near the apex (von Bekesy 1960). This could be the reason for longer latencies of waveform evoked by tone bursts la this study.

A statistically significant difference was found between tone burst and clicks for mean latency values of N_a at 60 dB nHL. In young adults difference was significant at 0.01 level and in geriatrics it was significant at 0.05 level (Table-9). No significant difference was found at 40 dB nHL in both young adults and geriatrics (Table-10).

A statistically significant difference was found between tone burst and clicks for Pa at 60 dB nHL in young adults at 0.01 level and ia geriatrics at 0.05 level (Table- 9). A statistically significant difference was also found at 40 dB nHL. la young adults at *0.05* level and in geriatrics at 0.01 level (Table-10).

Bahavioural threshold approximation by MLR

Maurizi et al (1984) reported that a just detectable wave P_a was a more significant measure of auditory threshold than exact latency of component.

Goldstein et al (1976) reported that MLR for clicks approximated behavioural thresholds within 30 dB SL. Mendel et al (1975); Madell and Goldstein (1972) reported that MLR could be obtained within 10-30 dB above behavioural threshold.

In the present study, minimum intensity level at which a clear Pa or N_a was obtained was used to detect threshold of MSA for both tone burst and clicks.

Behavioural threshold at 500 Hz was compared with MLR threshold for tone burst, as a 500 Hz tone burst had been used in this study. An average of pure tone threshold at 2000 Hz and 4000 Hz was compared with MLR click thresholds. This was because it has been reported that click ABR threshold correlates best with hearing thresholds at 20O0 Hz - 4000 Hz (Martin and Coats, 1977)

Results are that MLR was obtained 15-30 dB above behavioural threshold when tone burst was used in young adults. For geriatrics it was obtained 10-40 dB above the behavioural threshold. Mean difference between MLR threshold for tone burst and behavioural threshold was 20 dB in young adults and 22.5 dB is geriatrics. (Table-ll)

MLR for clicks was obtained from 17.5 - 35 dB above behavioural threshold in young adults and 12.5 - 32.5 dB in geriatrics. Mean difference between MLR thresholds for clicks and behavioural threshold was 25.8 dB in young adults and 22.75 dB in geriatrics (Table-12).

Clicks threshold are about 6-7 dB less esnsitive than tone burst for young adults and equally sensitive as tone bursts in geriatrics, in this study.

Table-1: Pure tone thresholds for *normal* young adult (in dB)

S. No	*Ear* tested	250 Hz	500hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	Pure tone average
1	Left	10	15	10	10	5	15	11.6
2	Right	10	10	15	15	10	5	13.3
3	Right	5	10	5	10	5	5	8.3
4	Right	10	10	15	10	5	15	11.6
S	Right	10	15	10	10	15	10	11.6
6	Left	10	10	5	10	5	5	8.3
7	Left	10	10	15	5	5	10	10.0
8	Right	10	5	5	10	10	10	6.6
9	Left	10	S	10	5	10	15	6.6
10	Left	10	10	5	10	10	10	8.3
11	Right	10	10	15	10	10	10	11.6
12	Left	10	15	10	15	10	10	13.3

Table -2 : Pure tone thresholds of geriatic subjects (in dB)

S.No.	Ear tested	Frequencies						Pure tone average.
		250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	
1	Left	15	15	10	0	15	20	8.3
2	Right	5	5	10	15	15	15	10.0
3	Left	29	20	10	20	25	20	16.6
4	Right	19	0	0	10	5	10	3.3
5	Left	10	15	15	20	20	25	16.6
6	Right	15	10	10	0	10	15	6.6
7	Left	10	15	15	10	15	15	13.3
8	Right	10	10	15	20	10	5	15.0
9	Left	15	15	10	15	20	25	13.3
10	Right	15	10	15	10	10	20	11.6

Table-3: Peak latencies for tone bursts in young adults (in msecs.)

