AN NORMATIVE DATA ON ACOUSTIC REFLEX LATENCY TESTING IN NORMAL ADULTS AND CHILDREN

REG. NO.M9313

AN INDEPENDENT PROJECT SUBMITTED AS PART FULFILLMENT FOR THE FIRST YEAR M.Sc (SPEECH AND HEARING) TO THE UNIVERSITY OF MYSORE.

All India Institute of Speech, and Hearing, Mysore,

MAY 1994.

TO
AMMA, ANNA
AND
SISTERS

WHOSE LOVE AND AFFECTION ARE
RESPONSIBLE FOR WHAT
I WAS
I AM,
& I WILL BE ....

CERTIFICATE

This is to certify that the Independent Project entitled:

AN NORMATIVE DATA ON ACOUSTIC
REFLEX LATENCY TESTING IN
NORMAL ADULTS AND CHIDLREN

is the bonafide work inpart fulfillment for the First Year M.Sc, (Speech and Hearing) of the student with Reg. No.M9313.

MYSORE
MAY 1994

Dr.(Miss) S.Nikam
Director
All India Institute of
Speech and Hearing
Mysore.

CERTIFICATE

This is to certify that this Independent Project entitled:

AN NORMATIVE DATA ON ACOUSTIC
REFLEX LATENCY TESTING IN
NORMAL ADULTS AND CHIDLREN

has been prepared under my supervision and guidance.

MYSORE
MAY 1994

Dr.(Miss) S.Nikam
GUIDE

DECLARATION

I *hereby declare that this*
Independent Project entitled:

AN NORMATIVE DATA ON ACOUSTIC
REFLEX LATENCY TESTING IN
NORMAL ADULTS AND CHILDREN

is the result of my own study -under the guidance of
Dr.(Miss) S.Nikam, prof, and HOD,
Department of Audiology, and Director
All India Institute of Speech and Hearing,
Mysore,
has not been, submitted earlier to
any University for any other Diploma or Degree,

MYSORE
MAY 1994

REG. MO.M9313

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time and time again
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"You are some one who's more wonderful than words could ever say"

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Out of the depths to the Glory above,
you have lifted me in wonderful love.
Blessed is the spirit of mine,
To have you as my parents.

To my cutest and dearest sisters —

In every word of courage,
you have given to my need.
I find constant challenge
A special relationship creed.

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INTRODUCTION

The electro-acoustic immittance audiometry has become an important addition to clinical audiological test equipment. Immittance audiometry is now an integral part of the clinical audiological test battery. At present there is much descriptive information regarding the acoustic reflex (AR) response (Jerger, 1970; Robertson et al. 1968; Northern and Downs, 1974; Jerger, et al. 1974). Certain parameters of the acoustic reflex are known to change as its function of some disease states (Jerger et al. 1974). The acoustic reflex has been studied as a sensitivity indicator that can be utilized to identify hearing-impairment (Anderson et al. 1970; Colletti, 1974, 1975). Careful analysis of the acoustic reflex gives objective information regarding certain aspects of auditory function. More specifically, spatial and temporal patterns of auditory function can be measured using the acoustic reflex (Moller, 1974; Dallas, 1973).

Numerous investigators have collected data on the acoustic reflex threshold (ART) in humans (Dallos, 1964; Peterson and Liden, 197S; Jerger et al. 1974; Zwislocki, 1971). A general statement regarding such findings indicates that the ART varies with the type and duration of acoustic stimulus, as well as the age of the subject (Dallos, 1964; Peterson and Liden 1972; Niemeyer and Kesterhenn, 1974; Jerger et al. 1974; Djupesland and Zwislocki, 1971; Woodford et al. 1975).

While substantial normative data have been accumulated on the acoustic reflex threshold, there has been little data on the latency parameters of the acoustic reflex. Latencies will vary as a function of the method by which the acoustic reflex threshold is studied. Several definitions of the acoustic reflex latency have been suggested (Colletti, 1975; Sunderland, 1974; Strasser, 1975; Moller, 1962, 1974; Borg, 197S; Liden et al. 1974). Latency, like acoustic reflex threshold, may be altered by certain pathological condition of the auditory system (Noris, 1974; Colletti, 1975; Strasser, 1977). Clinically a change in latency may be pathognomonic; if the change occurred prior to onset of more obvious symptom, audiological evaluation of latency parameters could provide early diagnostic information. Consequently, there is a need for a uniform and specific definition of acoustic reflex latency parameters in normal human auditory systems.

The effect of the acoustic signal on the latency parameters has not been thoroughly studied. Dallas (1964, 1973) found the duration of the latent period was inversely proportional to the strength of the acoustic stimulus.

Sunderland (1974) found that the latency period increased as the rise time of a 1000 Hz acoustic signal increased. There is some evidence that changes in the acoustic stimulus affect latency values; however, more information is needed.

The purpose of the study was to specify the acoustic reflex latency in humans with normal auditory systems, and to determine if changes in stimulus on time alter latency parameters of the acoustic reflex.

REVIEW OF LITERATURE

The concept of impedance was first applied to clinical audiology by Metz in 1946. Impedance was measured using an electro-mechanical bridge. Development of electroacoustic impedance bridges led to widespread use of impedance audiometry and acceptance of this technique as an integral part of the clinical audiological test battery (Jerger, 1975). Impedance may be defined as a complex ratio of two vector quantities; force or pressure and flow of energy. Any change in properties of the middle ear system is reflected by impedance changes at the tympanic membrane (Lilly, 197S). The electro-acoustic impedance bridge measures changes in sound pressure level (SPL) within the occluded ear canal. Any change in the volume of this closed cavity results in a change in the SPL within the cavity. Contraction of the intra-aural muscles causes a change in the acoustic transmission properties of the middle ear resulting in a change in acoustic properties of the occluded ear canal. The subsequent change in SPL is recorded by a microphone in the "closed cavity" and delivered to a wheat stone bridge circuit and a voltage meter. The resulting deflection of the meter is a recording of the intra-aural muscle activity (Jerger, 197O; Klockhoff, 1961).

Acoustic impedance measurements give an indirect indication of changes in middle ear impedance (eg. muscle contraction). It has been established that this indirect measure is a valid way of studying middle ear muscle reflex activity.

The acoustic reflex is a bilateral unconditioned muscle reflex that occurs in response to loud acoustic stimuli. Upon contraction the stapedius muscle pulls on the stapes resulting in the impedance change of the middle ear system (Metz, 1946; Jepsen, 1963). Absence of the reflex is associated with abnormalities in the peripheral and central auditory system. The work of Jepsen (1963) and Klockhoff has shown that contraction of the stapedius muscle alone in response to intense acoustic stimulus responsible for the change in impedance at the tympanic membrane in humans. Contraction of both the tensor tympani muscle and the stapedius muscle, may be elicited by non-acoustic stimuli, such as tactile stimulation near the auricle, air jet stimulation, electric shock and anxiety arousal stimuli (Klockhoff, 1961; Fee et al. 1975; Liden, et al. 1970).

Parameters of the acoustic reflex:

Acoustic reflex threshold:

The acoustic reflex threshold varies with the type of acoustic stimulus and the age of the subject. A number of studies have established that the ART for white noise is lower than the ART for pure tone stimulation (Dallos, 1964; Peterson and Liden, 197S; Niemeyer and Sesterhenn, 1974; Jerger et al. 1974).

Threshold measurements of the acoustic reflex in humans with normal auditory function have demonstrated that the mean ART range is from 84 dB to 96 dB SL for puretones, 250 Hz through 4000 Hz. Reflex thresholds have been found to be age dependent and are elevated in young populations (new born to SO years) and *are* reduced in older populations (60-80 years) (Jerger, 1972; Habener and Sayder, 1974; Jerger, et al. 1974).

Studies have established the utilization of the ART by varying stimulus type and intensity as a clinical tool for predicting hearing threshold. Niemeyer and Sesterhenn (1974) compared ART for white noise, pure tones and 24 pure tone mixtures (one single tone at every critical band width) in normal individuals and those with sensori-neural hearing loss. The authors suggested methods for calculating hearing thresholds based on comparison of ART obtained utilizing different stimuli. Jerger et al. (1974) in a subsequent study used the difference between ART obtained with broad band filtered noise, and pure tones to predict severity of loss (Eg. normal, mild-moderate, severe, profound). Using this technique, it was possible to ascertain information about the configuration of the audiometric contour. This technique, as suggested by Niemeyer and Sesterhenn (1974) and by Jerger et al (1974) may have important potential application in testing infants and other difficult to test patients.

Amp1itude of the acoustic reflex

The amplitude of the acoustic reflex has dynamic range of 30 dB between threshold level and saturation threshold. It is both frequency and age dependent. Amplitude of the reflex is greatest at S000 Hz and least at 4000 Hz. The population in the age span of 20-40 year and exhibits the most consistent amplitude frequencies of 500, 1000, S000 and 4000 Hz (Jerger, 197S; Habener and Snyder, 1974).

