TO MY FATHER

A COMPARATIVE STUDY ON THE REFLEX AMPLITUDE AND DECAY TIME FOR CONTRA LATERAL AND IPSILATERAL STIMULATION AT DIFFERENT FREQUENCIES AND AT DIFFERENT SENSATION LEVELS IN NORMALS

A DISSERTATION SUBMITTED IN PART FULFILMENT

FOR THE DEGREE OF MASTER OF SCIENCE

(SPEECH & HEARING)

UNIVERSITY OF MYSORE, 1980

CERTIFICATE

This is to certify that the Dissertation entitled " A COMPARATIVE STUDY ON THE REFLEX AMPLITUDE AND DECAY TIME FOR CONTRALATERAL AND IPSILATERAL STIMULATION AT DIFFERENT FREQUENCIES AND AT DIFFERENT SENSATION LEVELS IN NORMALS "is the bonafide work in part fulfillment for the Degree of Master of Science in speech and Hearing, Carrying 100 marks of the student with Register No. 3

N. Rathna 31/10/80
Director, I/C
All India Institute of Speech & Hearing,
Mysore-6.

CERTIFICATE

This is to certify that this Dissertation has been prepared under my supervision and guidance.

Oct 31 '80

GUIDE.

DECLARATION

This Dissertation is the result of my own study undertaken under the guidance of Mr. J.D. Samuel, Lecturer in Audiology, All India Institute of Speech & Hearing, and has not been submitted earlier at any University for any other Diploma or Degree.

Mysore.

October

Register No. 3

ACKNOWLEDGEMENT

I acknowledge my indebtedness to my guide Mr. J. Dayalan Samuel, Lecturer in Audiology, for his valuable guidance.

I am grateful to Mr. M.N. Vyasmurthy for his advise and valuable discussions which were essential throughout the study.

I am indebted to Dr. N. Rathna, Director, AIISH, for the help and advise given to me.

I am especially grateful to Dr. (Miss.) S. Nikam, Professor and Head of the Department of Audiology for making available the research materials connected with the study.

I wish to express my gratitude to Miss. Rajalakshmi for the constant encouragement and support which she has given me throughout the study.

The co-operation of the subjects, many of when spent a considerable amount of time in unpalatable experimental conditions, was unfailing and I would like to extend my thanks to them all.

Most of all, I acknowledge my indebtedness to Mr. M.R. Jayaraja Urs, for the neat and quick typing of the manuscript.

And also I am grateful to Mr. H.S. Gopal, whose suggestions and constructive criticisms were desirable.

I am also grateful to Ravi Shankar, K.C., Venugopal, K.M.V. Bhat, V. Aithal (M.Sc., Students), and Umadevi (II Bsc., Student) for their co-operative throughout the study.

To all those mentioned, I owe a great deal. There are many others, who helped, one way or the other, and I say them "Thank You".

TABLE CONSTANTS

LIST OF TABLES

LIST OF FIGURES

FIGURES PAGE

13. Stapedial reflex amplitudes at 500 Hz, at different sensation levels, for ipsileteral (left probe) and contralateral (left ear phone, right probe) stimulation 38e

14. Stapedial reflex amplitudes at 1000 Hz, at different sensation levels, for ipsileteral (left probe) and contralateral (left ear phone, right probe) stimulation. 38f

15. Stapedial reflex amplitudes at 2000 Hz, at different sensation levels, for ipsileteral (left probe) and contralateral (left ear phone, right probe) stimulation. 38g

16. Stapedial reflex amplitudes at 4000 Hz, at different sensation levels, for ipsileteral (left probe) and contralateral (left ear phone, right probe) stimulation 38h

17. Stapedial reflex amplitudes versus frequency for contralater (right ear phone, left probe) and ipsilateral (left probe) stimulation. 40a

18. Stapedial reflex amplitudes versus frequency for contralater (left ear phone, right probe) and ipsilateral (left probe) stimulation. 40b

CHAPTER – I

I N T R O D U C T I O N

The advent of impedance audiometry has added new scope and dimension to clinical audiology (Deutsh, 1972). Measurement of functional integrity which was not a concern of audiologists became the most important concern of their profession. Once audiologists were concerned with only hearing measurement and aural rehabilitation. The sincere and hardwork of audiologists have gained them an important role in otologic diagnosis, especially where otoscopy reveals no clues. Thus impedance audiometry has enhanced the horizon of diagnostic capabilities of audiologist.

Impedance audiometry finds application in every phase of clinical audiology. without it, hearing evaluation is incomplete, once it was considered as only a test for middle ear, but now it is applied everywhere; let it be screening, site of lesion or even hearing aid fitting.

In 1971, only 15% of the audiologist used impedance audiometry, where as in 1977 only 15% of audiologists do not use it in regular hearing evaluation (Martin and Pennington 1971) That reveals the excitement, impedance has created among audiologists. Even other fields like pediatrics speech pathology and neurology use it their diagnostics.

It appears now as though audiologists would be handicapped without it. This could be best illustrated by quoting Jerger[1], who says, “we fnkly wonder how we ever got along without it”.

The impedence measuring technique can be easily mastered, valid and meaningful results could be obtained for almost every patient and with some reservations, the data of impedance audiometry constitute extremely valuable diagnostic information. Beyond that “the measuring technique is objective, non-invasive and economical procedure” (Ransone, 1977).

Impedence measurement includes tympanometry, static compliance and stepedius reflex test. Tympanometry and static compliance forms the relative impedance measurement, while elicitation of stepedial reflex consitututes the obsolute impedance measurement.

Tympanometry was first described by Terkildson and Thomson in 1954. Tympanometry is an objective procedure which measures the change in sound pressure level of on injected tone in on hermetrically sealed ear canal at veryng air pressures, usually from positive 200 mm to negative 400 mm H_2o. The sound pressure level changes are measured in terms of volume. The volume is estimated in terms of cubic centimeters and are plotted against different air pressures. Such a graph is known as

---

1 James Jerger (1970)
“Clinical experience with impedance Audiometry”, Archives of Oto. Laryngeal 92 (1970), 311-24.

‘Tymanogram’ which indicates the mobility of a tympanic membrane and the associated ossiculer chain.

The analysis of typonograms in terms of pressure status of the middle ear space, amplitude and shape provided information which can help identify pathologies as well as differentiate between them (Feldman, 1976).

The static acoustic compliance or impedance measurement refers to the determination f the obsolete magnitude of either of these two reciprocal expressions of energy transfer, In electro acoustic measurements they are derived by measuring the flow of energy when the ear drum is held in a rigid position by a positive or negative air pressure and comparing it with the flow either at ambient atmospheric pressure or at some other point of peak flow, The difference between these two is en index of static compliance at the drum. The acoustic impedance value as such is simply too variable for accurate diagnosis.

The most exciting portion of impedance audiometry actually lies in the last test, which determines the stapedial reflex. The stepedius is a small muscle situated at the end of the osscicular chain most distant from the tympanic membrane. Stapedius reflex is nothing but the contraction of this stapedius muscle. Contraction of the stapedius muscle, can be made by acoustically and non-acoustically, when it contracts it alters the stiffness of the whole ossicular chain and the middle ear system. This can be seen as a change in the impedance in the impedance balance meter. Terkildson et al. (1970) have suggested that the deflection o the needle is proportional to the change of impedance.

The registration of changes in the acoustic impendance is a convenient method for the investigation of the stapedial reflex, because it may be performed without discomfort to the patient.

Of the three measures of impedance audiometry, the stapeidal reflex thresholds are probably most useful individually (Jerger. 1970) Relative impedance changes while not as diagnostic as absolute, comparisons can lend support to the interpretation of impedence measurement.

The stapedial reflex threshold is defined as the lowest intensity at which a visible or recordable defection of the impedance balance needle occurs consistently with stimulus presentation.

Considerable variations can be found in the literature dealing with threshold of the stapedial reflex in man. Weiss, et al (1962), while determining the threshold level of the human stapedius reflex found mean values of 96 to 107 dB spl. for 400 to 6400 Hz range. Hall (1972) reported the stapedius reflex thresholds for 500 to 2000 Hz in normal ears in general, range between 70 and 100 db HTL. However it is generally agreed that a normal hearing subject exhibits acoustic reflex threshold in the range of 85 to 95 dB HL, for pure tones.

The great value of the electro acoustic impedance bridge for middle ear reflex measurement was widely recognized and variety of new tests were suggested to further increase its usefulness. Based on the pioneering efforts of Metz (1946), subsequent workers have refined instrumentation and technique to produce on invaluable tool for differential diagnosis. One example of this is, measurement of ipsilateral reflex.

In ipsilateral reflex or uncrossed reflex, stimulation and measurement are performed in the same ear, whereas in contralateral reflex or crossed reflex test, ne ear (test ear) is stimulated, while measurement is done in the opposite ear.

Need for the study

It is frequently taken for granted that the acoustically evoked stapedius reflex is bilaterally symmetrical. Moller (1962) described an asymmetry of the acoustic stapedius reflex with an ipsilaterally 2 to 14 dB lower threshold.

Reker (1977) reported the median value of the ipsilateral reflex thresholds. They are 59 dB at 500 Hz, 62.5 at 1000 Hz, 67 dB at 2000 Hz and 67 dB at 4000 Hz. The difference between ipsilateral and contrelateral stapedius reflex thresholds was in the range of 15 dB.

The contrelateral reflex are is different from silateral reflex are: Fig. 1 indicates the probable connections within the brain stem between the afferent and efferent sides of the stapedial reflex are. It shows how impulses travelling from right cochlea up the VIII nerve and arriving at right Cochlear nucleus reach the facial nerve nucleus on both sides. Hence the bilateral nature of the stapedial reflex. It also shows, ipsofacts the ipsilateral acoustic reflex pathway. The figure illustrates the important concept that the contralateral reflex arch involves neurons which cross the midline, where as ipsilateral are does not.

There studies leave an impression that there may be stapedial reflex amplitude differences between contralteral stimulation and ipsilateral stimulation.

Puropose of the study:

It was sought to study the stapedius reflex amplitudes for impsilateral and contralaeral stimulation and to arrive at some general conclusions regarding the differences, it existed.

Definitions of the terms used

Acoustic Reflex threshold:- Acoustic reflex threshold is the intensity (in dBs) which is capable of inducing a reflex contraction of stapedius muscle, as induced by comptaince change in the impedance of the tympanic membrane. (Jespan 1966).

Contrelateral Reflex:- The acoustic reflex monitored in one ear and stimulated contralateral ear. (Feldman and Wilber).

Ipsilateral Reflex:- The acoustic reflex monitored on the same side as the reflex – inducing stimulus is presented (Feldman and Wilber).

Reflex:- Reflex is a regulatory and control processes in all living organisms (Borg, 1972).

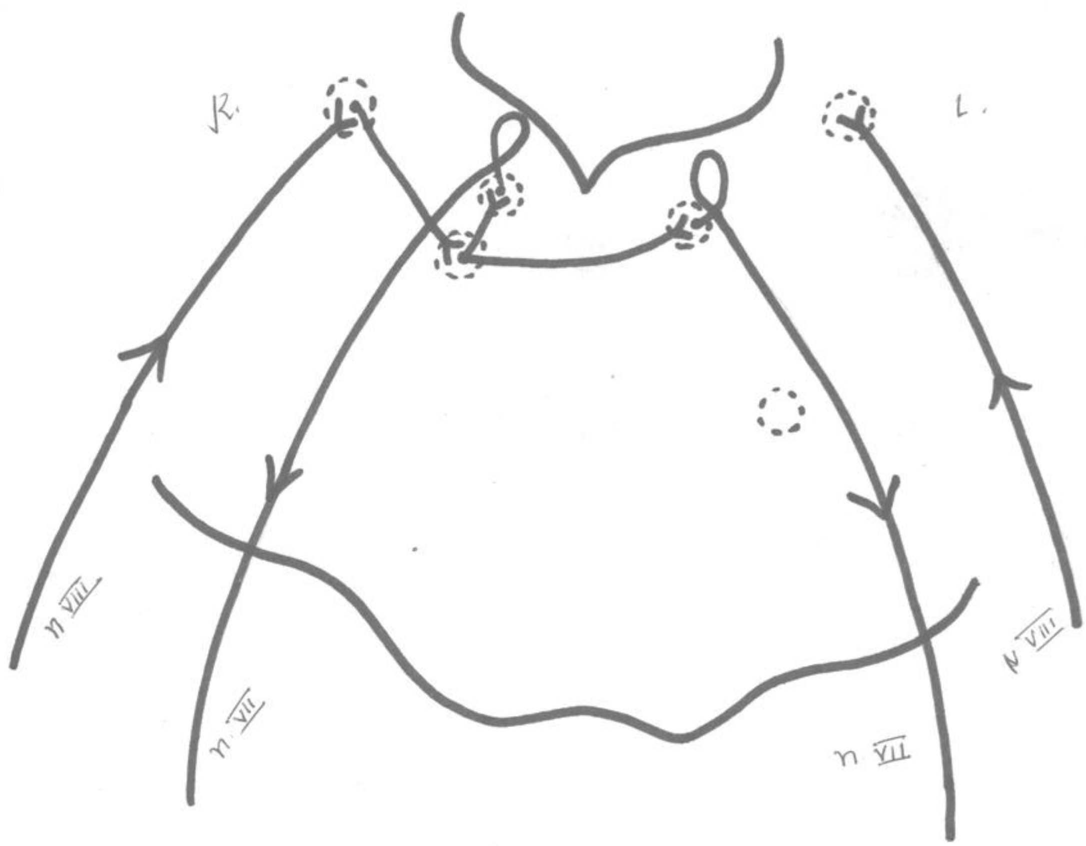


FIGURE SHOWS THE CROSS SECTION OF PONS, INDICATING PROBABLE COURSE OF STAPEDIAL REFLEX ARC.

CHAPTER II

REVIEW OF LITERATURE

Acoustic reflexes were reported first in 1978 by Mensen, who demonstrated contractions of the tenser tympanic muscle in dogs consequent to acoustic stimulation. In 1886, Pollock also studied the muscle activity in doge and reported that reflex contractions of their tensor tympani to be dependent upon the magnitude of the auditory stimulus and the reflex activity occurred bilaterally upon unilateral stimulation.

Several other investigators like Kate (1961), Klockhoft (1961) have conducted experiments with animals in which the tensor tympani can be exposed for observation and recording. In animals such as Cats, Rabbits, Guines Pigs and Dogs, A demo strable tensor tympani reflex has been reported.

Luscher (1929 and 1930) was the first to show that acoustic reflex contraction of the stepedi is a constant phenomenon in man. No observed stapedi muscle directly using an ear microscope through perforation of the tympanic membrane, He demonstrated regular and constant reflex contractions of the muscle, which could be elicited both from homolateral and contralateral ear, He demonstrated that acoustic reflex could be conditioned, He also showed tht acoustic reflex could be eclicited between 30 to 14000 Hz.

Jepson (1963) has provided on excellent treatise on reflex activity of the middle ear muscles. And he called the middle ear muscle reflexes as intrinsic acoustic reflex and Cochleo Palpebral reflexes as extrensic acoustic reflexes.

Klockhoff (1961) and Jepson (1963) have provided an excellent review of reflex measurement technique. The reflex measurement techniques are, direct observation, electro myography, extra tympanic monometry, electrical stimulation and acoustical stimulation. It in beyond the scope of this chapter to review the vast materials. related to the measurement of the middle ear muscle reflexes. Of all the methods, the simple way of producing a stupedius contraction in by acoustic stimulation, of the opposite ear.

The actions of the middle ear muscles are controlled reflexively. The presumed course of the acoustic reflex with is given based on the work of several investigations on animals and human beings. (in figure 1).

The stepedial reflex are, in its simplest form consists of an afferent neuron, a synopse, and an efferent neuron. The cochlear nerve constitute the afferent branch and the favel nerve constitutes the efferent branch, while the reflex is carried out in the pons (Hall, 1977).

In studying the intra-aural reflex activity in man most investigators have been concerned with reflex contractions of stepedius muscle rather than the tensor tympani.

It has been indicated that probably the stepedius muscle alone responds with a recordable reflex. This is supported by impedance. measurements taken by Lloyd (1975) on patients who underwent stapedectomy operation. This study showed that an acoustic tensor tympani reflex in man, probably cannot be observed using impendence techniques. Therefore the term ‘stepedius reflex’, or ‘ acoustic stapedius’ reflex is preferred in conjunction with impedance measures.

The threshold of the acoustic reflex is defined as the level above the threshold of hearing (SL) at which a sound is just capable of eliciting a reflex contraction of stapedive muscle.

Jepson (1955) investigated the threshold of the stepedius reflexes in a control series of 91 normal subjects, ranging in age from 10 to 80 years. Reflex thresholds were determined using the impedance technique. Both ears of each subject were examined at frequencies of 250 Hz, 500 Hz, 1000 Hz, 2000 Hz and 4000 Hz with stimulus intensity being varied in standard clinical increments of 5 dB. Frequencies of 125 Hz and 8000 Hz were also examined, but the results were not reported because of lack of reflex responses at these frequencies in a majority of the subjects tested.

A number of interesting observations were recorded from the results of the Jepsen’s (1966) study. As expected auditory threshold sensitivity was poorer in the older subjects when than in younger groups. Accompanying this decrease in hearing sensitivity was an increase in the sensitivity of acoustic reflexes in the older subjects. This change occured at each test frequency but was more pronounced for frequencies above 1000 Hz. This may be assumed to be a manifestation of recruitment (Jespsen, 1966).