S. Bo,	Ear Tested	Intensity in dB	No	Po	Pa	Pb	Nb	Pb	NC
1	Left	60	16.6	19. 4	24.0	32.4	48.6		
		40		19.8	24.4	36.2	49.2	60.8	
2	Right	60		13.0	21.2	34.4	48.4		
		40			18.2	34.8		-	
		30			22.2	34.2			
3	Right	60	-	-	20.0	29.4	44.4		
		40			22.0	29.0	42.8		
4	Right	60			21.8	30.0	46.2		
		40			21.4	33.2	47.0	-	
		30	15.8	19.4	22.8	33.6	52.2		
5	Right	60		16.4	24.4	38.4	48.4		
		40		16.2	24.6	31.4	51. 0	-	
		30	8,6	17.2	24.2				
6	Left	60			22.6	32.8	46.2	- -	
		40	-		24.2	34.0	47.4		
		30			26.2	36.1	45.8		
7	Left	60			22.2	35.0		- -	
		40		-	23.6	36.0			
		30			24.0	37.0	47.2		
8	Right	60			21.8	29.2	41.0		
		40			24.0	30.8	43.6	53.4	67.6
		30		20.0	25.2	36.2	44.6	55.4	69.0
9	Left	60			22.4	33.4	41.4		
		40		13.0	21.4	32.6	42.2	- -	
		30	9.6	13.4	24.0	34.4	45.4	- -	
10	Left	60			17.0	28.2	42.6	- -	
		40	-	10.0	19.2	35.4	42.8		
		30		14.6	19.4				
11	Right	60			22.6	28.4			
		40		10.0	23.4	31.4	40.6	52.8	
		30		10.8	24.4	33.4	-		
12	Left	60		10.4	20.6	31.4	47.2		
		40		11.2	24.0	33.6	48.2		
		30	-	11.2	25.0	34.6	48.2		