The extent of impedance change at the tympanic membrane when measured by the acoustic impedance bridge is a direct reflection of the magnitude of the acoustic reflex.

Acoustic reflex decay

Decay of the acoustic reflex is the time, in seconds, that is required for the response amplitude to be reduced by 50'/. The precise mechanism of decay is not known but the frequency dependent characteristics of the acoustic reflex decay indicates the mechanism in the afferent portion of the acoustic reflex arc (Anderson et al. 1970) such decay has been shown to exist in normal ears centered around 4000 Hz. However, it is virtually non-existent at 500 and 1000 Hz (Habener and Snyder, 1974).

Several researchers have shown that the 4000 Hz area of the basilar membrane is the area most sensitive to damage by noise, drugs and other ototoxic agents (Johnsson, 1971; Johnsson and Hawkins, 1972a, 197Sb). This may be a partial explanation for abnormalities of the acoustic reflex at 4000 Hz in normal hearing individual. The reduction of neural elements seen in such cases in absence of any definable pathological state may explain reflex decay in normal hearing individuals at 4000 Hz.

Rise time of the acoustic reflex.

A review of the bioacoustic literature regarding the rise time of the acoustic reflex indicates that this parameter has been studied as part of the initial response of the acoustic reflex. Rise response to change from 10% to 90%. of maximum response amplitude. This same definition will be used to describe the rise time of the acoustic reflex.

Colletti (1974, 1975) used a strip chart *recorder* connected to the output of an impedance bridge to study the acoustic reflex in a normal and abnormal human population. Colletti observed a slow rise in some patients with multiple sclerosis. This alternation in rise time differs markedly from normal and cochlear impaired ears which exhibited a rapid rise time once muscle contraction began. This change in acoustic reflex rise time should be studied further as it relates to acoustic reflex latency. As such, it is most important for it to be defined accurately in a quantitative manner.

<u>Acoustic reflex latency</u>

Latency is the time, in seconds, it takes for a biological system to respond to an appropriate stimuli. Latency of the acoustic reflex is the time taken for the middle ear muscles to contract following acoustic stimulation. Some researchers (Moller, 1972, 1974; Borg, 1972; Liden, et al. 1974) describe latency as the time, in seconds, from stimulus onset to the time when the acoustic reflex has attained 10'/. of maximum amplitude. Colletti (1974, 1975) defines latency as the period from signal onset to 5V. of maximum impedance change; while Sunderland (1974) and Strasser (1975) have suggested measuring latency from signal onset to the beginning of impedance change. Consequently, it becomes awkward to compare results from various reports.

Latency of the acoustic reflex has been measured by direct observation (Luscher, 1929), electromyography (Djupesland, 1965; Jepsen, 1963), recording of the cochlear microphonic, and observation of acoustic impedance change (Dallos, 1964). Using acoustic impedance change to measure acoustic reflex latency in human subjects, Dallos (1964, 1973) found the duration of the latent period was inversely proportional to the strength of the acoustic stimulus. Additionally, he reported a variation in individual response latencies. These qualitative observations are consistent with data reported by Borg <197£, 1972a) in animal exper iments.

Dallos described the acoustic reflex as an asymmetrical response; ie. it is a nonlinear response whose characteristics depend on the direction (increase or decrease) and magnitude of the eliciting stimulus. The "on" response of the acoustic reflex is nonlinear while the "off" response behaves in a linear fashion (Dallos, 1964). The fact that the system is nonlinear means the contraction process differs from the relaxation process. Research has indicated that latency parameters contain important biologic information and can be used as sensitive indicators of disease status (Colletti, 1974, 1975; Norris, 1974; Strasser, 1975).

Norris et al. (1974) used an ordered series of latency measures in an effort to find a method of evaluating differences between a "cochlear impaired and a normal population". Their approach is graphically illustrated in Fig.l and includes definition of 5 different latency values. Latencies were defined as follows:

L1 = Latency from onset of stimulus to initial reflex response.

L2 = Latency from initial response to peak of the response.

L3 = Latency from response peak to point where reflex reaches 95% return to baseline.

L4 = Latency from cessation of stimulus to 95% return to baseline.

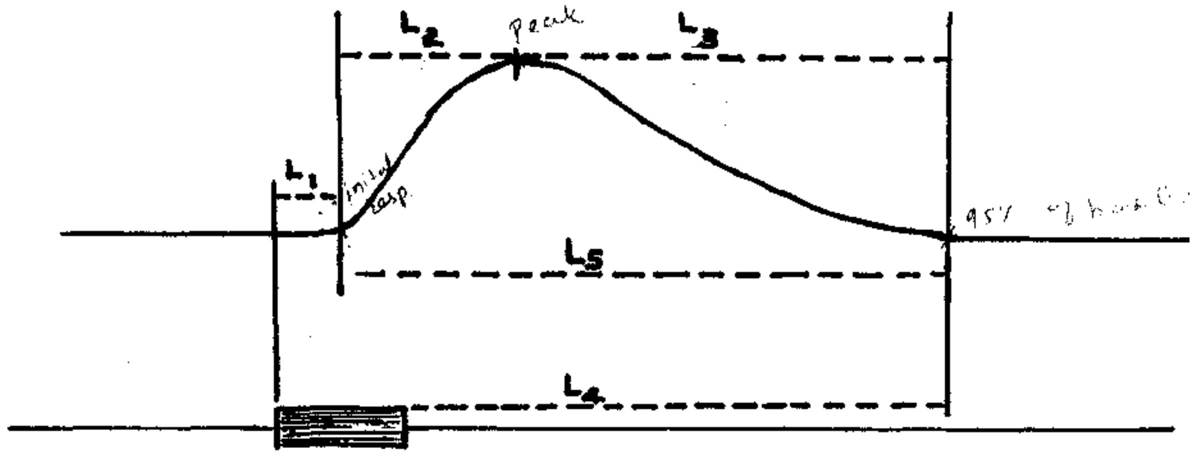


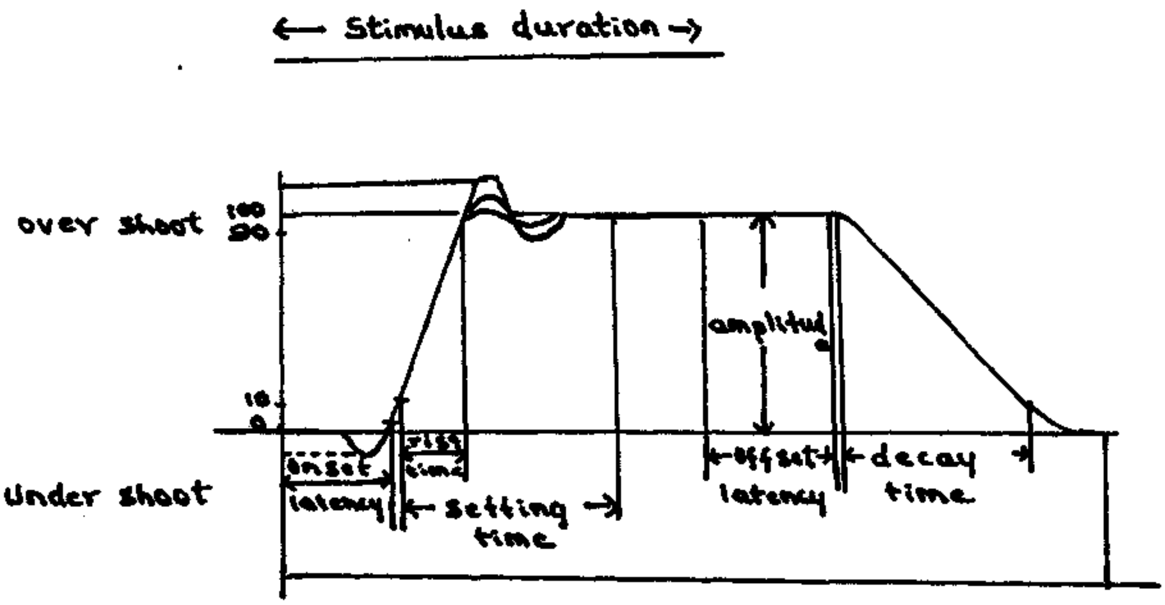
Fig.l: Definition of latency parameters of the acoustic reflex, from Norris, 1974).

L1 = Latency from onset of stimulus to initial reflex response.

L2 = Latency from initial response to peak of the response.

L3 = Latency from response peak to point where reflex reaches 95% return to baseline.

L4 = Latency total response time, L2 plus L3.



Parameters of the stapedius reflex.

Fig.S: Definitions of acoustic reflex parameters as defined by Colletti.

L5 = Total response time, L2 Plus L3.

Norris et al.(1974) elicited the acoustic reflex with a 1000 Hz stimulus at an intensity 10 dB above clinical threshold. Recordings were made using an electroacoustic impedance bridge (Madsen) and a two channel strip recorder.