To remove the influence of age extremes on the test results, Jepson avragaed auditory and reflex threshold findings for those subjects taking within 15-34 years of age. The threshold curves shows that reflex contdraction at all frequencies occurred generally within a range of 70-90 dB above auditory threshold. Mean thresholds show a greater reflex sensitivity for mid frequency sound of 1000 Hz and 2000 Hz.

Peterson, Lamb and Hensen (1965), also studied reflex thresholds variability in adults. Nevertheless mean thresholds still were obtained at sensation levels around 90 dB. Examinations of reflex threshold date for individual subjects revealed large within-subject variability. Test re-test dispersion over ten trials for each subject generally was in the order of 3 – 10 dB, but in some subjects as high as 30 dB. The greatest within – subject variability was found at 4000 Hz.

Other investigators (Moller, 1962) Lamb, Peterson and Mansen (1968) have reported measurement of reflex sensitivity employing electro acoustic impedance devices. Moller (1962) found the threshold for muscle contraction to be about 80 dB above and roughly parallel to the auditory thresholds.

Hall (1977) reported the stapedial reflex to pure tones at 500 – 2000 Hz in normal ears in general range between 70 and 100 dB HTL. The mean stepedial reflex threshold was approximately 85 dB HTL.

In genral the results have shown that the stepedius reflex threshold is about 80 dB above nearing threshold for pure tones.

The reflex is usually elicited at sensation levels of 70 to 95 dB, in ears with Cochlear pathology the reflex may be elicited at sensation levels of less than 60 dB. This phenomenon was first described by Metz (1952).

Kristensen (1952), Lamb at al (1968) and Wilber at al (1976) have shown a direct relationship between recruitment and stepedial reflex threshold.

Beedle and Hardford (1973) compared acoustic reflex growth in 10 normals and 10 sensori-neural loss with recruitment cases. They found that the slope of the acoustic reflex growth function is much greater and more rapid for the normal ears than for the either ear of the subjects. Also the acoustic reflex growth is essentially the same for the impaired ears and good ears. On the basis of these results they questioned the relationship that is thought to exist between loudness experience and the acoustic reflex.

Whether the phenomenon is actually directly related to recruitment or not is of less importance than the fact that it appears to be related to Cochlear pathology (Wilber, 1976)

Hozo (1977), compared this Metz test with SISI, bakesy, and ABLB test, in neuro Labrinthophathy cases. He concluded that Metz test showed highest degree of validity.

In retrocochlear pathology, one should expect to find either an absent acoustic reflex at sensation levels of 70 dB to 95 dB, or reflexes that are present, but which decay more rapidly than would be expected in the normal ear . Anderson et al (1969) pointed out that one could observe a decay in the acoustic reflex pattern for patients with VIII nerve pathology when a stimulus was presented at a reflex sensation level of 16 dB for 10 seconds. When stimuli were presented in this manner one might observe the amplitude of the reflex decay to a 50 % level in less than 10 seconds.

Jerger and Jerger (1974) reported that in a series of 30 patients with eighth nerve disorders, relexes were normal in 23% of the cases, while 13% showed decay and 64% has no acoustic reflexes.

Kamzaki (1977), with the measurement stapedial reflex threshold and reflex decay, the findings suggesting retro cochlear pathology, identified 78% of the cases, Sheely (1976) reported 80% of success.

Chiver-Allis (1977), examined the criteria proposed by Anderson et al (1962) for the diagnosis of early acoustic neuromas, using the acoustic reflex. Normally hearing subjects and sesori-neural loss cases were studied and yielded high false positive detection rates, by the threshold criteria. And he suggested that the threshold asymmetry of the reflex may be more useful than the absolute threshold.

Recent investigations of the acoustic reflex have shown that it may be possible to detect not only the presence but also the degree of end organ hearing. The basis for this phenomenon seems to be a change in the critical band width for loudness summation in the ear with sensori-neural hearing loss. In the cases of sensori- neural hearing loss, it is hypothesized that due to widening of critical bands, the number available for loudness summation is reduced. In addition, the sloping frequency response characteristic of the senori-neural ear greatly attenuates the relative loudness contributions of critical bands in the high frequency region. The net result is a noise tons reflex threshold difference (S.N.D.) much smaller than the normal difference.

The concept of a wider critical band and, therefore, of a differential between white noise and pure tone thresholds which varied by pathology was expended and refined by Niomeyer and Seaterhenn (1974) to a rather detailed and ingenious procedure for predicting the amount of hearing loss.

Jerger et al (1974) made a refinement of the Nicmeyer procedure for predicting the amount of hearing loss. This procedure has been lebelled summatin test. They divided the hearing loss categories of their population into normal wild to moderate, serve and profound. They further reported that in only 4% of the patients in their series a serious error was found.

Moller (1961) reported that crossed reflexes are less excitable then the ipsilateral reflexes in non-anesthetized subject (both animals and human). The differences are increased by anesthesis.

Moller (1962) noted that reflexes in ears receiving the test stimuli occurred at a lower or more sensitive levels (2 to 14 dB) than those in the contralateral ears.

Owchi (1977), measured stapedial reflex thresholds, using Madsen (20 72) impedance bridge in 24 subjects with normal hearing, in 23 patients with unilateral sensori-neural hearing loss and in 14 patients with symmetrical sensroi-neural hearing loss. Stepedial reflex thresholds were measured for pure tone singals of 500,1000, 2000 and 4000 Hz and for while noise, contralaterally. Uncrossed stapedial reflex thresholds were measured for 500, and 1000 Hz. Results indicated that stapedial reflex thresholds for ipsilateral stimulation that stapedial for contrelateral stimulation.

These differences between ispilateral stepedial reflex thresholds and contralateral stepedial reflex thresholds are thought to exist because of differences in intensity levels, though the dial reading is same in both the types of stimulation. In silateral stimulation, the intensity of the stimulus depends considerably on the position of the probe in the acoustic meatus. For this reason, the valves of the ipsilateal threshold were lower than contralateral stimulation.

Reker (1977), controlled this variable, by applying a stiumulus sound of high intensity to the deaf ear of subjects with one completely deaf ear, using a normal head phone. After substraction of individual inter-aural attenuation, the exact ipsileteral intensity was obtained. Even with this method Reker obtained lower ipsilateral thresholds than contralateral thresholds. The differences between ipsileteral and contralateral stapedius reflex threshold was in the range of 15 dB.

Greinsen and Rasmussen (1965), performed ipsilateral reflex thresholds, and contralateal reflex thresholds in two cases with brain stem tumours. In these patients the contralateral stimulation produced, no response, while ipsilateral stimulation resulted in a normal reflex thresholds.

These indications can only be explained by an interruption of the reflex are of the stepedial muscle at a point within the brainstem between the Cochlear nucleus on the one side and facial nucleus on the other side.

Jerger and Jerger (1977), highlighted the diagnostic value of crossed and uncrossed reflexes, in eighth nerve and brainstem disorders, based on the Grainsen and Rassmussen (1965).

Alberti (1977), evaluated ipsilateral stepedius reflex testing in 166 patients, and emphasized its clinical utility. He concluded that it proves of values in determining the state of an ear.

a) Opposite to a conductive loss.
b) the less heard-of-hearing ear in the presence of bilatearal asymmetrical-neural hearing loss,
c) in patients with absent contraleteral acoustic reflexes at 500, 1000, and 2000 Hz.
d) and in suspected central lesions.

As such, there is no study which has explored the possibility of any difference in stepedial reflex amplitudes for ipsilateral and contralateral stimulation. Present study is an attempt to explore this area.

CHAPTER – III

M E T H O D O L O G Y

Contralateral and ipsilateal stepedial reflex amplitudes were compared for sustained pure-tone stimulation in normally hearing subjects. Reflex amplitudes at different frequencies and at different sensation levels were compared.

Purpose:-

It was sought to study the stapedius reflex amplitudes for ipsilateral and contralateral stimulation and to arrive at some general conclusions regarding the differences, if existed.

Subejcts:-

The study included 4 young adults. Two of them wre males. Their ages ranged from nineteen to twenty three years with a mean age of 21.5 years. Everyone in the group had bilaterally normal hearing as ascertained by a pure – tone audiometry, (i.e., better or equal thresholds than 15 dB, re, ANSI 1969), for the frequency range from 250 to 8000 Hz. All of them revealed normal bilateral tympanograms and all of them had normal reflex thresholds.

No subject reported a history of ear disease, drug was or serious medical illness and all were otoscopically normal.

Apparatus and Test environment

For preliminary pure-tone audiometry a commercial clinical diagnostic audiometer (Madsen OB 70) was used. The transducers (T.D.N.39) of the audiometer were housed in cushions (MX-41/AR) and were enclosed by the associated cup enclosure devices. Ascending technique was used to establish thresholds.

The experimental instrumentation was a commercial impedance audiometer (Inter acoustics AZ 7). the AZ7 impedance audiometer is designed according to the proposed ANSI standards for the impedance audiometers and fulfile the requirement for type 1 instruments.

Testing was perfomed in the sound treated rooms (custom made) of All India Institute of Speech and Hearing, Mysore.

Calibration of equipment

The clinical diagnostic audiometer (Madsen OB 70) which was used in this study to establish pure – tone thresholds was calibrated to ANSI (1969) standards. The following instruments were used to calibrats, artificial ear assembly (Bruel and Kjaer Type 1913).

Impedance audiometer calibration was done to check air pressure leakage, sensitivity and probe- tone sound pressure level. Procedure was based on instructions given by Wilber (1976, 1978) and Operator manual of the instrument.

Air Pressure leakage was checked using following steps.

- Probe tips was inserted in to 2 cc cavity of the instrument.

- Air pressure knob was rotated until the pressure needle read positive 200 mm of H_2o. And pressure needle was observed for any leakage. Mermatic seal was obtained using suitable ear tip.

- Interval aira leakage was else checked by closing off monometer way at the panel of the instrument.

- Pressure range was adjusted as instructed by the manual.

Compliance measurement were made as instructed in the manual and proper adjustments were made at the start of every test.

Mesurement of 220 Hz probe tone spl. was done using the following steps

- Probe tip was attached to 2 c.c. Coupler.

- 2 c.c. Coupler was attached to a sound level meter in conjunction with Condenser Microphone (B & K 4132) and associated octave bend pass filter centered at 250 Hz.

The ear phone (T.D.M 39) with the associated Cushion (MX 41/AR) was mounted on a artificial ear (B & K 4152), calibration of the ear phone was similar to that of audiometer earphone calibration.

Ipsilateral reflex stimulater aws checked by attaching the probe to the 2 c.c. Coupler and monitoring the output through Sound level meter.

Reflex measuring system of the instrument was checked as per the manual instructions.

TEST PROCEURE:-

The whole testing procedure was divided into 4 experiements.

After establishing the pure-tone thresholds, the acoustic impedance of the test ear was measured prior to the start of each experimental session. The reflex threshold for the particular test was obtained just before the start of the stapedial reflex amplitude measurement.

Experiment- I (See Fig. 1)

Reflex amplitudes for frequencies 500, 1000, 2000 and 400 Hz. at 5 dB, 10 dB, 15 dB, and 20 dB sensation levels were determined. In this experiment the tones were presented to right ear through the earphone, left ear was the monitoring ear.

Experiement- II (See Fig. 2)

Reflex amplitudes for frequencies 500, 1000, 2000 and 4000Hz. at 5 dB, 10 dB, 15 dB, and 20 dB sensation levels were determined. In this experiments the stimulated and monitored ear was left ear.

Experiment –III (See Fig. 3)

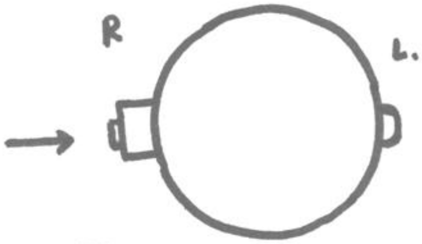
Reflex amplitudes for frequencies 500, 1000, 2000 and 400 Hz. at 5 dB, 10 dB, 15 dB, and 20 dB sensation levels were determined. In this experiment the tones were presented to left ear through the earphone. Right ear the monitoring ear.

Experiment – IV (See Fig 4.)

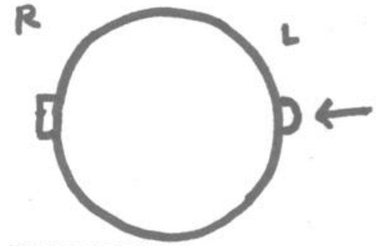
Reflex amplitudes for frequencies 500, 1000, 2000 and 400 Hz. at 5 dB, 10 dB, 15 dB, and 20 dB sensation levels were determined. In this experiment, stimulated and monitored ear was the right ear.

As stated earlier, each experiment involved 4 test frequencies and each test frequency included 4 sensation levels (Ref. Acoustic reflex threshold). Thus there were 16 conditions in each experiment. In each condition stepedial reflex amplitude was noted for 5 seconds, 10 seconds, 15 seconds and 20 seconds. Thus there were 64 readings in each experiment and totally each subject yielded 256 readings.

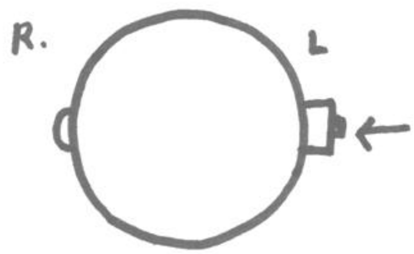
Each experiment was completed in one session. the entire testing for a subject was completed in 4 sessions. Order of frequency presentation was random in each experiment. The order of presentation of the tones at different sensation levels was counter balanced the avoid order effects.



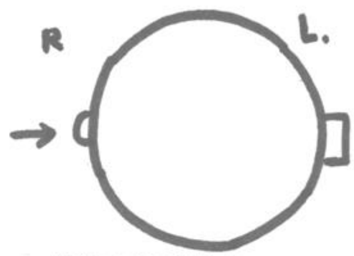
EXPERIMENT 1



EXPERIMENT 2



EXPERIMENT 3



EXPERIMENT 4

CHAPTER – IV

RESULTS AND DISCUSSION

In this study stepedius reflex amplitudes for insilateral and contrelateral stimulation were measured and analyzed.

RESULTS

Data were collected from all the 4 subjects. In one subject reflex amplitude could not be obtained at 20dBSL, For 500 Hz, since his reflex threshold for that frequency was 95 dB and also maximum output limit of the impedence audiometer (interacoustics AZ7) for that frequency was 110dBHL.

Here the reflex amplitude is defined as the magnitude of the deflection of the balance meter needle along the compliance scale of the balance meter. (Interacoustic AZ7) has been provided with two types of scales. They are compliance ml (Upper scale) and reflex al (lower scale). For the present purpose, the upper scale was chosen because more precise observation of stapedial reflex amplitude could be made.

Reflex amplitudes were observed for the duration of 20 seconds. at different sensation levels, for both ipsileteral and contralateral stimulation. The results were tabulated as shown in the data sheet. The Table (1 to 8) show individual results of each subject. And Tables (9 and 10) show average results of all the 4 subjects.

Subject A

	CONTRALATERAL RIGHT EAR PROBE							IPSILATERAL RIGHT PROBE					
		REFLEX AMPLITUDE							REFLEX AMPLITUDE				
	SL	5	10	10	15	20		SL	I	5	10	15	20
500	5	3	3	3	2	2	500	5	6	6	6	6	6
	10	5	5	5	5	5		10	12	12	12	12	12
	15	6	6	6	6	6		15	13	13	13	13	12
	20	8	8	7	6	6		20	15	15	15	15	15
1000	5	10	10	10	10	10	1000	5	15	15	14	13	13
	10	13	13	12	12	12		10	18	18	17	16	15
	15	16	16	16	15	15		15	20	19	19	18	18
	20	18	18	15	13	13		20	21	19	16	18	18
2000	5	11	10	7	4	3	2000	5	18	17	12	8	8
	10	21	20	13	8	7		10	22	20	18	17	16
	15	25	25	21	18	15		15	25	23	19	13	9
	20	27	23	19	17	16		20	27	22	19	12	10
4000	5	6	4	3	2	2	4000	5	8	5	3	2	1
	10	8	6	4	3	2		10	10	7	5	4	3
	15	10	6	4	3	2		15	11	5	3	2	2
	20	11	5	3	2	1		20	13	8	7	6	6

Table 1. Showing individual raw data of the subject ‘A’ for contralateral (left phone right probe) and ipslitateral stimulation, (rightprobe).

Subject B

CONTRALATERAL RIGHT EAR PROBE							IPSILATERAL RIGHT PROBE						
REFLEX AMPLITUDE							REFLEX AMPLITUDE						
	SL	I	5	10	15	20		SL	I	5	10	15	20
500	5	8	7	11	9	9	500	5	9	9	9	9	9
	10	10	8	8	10	11		10	10	10	11	10	11
	15	11	12	12	12	13		15	11	11	11	10	11
	20	14	15	16	17	20		20	14	12	12	11	11
1000	5	6	7	7	7	7	1000	5	7	7	7	7	7
	10	8	8	8	8	8		10	8	8	8	8	8
	15	9ø	9	8	7	7		15	9	9	9	9	9
	20	10	10	10	9	9		20	12	12	11	11	10
2000	5	7	5	5	5	5	2000	5	8	5	5	4	4
	10	9	9	9	10	10		10	9	6	3	3	2
	15	10	6	10	11	12		15	11	9	7	4	4
	20	12	7	6	6	6		20	12	10	8	9	8
4000	5	5	4	3	2	1	4000	5	6	4	3	2	2
	10	6	65	4	3	2		10	7	5	4	3	1
	15	8	6	5	3	2		15	8	6	3	2	2
	20	10	6	5	3	2		20	10	7	4	3	3

Table 2. Showing individual raw data of the subject ‘B’ for contralateral (left phone right probe) and Ipslitateral, (right probe) stimulation.