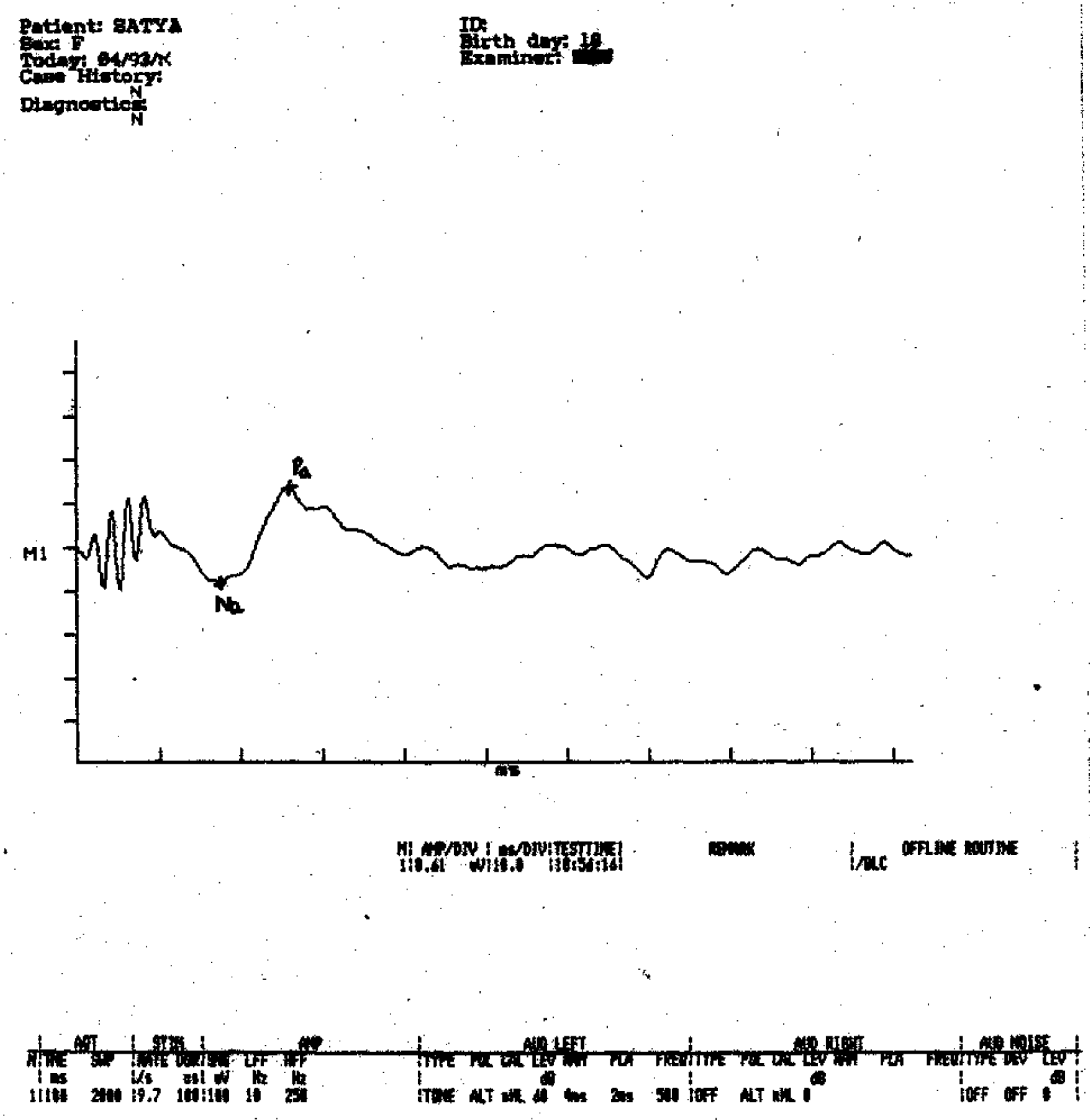


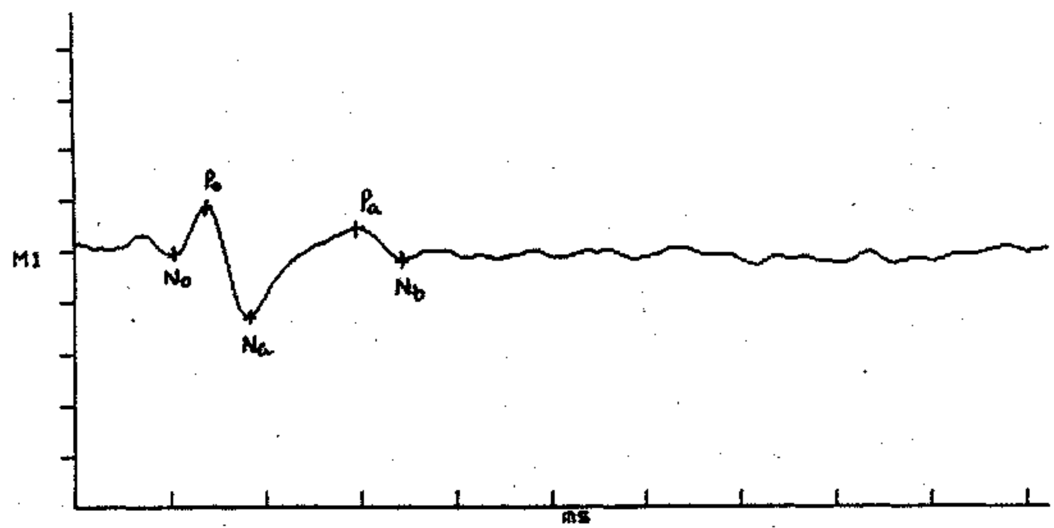
Fig. MLR waveform elicited using tone bursts at 60 dB nHL in a young adult.