Latencies were measured from.Stimulus onset. The chief difference between the two population studied was in relaxation time of the reflex. The "cochlear impaired" population showed a significant difference in L3, L4 and Ls values exhibiting longer latencies in all cases. Norris (1974) felt L3 was the key variable since all contribution of the contraction phase had been eliminated. Norris (1974) hypothesized that the cochlear impaired ear showed delay in neural response to cessation of the stimulus. If latency is tobe used to detect differences between normal and abnormal auditory mechanisms, it is necessary to quantitative describe all latency parameters of the acoustic reflex. The non–linear portion of the response must be investigated as well as differances in relaxation of response as noted by Norris et al. (1974).

Colletti (1974) has attempted to standardize the parameters of acoustic reflex response. He defined several latency periods as described in Fig.2 shown above and considered 3 parameters.

Onset latency, rise time and amplitude to contain important biologic information. Colletti (1974) studied these latency parameters with varying intensities of step stimuli at four frequencies (500, 1000, 8000 and 4000 Hz). He reported that these 3 parameters are a function of stimulus intensity. He defined these parameters as follows:

Onset latency:

The time interval between onset of stimulus and 5% of the maximum amplitude of the response.

Rise time

The time required for the response to rise from 10% to 90% of its final value.

Amplitude

It is expressed in arbitrary units as width of its response at steady state.

Off set latency

Time interval for the response to fall to 95% of its value after cessation of the stimulus.

Decay time

The time interval between 90% and 10% of the amplitude of the response after the cesstion of the stimulus.

Strasser (1975) used a 1000 Hz signal to elicit acoustic reflexes in normal subjects and subjects with acoustic neuromas. He found that the subjects with acoustic neuromas exhibited initial latencies that were 30 msec, longer than the mean latency value for the normal subjects. Latency in Strasser's study was defined as the period from signal onset to beginning of initial response.

It has been suggested by a number of investigators that onset latency of the acoustic reflex may be a sensitive indicator of retro cochlear pathology (RCP), (Clemis and Sarno, 1980; Mangham et al. 1980; Hess, 1979; Bosatra et al. 1975, 1976).

Both Clemis and Sarno (1980) and Mangham et al. (1980) have reported a delayed onset latency in the affected ear of patients with 8th nerve tumors. Hess (1979) found delayed onset latencies in patients with multiple sclerosis and Bosatra et al. (1975, 1976), as well, for patients with various brainstem lesions.

Jerger and Hayes (1983) also reported a delayed onset latency in patients with 8th nerve tumors in the affected ear.

Signal parameters and the acoustic reflex

The different parameters of the acoustic reflex *are* influenced by variations in stimulus parameters (eg. intensity, duration, frequency, rise time). Djupesland and Zwislocki (1971) found stimulus duration had a definite effect on the reflex threshold. As stimulus duration increased, the intensity needed to elicit the acoustic reflex decreased. They attributed this occurrance to temporal summation occuring at or below the level of the superior olivary complex in the acoustic reflex are.

Woodford et al. (1975) have investigated the threshold of the reflex as a function of stimulus duration. Measuring clinical reflex thresholds, this group reported ART was dependent on duration of the stimulus. They found variations of as much as 30 dB over a 10 - 500 msec range of stimulus duration.

Sunderland (1974) used a 1000 Hz tone with varying rise times to elicit the aoustic reflex in a group of normal subjects. He found that the latency period increased as the signal rise time increased. They attributed this occurrance to temporal summation occuring at or below the level of the superior olivary complex in the acoustic reflex arc.

Fertitta and Martin (1973), Borg (1982), and Gorga and Stelmachowicz (1983) all noted longer onset latencies as frequency increased.

Church and Cudahy (1984) reported that the onset slope of the reflex elicited by a 5OO Hz signal was steeper than the slope produced by a 200O Hz signal, although the initial onset latency was similar for both signals.

Finally Bosatra et al. (1976) comparing latencies at equivalent sensation level (SL), noted a curious interaction between the sensation level and the puretone vs broad band noise latency difference. At a sensation level of 10 dB the noise signal generally showed a shorter latency than the 500 Hz signal, but at sensation level's of 20 and 30 dB, the difference was in the opposite direction ie. the latency for the noise signal was longer than for the 500 Hz signal.

METHODOLOGY

The methodology of the present study is described under the following headings:

1) Subjects

S) Instrumentation

3) Calibration

(4) Test environment

5) Test procedure

1) Subjects:

Sixty normal adults (30 males and 30 females) between the age of 18 and HB years (Mean age S3 years) and 30 normal children (15 males and IS females) between 5 and 15 years (Mean age 10 years) were selected. The selection of the subjects were on the basis of the following characteristics.

-> No significant history of middle ear disease, vertigo, tinnitus or eustachian tube mal functioning.

-> Thresholds had to be 20 dB HL or better for frequencies from 250 to 4000 Hz.

-> Speech reception thresholds were within 5 dB of pure tone averages for 500 Hz, 1000 Hz and S000 Hz.

-> They had to have normal tympanogram.

2) Instrumentation:

The Grason Stadler Instrument 33 Middle ear analyzer version 2 was used for the present study. It is a microprocessor based instrument which has facilities for complete automatic or manual diagnostic testing of middle ear function. Admittance (Y) and its components, susceptance (B) and conductance (G), acoustic reflex and acoustic reflex latency can be measured by using this instrument.

An audiometer (Madsen OB 822) calibrated according to ISO Standards was also used to check the behavioral thresholds (air-conduction and bone-conduction) at octave frequencies using the modified Hughson-Westlake procedure.

3) Calibration:

Grason-Stadler—33 Middle ear analyzer version 2 was calibrated according to the standards specified in the manual, prior to and during the study.

The audiometer was also calibrated using sound level meter (B&K 2230) and a microphone (B&K 4144). The calibration of earphone output has been accomplished with the help of artificial ear (B&K 4152) along with the sound level meter and microphone of 1 inch and earphone (TDH 39P).

4) Test Environment

The test was conducted in an air-conditioned sound treated room. The environmental conditions like temperature (85 F) and the humidity conditions were within specified limits. The noise levels were measured using a sound level meter (B&.K SS09), octave filter set (B&.K 1613) and a condensor microphone (B&K 4165), and the noise levels were within permissible limits as per ANSI 1977 specification.

5) Test Procedure;

The patient was seated comfortably. The probe box was attached to the velcrostrip and placed on the shoulder of the patient. The correct size of ear tip was selected and securely inserted into the ear canal to obtain an airtight seal.

Acoustic reflex latency;

1) The tympanometry and acoustic reflex thresholds were established just prior to latency testing with (GSI-33) Middle Ear Analyzer (version S) .

S) The acoustic reflex latencies was established for 500 Hz and 1000 Hz tones with a stimulus on-time of 200 msec. and 300 msec, in both ears and the acoustic signalhad a duration of

1000 msec. A probe tone frequency of 226 Hz was used and the stimuliwas presented at 10 dB above the established acoustic reflex threshold.

Pathological fatigue was avoided by setting the inter–stimulus interval at 10 seconds. The rise time of the signal and the total duration at full amplitude were carefully specified and controlled. Thus, all the values are displayed automatically on the screen and noted down for further analysis.

Ten percent (10% of subjects in each group was tested twice to provide a reliability check.

RESULTS AND DISCUSSION

(__ The purpose of the present study was:

1. To obtain normative data for GSI-33 Middle Ear Analyzer of acoustic reflex latency in males and females in the age range of (a) 18 to 28 years (b) 5 to 15 years.
2. To study the differences if any, between right and left ear latency scores.
3. To see whether there was any significant sex difference in adults and children with respect to acoustic reflex latency scores.
4. To observe the inter—stimulus differences if any between two signals ie. 500 Hz vs. 1000 Hz.
5. To study if there is a significant inter-stimulus difference between two signals varying in on-time ie. 200 msec. vs. 300 msec.

The data was collected based on the methodology given in the previous chapter. These data were subjected to statistical analysis using parametric statistical test-paired and unpaired t-test (Garett, 1966).

The parameter considered in the present study were contralateral acoustic reflex thresholds, on—time of the stimulus.

The results and discussion regarding each parameter studied are presented as follows:

Table-I: Normative data of acoustic reflex latency (in ms) for males in the age range 18 to 25 years using <GSI-33) Middle Ear Analyzer (vrsion 2).

Acoustic signal	L1	L2	L3	L4
a) 200 msec (500 Hz)				
Mean	89.52	153.89	293.54.	115.14
SD	14.59	15.4	105.59	61.58
Minimum	56	120	2	22
Maximum	120	176	520	276
b) 300 msec (500 Hz)				
Mean	96.72	192.03	297.10	132.89
SD	31.69	41.76	86.39	79.62
Minimum	52	114	82	20
Maximum	180	292	458	220
c) 200 msec (1000 Hz)				
Mean	94.11	165.43	286.29	146.75
SD	21.39	20.37	87.56	37.77
Minimum	60	104	111	71
Maximum	138	212	461	222
d) 300 msec (1000 Hz)				
Mean	99.97	226.09	290.45	119.83
SD	24.42	43.84	87.90	32.08
Minimum	51	138	114.	55
Maximum	148	3i4	466	183

Where, LI = Latency from onset of stimulus to initial reflex response ie. 10% on time.