Subject C

	CONTRALATERAL RIGHT EAR PROBE							IPSILATERAL RIGHT PROBE					
	REFLEX AMPLITUDE							REFLEX AMPLITUDE					
	SL	I	5	10	15	20		SL	I	5	10	15	20
500	5	7	7	6	6	7	500	5	9	8	7	7	7
	10	10	10	10	10	10		10	10	10	10	9	9
	15	13	12	12	12	12		15	13	13	13	12	12
	20	13	13	12	12	12		20	14	14	13	13	13
1000	5	6	5	4	4	4	1000	5	8	6	5	4	4
	10	8	10	9	9	9		10	13	11	10	9	9
	15	10	10	10	10	9		15	14	13	11	11	10
	20	13	12	12	11	11		20	15	14	13	12	11
2000	5	7	6	5	4	3	2000	5	10	5	4	2	2
	10	10	7	6	5	4		10	13	5	4	3	1
	15	12	9	6	4	4		15	14	11	8	5	3
	20	15	12	7	5	3		20	16	14	10	5	3
4000	5	5	2	2	1	1	4000	5	8	4	2	1	1
	10	10	4	2	2	1		10	10	6	3	1	1
	15	15	6	4	2	1		15	15	7	4	1	1
	20	20	9	3	2	2		20	14	8	4	2	1

Table 3 Showing individual raw data of the subject 'C' for contralateral (left phone right probe) and Ipslitateral, (right probe) stimulation.

Subject D

	CONTRALATERAL RIGHT EAR PROBE							IPSILATERAL RIGHT PROBE					
	REFLEX AMPLITUDE							REFLEX AMPLITUDE					
	SL	I	5	10	15	20		SL	I	5	10	15	20
500	5	5	4	4	3	3	500	5	7	7	7	7	7
	10	6	6	6	6	6		10	13	13	13	13	13
	15	7	7	7	7	7		15	14	14	14	14	13
	20	9	9	8	7	7		20	16	16	16	16	16
1000	5	11	11	11	11	11	1000	5	17	16	15	14	14
	10	14	14	13	13	13		10	19	19	18	17	16
	15	16	16	16	15	15		15	20	20	20	19	19
	20	18	18	15	14	14		20	21	19	19	19	19
2000	5	13	11	8	5	4	2000	5	20	18	13	9	9
	10	24	21	14	9	8		10	23	21	19	18	17
	15	28	26	22	19	16		15	27	24	20	14	10
	20	30	26	22	18	17		20	29	25	21	15	12
4000	5	8	5	4	3	3	4000	5	10	6	4	3	2
	10	10	7	5	4	3		10	12	8	6	5	4
	15	12	7	5	4	3		15	14	9	6	3	3
	20	14	8	6	7	4		20	16	10	7	6	5

Table 4 Showing individual raw data of the Subject 'D' for contralateral (left phone, right probe) and ipsilateral (right probe)

Subject A

	CONTRALATERAL LEFT EAR PROBE							IPSILATERAL LEFT EAR PROBE					
	REFLEX AMPLITUDE							REFLEX AMPLITUDE					
	SL	I	5	10	15	20		SL	I	5	10	15	20
500	5	6	6	6	6	5	500	5	9	9	8	8	8
	10	9	9	8	8	8		10	13	13	13	13	12
	15	12	12	11	11	10		15	18	18	18	18	17
	20	15	15	14	13	13		20	19	19	19	19	19
1000	5	9	9	9	9	8	1000	5	14	14	14	13	11
	10	13	13	13	13	14		10	18	17	16	16	15
	15	16	16	16	16	16		15	28	28	27	26	26
	20	22	22	21	20	18		20	29	28	27	26	26
2000	5	8	6	5	3	2	2000	5	7	5	4	2	0
	10	20	18	12	8	8		10	29	27	20	13	10
	15	24	23	18	15	12		15	33	30	15	20	13
	20	27	23	18	14	12		20	35	30	25	20	15
4000	5	6	4	4	3	3	4000	5	7	6	4	3	2
	10	8	5	4	3	2		10	15	8	6	5	3
	15	16	12	9	5	4		15	18	13	8	5	4
	20	18	10	6	6	3		20	27	13	8	6	4

Table 5 Showing individual raw data of the Subject 'A' for contralateral (right phone, right probe) and ipsilateral (Left probe) stimulation.

Subject B

	CONTRALATERAL LEFT EAR PROBE							IPSILATERAL LEFT EAR PROBE					
	REFLEX AMPLITUDE							REFLEX AMPLITUDE					
	SL	I	5	10	15	20		SL	I	5	10	15	20
500	5	5	5	5	5	5	500	5	6	6	6	6	6
	10	7	7	7	7	7		10	8	8	8	8	8
	15	11	11	11	12	12		15	11	11	12	12	12
	20	-	-	-	-	-		20	-	-	-	-	-
1000	5	5	6	6	6	6	1000	5	7	7	7	7	7
	10	9	9	9	8	8		10	10	10	10	11	11
	15	11	11	10	10	10		15	12	12	11	11	11
	20	13	13	13	13	12		20	13	13	12	12	12
2000	5	6	4	3	3	2	2000	5	6	5	3	3	2
	10	9	7	5	5	5		10	10	7	6	5	5
	15	11	9	8	8	7		15	12	10	10	7	6
	20	14	13	10	10	9		20	15	13	11	11	9
4000	5	7	5	4	3	2	4000	5	8	5	4	3	2
	10	8	6	4	3	2		10	9	5	4	3	2
	15	9	7	4	3	2		15	10	5	4	3	2
	20	11	8	6	3	3		20	12	6	5	3	3

Table 6 showing individual raw data of the subject 'B'

for contralateral (right phone left probe) and ipsilateral (left probe) stimulation.

Subject C

	CONTRALATERAL LEFT EAR PROBE							IPSILATERAL LEFT EAR PROBE					
	REFLEX AMPLITUDE							REFLEX AMPLITUDE					
	SL	I	5	10	15	20		SL	I	5	10	15	20
500	5	7	6	6	6	6	500	5	10	9	8	8	7
	10	9	9	8	8	7		10	12	11	11	9	8
	15	12	11	11	10	10		15	13	11	11	9	7
	20	15	13	13	12	11		20	15	13	12	10	8
1000	5	7	7	7	6	6	1000	5	9	8	8	7	6
	10	8	7	7	6	6		10	10	9	7	7	5
	15	10	9	8	8	8		15	11	10	8	8	6
	20	13	12	12	11	10		20	13	10	10	9	8
2000	5	4	4	4	3	3	2000	5	4	3	3	2	1
	10	6	4	4	3	2		10	7	5	4	3	2
	15	8	5	4	3	2		15	9	4	3	2	1
	20	10	3	6	4	2		20	11	7	5	2	1
4000	5	4	3	2	1	1	4000	5	6	4	3	2	1
	10	5	3	2	2	1		10	8	5	4	2	1
	15	8	4	3	2	1		15	11	8	6	5	4
	20	11	6	5	3	2		20	12	8	7	6	4

Table 7 Showing individual raw data of the subject 'C' for contralaeral (right phone left probe) and ipsilaeral (left probe) stimulation.

Subject D

	CONTRALATERAL LEFT EAR PROBE							IPSILATERAL LEFT EAR PROBE					
	REFLEX AMPLITUDE							REFLEX AMPLITUDE					
	SL	I	5	10	15	20		SL	I	5	10	15	20
500	5	4	4	3	2	2	500	5	5	5	5	5	5
	10	5	5	5	5	5		10	11	11	11	11	11
	15	7	7	7	7	7		15	12	12	12	12	11
	20	9	9	8	6	6		20	14	14	14	14	13
1000	5	9	9	9	9	9	1000	5	16	16	15	14	14
	10	12	12	11	11	11		10	18	16	15	14	14
	15	15	15	15	14	14		15	20	19	18	17	16
	20	20	19	15	14	14		20	22	20	20	19	19
2000	5	10	9	6	3	2	2000	5	19	18	20	20	18
	10	17	15	8	6	5		10	22	21	13	8	8
	15	24	22	18	15	11		15	25	24	20	14	10
	20	25	20	16	15	12		20	27	24	20	13	11
4000	5	7	5	4	3	2	4000	5	8	6	4	3	2
	10	9	7	5	4	3		10	10	8	4	3	2
	15	12	8	5	4	3		15	12	9	4	3	2
	20	13	9	3	2	1		20	14	10	5	4	3

Table 8 Showing individual raw data of the subject 'D' for contralaeral (right phone left probe) and ipsilaeral (left probe) stimulation

Average

	CONTRALATERAL RIGHT EAR PROBE							IPSILATERAL RIGHTEAR PROBE					
	REFLEX AMPLITUDE							REFLEX AMPLITUDE					
	SL	I	5	10	15	20		SL	I	5	10	15	
500	5	5.75	5.25	6.00	5.00	5.25	500	5	7.75	7.50	7.25	7.25	
	10	7.75	7.25	7.25	7.75	8.00		10	11.25	11.25	11.50	11.00	1
	15	9.25	9.25	9.25	9.25	9.50		15	12.75	12.75	12.75	12.50	1
	20	11.00	11.25	10.75	10.25	11.25		20	14.75	14.25	14.00	13.75	1
1000	5	8.25	8.25	8.00	8.00	8.00	1000	5	11.75	11.00	10.75	9.50	9
	10	10.75	11.00	10.50	10.50	10.50		10	14.50	14.00	13.25	12.50	12
	15	12.75	12.75	12.50	11.75	11.50		15	15.75	15.25	14.50	14.25	14
	20	14.75	14.50	13.00	11.75	11.75		20	17.25	16.00	15.25	15.00	14.
2000	5	9.50	8.00	6.25	4.50	3.75	2000	5	14.00	11.25	8.50	5.75	5.
	10	16.00	14.25	10.25	8.00	7.25		10	16.75	13.00	11.00	10.25	9.
	15	18.75	16.50	14.75	13.00	12.75		15	19.25	16.75	13.50	9.00	6.
	20	21.00	17.00	13.50	11.50	10.50		20	21.00	17.75	14.50	10.25	8.
4000	5	6.00	3.75	3.00	2.00	1.75	4000	5	8.00	4.75	3.00	2.00	1.
	10	8.50	5.50	3.75	3.00	2.00		10	9.75	6.50	4.50	3.25	2.
	15	11.25	6.25	4.50	3.00	2.00		15	11.25	6.75	4.00	2.00	2.
	20	13.50	7.00	4.25	3.50	2.25		20	13.25	8.25	5.25	4.25	3.

Table 9 Showing raw data of the subjects average for contralateral (Left phone right probe) and ipsilateral (right ear probe) stimulation.

Average

	CONTRALATERAL LEFT EAR PROBE							IPSILATERAL LEFT EAR PROBE					
	REFLEX AMPLITUDE							REFLEX AMPLITUDE					
	SL	I	5	10	15	20		SL	I	5	10	15	
500	5	5.50	5.25	5.00	4.75	4.50	500	5	7.50	7.25	6.75	6.75	[illegible]
	10	7.50	7.50	7.00	7.00	6.75		10	11.00	10.75	10.75	10.25	[illegible]
	15	10.50	10.25	10.00	10.00	9.75		15	13.50	13.00	13.25	12.75	11
	20	13.00	12.50	12.00	10.50	10.00		20	16.00	15.50	15.00	14.50	14
1000	5	7.50	7.75	7.75	7.50	7.25	1000	5	11.50	11.25	11.00	10.50	9
	10	10.50	10.25	10.00	9.50	9.75		10	14.00	13.75	12.00	12.00	11
	15	13.00	12.75	12.25	12.00	12.00		15	17.75	17.25	16.00	15.50	15
	20	17.00	16.50	15.25	14.50	13.50		20	19.25	17.75	17.25	17.00	16.
2000	5	7.00	5.75	4.50	3.00	2.25	2000	5	9.00	7.75	5.75	3.75	2.
	10	13.00	11.00	6.75	5.50	5.00		10	17.00	15.00	12.50	10.25	8.
	15	16.75	14.75	12.00	10.25	6.25		15	19.75	17.00	12.00	10.75	7.
	20	19.00	16.00	12.25	10.75	8.75		20	22.00	18.50	15.50	11.50	9.
4000	5	6.00	4.25	3.50	2.50	2.00	4000	5	7.25	5.25	3.75	2.75	1.
	10	7.00	5.25	3.75	3.00	2.00		10	10.50	6.75	4.50	3.25	2.
	15	11.25	7.75	5.25	3.50	2.25		15	12.75	8.75	5.50	4.00	3.
	20	13.25	8.25	5.00	3.50	2.25		20	16.25	9.25	6.25	4.75	3.

Table Showing raw data of the subjects average for contra-lateral (right phone left probe) and ipsilateral (left probe) stimulation.

Analysis

Results of the present study were analysed under 3 sections.

(1) Analysing stepedial reflex amplitudes and reflex decay when the same steapdius muscle is involved for both ipsilateral stimulation
and contralateral stimulation. This is illustrated below.

Right phone ear – Left probe ear.
(Contralateral stimulation.)
Left Probe ear.
(Ipsilaeral stimulation)
Mere Left stapedius muscle is involved.

Left phone ear – Right probe ear
(Contralateral stimulation)
Right probe ear.
(Ipsilateral stimulation)

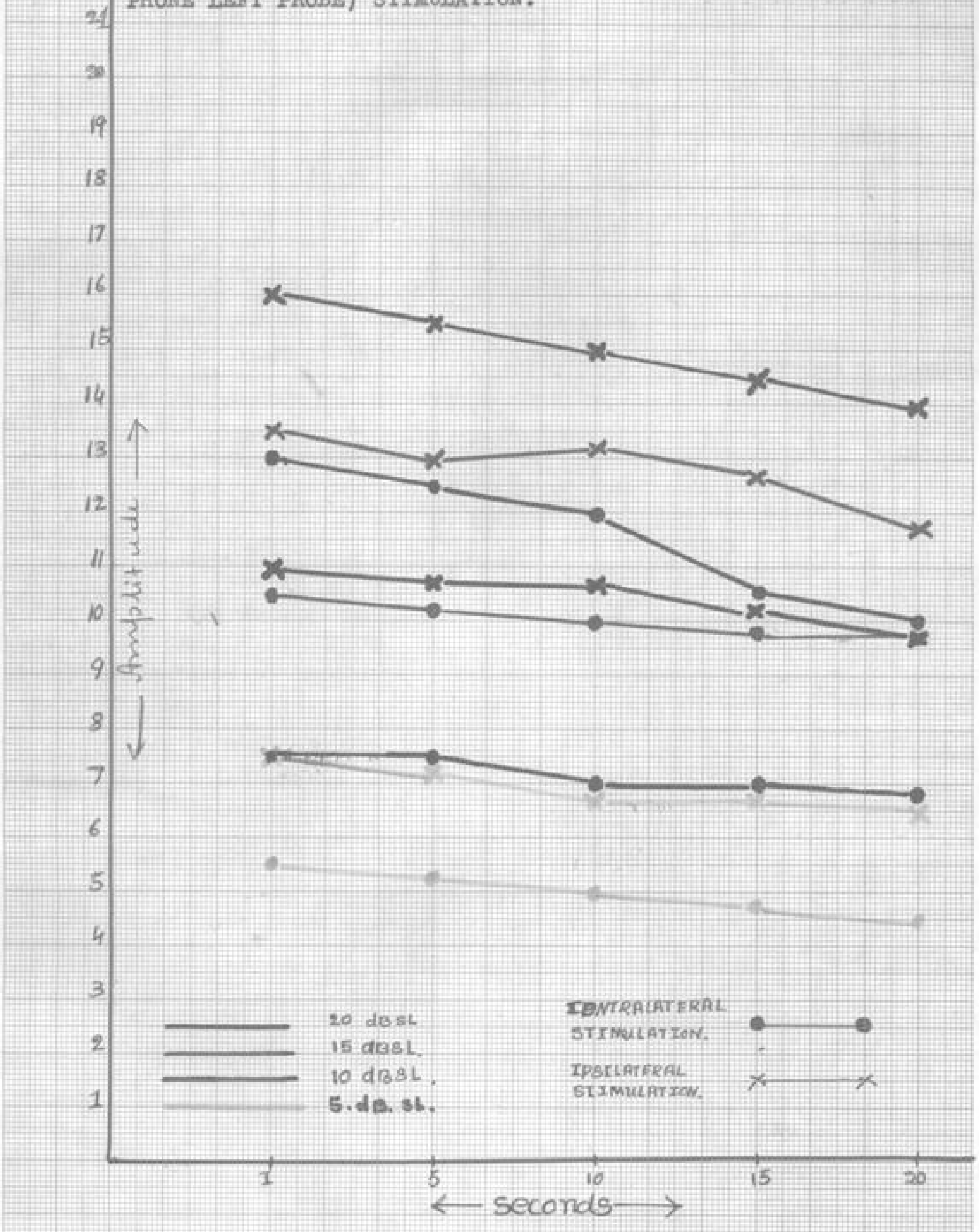
Mere right stapedius muscle is involved.

The data of these conditions are graphically represented. (Figure 1 to 8). Reflex amplitudes on the ordinate. Each division on the ordinate represents one division in the compliance scale of the balance meter. 10 such divisions form 1 ml. Absence represents time in seconds. Letter ‘I’ on the obsesses represent initial deflection of the needle.