Table-4: Peak latency for clicks in normal young adults. (in m. sec)

S. No.	Ear tested	Intensity in dB nHL	No	Po	Na	Pa	Nb	Pb
1	Left	60	-	13.4	18.0	28.0	- -	
		40	-	13.4	18.6	31.2	- -	
2	Right	60	9.8	13.4	18.2	32.0	45.8-	
		46	11.8	15.4	18.4	35.0	39.6-	
3	Left	60		-	15.6	27.2	- -	
		40	11.2	14.2	18.4	29.4	42.0-	
4	Right	60	10.0	13.8	18.0	30.2		
		40	10.2	14.0	18.2	30.2		
		30	11.4	16.0	18.8	32.0	- --	
5	Right	60		12.0	17.5	28.6	- --	
		40	11.4	13.0	18.1	29.2	- -	
6	Left	60		13.4	19.8	30.4		
		40	11.0	15.2	20.0	29.4	- -	
		30	10.6	14.2	19.8	31.0	- -	
7	Right	60	9.0	13.2	20.6	27.8		
		40	9.4	14.6	20.0	28.2	- -	
8	Left	60	10.2	16.0	20.8	29.4	41.2-	
		40	12.4	16.8	22.2	28.8	41.8-	
		30	11.4	17.2	21.0	30.0	45.4-	
9	Left	60	-	13.4	19.2	31.6	- -	
		40	-	13.5	20.0	32.0	- -	
		30	-	14.2	19.8	31.8	- -	
10	Right	60	9.2	12.0	17.3	30.8	41.2	
		40	-	12.4	19.2	35.2	42.0	
		30	-	13.4	21.6	35.6	- -	
11	Left	60	9.2	12.2	17.4	30.8		
		40	9.4	12.4	19.2	35.2	41.2-	
12	Left	60	10.0 ,.	13.8	18.2	29.6	34.2-	
		40	10.8	14.0	19.2	32.4	43.0-	
		30	12.4	16.8	20.4	27.0		

Patient: SATHYA
Sex: F
Today: 04/05/K
Case History:
Diagnostics:
N

ID:
Birth day: 18
Examiner: 8



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	ACQ		STIM		AMP			AUD LEFT							AUD RIGHT							AUD NOISE		
M	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	µs	µV	Hz	Hz				dB							dB						dB
1	100	2000	9.7	100	100	10	250	OFF	ALT	nHL	0				CLICK	ALT	nHL	60				OFF	OFF	0

Fig : MLR waveform elicited using clicks at 60 dB nHL in a young adult.

Table - 5 : Peak latencies for tone bursts in geriatrics (in m sec)

S No	Ear tested	Intensity in dB nHL	No	*Po*	*Na*	Pa	Nb	Pb
1	Left	60-		14.8	22.0	30.0	40.4	52.6
		40	11.6	13.4	23.6	31.6	43.2	
		39-		-	23.8	34.8		
2.	Right	60	14.8	18.6	22.8	30.0	43.0	
		40-		19.2	22.8	31.6	43.8	
3.	Left	60-		14.2	19.8	29.2	40.2	
		40-			20.4	33.0	41.8	-
		36	11.8	14.6	19.6	36.2		-
4.	Right	60	12.0	16.6	22.6	32.0		
		40-		17.2	24.2	36.0	42.8	50.8
5.	Left	60	12.0	14 .8	23.8	32.1	41.4	52.1
		40-		19.6	24.2	33.6		
		30-		20.0	23.8	35.4		
6-	Right	60-		12.4	20.0	30.8		-
		40-		22.6	32.8	38.2	-.	
7	Left	60-		17.0	21.0	32.8	44.4	55.4
		40-		21.0	24.2	33.2	43.6	
8	Right	60-		13.6	22.2	30.6		
		40-		18.6	24.6	33.6	44.4	53.0
		30-			26.2	34.2	46.2	52.6
9	Left	60		16.0	22.6	34.0	45.5	
		40		-	22.2	35.2	44.2	
		30			27.0	34.8	49.4	
10.	Right	60			19.2	29.0	42.2	
		40		11.2	23.8	31.0	43.8	52.6
		30		17.0	27.0	33.2	45.2	