L2 = Latency from response peak to point where reflex reaches 90% return to baseline ie. 90% on time.

L3 = Latency from cessation of stimulus to 90% ie. 90% off time.

L4 = Latency from cessation of stimulus to 10% ie. 10% off time.

Table I and II Summarize the results of acoustic reflex latency testing (ARLT) in males and females. The mean, standard deviation and range for latency, on-time and frequency are shown. The results showed that the latency period (L1, L2, L3 and L4) increased as the on-time of the signal increased. This is in contrast with the study by Colletti (1974); Norris (1974); Sunderland (1974); Strasser (1975); Woodford et al. (1975).

The results also revealed that longer onset latencies with an increase in the stimulus for both males and females; this is in contrast with the study by Fertitta and Martin (1973); Borg (1982); and Gorge and Stelmachowicz (1983).

In tables I and II it can be seen that latency value is higher for L3 (Latency from cessation of stimulus to 90'/. ie. 90% off-time) followed by L2, L4 and finally L1.

The results also revealed that the acoustic reflex latency values to be higher in females than in males.

Table II: Normative
females in

Acoustic signal	Ll	L2	L3	L4
a) £00 msec (500 Hz)				
Mean	95.48	163.48	330.13	1£4.72
SD	18.29	21.78	111.44	63.84
Minimum	58	119	107	34
Maximum	132	207	554	252
b) 300 msec (500 Hz)				
Mean	105.41	192.52	320.65	130.46
SD	22.99	39.54	98.10	39.72
Minimum	59	113	124	51
Maximum	151	271	516	£09
c) 300 msec (1000 Hz)				
Mean	104.05	170.77	313.70	151.93
SD	22.08	27.76	105.32	47.14
Minimum	59	115	103	57
Maximum	148	226	524	246
d) 300 msec (1000 Hz)				•
Mean	108.46	225.64	315.61	126.82
SD	30.05	43.28	92.07	34.87
Minimum	48	139	131	57
Maximum	168	312	499	196

Table-III: Normative data of acoustic reflex latency (ms) for males in the age range of 5-15 years using GSI-33.

Acoustic signal	LI	L2	L3	L4
a) 200 msec (500 Hz)				
Mean	94.17	165.83	315.74	143.17
SD	18.01	24.13	120.70	54.53
Minimum	50	124	126	34
Maximum	130	212	557	252
b) 300 msec (500 Hz)				
Mean	102.78	201.04	272.43	126.7
SD	20.88	50.60	96.90	38.36
Minimum	61	99	78	49
Maximum	144	302	466	202
c) 200 msec (1000 Hz)				
Mean	103.04	168.91	286.87	142.52
SD	56.78	32.67	117.47	57.65
Minimum	49	98	100	27
Max imum	156	229	522	257
d) 300 msec (1000 Hz)				
Mean	129.47	218.17	270.17	121.30
SD	79.07	56.26	119.31	32.99
Minimum	28	105	100	55
Max imum	287	330	508	188

Table-IV: Normative data of acoustic reflex latency (ms) for females in the age range of 5-15 years using BSI-33

Acoustic signal	LI	L2	L3	L4
a) S00 msec (500 Hz)				
Mean	99.58	165.88	339.75	159.83
SD	20.41	16.47	117.57	60.27
Minimum	58	132	105	40
Maximum	140	198	574	280
b) 300 msec (500 Hz)				
Mean	103.25	220.42	322.5	133.75
SD	23.17	40.29	105.96	33.56
Minimum	57	140	110	68
Maximum	150	302	534	200
c) 200 msec (1000 Hz)				
Mean	93.12	173.25	322	152.58
SD	19.75	21.08	122.65	43.22
Minimum	54	131	80	66
Max imum	133	215	568	240
d) 300 msec (1000 Hz)				
Mean	102.5	242.92	298.7	128.67
SD	29.58	23.75	105.53	21.20
Minimum	44	195	90	86
Max imum	162	290	510	171

Tables III and IV summarize the results of acoustic reflex latency testing (ARLT) in children both male and female. The mean, standard deviation and range for latency, on-time and frequency *are* shown. The results demonstrate that the latency period (LI, L2, L3 and L4) increased as the on-time of the signal increased and as stimulus frequency is raised.

Results also revealed longer onset latencies as frequency increased in both male and female children.

In Tables III and IV it can be seen that latency value is highest for L3 (90% off time) followed by L2, L4 and finally L1).

Results also revealed that higher acoustic reflex latency was seen in females than in males.

Table-V: Mean, standard deviation and value, probability and coefficient correlat;ion of acoustic reflex latency testing 1between the right and left ear :in males (GSI-33), in the age range of 18-25 years.

Acoustic signal		Ear	Mean	SD	t-value	Probability level
a) S00 msec		R	95.71	6.78	.18910	0.8514 NS
(500 Hz)		L	95.89	6.80		
	L1	R	89.75	15.38	. 1661	0.8695 NS
		L	89.08	13.98		
	L2	R	151.15	14.81	1.0512	0.3032 NS
		L	154.77	16. 14		
	L3	R	285.69	110.30	.4892	0.6290 NS
		L	296.54	102.22		
	L4	R	107.07	52.55	.9020	0.3756 NS
		L	122.15	70.30		
b) 300 msec	L1	R	96.43	22.99	7.155	0.9435 NS
(500 Hz)		L	96.71	20.69		
	L2	R	191.17	41.69	0.463	0.962 NS
		L	190.69	42.53		
	L3	R	285.57	82.86	1.189	0.245 NS
		L	306.78	90. 21		
	L4	R	141.71	100.16	.916	0.367 NS
		L	123.21	52. 29		
c) 800 msec		R	122.14	149.93	1.0046	0.324 NS
(1000 Hz)		L	93. 21	6.899		
	L1	R	89.92	19.69	1 .604	0.121 NS
		L	97.08	22.59		
	L2	R	164.54	18.80	.286	0.777 NS
		L	166	22. 11		
	L3	R	278	83.54	.238	0.813 NS
		L	283.62	92.39		
	L4	R	136.61	32.99	1.856	0.075 NS
		L	152.08	40.88		
d) 300 msec	L1	R	49.71	25.63	.285	0.778 NS
(1000 Hz)		L	100.78	23.57		
	L2	R	226.68	48.73	.251	0.804 NS
		L	225.29	39. 19		
	L3	R	38a.14	85. 10	.558	0.581 NS
		L	292.93	91.77		
	L4	R	119.64	26.79	. 106	0.916 NS
		L	120.43	37. 10		

NS -> Not significance; S -> Significance.

In the table V 't' test was made use of in determining whether there was any significant difference between the right and left ear in males with respect to acoustic reflex latency at *5%* level of significance and the results indicated that there was no significant difference between the right and the left ear inmales at 0.05 level.

Table-Vis Mean, SD, t value, probability correlation of acoustic reflx latency testing between the right and left ear in females (GSI-33) in the age range of 18-25 years.

Acoustic signal		Ear	Mean	SD	t-value	Probability level
a) 200 msec (500 Hz)		R	93.23	6.39	1.608	0.119 NS
		L	90	6.83		
	L1	R	93.67	17.21	.549	0.588 NS
		L	97.33	19.47		
	L2	R	158.65	14.46	1 .899	0.069 NS
		L	168.47	26.66		
	L3	R	339.35	112.09	.629	0.534 NS
		L	320.60	111.85		
	L4	R	117.81	68.08	.518	0.609 NS
		L	131.47	58.37		
b) 300 msec (500 Hz)	L1	R	98.52	18.15	2.600	0.014 S
		L	112.53	25.48		
	L2	R	186.13	35.20	.670	0.508 NS
		L	192.90	55.51		
	L3	R	329.48	101.68	1.070	0.291 NS
		L	301.81	109.04		
	L4	R	124.39	45.26	1.544	0.139 NS
		L	136.73	32.65		
c) 200 msec (1000 Hz)		R	89.68	5.47	.658	0.516
		L	90.65	6.42		
	L1	R	100.34	17.99	1.753	0.090 NS
		L	108.14	25.56		
	L2	R	162.32	21.58	2.519	0.08 S
		L	179.79	31.01		
	L3	R	311.88	111.28	..401	0.691 NS
		L	315.72	100.26		
	L4	R	145.87	44.20	.538	0.594 NS
		L	158.41	50.05		
d) 300 msec (1000 Hz)	L1	R	103.74	29.69	1.226	0.231 NS
		L	113.33	30.12		
	L2	R	224.65	49.18	.505	0.618 NS
		L	226.67	37.04		
	L3	R	309.48	95.05	.647	0.523 NS
		L	321.93	90.05		
	L4	R	123.81	38.102	.716	0.479 NS
		L	129.93	31 .53		

NS -> Not significant; S -> Significance

Table-VII: Mean, SD, t value, probabi1iLty and co-efficient correlation of acoustic reflex latency testing between the right and left ear in males (6SI-33) in the age range of 5-15 years.