In these conditions following observations were made.

FIGURE. I

STAPEDIAL REFLEX AMPLITUDES AT 500Hz, AT DIFFERENT SENSATION LEVELS, FOR IPSILATERAL(LEFT PROBE) AND CONTRALATERAL(RIGHT EAR PHONE LEFT PROBE) STIMULATION.



35 b

FIGURE 2

STAPEDIAL REFLEX AMPLITUDES AT 1000Hz AT DIFFERENT SENSATION LEVELS FORIPSILATERAL(LEFT PROBE) AND CONTRALATERAL(RIGHT EAR PHONE LEFT PROBE)STIMULATION.

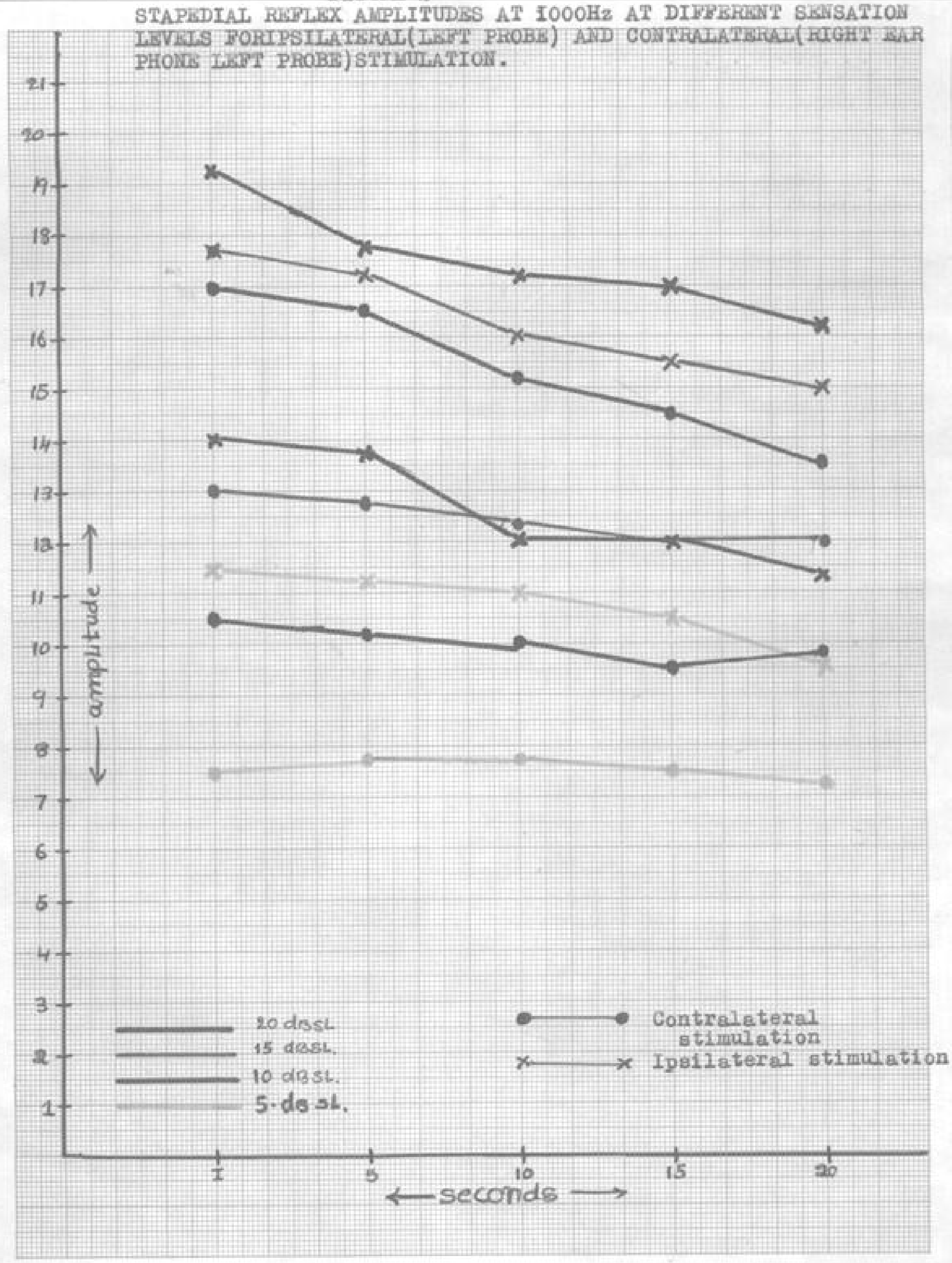


FIGURE 3
STAPEDIAL REFLEX AMPLITUDES AT 2000Hz AT DIFFERENT SENSATION LEVELS FOR IPSILATERAL(LEFT PROBE) AND CONTRALTERAL(RIGHT EAR PHONE LEFT PROBE) STIMULATION.

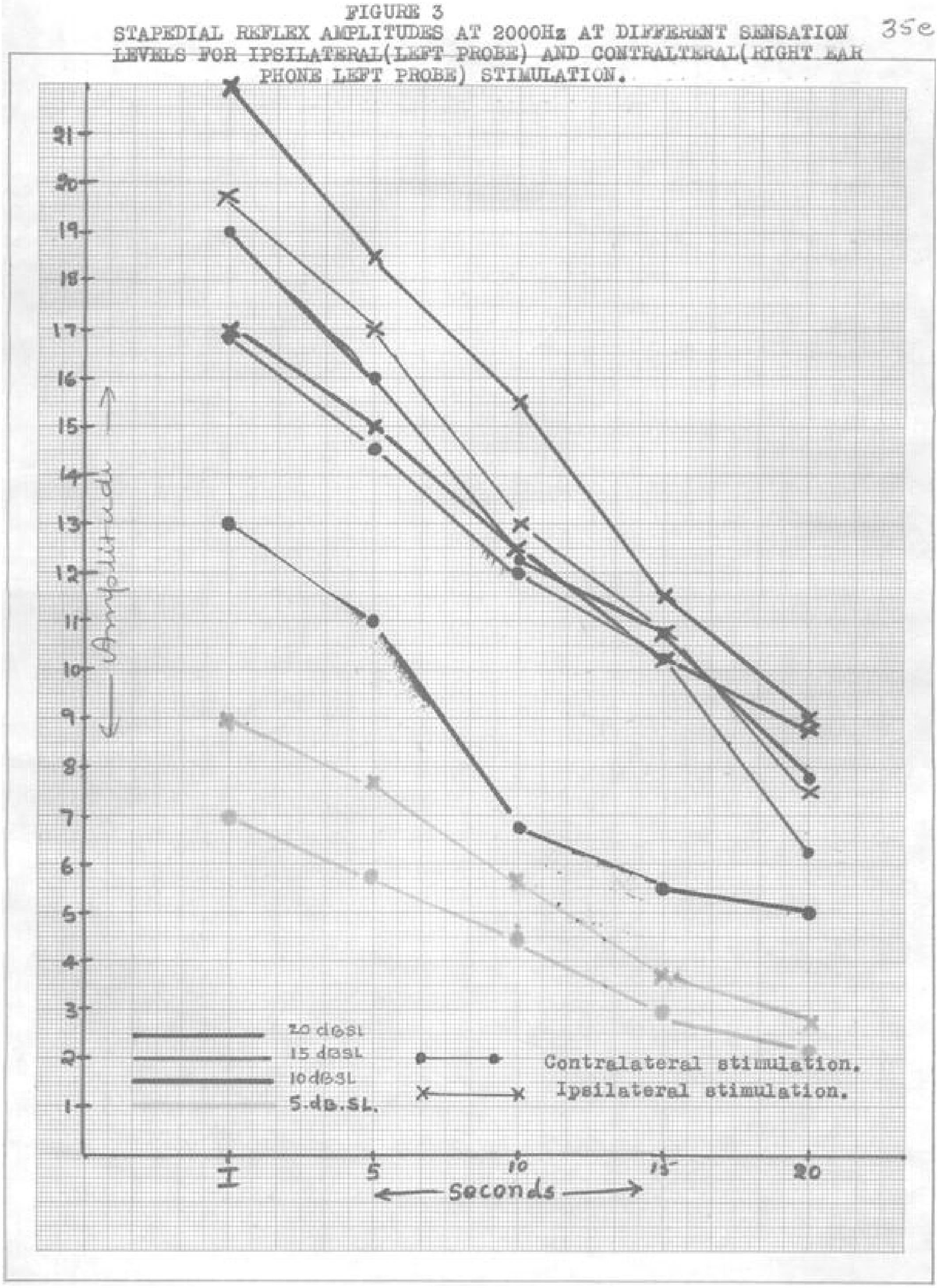


FIGURE 4

STAPEDIAL REFLEX AMPLITUDES AT 4000Hz AT DIFFERENT SENSATION LEVELS FOR IPSILATERAL(LEFT PROBE) AND CONTRALETERAL(RIGHT EAR PHONE LEFT PROBE) STIMULATION.

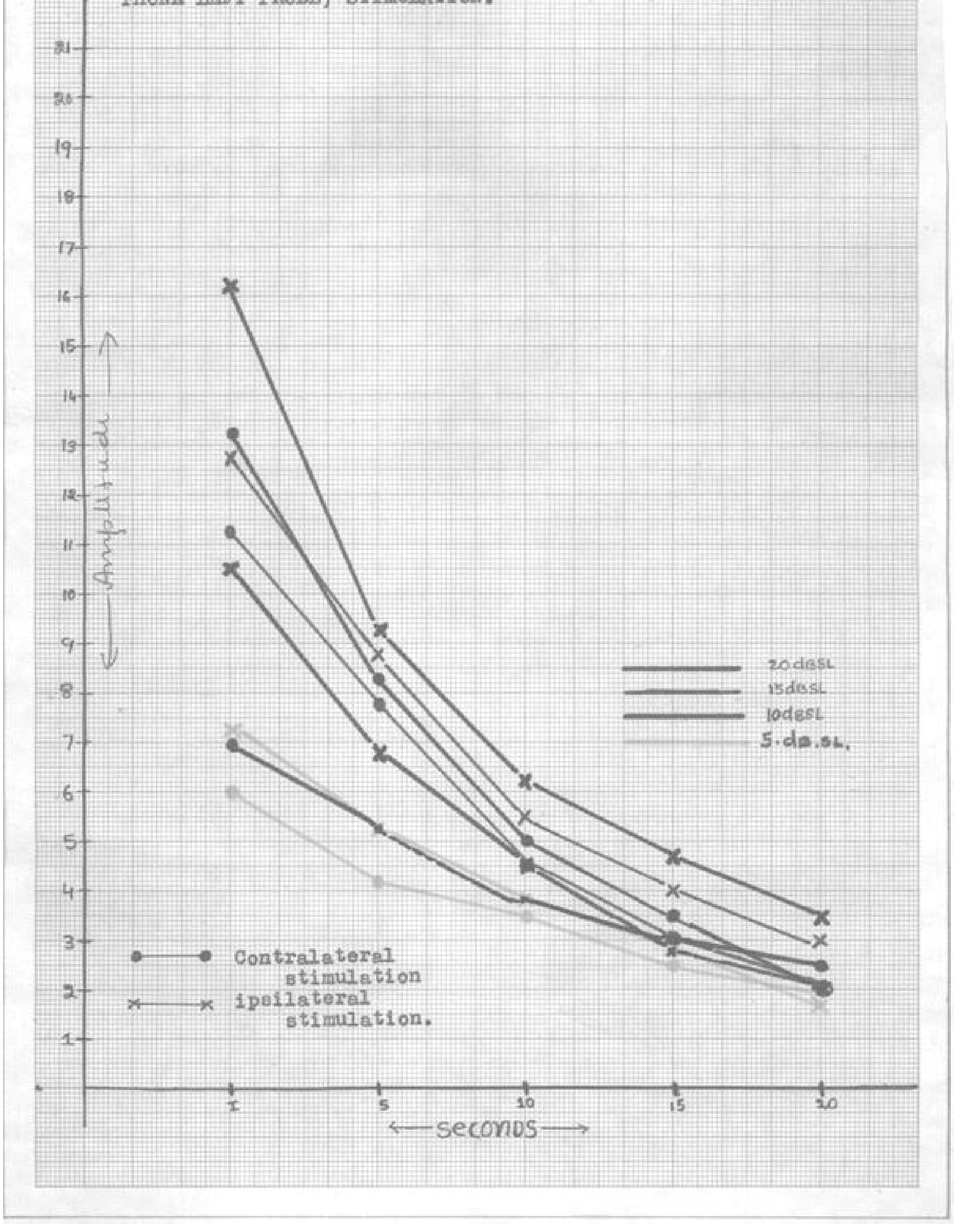


FIGURE 5

STAPEDIAL REFLEX AMPLITUDES AT 500Hz AT DIFFERENT SENSATION LEVELS FOR IPSILATERAL(RIGHT PROBE) AND CONTRALATERAL(LEFT PHONE RIGHT PROBE)STIMULATION.

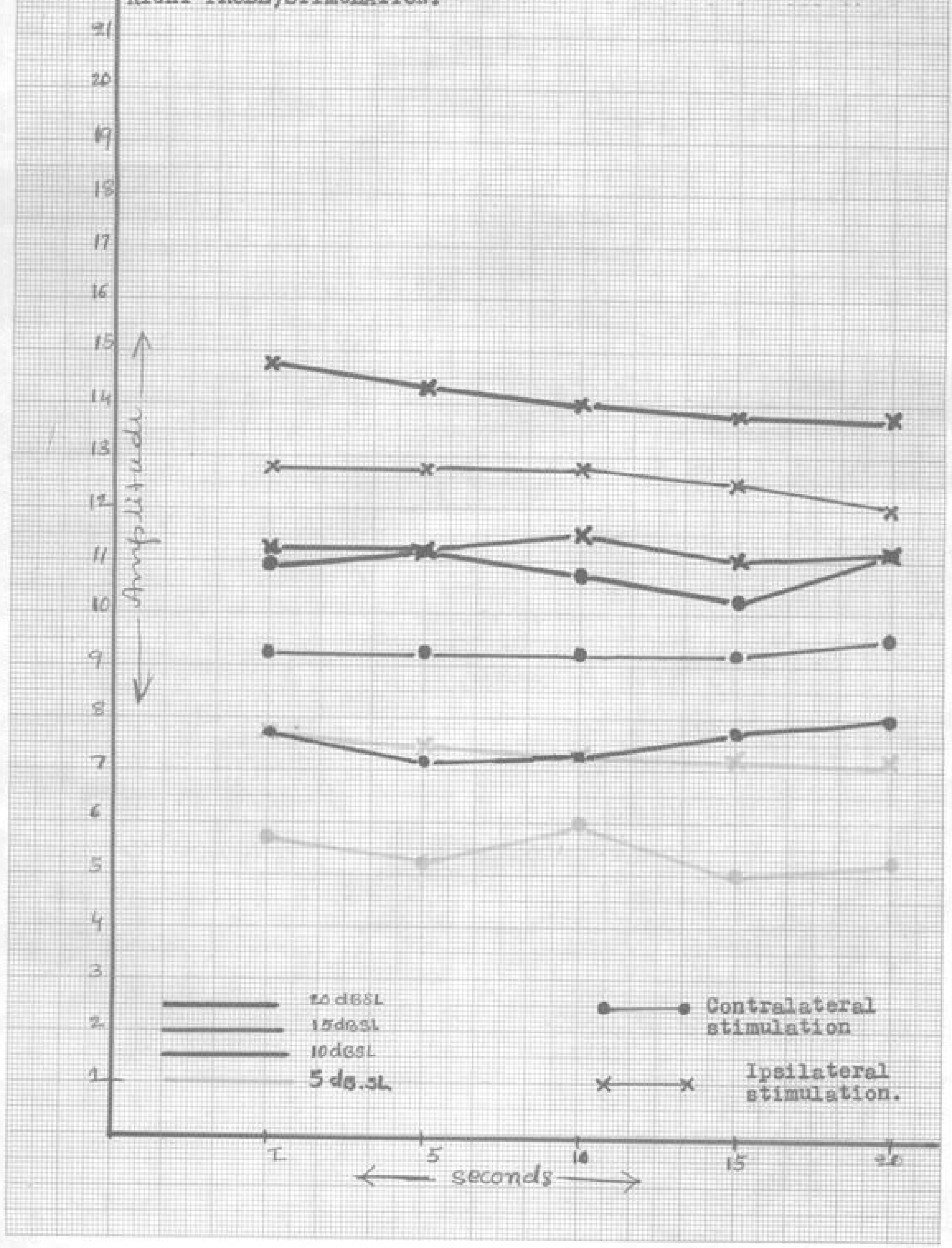


FIGURE 6

STAPEDIAL REFLEX AMPLITUDES AT 1000Hz at DIFFERENT SENSATION LEVELS FOR IPSILATERAL(RIGHT PROBE) AND CONTRALATERAL(LEFT PHONE RIGHT PROBE) STIMULATION.