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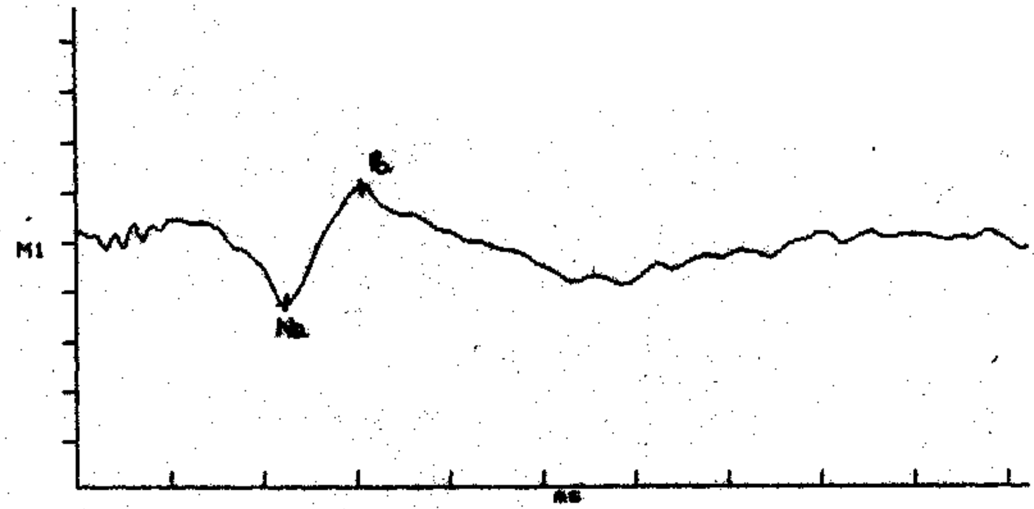
Sex: F
Today: 06/07/K
Case History:
N
Diagnostics:
N

ID:
Birth day:
Examiner: DIRC



MS AMP/DIV	ms/DIV	TESTTIME	REMARK	/NLC	OFFLINE ROUTINE
10.41 uV	10.0	14:37:30			

AVE		STIM	AMP				AUD LEFT							AUD RIGHT							AUD NOISE		
M TIME ms	SMP	RATE 1/s	DUR ms	SENS uV	LPF Hz	HPF Hz	TYPE	POL	CAL	LEV dB	DUR	PLA	FREQ	TYPE	POL	CAL	LEV dB	DUR	PLA	FREQ	TYPE	DEV	LEV dB
1 100	2000	19.7	100	100	10	250	OFF	ALT	nHL	0				TONE	ALT	nHL	60	4ms	2ms	500	OFF	OFF	0

Fig. MLR waveform elicited using tone burst at 60 dB nHL in a geriatrics.

Table-6:Peak latencies for clicks in Geriatrics (in m.secs.)

20.8

Sl. No	Ear tested	Intensity in dB nHL	NO	PO	Na	Pa	Nb	Pb
1.	Left	60	-	-	21.8	29.4	34.6	40.8
		40	-		21.8	29.0	35.0	41.2
2.	Right.	60	10,6	16.0	21.8	27.6	34.6	
		40		16.0		29.0	36.8	-
3.	Left	60	-	13.4	16.8	26.4	-	
		40	-	13.0	19.0	28.4	39.0	-
4.	Right	60	10.8	14,0	19.0	34.8	-	-
		40	13.0	16.0	20.6	35.2	-	-
5.	Loft	60		13.2	18.2	27.2	35.2	-
		40	13.8	17.2	22.0	27.2	34.8	-
6.	Right	60	9.6	13.0	17.6	28.8	39.2	
		40	12.4	14.2	18.4	28.4	40.0	
		30	11.0	14.4	21.4	27.6	41.0	47.0
7.	Loft	60	-	13.0	19.8	26.6	35.8	-
		40	-	14.2	22.4	26.8	36.6	-
8.	Light	60	9.8	12.6	19.9	26.3	34..2	42.0
		40	10.0	13.2	23.4	26.8	35..9	-
		30	-	14.0	24.0	27.8	35.9	-
9.	Left	60	13.0	18.4	27. 0	35.2	-	-
		40	13.4	18.8	27.2	36.0	-	-
		30	14.1	22.1	28. 0	36.1	-	-
10.	Right	60	-	13.4	18.9	27.2	35.2	-
		40	-	14.0	19.1	27.8	36.0	-
		30	-	14.1	22.4	28.4	36.1	-