Acoustic signal		Ear	Mean	SD	t-value	Probabi1ity level
a) 200 msec (500 Hz)		R	100	5.22	.203	.839 NS
		L	99.55	4.16		
	L1	R	91 .5	19.26	.864	0.408 NS
		L	97.09	16.96		
	L2	R	170.5	27.91	.699	0.500 NS
		L	160.73	19.21		
	L3	R	319	130.57	.719	0.488 NS
		L	312.18	115.20		
	L4	R	194.23	233.64	.709	0.495 NS
		L	152.73	75.39		
b) 300 msec - (500 Hz)	L1	R	102.67	19.64	.588	0.569 NS
		L	102.91	23.12		
	L2	R	202	33.77	. 171	0.868 NS
		L	200	49.50		
	L3	R	263.83	87.07	.615	0.552 NS
		L	281.82	110.13		
	L4	R	130.83	31.52	1.259	0.237 NS
		L	121.09	45.72		
c) 200 msec (1000 Hz)		R	100.83	5.15	0	1.000 NS
		L	100	5.0		
	L1	R	99.33	25.87	.774	0.456 NS
		L	107.09	28.4		
	L2	R	169.83	31.46	.802	0.441 NS
		L	202.91	137.67		
	L3	R	294.00	135.76	1.036	0.325 NS
		L	279.09	99.80		
	L4	R	143	67.33	5.806	0.954 NS
		L	142	48.20		
d) 300 msec (1000 Hz)	L1	R	204.67	225.44	1.3862	0.196 NS
		L	111.09	26.96		
	LS	R	220	54.41	.030	0.976 NS
		L	216.18	60.82		
	L3	R	288.83	139.10	2.195	0.053 NS
		L	249.82	95.70		
	L4	R	125.5	37.53	1.276	0.231 NS
		L	116.73	28.29		

NS -> Not significant; S —> Significant.

Table-VIII: Mean, SD, t value, probaility and correlation of acoustic reflex latency testing between the right and left ear in females (GSI-33) in the age range of 5-15 years.

Acoustic signal		Ear	Mean	SD	t-value	Probability level
a) 200 msec		R	97.23	5.64		
(500 Hz)		L	98.75	5.69	.265	0.736 NS
	L1	R	97.67	20.66	.188	0.856 NS
		L	101.5	20.89		
	L2	R	162.5	16.32	.244	0.812 NS
		L	167.67	16.92		
	L3	R	360.0	125.13	1.597	0.141 NS
		L	319.5	111.13		
	L4	R	148.17	57.06		
		L	171.5	63.57	.766	0.464 NS
b) 300 msec	L1	R	100.17	22.65		
(500 Hz)		L	106.33	24.25	.628	0.544 NS
	L2	R	210.33	31.84		
		L	230.5	46.47	1.156	0.275 NS
	L3	R	33	94.65		
		L	332	119.67	.240	0.815 NS
	L4	R	124.33	26.38		
		L	209.83	221.59	1.254	0.238 NS
c) 200 msec		R	95	4.26		
(1000 Hz)		L	96.25	3.12	.362	0.724 NS
	L1	R	93.5	15.07		
		L	86.08	34.99	0.674	0.54 NS
	L2	R	177.67	21.11		
		L	168.83	21.00	1.157	0.274 NS
	L3	R	314.5	131.86		
		L	337.83	133.72	0.409	0.691 NS
	L4	R	146.17	45.23		
		L	159	42.07	0.794	0.445 NS
d) 300 msec	L1	R	96.17	25.45	0.951	0.364 NS
(1000 Hz)		L	108.83	33.09		
	L2	R	242.83	20.40	8.288	0.935 NS
		L	243	27.63		
	L3	R	301.33	89.98	0.322	0.754 NS
		L	295	123.17		
	L4	R	120.67	11.67		
		L	136.67	25.76	2.229	0.050 NS

NS —> Not significance —> Significance

From Tables VII and VIII it is evident that all the probability values *are* greater than the 0.05 level. Hence there is no significant difference between the right and left ears in males and females for acoustic reflex latency threshold at 5% level of significance.

It is also evident from Tables VII and VIII that the mean and standard deviation for males in right *ear* was higher when compared to left ear but in females left *ear* predominated over the right ear both in mean and standard deviation.

Administering the 't' test showed that there was no sex difference except for 2 stimulus on time ie. 10% on time for 300 msec. (500 Hz) and 200 msec (1000 Hz) where a significant difference was noticed. These results are shown in Table IX. The results in Table IX also revealed higher mean and standard deviation for males and females.

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From Table X with regard to acoustic reflex latency testing no sex difference was noticed in children when data obtained using the GSI—33 Middle Ear Analyzer version-2. However results showed higher mean and standard deviation for females compared to those females.

Table-IXj Mean, SD, t value, probability of acoustic reflex latency testing 1between males and females (6SI-33) in the age range of :18-25 years.

Acoustic signal		Ear	Mean	SD	t-value	Probability level
a) 200 msec		F	91.61	6.76		
(500 Hz)		M	96.63	6.74	3.586	0.0005 S
	L1	F	95.47	1B.29	1.9138	0.058 NS
		M	89.52	14.59		
	L£	F	163.48	21.74	2.7267	0.0074 S
		M	153.89	15.44		
	L3	F	330.13	111.44	1.8194	0.714 NS
		M	293.54	105.89		
	L4	F	124.72	63.84	.6444	0.5206 NS
		M	115.14	61.58		
b) 300 msec	L1	F	105.41	22,.99	2.1176	0.0363 S
(500 Hz)		M	96.72	21,.68		
	LS	F	192.52	46,.22		
		M	192.03	41,76	0.31388	0.7542 NS
	L3	F	310.65	98,.10	1.0492	0.2962 NS
		M	297,.10	86,.39		
	L4	F	130.46	39,.72	.2289	0.8318 NS
		M	119,.41	49,.96		
c) 200 msec		F	90,.16	5.,93		
(1000 Hz)		M	93,.53	6..86	1.2850	0.2013 NS
	L1	F	104,,05	22.,08		
		M	94,.10	21.,39	2.4696	0.0150 NS
	L2	F	170..77	27.,76		
		li	165,.43	20.,37	1.1737	0.2429 NS
	L3	F	313.,70	105.,32		
		M	286..29	87.,56	1.5237	0.1303 NS
	L4	F	151,93	47.,14		
		M	146..75	37.,77	1.2227	0.2239 NS
d) 300 msec	L1	F	108.,46	30.05	1.68714	0.0942 NS
(1000 Hz)		M	99.,96	24.42		
	L2	F	225.,64	43.28		
		M	226.09	43.84	5.5944	0.9555 NS
	L3	F	315.,61	92.07		
		M	290.45	87.90	15231	0.1304 NS
	L4	F	126.82	34.87		
		M	119.83	32.08	1.1366	0.2580 NS

NS -> Not significance ; S -> Significance.

Table-X: Mean, SD, t-value, probability of acoustic reflex latency testing between males and females (GSI-33) in the age range of !5-15 years

Acoustic signal and parameters		Sex	Mean	SD	t-value	Probability level
a) 200 msec (500 Hz)		M	99.78	4.64		
		F	98.17	5.56	1.0075	0.3192 NS
	L1	M	94.17	18.0		
		F	99.58	20.41	.96176	0.3413 NS
	L2	M	165.83	24.13		
		F	165.08	16.47	.1237	0.9021 NS
	L3	M	315.74	120.70		
		F	339.75	117.57	.6908	0.4932 NS
	L4	M	143.17	54.53		
		F	159.83	60.27	.5460	0.5878 NS
b) 300 msec (500 Hz)	L1	M	102.78	20.88		
		F	103.55	23.17	7.255	0.9425 NS
	L2	M	20.04	50.59		
		F	220.42	40.29	1.455	0.1526 NS
	L3	M	272.43	96.89		
		F	322.5	105.96	1.688	0.0983 NS
	L4	M	126.7	38.36		
		F	133.75	33.56	1.1905	0.2401 NS
c) S00 msec (1000 Hz)		M	100.43	4.98		
		F	95.63	3.70	3.7677	0.0005 S
	L1	M	103.04	26.78		
		F	93.12	19.75	1.6592	0.1039 NS
	LS	M	163.91	32.67		
		F	173.25	21.08	.6121	0.5435 NS
	L3	M	286.87	117.47		
		F	322.0	122.65	1.0838	0.2842 NS
	L4	M	142.52	57.65		
		F	152.58	43.22	.6789	0.5006 NS
d) 300 msec (1000 Hz)	L1	M	129.47	79.07		
		F	102.5	29.58	1.6541	0.1051 NS
	L2	M	218.17	56.26		
		F	242.92	23.75	1.9789	0.0540 NS
	L3	M	270.17	119.31		
		F	298.17	105.33	.8528	0.3982 NS
	L4	M	221.30	32.99		
		F	228.67	21.19	.9142	0.3655 NS

NS -> Not significance s -> Significance

Table-XI: Mean, SD, t-value, Probability and coefficient correlation between 200 msec and 300 msec in right ear and left ear at 500 Hz and 1000 Hz in males in the age range of 18-25 years.