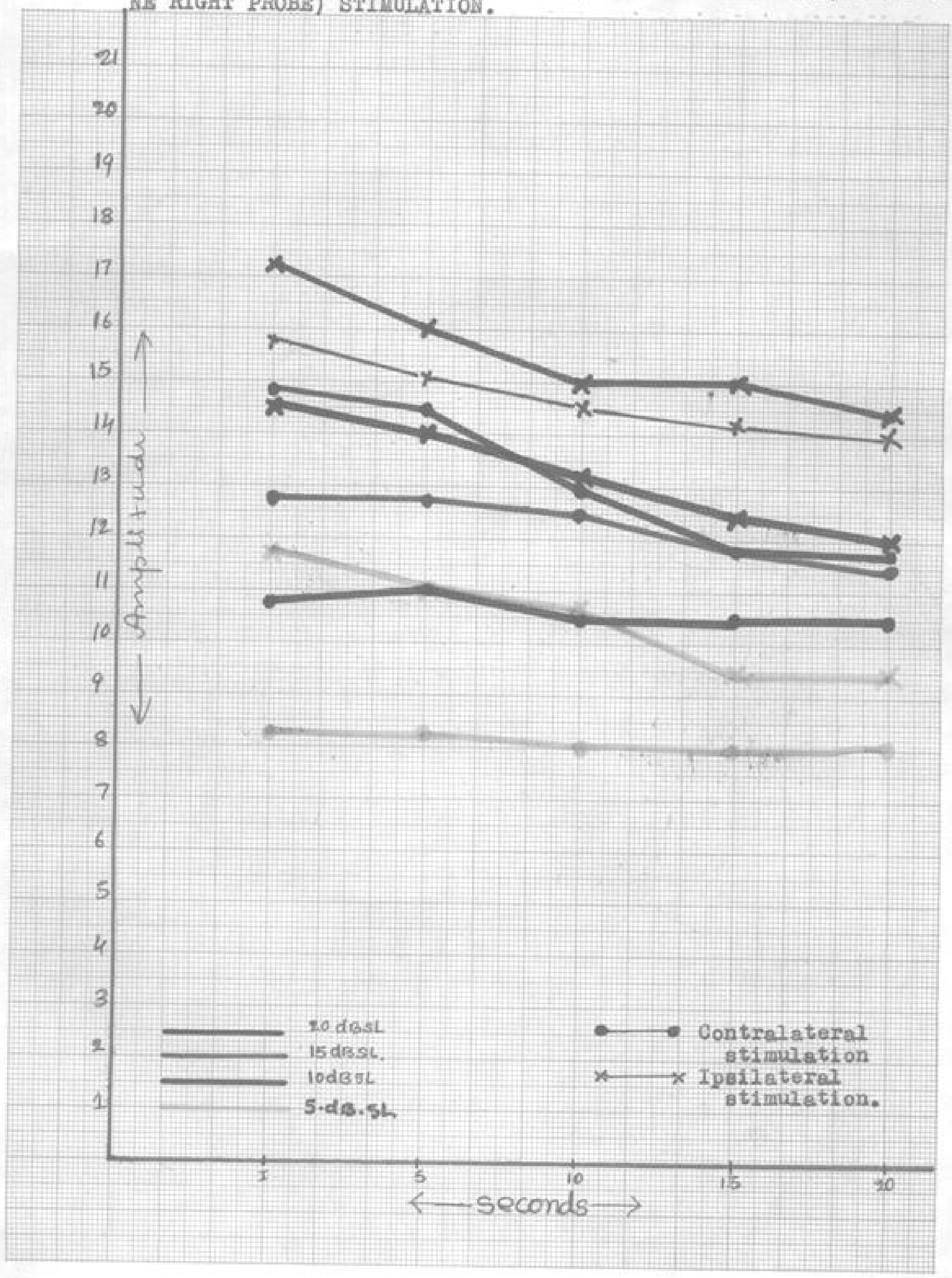


FIGURE 7
STAPEDIAL REFLEX AMPLITUDES AT 2000Hz AT DIFFERENR SENSATION LEVELS FOR IPSILATERAL(RIGHT PROBE) AND CONTRALATERAL(LEFT PHONE RIGHT PROBE) STIMULATION.

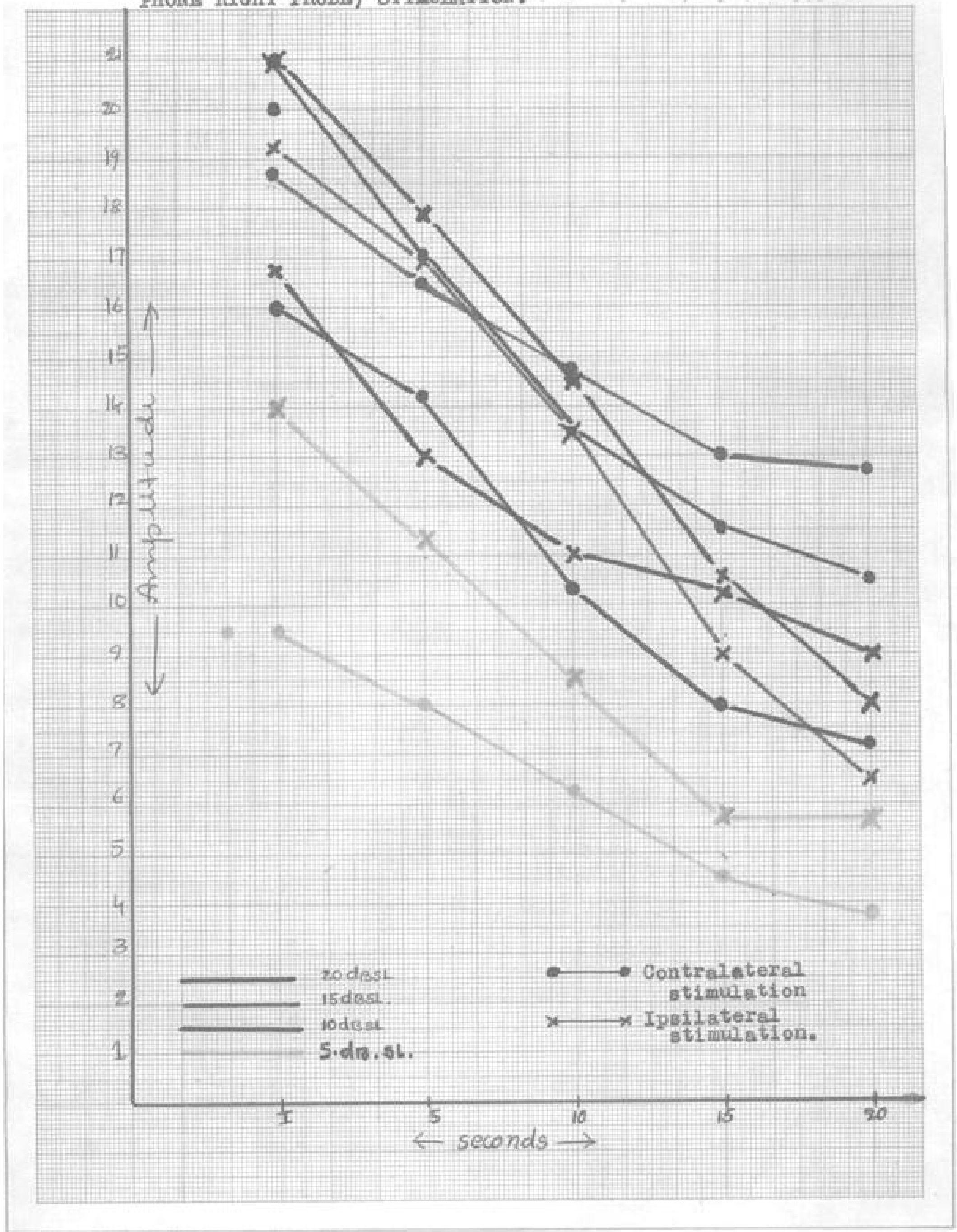
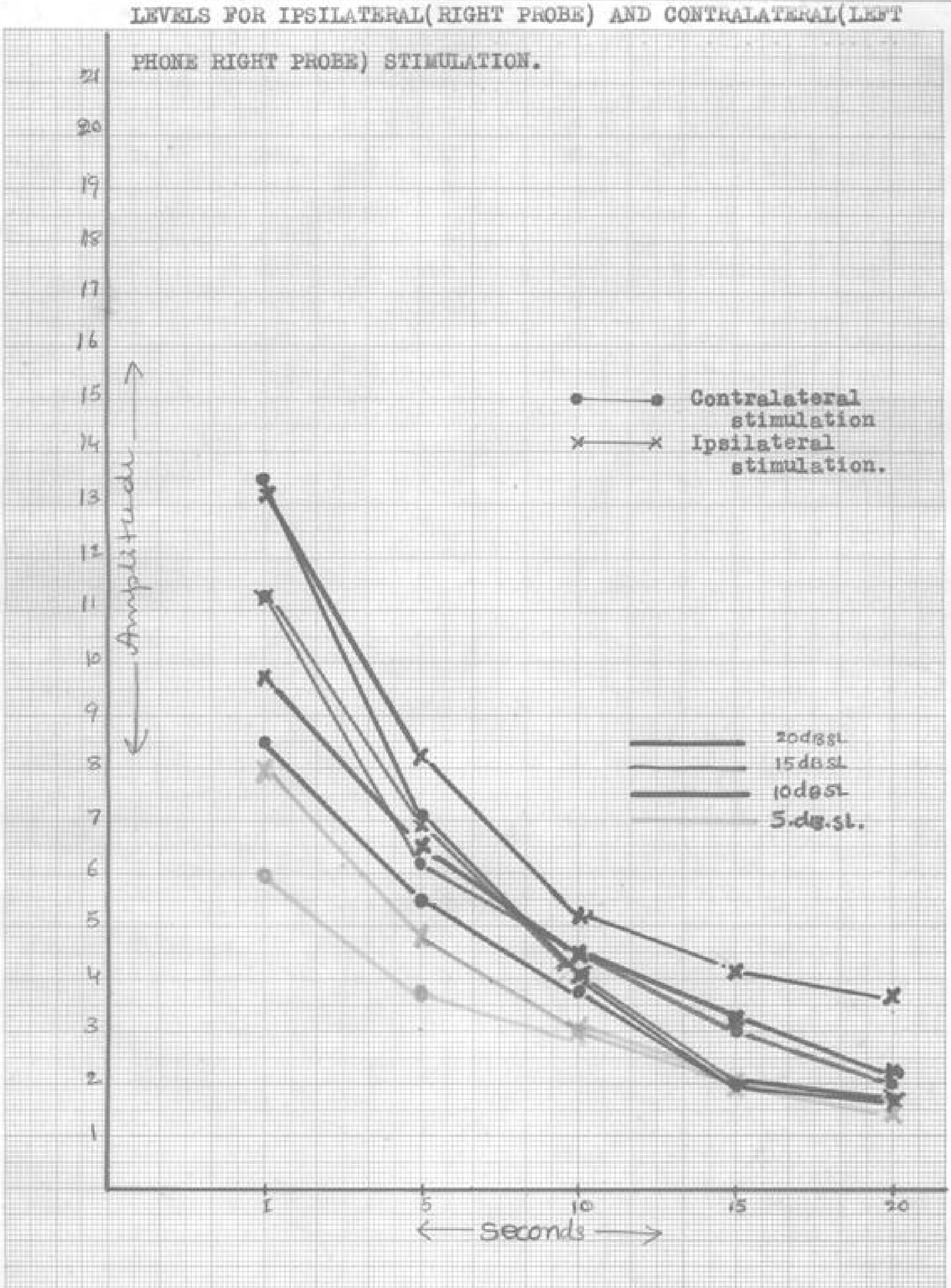


FIGURE 8

STAPEDIAL REFLEX AMPLITUDES AT4000Hz AT DIFFERENT SENSATION LEVELS FOR IPSILATERAL(RIGHT PROBE) AND CONTRALATERAL(LEFT PHONE RIGHT PROBE) STIMULATION.



There was increase in steapedius reflex amplitude with increase in sensation levels, in both contralateral and ipsilateral stimulation.

This increase in stapedius reflex amplitude was not linear with increase in sensation levels in both contralateral and ipsilateral stimulation, for all the frequencies tested.

There were differences in reflex amplitudes for contralateral and ipsilateral stimulation at all the frequencies tested. in all the frequencies and at all the sensation levels reflex amplitudes were more in case of ipsilateral stimulation. Only for 2 KHz. that too at only, 20dBSL both were equal (See figure. 7).

The reflex amplitude differences between ipsilateral and contrelateral stimulation was not the same for all the sensation levels.

The differences in reflex amplitudes between ipsilateral and contralateal stimulation is maintained throughout 20 seconds in lower frequencies with little variations. But the differences were reduced markedly at the end of 15 and 20 seconds at higher frequencies. And at times ipsilateal reflex amplitude reduced more than contralateral reflex amplitude at the same sensation level and frequency. This was seen only in higher frequencies (See fig . 7 and 8 at 15dB and 20dBSL). This phenomenon is not consistent, at all the sensation levels, of higher frequencies. No reflex decay was observed in lower frequencies (500 and 1000 Hz) for both ipsilaeral and contralateral stimulation. (see fig. 1, 2, 5 and 6). However, slight decrease in reflex amplitude at the end of 20 seconds for 1 KHz stimulation was observed.

At 2 KHz reflex decay was observed after 13 to 20 seconds for both ipsilateral and caontralateral stimulation (using criteris of Anderson, 1970). Exception to this was, at 15dBSL in left phone ear and right probe condition there was only 30% decay (see fig. 7). And no reason could be given for this. and there was no consistent variation in reflex decay time depending upon sensation level both in cotralateral and ipsilateral stimulation.

At 4 KHz reflex decay (50%) was observed 7 to 12 seconds for both contralateral and ipsilateral stimulation, at all the sensation levels (Graph 4 and 8).

(2) Analyzing the stepedial reflex amplitudes and decay when the stimulated ear is same for both ipsilateral stimulation and contralateral stimulation, but different muscles were contracted. This is illustrated below.

Right Phone ear – Left Probe ear (Contralateral)

Right Probe ear (Ipsilateral)

Mere right ear was stimulated.

Left Phone ear – Right Probe ear (Contrelateral)

Left probe ear (Ipsileteral)

Mere left ear was stimulated.

The data obtained from these conditions are graphically represented in figure 9 to 16. Reflex amplitude were marked on the ordinate, each division on the ordinate represents one division on the compliance scale of the balance meter. 10 such division form 1 ml. Abscess represents time in seconds. Letter ‘I’ on the abscises represent initial deflection of the needle.

In these conditions following observations were made.

There was increase in steapedius reflex amplitude with increase in sensation levels, in both contralateal stimulation and ipsilataeral stimulation.

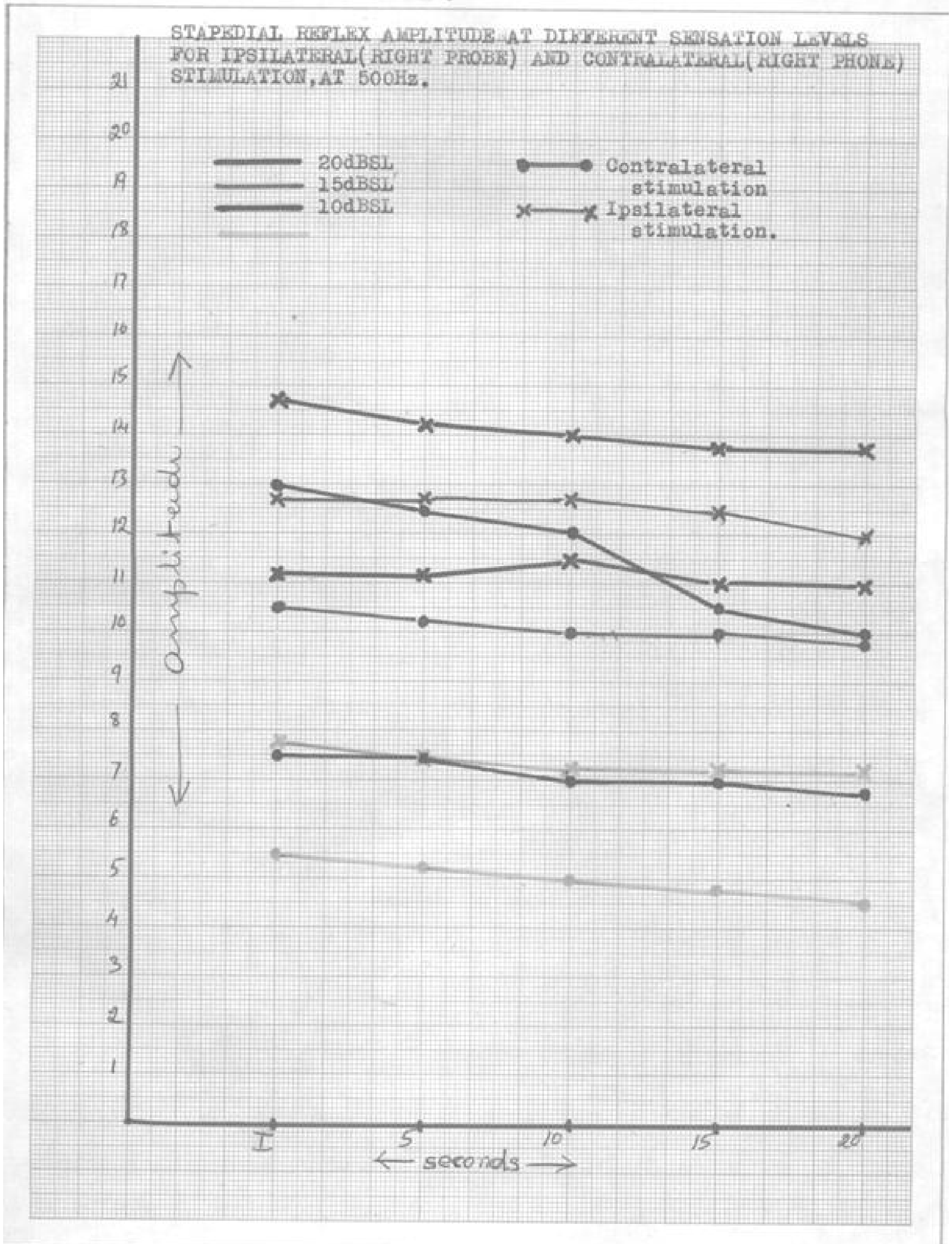
This increase in stapedius reflex amplitude was not linear with increase in sensation levels in both contralaeral and ipsilateal stimulation for all the frequencies tested.