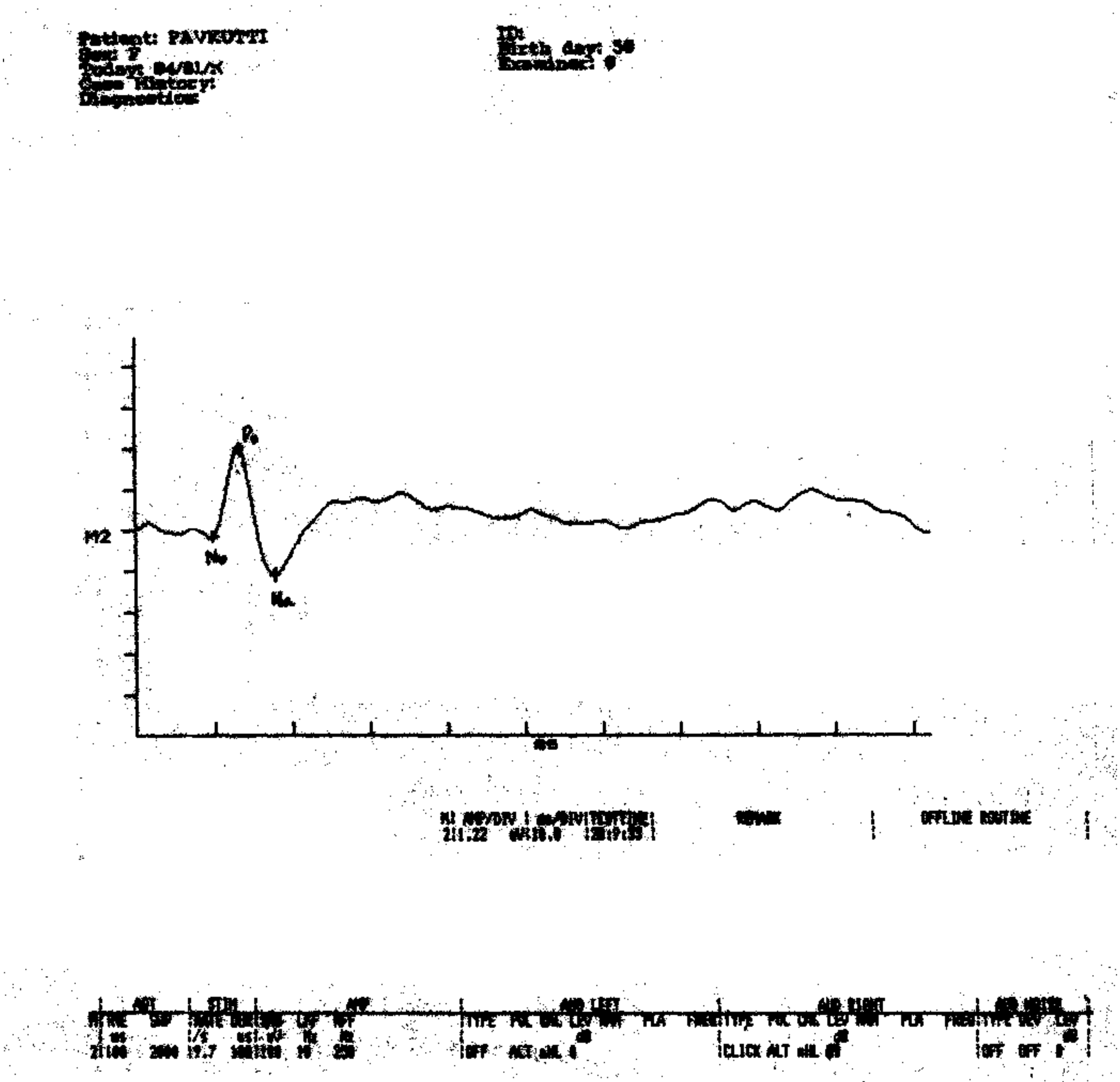


Fig:MLR Waverform elicited using clicks at 60 dB nHL
in a geriatric

Table-7: Number of subiects (voung adults and geriatrics) for whom responses were obtained for the peaks No, Po, Na, Pa, Nb, Pb

Subjects	No		Po		Na		Pa		Nb		Pa	
	Tone bursts	Clicks	Tons bu»fct	Clicks	Tone burst	Clicks	Tone burst	Clicks	Tone burst	clicks	Tone burst	Clicks
Young adults S-12	4	8	12	12	12	12	12	.12	12	6	3	0
Geria-tric N-10	5	7	10	9	10	10	10	10	10	7	7	3

N - Total number of subjects tested.