Parameters		Ear	Mean	SD	t-value	Probability level
a) 500 Hz	L1	R	89.52	14.59	2.4274	0.0222 S
	L2	R	153.89	15.44	6.3196	0 S
	L3	R	293.54	105.5	1.9001	0.9850 NS
	L4	R	115.14	61.58	1.3287	0.1950 NS
b) 500 Hz	L1	L	89.85	13.98		
			96.89	20.70	1.3572	0.1873 NS
	L2	L	155.57	16.14		
			192.87	42.53	4.4137	0.0001 S
	L3	L	300.36	102.22		
			306.69	90.21	.2224	0.8257 NS
	L4	L	119.29	70.2		
			124.76	52.29	.32669	0.7465 NS
c) 1000 Hz	L1	R	90.07	19.70	2.4489	0.0211 S
			99.03	25.63		
	L2	R	164.29	18.79	8.3349	0 S
			226.79	48.73		
	L3	R	279.21	83.54	.2018	.8415 NS
			284.89	85.10		
	L4	R	138.36	32.99	2.7986	0.0094 S
			119.24	26.79		
d) 10000 Hz	L1	L	98.14	22.59		
			100.89	23.57	.70186	0.4888 NS
	L2	L	166.57	22.11		
			225.38	39.19	9.1307	0 S
	L3	L	293.36	92.39		
			296	91.77	.1359	0.8929 NS
	L4	L	155.14	40.88		
			120.41	37.10	7.045	0 S

NS -> Not significance; S -> Significance

Table-XIII Mean, SD, t-value. Probability and correlation between 200 msec and 300 msec in right *ear* and left ear at 500 Hz and 1000 Hz in females in the age range of 18-25 years.

Parameters		Ear	Mean	SD	t-value	Probability level
a) 500 Hz	L1	R	93.68	17.21		
			98.52	18.15	2.3843	0.0236 S
	L2	R	158.65	14.46		
			186.13	35.20	5.2723	0 s
	L3	R	339.35	112.09		
			329.48	101.67	.6334	0.5313 NS
	L4	R	117.81	68.08		
			124.38	45.26	.4732	0.6394 NS
b) 500 Hz	L1	L	97.33	19.47		
			112.53	25.48	4.901	0 S
	L2	L	168.46	26.66		
			192.90	55.51	4.8803	0 S
	L3	L	320.6	111.85		
			301.81	109.04	.5139	0.6113 NS
	L4	L	131.46	63.03		
			136.73	32.65	.8472	0.4040 NS
c> 1000 Hz	L1	R	100.34	17.99		
			103.74	29.69	.5385	0.5942 NS
	L2	R	162.32	21.58		
			224.65	49.18	6.1510	0 S
	L3	R	311.87	111.27		
			309.48	95.05	3.1639	0.9750 NS
	L4	R	145.87	44.19		
			123.81	38.10	1.8275	0.0776 NS
d) 10000 Hz	L1	L	108.14	25.56		
			113.33	30.11	1.0179	0.3174 NS
	L2	L	179.79	31.01		
			226.66	37.03	5.2325	0 S
	L3	L	315.72	100.26		
			321.93	90.05	.8263	0.4156 NS
	L4	L	158.41	50.04		
			129.93	31.53	3.4619	0.0017 S

NS -> Not significance; S -> Significance

Table-XIII: Mean„ SD, t-value, probability and correlation between 200 msec <and 300 msec in right ear and left ear at 500 Hz and 1000 Hz in males in the age range of 5-15 years.

Parameters		Ear	Mean	SD	t-value	Probability level
a) 500 Hz	L1	R	91.5	19.26		
			102.66	19.63	1.4814	0.1666 NS
	L2	R	170.5	27.91		
			202	53.77	2.8922	0.0146 S
	L3	R	319	130.57		
			263.83	87.07	2.8146	0.0168 S
	L4	R	194.23	233.63		
			130.83	31.52	1.0283	0.3259 NS
b) 500 Hz	L1	L	97.09	16.96		
			102.91	20.12	1.8537	0.0935 NS
	L2	L	160.73	19.21		
			200	49.50	3.3974	0.0068 S
	L3	L	312.18	115.20		
			281.82	110.13	2.9150	0.0154 S
	L4	L	152.73	75.40		
			121.09	45.72	1.9164	0.0843 NS
c) 1000 Hz	L1	R	99.33	25.87		
			204.66	225.44	1.5377	0.1524 NS
	L2	R	169.83	31.45		
			220	54.41	4.1952	0.0015 S
	L3	R	294	135.76		
			288.83	139.10	0.2696	0.7925 NS
	L4	R	143	67.33		
			125.5	37.53	1.6337	0.1306 NS
d) 1000 Hz	L1	L	107.09	28.40		
			111.09	26.96	0.7023	0.4985 NS
	L2	L	202.91	137.67		
			216.18	80.82	0.3330	0.7460 NS
	L3	L	279.09	99.79		
			249.82	95.69	1.6474	0.1305 NS
	L4	L	142	48.19		
			116.73	28.29	2.9916	0.0135 S

NS -> Not significance; S -> Significance

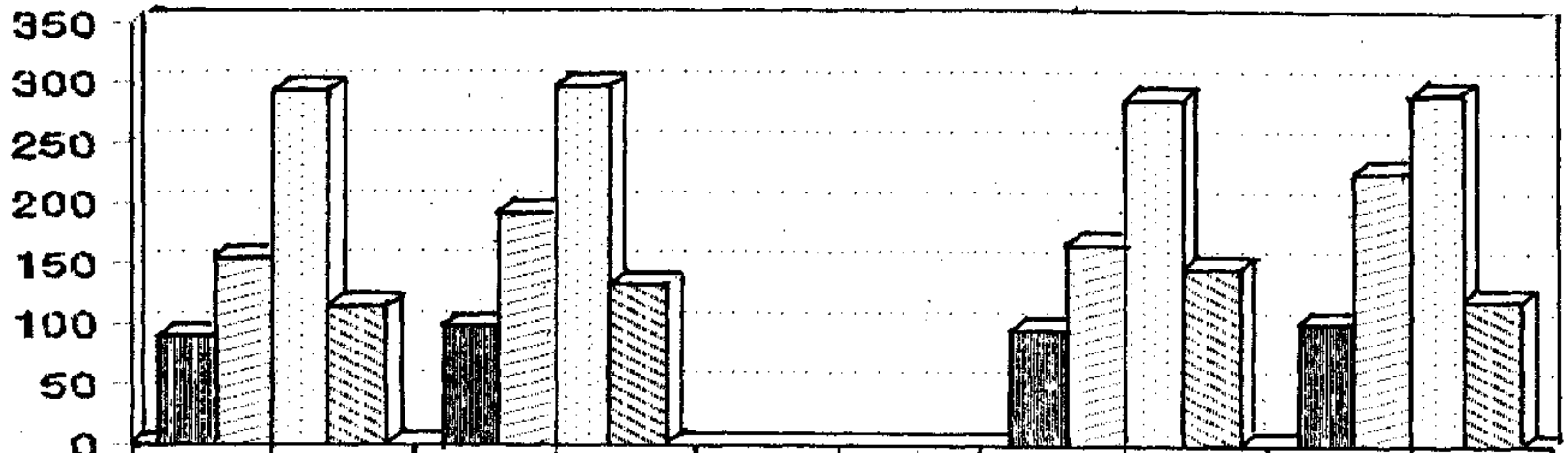
Table-XIV: Mean,, SD, t-value, probabiliLty and correlation between S00 msec and 300 msec in right ear and left ear at 500 Hz and 1000 Hz in females in the age range of 5—15 years.

Parameters		Ear	Mean	SD	t-value	Probability level
a) 500 Hz	L1	R	97.67	20.66		
			100.17	22.65	.5961	.5631 NS
	L2	R	162.5	16.32		
			210.33	31.83	6.0794	0.00 S
	L3	R	360	125.13		
			313	94.65	2.3559	0.0381 S
	L4	R	148.17	57.06		
			124.33	26.38	1.4482	0.1754 NS
b) 500 Hz	L1	L	101.5	20.89		
			106.33	24.15	1.6113	0.1354 NS
	L2	L	167.66	16.92		
			230.5	46.47	5.1485	0.0003 S
	L3	L	319.5	111.13		
			332	119.67	.4078	0.6912 NS
	L4	L	171.5	63.57		
			209.83	221.59	.5411	0.5992 NS
c) 1000 Hz	L1	R	93.5	15.07		
			96.17	25.45	.4345	0.6723 NS
	L2	R	177.67	21.11		
			242.83	20.40	10.757	0 S
	L3	R	314.5	131.86		
			301.3	89.98	.7101	0.4924 NS
	L4	R	146.17	45.23		
			120.67	11.67	1.9845	0.0727 NS
d) 10000 Hz	L1	L	87.08	34.99		
			108.83	33.09	2.5461	0.0272 S
	L2	L	168.83	21.00		
			243	27.63	11.7405	0.0 S
	L3	L	337.83	133.72		
			295	123.16	1.9732	0.8317 NS
	L4	L	159	42.07		
			136.67	25.76	1.9515	0.0769 NS

NS-> Not significance; S -> Significance.