There were differences, in reflex amplitudes for contrelateral and imsileteral stimulation at all the frequencies tested. However, there was an exception at 4 KHz – reflex amplitude at 15dBSL and 20dBSL was same for both ipsilateral and contralateral stimulation. (See figure 12)

In only one condition i.e., at 2 KHz (when left ear was stimulated) at 5dBSL, contralteral reflex amplitude was greater than ipsileteral reflex amplitude (see figure 15).

38a

FIGURE 9



STAPEDIAL REFLEX AMPLITUDE AT DIFFERENT SENSATION LEVELS FOR IPSILATERAL(RIGHT PROBE) AND CONTRALATERAL(RIGHT PHONE) STIMULATION,AT 500Hz.
20dBSL
15dBSL
10dBSL
Contralateral stimulation
Ipsilateral stimulation.
Amplitude
seconds

FIGURE 10

STAPEDIAL REFLEX AMPLITUDE AT 1000Hz AT DIFFERENT SENSATION LEVELS FOR IPSILATERAL(RIGHTPROBE) AND CONTRALATERAL(RIGHT PHONE LEFT PROBE)STIMULATION.

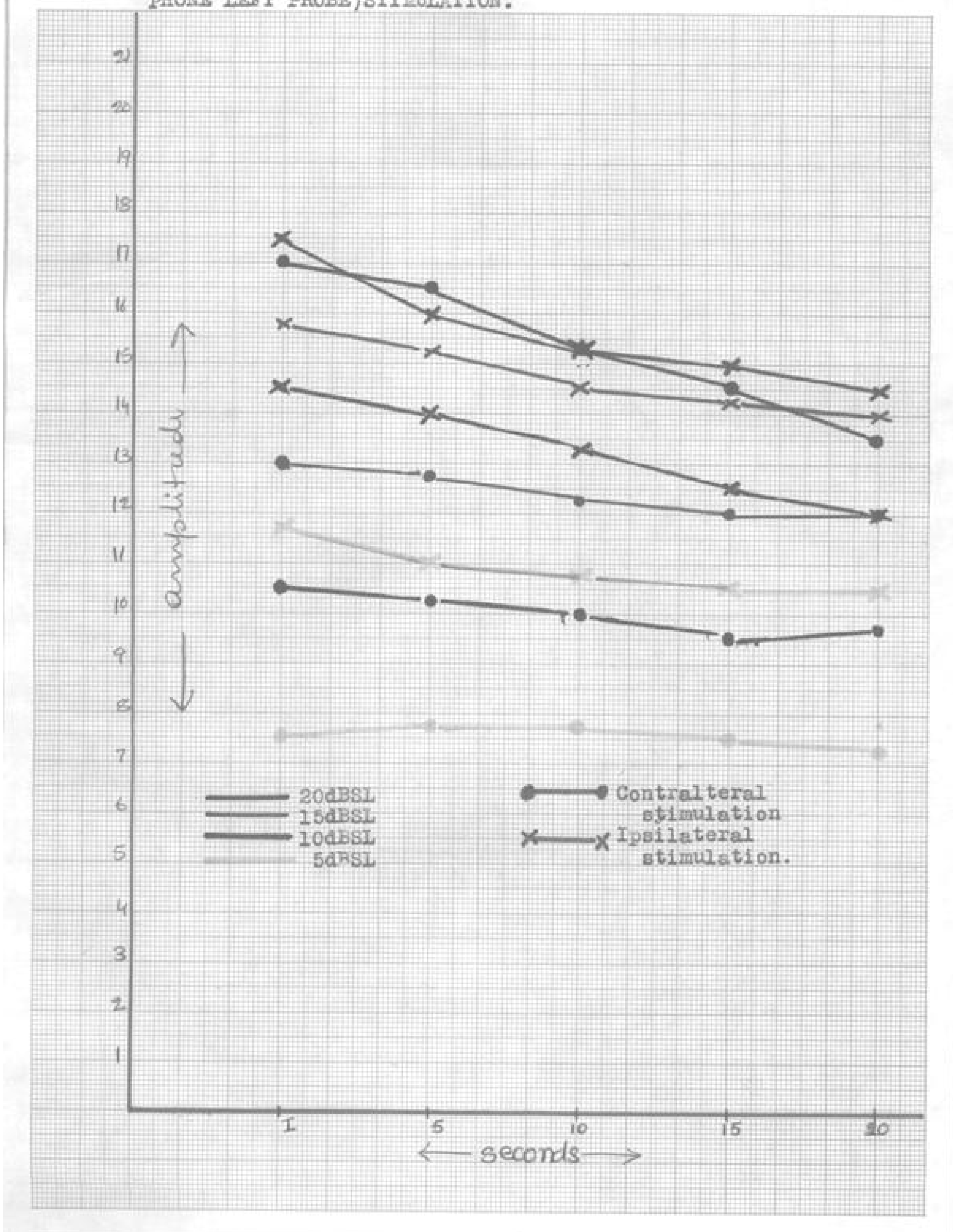


FIGURE 11
STAPEDIAL REFLEX AMPLITUDE AT 2000Hz AT DIFFERENT SENSATION LEVELS FOR IPSILATERAL(RIGHT PROBE) AND CONTRALATERAL (RIGHT) PHONE LEFT PROBE) STIMULATION.

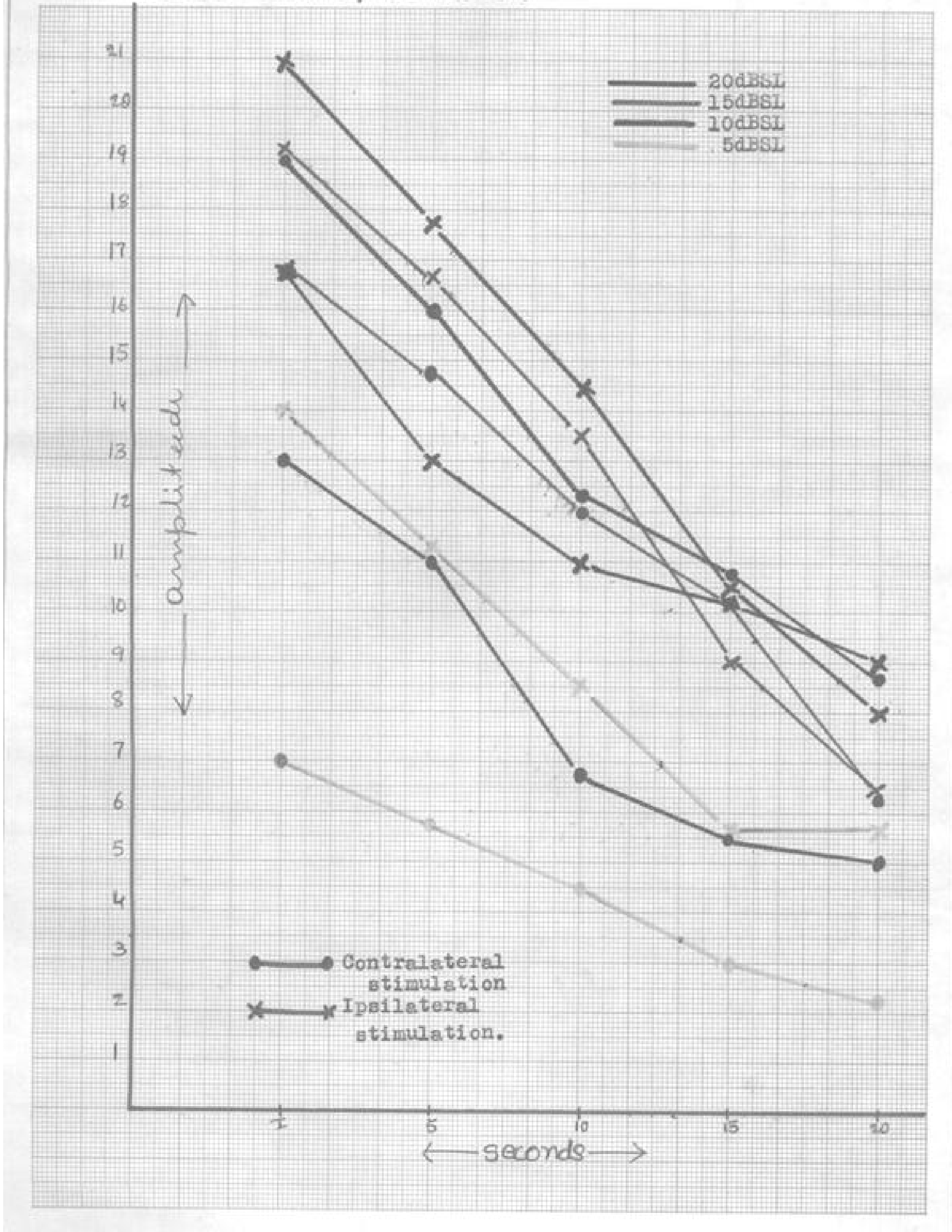


FIGURE 12
STAPEDIAL REFLEX AMLITUDE AT 4000Hz AT DIFFERENT SENSATION LEVELS FOR IPSILATERAL(RIGHT PROBE) AND CONTRALATERL(RIGHT PHONE LEFT PROBE) STIMULATION.

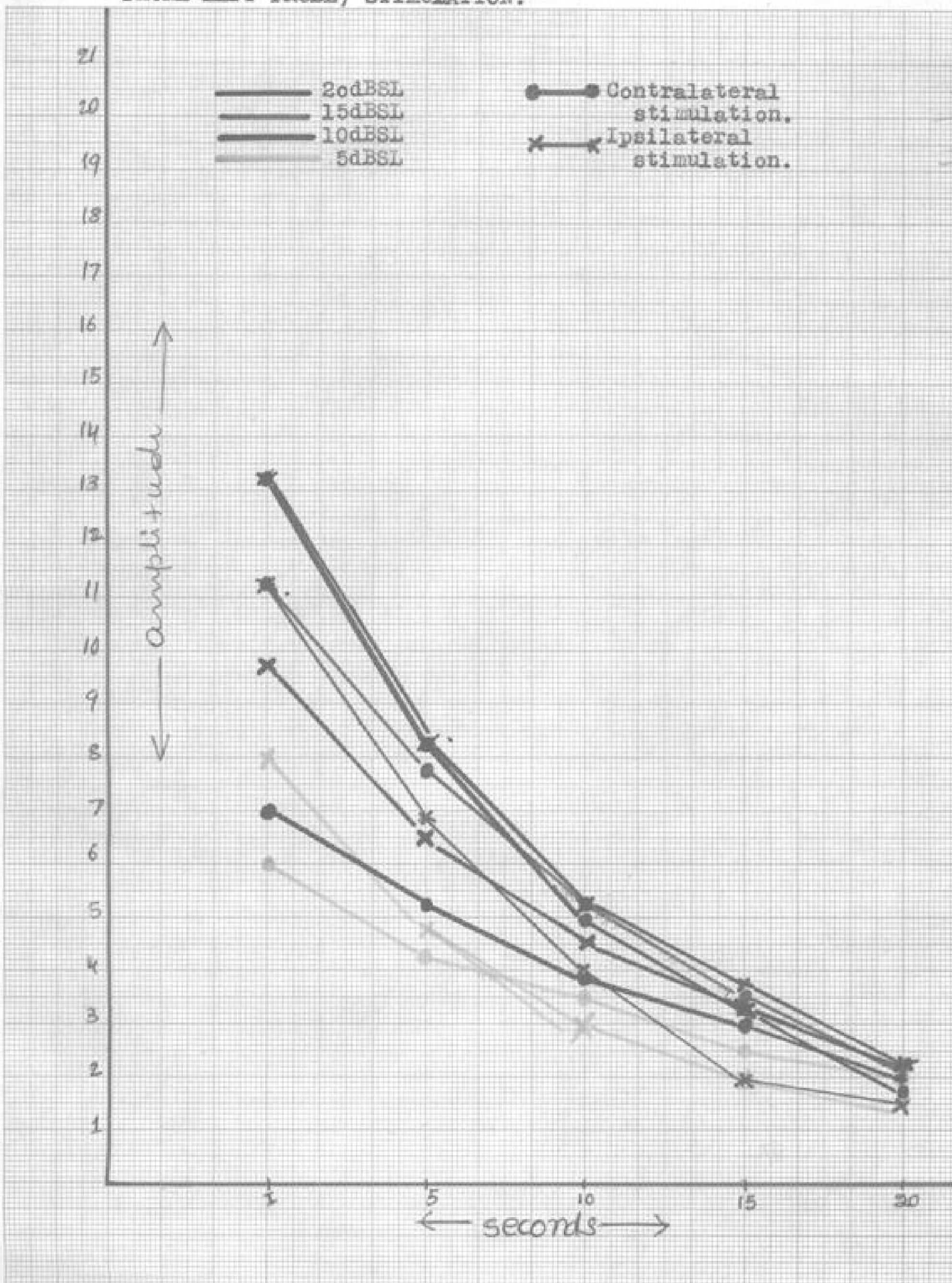


FIGURE 13

STAPEDIAL REFLEX AMPLITUDE AT 500Hz AT DIFFERENT SENSATION 38 e
LEVELS FOR IPSILATERAL(LEFT PROBE) AND CONTRALATERAL(LEFT PHONE)
LEFT PROBE) STIMULATION.

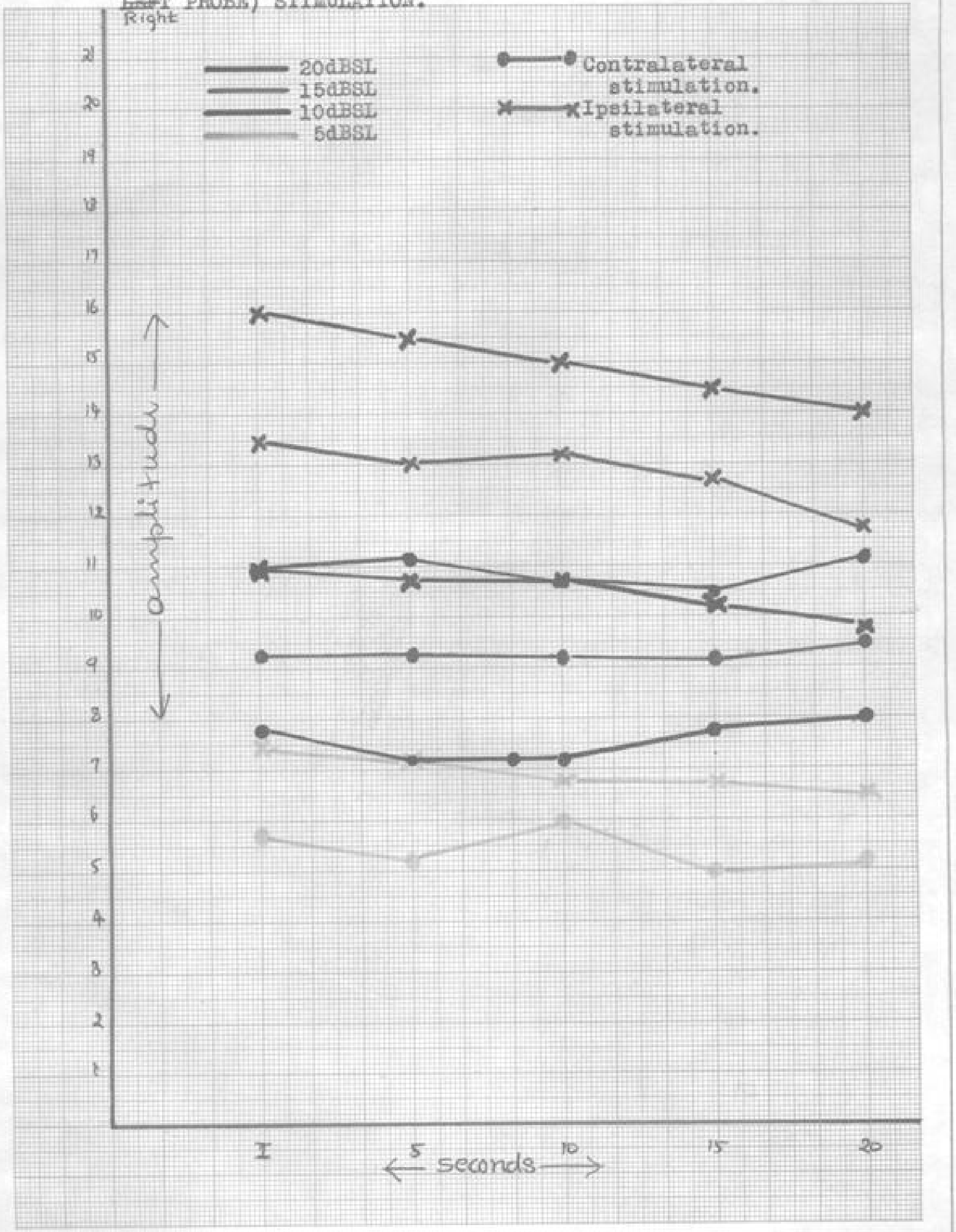


FIGURE 14
STAPEDIAL REFLEX AMPLITUDE AT1000Hz AT DIFFERENT SENSATION LEVELS FOR IPSILATERAL(LEFT PROBE) AND CONTRALATERAL(LEFT PHONE RIGHT PROBE) stimulation.