Table-8: Peak latency means for 60 dB nHL, 40 dB nHL and 30 dB nHL for tone bursts and clicks in both young adults and geriatrics. (in msecs).

Sl. No.	Peak	Intensity	Young adults				Geriatrics			
			N	Tone burst	N	Clicks	N	Tone burst	N	Clicks
1.	No	60	1	16.6	7	9.63	3	12.93	5	10.76
		40	0	-	9	10.8	1	11.6	5	12.52
		30	3	11.33	5	11.04	1	11.8	2	12.55
2.	Po	60	4	14.8	11	14.54	9	15.3	9	14.11
		40	3	13.36	12	12.89	7	17.17	9	15.17
		30	7	15.23	6	15.3	3	17.2	4	16.15
3.	Na	60	10	21.72	12	18.38	10	21.56	10	20.08
		40	10	22.52	12	19.29	10	30.33	10	21.47
		30	10	23.44	16	20.23	6	24.56	4	23.95
4.	Pa	60	10	31.92	12	29.7	10	23.98	10	29.95
		40	10	33.2	12	31.35	10	33.7	10	29.45
		30	10	34.95	6	31.23	6	34.77	4	27.95
5.	Nb	60	10	45.44	4	40.6	7	42.46	7	35.54
		40	10	45.48	4	42.5	9	42.87	8	36.65
		30	6	47.23	4	42.05	0	-	3	37.67
6.	Pb	60	-	-	0	-	3	53.37	2	41.4
		40	-	55.67	0	-	3	52.13	2	41.2
		30	-	-	0	-	1	52.6	1	47.0

N = number of subjects for whom response was obtained.

Table-9: Minimum, max imum, mean and standard deviation latency values of Na and Pa at 60 dB nHL for tone burst and clicks in young adults and geriatrics.

	Statistical parameters	Na Peeks (in m secs)		Pa	
		Tone bursts	Clicks	Tone bursts	Clicks
Young adults	Minimum	17.0	15.6	28.2	27.2
	Maximum	24.4	20.8	38.8	32.0
	Mean	21.72	18.38	31.92	29.7
	Standard Deviation	1.94	1.49	3.08	1.54
	Significant difference	Present		Present	
Geriatrics	Minimum	19.2	16.8	22.8	26.3
	Maximum	23.4	27.0	34.0	37.2
	Mean	21.56	20.08	30.33	29.95
	Standard deviation	1.46	2.92	3.08	4.6
	Significant difference	Present		Present	

Table-10: Minimum, maximum, mean and standard deviation latency values of Na and Pa at 40 dB nHL for tone burst and clicks in young adults and geriatrics.

	Statistical parameters	Peaks (in m sec)			
		Na		Pa	
		Tone burst	Clicks	Tone bursts	Clicks
Young adults	Minimum	18.2	18.1	29.0	28.2
	Maximum	24.6	22.2	36.2	35.2
	Mean	22.55	19,29	33.2	31.35
	Standard deviation	2.13	1.15	2.24	2.6
	Significant difference	Not present		present	
Geriatrics	Minimum	20.4	18.4	31.0	26.8
	Maximum	30.0	27.2	36.0	36.0
	Mean	23.98	21.47	33.16	29.47
	Standard deviation	2.47	2.59	1.57	3.33
	Significant difference	Not present		present	

Table-ll: Pure tone thresholds for 500 Hz and MLR threshold for 500 Hz tone burst in young adults and geriatrics (in dB).