From Tables XI and XII it is evident that half of the parameters of probability values are below the 0.05 level of significance. hence there is a significant difference between two different stimulus on time (ie. S00 msec. vs. 300 msec) in both males and females of 500 Hz ad 1000 Hz.

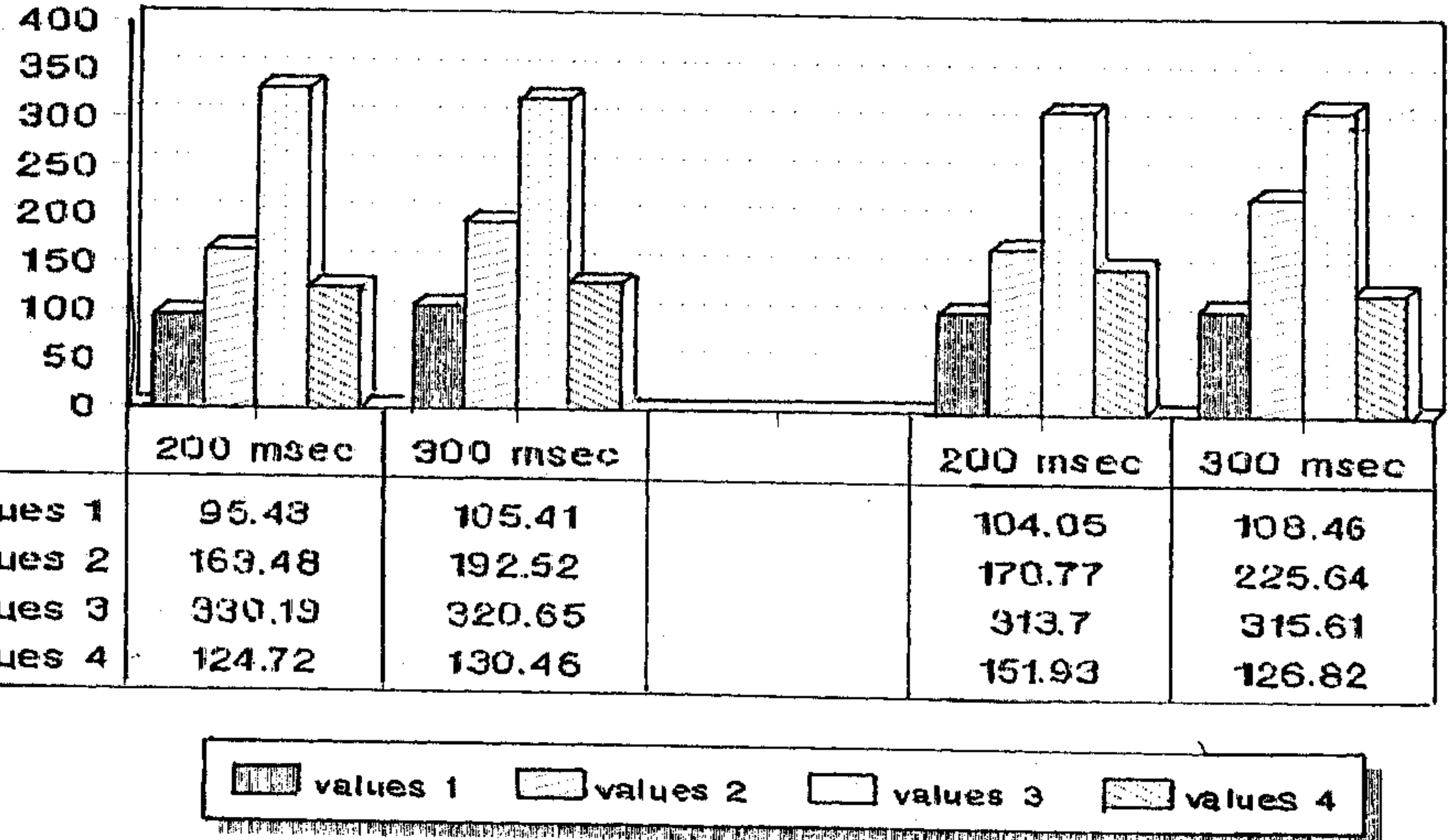
From Tables XIII and XIV it is evident that half of the parameters of probability values *are* lower than the expected value of 0.05 level of significance. Hence there is a significant sex difference in children between the two different stimulus on time (ie. S00 msec. vs. 300 msec) at 500 Hz and 1000 Hz.



	200 msec	300 msec		200 msec	300 msec
values 1	89.52	96.72		94.11	99.97
values 2	153.89	192.03		165.43	226.09
values 3	293.54	297.1		286.29	290.45
values 4	115.14	132.89		146.75	119.83

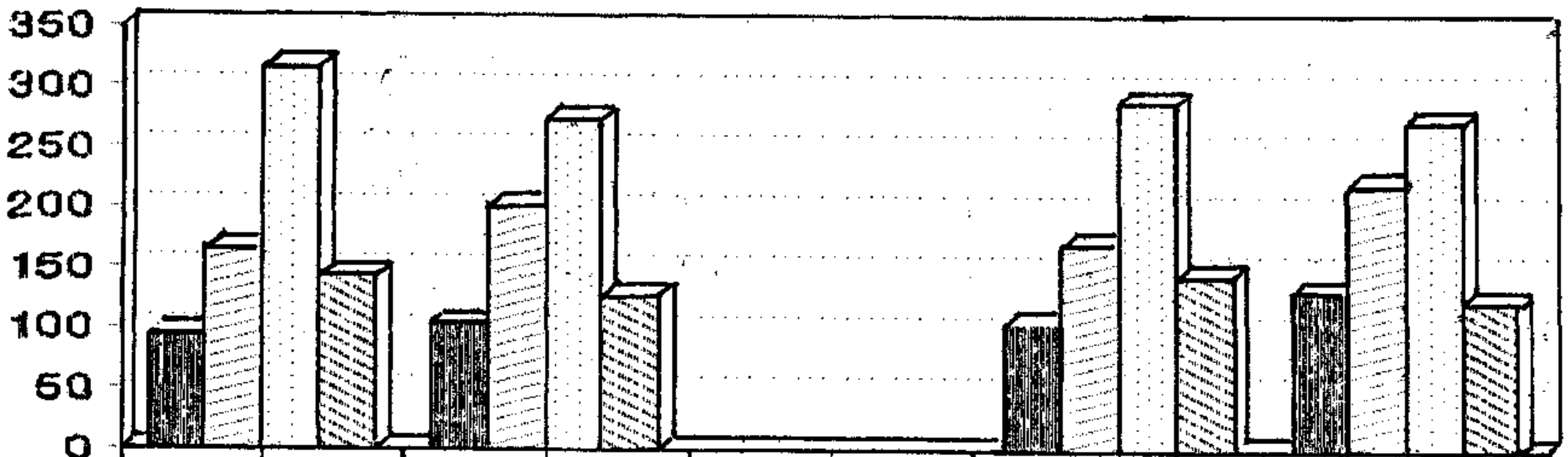
values 1 values 2 values 3 values 4

Graph-1: Representing acoustic reflex latency values for males
(18 to 25 years)



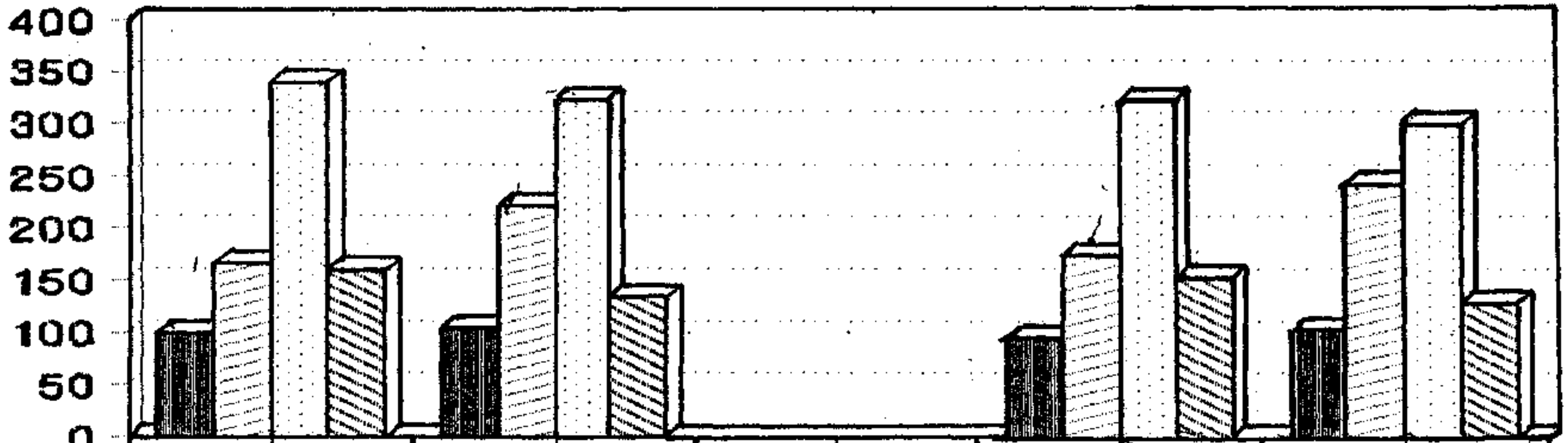
	200 msec	300 msec		200 msec	300 msec
values 1	95.43	105.41		104.05	108.46
values 2	163.48	192.52		170.77	225.64
values 3	330.19	320.65		313.7	315.61
values 4	124.72	130.46		151.93	126.82