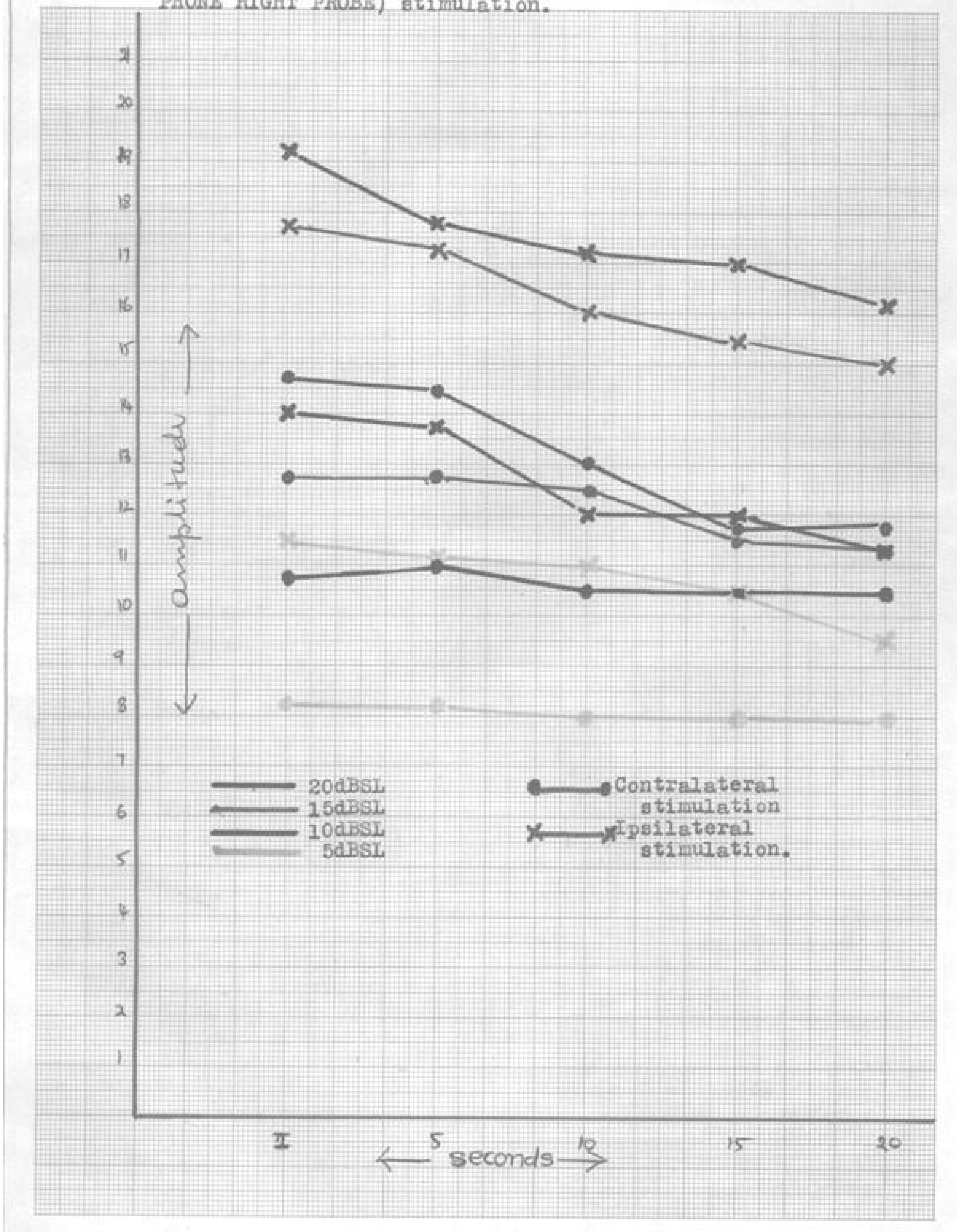


FIGURE 15

STAPEDIAL REFLEX AMPLITUDE AT 2000Hz AT DIFFERENT SENSATION LEVELS FOR IPSILATERAL(LEFT PROBE) AND CONTRALATERAL(LEFT PHONE RIGHT PROBE) STIMULATION.

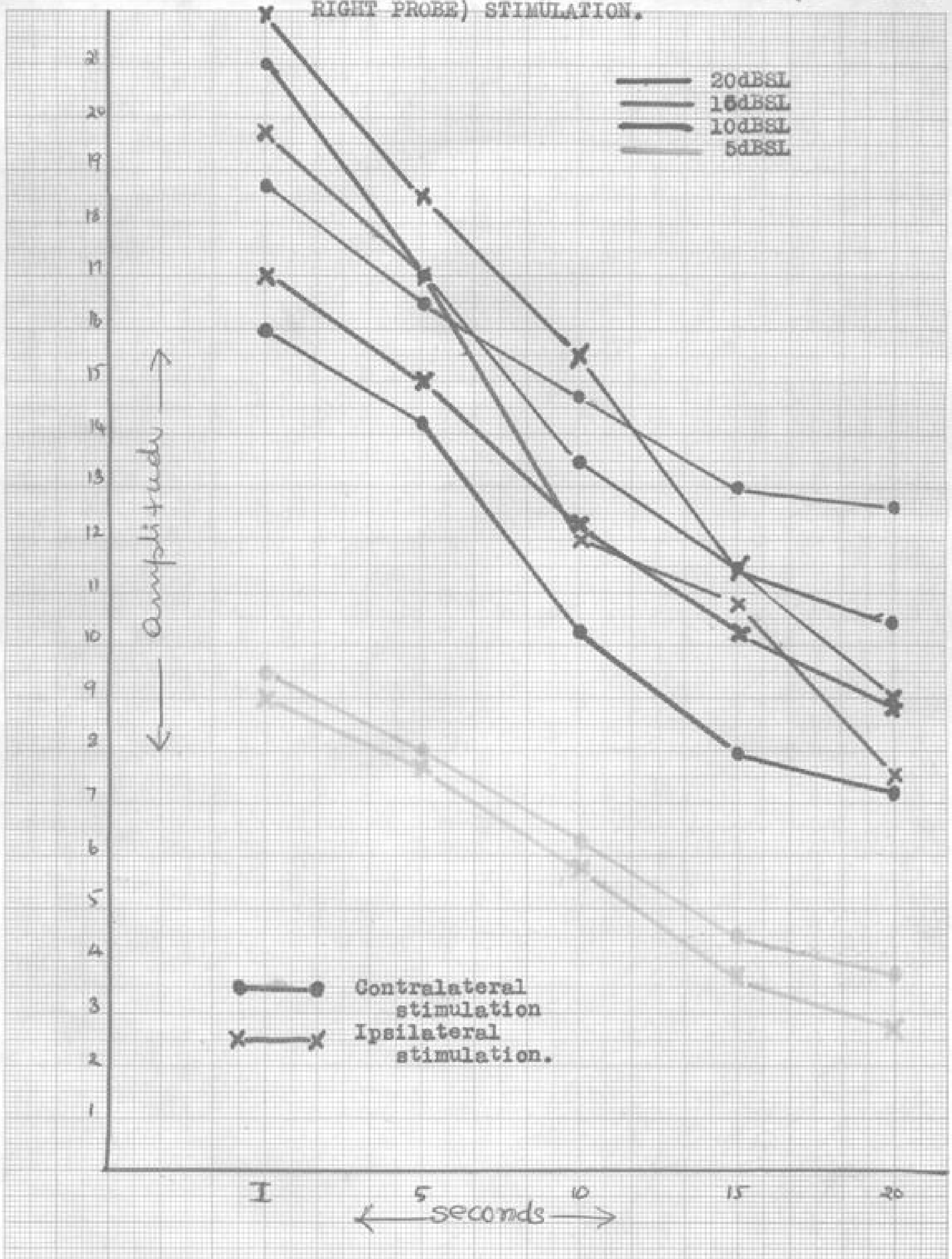
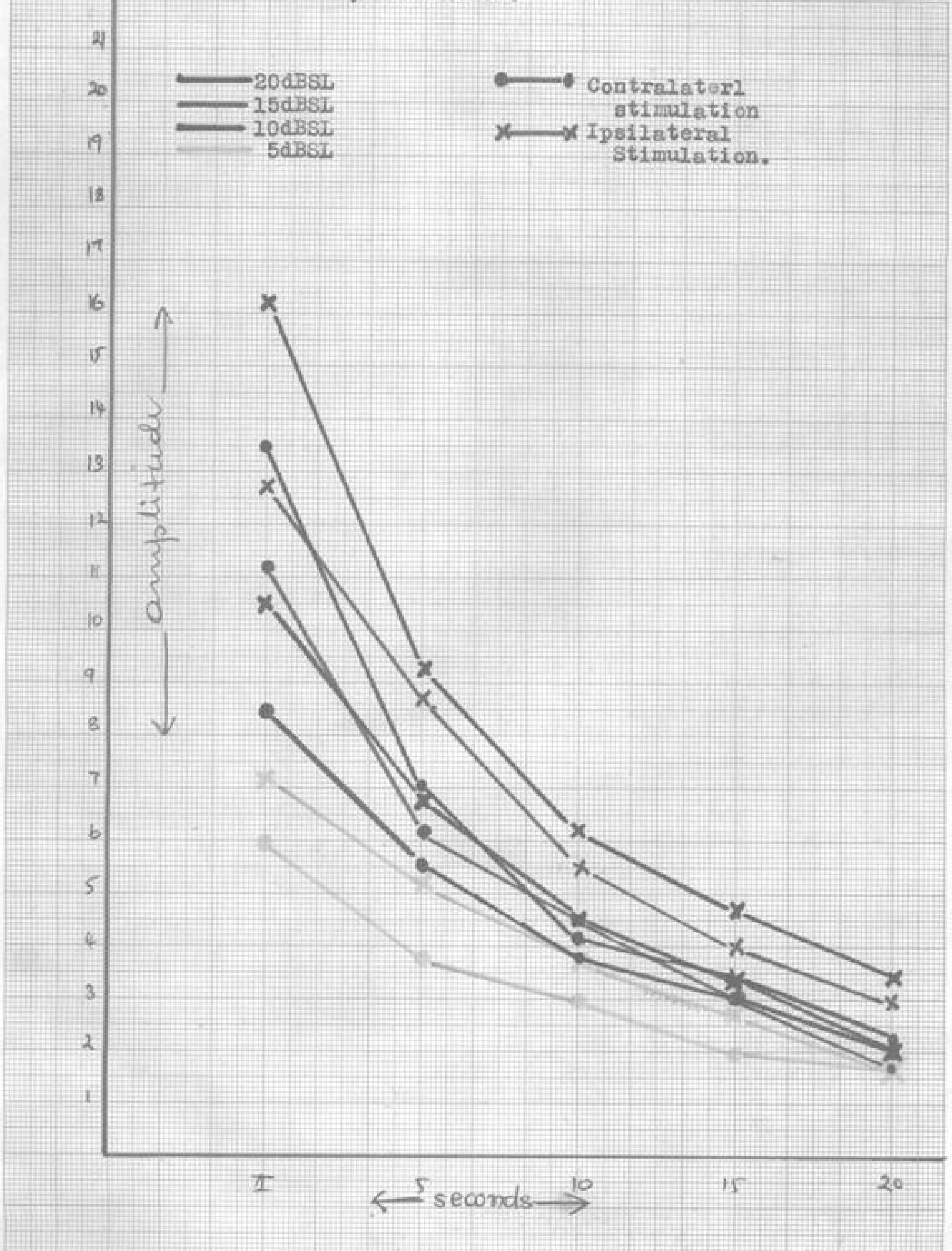


FIGURE 16
STAPEDIAL REFLEX AMPLITUDE AT 4000Hz AT DIFFERENT SENSATION LEVELS FOR IPSILATERAL(LEFT PROBE) AND CONTRALATERAL(LEFT PH.-one RIGHT PROBE)STIMULATION.



In rest of the frequencies and at all sensation levels ipsilateral reflex amplitudes were greater than the contralateral reflex amplitudes.

The reflex amplitude differences between ipsilateral and contralateral stimulation were not the same for all the sensation levels.

The difference in reflex amplitudes for ipsilateral stimulation and contralarteal stimulation was maintained throughout the 20 seconds in lower frequencies (500 and 1000 Hz) with little variations. But differences in amplitude between ipsilateral and contralateral stimulation were markedly reduced at the end of 15 and 20 seconds, in higher frequencies (see figure 11,12,15 and 16).

No reflex decay was observed in lower frequencies (500 and 1000 Hz) for both ipsilateral and contelateral stimulation (see figure 9,10,13 and 14). However slight reduction in amplitude at the end of 20 seconds was observed at 1 KHz.

At 2 KHz reflex decay was observed within 13 to 20 seconds (using criteria of Anderson, 1970) depending upon sensation level.

Only exception to this was that there was only 30% decay within 20 seconds, at 15dBSL. (Left phone ear and Right probe stimulation). see figure 15.

And there was no consistent variation in reflex decay time depending upon sensation level in contralateral and ipsilateral stimulation.

At 4KHz reflex decay was observed after 7 seconds at 10, 15, and 20dBSL and after 13 seconds at 5dBSL, for both ipsilaeral and contralateral stimulation.

(3) Reflex amplitude versus Frequency:

How reflex amplitudes change with frequency are plotted in figure 17 and 18. It is evident that at all sensation levels (both ipsilateal and contralateral stimulation) Reflex amplitudes increase with frequency up to 2000 Hz and suddenly drops at 4000 Hz. Maximum amplitude was obtained at same sensation levels for 2 KHz. This was true of both ipsilateral stimulation and contralateral stimulation.

This indicates that 2KHz is more sensitive for reflex. Only exception to this finding was that at 5dBSL. peak was obtained at 1000 Hz in contralateral right phone and ipailateral left probe situation. This was attributed to error in measurement.

DISCUSSION

There have been considerable attempts to study both the theoretical and applied diagnostic aspects of the acoustic reflex in man. The current investigation was concerned with the differences in stapedial reflex amplitude for ipsilateral stimulation and constralateral stimulation.

FIGURE 17

STAPEDIAL REFLEX AMPLITUDE VERSUS FREQUENCY FOR CONTRALATERAL Le
(~~RIGHT~~ Left PHONE, ~~LEFT~~ Right PROBE) AND IPSILATERAL(~~LEFT~~ Right PROBE) STIMULATION