Sl No.	Young adults			Geriatrics		
	Puretone thresh-olds	MLR olds	Differe-nce	Puretone thresh-olds	MLR Thresh- -olds.	Differe-nce
1.	15	40	25	15	30	15
2.	16	30	20	5	40	35
3.	10	40	30	20	30	10
4.	10	30	20	0	40	40
5.	15	30	15	15	30	15
6.	10	30	20	10	40	30
7.	10	30	20	15	40	25
8.	5	30	25	10	30	20
9.	5	30	25	15	30	15
10.	10	30	20	10	30	20
11.	10	30	20			
12.	15	30	15			
Mean difference		20.8				22.5
Range of difference		15-30				10-40

Table-12: Pure tone average (for 2000 Hz and 4000 Hz and MLR thresholdforclicksand in adults and geriatrics (in dB)

Sl No.	Young adults			Geriatrics		
	Puretone 2000 Hz & 4000 Hz.	Clicks thresh-olds	Diffe-rence	Puretone 2000 Hz. & 4000 Hz	Clicks thresh-olds	Differe-nce
1.	7.5	40	32.5	7.5	40	32.5
2.	12.5	40	27.5	15.0	40	25.0
3.	7.5	40	32.5	22.5	40	17.5
4.	7.5	30	22.5	7.5	40	32.5
5.	12.5	40	27.5	20.0	40	20.0
6.	7.5	30	22.5	5.0	90	25.0
7.	5	40	35.0	12.5	40	27.5
8.	10	30	20.0	15.0	30	15.0
9.	7.5	30	22.5	17.5	30	12.5
10.	10	30	20.0	10.0	30	20.0
11.	10	40	30.0	-	-	
12,	12.5	30	17.5	-	-	
Mean difference			25.83			22.75
Range of difference			17.5-35.0			12,5-32.5

SUMMARY AND CONCLUSION

The present study was carried out to answer the following questions:

1. Does a change in the stimulus used to elicit MLR bring about a change in the latency of waveforms in the geriatrics?
2. Are these differences in the MLR waveforms obtained from young adults and geriatrics?
3. How well does MLA approximate the pure tone thresholds?

The study was conducted in twelve normal hearing young adults (18-22 years) and on ten geriatrics (50-62 years) Their hearing thresholds were determinedusing a diagnostic audimeter (Madsen OB 822). The subjects were tested for MLR with Nicolet Compact Auditory System using tone bursts and clicks. Testing was carried out in a sound treated room Latencies for various peaks obtained for tone burst and for clicks at 60 dB nHL, 40 dB nHL, and 30 dB nHL were noted.

The data was analysed descriptively and statistically. statistical analysis was done for mean, standard deviation and for significance of difference between 1atencies of tone bursts and clicks. Descriptive analysis was done to note any morphological changes in waveform when the stimuli was changed. Analysis was dona for data obtained from young adults and geriatrics.

The following conclusions may be drawn:

1. Clicks evoke early peak N_o more often than tone burst in both young adults and geriatrics.
2. Tone burst evoke later peaks N_b and P_b more often than clicks in both young adults and geriatrics.
3. Tone bursts evoke waveforms having longer latency values then clicks in both young adults and geriatrics.
4. There is a significant statistical difference between tone burst and clicks for N_a at 60 dB nHL, P_a at 60 dB nHL and 40 dB nHL in both young adults and geriatrics.
5. No statistically significant difference is there between tone bursts and clicks for N_a at 40 dB nHL in both young adults and geriatrics.
6. MLR can be obtained 15-30 dB above behavioural threshold at 500 Hz in young adults and 10-40 dB in geriatrics using tone bursts.
7. MLR can be obtained 17.5 dB - 35 dB above behavioural threshold (pure tone average of 2000 Hz and 4000Hz.) in young adults and 12.5 dB-32.5 dB in geriatrics using clicks.

Recommendations:

1. Study should be carried out on a larger population.
2. Potential of MLR in providing us with frequency-specific information should be probed into.
3. MLR in children should be studied to determine if there are differences when compared to adult MLR waveforms.

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