Graph-2: Representing acoustic reflex latency values for females (18 to 25 years)



	200 msec	300 msec		200 msec	300 msec
values 1	94.17	102.78		103.04	129.47
values 2	165.83	201.04		168.91	218.17
values 3	315.74	272.43		286.87	270.17
values 4	143.17	126.17		142.52	121.3

Graph-3: Representing acoustic reflex latency values for males (5 to 15 years)



	200 msec	300 msec		200 msec	300 msec
values 1	99.58	103.25		93.12	102.5
values 2	165.88	220.42		173.25	242.92
values 3	339.75	322.5		322	298.17
values 4	159.83	133.75		152.58	128.67

values 1 values 2 values 3 values 4

Graph-4: representing acoustic reflex latency values for females (5 to 15 years)

DISCUSSION

The purpose of this investigation was to establish norms for acoustic reflex latency testing in normal adults and children and to investigate the effect of acoustic signal on-time and effect of stimulus frequency on latency parameters in a normal hearing population. Acoustic reflex threshold in normal humans has been found to vary with stimulus duration, type of stimulus and age of the subject. Latency is contingent in ART; thus, signal parameters which effect threshold will effect latency.

Moller (1974) has discussed the difficulty involved in quantifying the acoustic reflex. Based on investigations with both human and animal subjects (Borg, 1972; Moller, 1962), a value of 10 percent of the maximal obtainable impedance change of the acoustic reflex has been defined as threshold. This 10*/. value is considered a sensitivity measure of the acoustic reflex. This study has defined quantitative threshold as the point of impedance change; this is in contrast with the study by McPherson and Thompson (1978), Strasser (1975) and Sunderland (1975). It is believed that the definition of threshold as the point of impedance change is a more reliable method than the 10% criteria suggested by Moller (1974). Using the point of impedance change as threshold would provide a specific point from which to measure latency regardless of whether the initial impedance change was in positive or negative direction.

One purpose of this study was to examine the effect of signal on-time and effect of stimulus frequency on latency. Results demonstrated a linear relationship ie. an increase in latency with increasing on-time and increasing frequency of the acoustic signal. This data is in agreement with Sunderland (1974); Fertitta and Martin (1973), Borg (198S) and Gorga and Stelmachowicz <1983>.

Latency values measured by Sunderland (1974), and in this study, show that latency increases as signal on-time increases, the results of this study is in consonance with that of McPherson and Thompson (1978). However, the absolute values differ. There *are* two possible explanation for the differing numerical values (1) differences in the frequencies of the acoustic stimulus; and (2) differences in the recording methods used.

Sunderland used a 1000 Hz acoustic stimulus and a polygraph to record acoustic reflex response. McPherson and Thompson (1978) used a 2000 Hz acoustic stimuli and an oscilloscope to record reflex activity. This study used 500 Hz and 1000 Hz acoustic stimuli and an automatic monitor screening to record reflex activity. However, it is felt that the difference in stimulus frequencies employed could be a contributing factor.

The L1 latency is the actual latency of the reflex while the difference of Ls (total response time) and L1 is the true latency of the acoustic reflex testing.

SUMMARY AND CONCLUSION

This study aimed to establish norms for the Middle Ear Analyzer (GSI-33) for acoustic reflex latency threshold in (18-28 years) males and females adults (18-28 years) as well as in children (5-15 years).

Furthermore, it examined the effect of stimulus on-time and frequency changes in relation to changes in the acoustic reflex latency parameters.

This study was carried out in a sound treated test room where ambient noise level met the ISO (1969) criteria. A total of sixty adults (30 males and 30 females) within the age range of 8 to 28 years and 23 children (11 males and 12 females) with in the age range of 5 to 15 years; having normal hearing, were taken for the study. Subjects were tested using Middle Ear Analyzer (6SI-33) on 166 ears (83 right and 83 left ear) at a pressure rate of 200 dapa /second for a 226 Hz probe tone.

A carefully controlled and monitored 500 Hz and 1000 Hz acoustic signal with two different on-time (200 msec and 300 msec) was presented 10 dB above each subject's clinical reflex threshold. The acoustic reflex latency response was obtained on a screen and later analyzed. Mean values and standard deviation for the latency parameters were determined.

The results were subjected to statistical analysis using parametric statistical test - paired and unpaired 't' test. The following conclusions were drawn based- on the statistical analysis.

1) Normative data for acoustic reflex latency threshold obtained using the Middle Ear Analyzer (6SI-33) for adults and children *are* depicted in Table I, II, III and IV.

2) There was no significant interaural and sex difference for acoustic reflex latency scores.

3) It has been proposed that latency be defined from the point of impedance change (quantitative reflex threshold) rather than from signal onset. The purpose of this definition is to provide a less variable latency measure.

4) Comparisons of latency values obtained revealed higher latency value for L3 (Latency from cessation of stimulus to 90% ie. 90% off-time) followed by L2, L4 and finally LI.

5) The results demonstrated that the latency value (LI, L2, L3 and L4) increases as the on-time of the signal increases and when stimulus frequency is increased.

6) Results revealed higher acoustic reflex latency values in females than males both in adults and in children.

7) There was no significant sex difference with regard to acoustic reflex latency value. However, results showed higher mean and standard deviation for males as compared to females in adults whereas in children females showed higher values than boys.

8) There was a significant difference between two different stimulus on time (ie. 200 msec vs. 300 msec) at 500 Hz and 1000 Hz irrespective of age and sex of the subject.

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APPENDIX - I

The GSI 33 version £ Middle Ear Analyzer (MEA) is a high tech, microprocessor - based admittance instrument designed to be used in a clinical or research setting. It contains total capabilities for complete, automatic or manual diagnostic testing for analysis of middle ear function. Admittance (Y), and its components susceptance (B) and conductance (G), may be measured with probe tone frequency of 226 Hz, 678 Hz and 1 KHz. The extensive battery of test mode choices include diagnostic tympanometry, acoustic reflex threshold and decay measurements, eustachian tube function testing, screening tympanometry, acoustic reflex latency testing, acoustic reflex sensitization and multiple frequency tympanometry (250 Hz to 2 KHz). The operator has a choice of 3 mountings to support the probe box; the standard clothes clip, as an optional operator wrist attachment. The probe box has two LEOs to indicate test status and also a right and left switch to designate the *ear* to be tested. The GSI-33 calculates gradient as the average of the compliance points at an interval of plus *or* minus 50 dapa. In GSI 33 the contralateral stimuli is presented through an insert receiver. GSI-33 was calibrated according to the specifications given by ANSI S3.39-1987), ANSI S3.6-1969, (R 1986), IEC 645-1979, IEC 126-1961, ISO 389-1975 and UL 544 Listed Hospital and Dental Equipment. (GSI 33 version 2 MEA

Instruction Manual, 1989). More in depth analysis of the acoustic reflexes, such as latency characteristics and the effects of high frequency sensitization, is possible with such sophisticated equipment. The need for manually written reports and bulky patient files even is being reduced. Test data may be stored in instrument memory and recalled *for* review prior to being transferred via an RS S3S interface to a PC.

APPENDIX-II

Acceptable Noise Levels for Audiometry

(SPL - Sound Pressure Level)

Test Frequency	Under earphones only (In dB SPL) MX-41 AR cushions		Sound field or bone conduction (in dB SPL)	
	Octave Band	1/3 Octave Band	Octave Band	1/3 Octave band
125	34.5	29.5	28.0	23.0
250	23.0	18.5	18.5	13.5
500	21.5	16.5	14.5	9.5
750	22.5	17.5	12.5	7.5
1000	29.5	24.5	14.0	9.0
1500	29.0	24.0	10.5	5.5
2000	34.5	29.5	8.5	3.5
3000	39.0	34.0	8.5	3.5
4000	42.0	37.0	9.0	4.0
6000	41.0	36.0	0	0
8000	45.0	40.0	20.5	15.5

Table: Acceptable noise levels (in dB SPL; in audiometric test rooms when testing is expected toreach 'O' dB HL (American National Standards Institute ANSI, 1977)