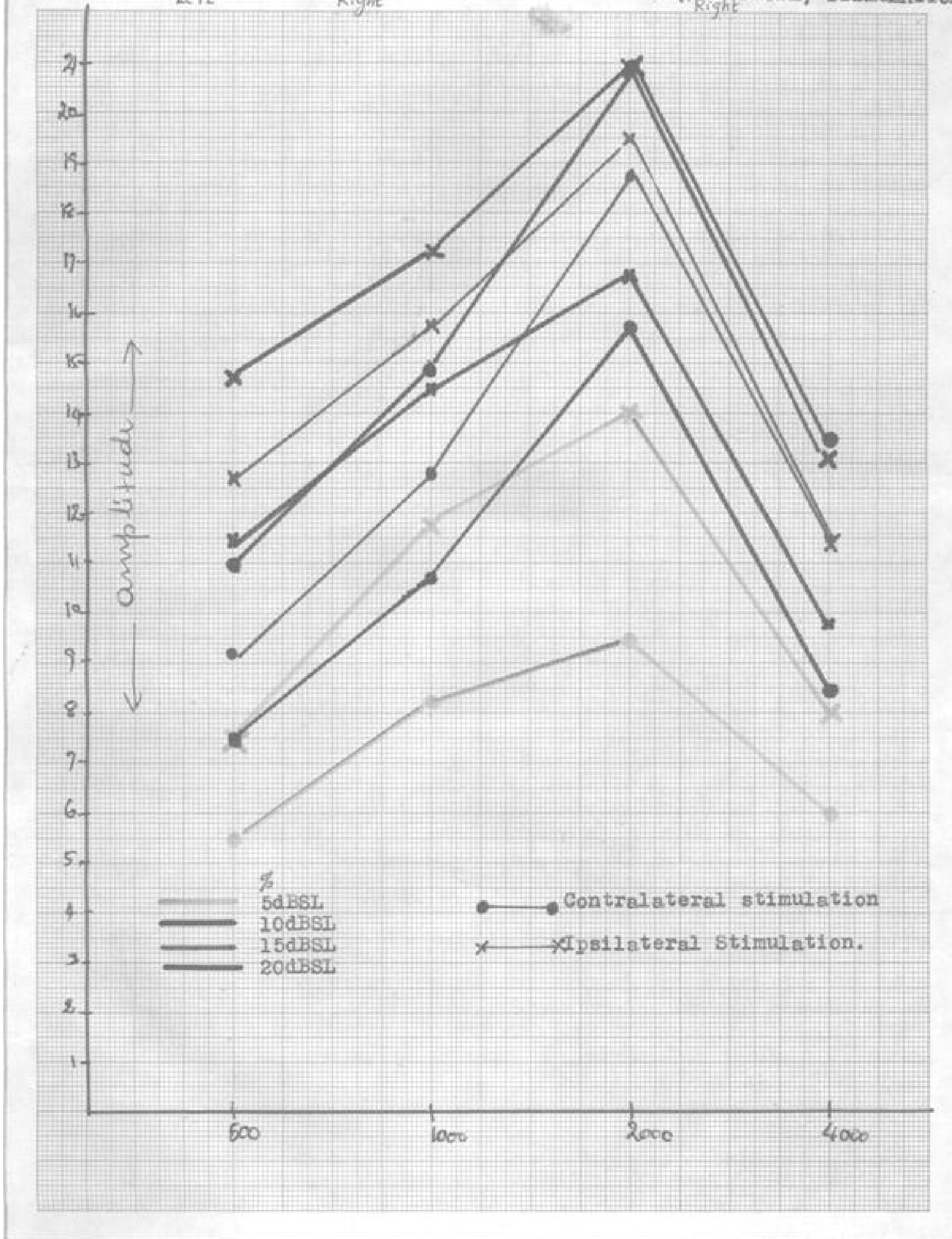
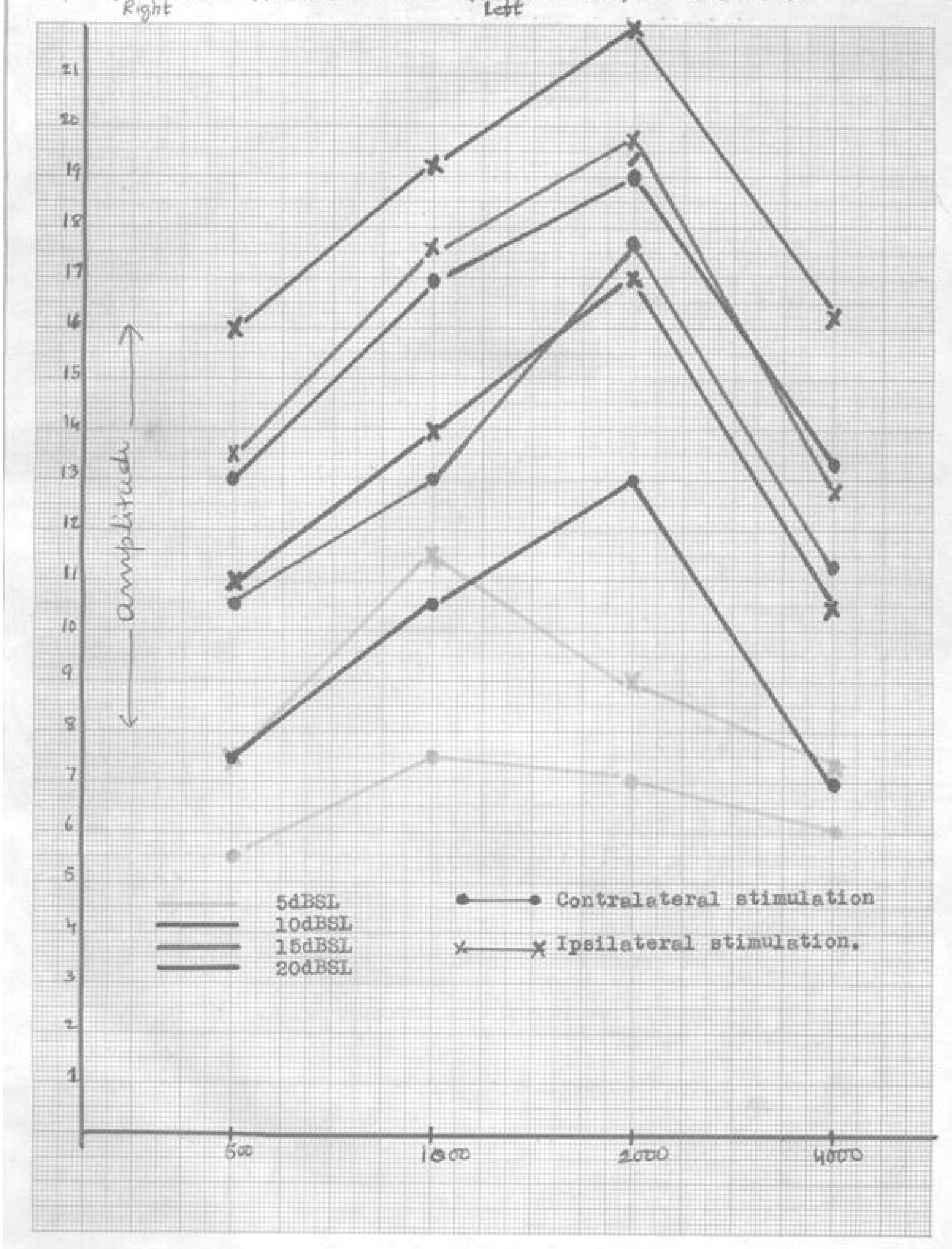


FIGURE 18
STAPEDIAL REFLEX AMPLITUDE VERSUS FREQUENCY FOR CONTRALATERAL (~~LEFT~~ Right PHONE), AND IPSILATERAL(~~RIGHT~~ Left PROBE) STIMULATION.



Results of the current study revealed the difference in stapedial reflex amplitude for ipsilateral stimulation and contralateal stimulation. At all the sensation levels (5dB, 10dB, 15dB and 20dBSL) and at all the frequencies tested the ipsilateral stimulation resulted in greater magnitude of reflex amplitude. This was observed even when stimulated ear was same for both ipsilateral stimulation and contralateral stimulation and also when the monitored ear was the same for both the type of stimulation. The exceptions to this finding were:

1. When the left ear was stimulated by presenting the tone at 5dBSL through the ear phone the magnitude of the reflex was greater than the magnitude of the reflex obtained when the left ear was stimulated by presenting the tone through the probe tube at the same sensation level. (See figure 15)

2. And, both imsilateal and contralateral stimulation resulted in equal stapedial reflex amplitude (see figure 12) at 15dBSL and 20dBSL to 4 KHz tone.

The greater magnitude of stepedial reflex amplitude for ipsilateral stimulation may be explained in the following manner.

5dBSL through a probe tip is not equal to 5dBSL through a head phone. This is because in ipsilateral stimulation volumes between ear drum and probe tip is leaser than the volume between ear drum and head phone in contralateral stimulation.

The difference is the volume cavity might be responsible for the difference in magnitude of the reflex.

The same explanation has been given to explain the better stapedial reflex thresholds for ipsilateral stimulation. In 1977 however, Reker while determining the normal values of the ipsilateral acoustic reflex, applied a stimulus sound of high intensity to the deaf ear of unilaterally completely deaf patients using a normal head phone. After subtraction of the individual cross-hearing loss, the exact ipsilateral intensity was obtained. Even with this method he found the difference between ipsilateral and constralateral stepedius reflex threshold was in the range of 15dB.

The results of this study confirms that difference in the volume cavity is not responsible for better acoustic reflex thresholds for ipsilateral stimulation. Thus difference in the volume cavity between ear drum and probe tips and ear drum and head phone, is not responsible greater stapedial reflex amplitude for ipsilateral stimulation.

Thus the alternative explanation would be, the possible difference in the ipsilateral reflex arch and contralateral reflex. Greinsen and Res Mussen (1970) have given the probable course of the stapedius muscle reflex arch for ipsilateral stimulation and contralatral stimulation. (see page No. 7a).

Increasing reflex response with increasing contralateral acoustic stimulation of pure-tone revealed a progressively greater magnitude of amplitude in all the conditions. This is an agreement with the report of earlier investigators (Anderson et al 1970; Peterson and Liden 1972).

Similarly there was increase in stepedial reflex amplitude with the increase in sensation level for ipsilateral stimulation in all the conditions. There was no exception to this. However there is no linear incease in stepedial reflex amplitude with the increase in sensation levels both in ipsilatral and contra-leteral stimulation. Peterson and Liden, (1972) reported that themaximum magnitude of the reflex was achieved at 20dBSL (ref. reflex threshold) and did not show further incease with the increase in stimulation.

Results of the data, illustrsted in the figure 1 to 16 indicate that the low frequencies (500 and 1000 Hz) do not appear to exhibit 50% reflex decay, for both ipsilateral stimulation and contralateral stimulation where as high frequencies do. This reflex decay is indicated by the decrease in reflex magnitude that occurs while the stimulus is maintained at a consistant sound pressure level.

Numerous investigators (Johnsson, et al 1967, Dallos 1964, Borg 68,) have reported on various aspects of reflex adaptation in man. Generally, the finds have indicated that reflex adaptation is greatest for high frequency pure tones (above 2 KHz) and that wide variation exists between individuals. Results of the present study also showed greatest adoption at high frequencies for both ipsilateral and contralateral stimulation in all the conditions. Swift decay at high frequencies is in support of earlier investigations of Anderson et al (1970) Chiverllis (1973), Wiley (1975).

Anderson et al (1970) reported that in normals 50% decay occurs at 2 KHz and 4 KHz (at 10dBSL) after 14 seconds and 7 seconds respectively. Chiverallie (1970) reported 14.6 seconds and 7.6 seconds. In the present study 50% decay time varied considerably between ipsilateral stimulation and contdralateral stimulation, at 2 KHz. This may be because of limited population studied. Hence a definite conclusion regarding 50% decay time could not be drawn.

However, at 4 KHz both ipsilateral and contralateral stimulations 50% decay was observed after 7 to 9 seconds.

CHAPTER – V

SUMMARY AND CONCLUSIONS

Contralateal or crossed stapeidus reflex are is different from ipsilateral or uncroseed stapeidal reflex arc. Contralateral reflex arc involved neurons which cross the midline, whereas ipsilateral does not. (Greenson and Resmuseen, 1970).

Moller (1962), reported ipsilateral acoustic reflex threshold to occur at lower intensity levels when compared to contalateral reflex thresholds. Later Reker (1977) reported similar findings. Though it is possible to mesure ipsilateral reflex decay, so far no study has attempted to explore this areas.

Also there is no information available comparing reflex amplitudes of contralateral stimulation and ipsilataral stimulation. This study was an attempt to compare stapedial reflex amplitude at different sensation levels and at different frequencies, of contralateral and ipsilateral stimulation.

The study included 4 young adults (2 females and 2 males) as subjects. Their age ranged 19 to 23 Years. Ipsilateral and contralateral reflex amplitudes were compared at 5 dBSL, 10dBSL, 15dBSL and 20 dBSL at 500 Hz, 1000 Hz, 2000 Hz. and 4000 Hz.

From the results obtained, following conclusions were made:

1. There was increase in stapediue reflex amplitude with increase in sensation levels, both in contralateral and ipsilateral stimulation.

2. Increase in stapedius reflex amplitude was not linear with increase in sensation levels in both contralarteral and ipsilateral stimulation.

3. Reflex amplitude were of greater magnitude in case of ipsilateal stimulation.

4. The difference in the reflex amplitude, between ipsilateral and contralateral stimulation was not not same for all the sensation levels.

5. There was no 50% reflex decay in lower frequencies (500 and 1000 Hz), in both ipsilateral and contralateal stimulation.

6. There was 50 % reflex decay in higher frequencies (2000 and 4000 Hz) in both ipsilateral and contralateal stimulation

7. There was no consistent difference in decay time for contralateral and ipsilateral stimulation.

8. Maximum reflex amplitude was obtained at 2 KHz for all the sensation levels, both in ipsilateral and contralateral stimulation.

Limitation of the Study:

1. The study included only 4 normal hearing subject, because 4 test instruments went out of order.

Recommendations:

1. Results of this study can be validated using large number of population.

2. Same study can be extended further using confirmed retro cochlear lesion. cases.

3. Inconsistent difference in decay time for ipsilateral stimulation and contralateral stimulation needs further research investigation.

BIBLIOGRAPHY

Anderson, M. Barr. B and Wedemborg. E.
"The early Dectection of Acoustic Tumours by the stepedius Reflex Test", in Sensorinural Hearing Loss.
by wolstenholme and Knight J.J & A Churchil, 104, Glocester, London.

Borg. E.
"A quantitative study of the effects of the acoustic stapedius reflex on Sound Transmission Through Middle Ear of Man. Acta Otolarygeal (stockh) 66 (1968) pp. 461-472.

Brog. E
"Acouastic Middle Ear Reflexes – Assensory Control System", Acta- Oto-Laryngol, Supp, 304 (1972).

Chiverallis, K.
"A Further examination of the use of The stapedius Reflex in the Diagnosis of Acoustic Neuroms", Audiology 16 (1977) pp. 331-337.

Dallos, P.J.
Dynamics of the Acoustic Reflex " Phenomendogical Aspects" Journal of Acoustical Society of America. 36 (1964) PP. 2175-2183.

Deutsh, L.J.
"Auditory Sensitization in the Human Stapedius Reflex", Journal of Auditory Research, 13 (1973), PP. 301-04.

Faldman, A.S and Wiber, L.A.
"Introduction", Aocustic impedance and Admittance – The Measurement of Middle Ear Function. ed, Feldman A.S. and Wilber L.A. Batlimore Md. The Williams and Wilkins Company. 1976. pp. 1-7.

Feldman, A.S.
"Tympanometry", Acoustic Impedance and Admittance – The Measurement of Middle Ear Fuction,ed. A.S. Feldman, Baltimore, M.D. The Williams and Wilkins Co., 1976. Pp. 103-55.

Flottorp, G. etal.
The Acoustic Stepedius Reflex in Relation to critical Bend Width, Journal of Acoustical Society of America, 49 (1971) PP. 457-461.

Greisen, S. and Rasmusen, P.E.
"Stapedius Muscle Reflexes and Otoneurlogical Examinations in Brain Stem Tumours" Acta Otolaryngol (Stockckholm) 70 (1970) pp. 336.

Hall, C.M.
"Stepedical Reflex decayin Retrocochlear and Cochlear Lesions. Review of Procedures and Methods. For conducting stepedial Reflex Decay", Annale of Otology, Rhinology and Leryngology 86 (1977). PP

Hojo.K

"The Metdz Test" Audiol (Jap) 20(1), (1977) 27-32

(Abstract of this study was taken from D.S.M Abstracts 1979.

Jepsen, C.

"The Threshould of the Reflexes of the Intra- tympanic muscles in a Normal Material Examined by means of The Impedence Method" Acta otolaryngological 39 (1955). PP. 406-408. (cited by J. Tonndortt, Beltons translation No. 22 Chicago 1970.

Jepson, (1966)

"Middle Ear Muscle Reflexes in Man" , in Modern Developments In Audiology ed. James Jerger, Academic Press, New York.

Jerger, J.

"Clinical Experience with Impedance Audiometry", Archieves of Otolarynology 92 (1970) pp. 311-24.

Jerger, J. et.al

"Predicting Hearing Loss from The Acoustic Reflex. Journal of Speech and Hearing Disorders. 39 (1974), pp. 11

Jerger, J. and Jerger, S.

"Audiologic comparison of Cochlear and VIII Nerve Disorders", Annals of Oto Rhinology and Laryngology 83 (1974) pp. 274.

Mensen, V.
Archives of Anotomy and Physiology 1878. pp. 312 (cited by Jepsen, C. in Middle Ear Muscle Reflexes in Men, in Modern Development in Audiology ed. by. Jerger, J. Academic Press. New York. 1963.

Johanason, B Kylin, B, and Lengty, M.
"Acoustic Reflex as a Test of Individual susceptibility To Noise" Acta Otolaryngol. (Stockh) 64 (1967), 256-62

Kamrzki, J.
"The Diagnostic Significance of The Measurement of the stapedial Reflex in Acoustic Neuroma and Brainstem Lesions", Audiology (Jap) 20 (1977), PP. 103-109. (Transalted abstract of this article was obtained in DSH Abstract 1979).

Kate, T.
Arch. Ges. Phyiol. 150, pp. 569. (cited by Japsen, O. in Middle Ear Muscle Reflexes in Man in Modern Developments in Audiology ed. by Jerger J. Academic Press. New York 1963.

Klockhoff, I and Anderson M.
"Reflex Activity" In The Tensor Tympani Muscle in Man", Acta Otolaryngologica Supp. (1961). pp. 164.

Kristensen, H. and Jepson, O.

"Recruitment In Otoneurologic Diagnosis" . Acta Otolaryngol", 42 (1952) pp. 553 (cited by Wilber L.A.Acoustic Reflex Measurement in Acoustic Impedance and Admittence std. by Feldman A.S. and Wiber L.A Baltimore M.D. Williams and Wilkins Co., 1976

Lamb, L Peterson, J and Hensen, S.

"Application of steapdius Muscle Reflex Measurements to Diagnosis of Auditory Problems. International Audiology. 7, (1968) PP. 188.

Lloyd, L.L.

"Impedance Audiometry". Auditory Assessment of the Difficult to Test. ed. RT. Fulton and L.E. Lloyd Rev. ed. pp> 179-234. Baltimore Md. Williams and Wilkins Co. 1975

Martin F.N. and Pennington, C.D.

"Current Trends In Audiometric Practices". Journel of American Speed and Hearing Association. 13(1971),671-77.

Metz, O

"The Acoustic impedance measured on Normal and Pathological Ears". Acta – Otolaryngology. Supp. 63 (1946). (cited in Acoustic Reflex Measurement, ' Acoustic Impedance And Admittance -The measurement of Middle Ear Fuction. Ed.

Feldman A.S. and

Wilber. L.A. Baltimore M.D. Williams and Wilkins. 1976.

Metz ,O.

“Threshold of Reflex contractions of Muscles of the Middle Ear

and Recruitment of loudness, Archives of Otolarynogol. 55 952) PP. 536.

Moller, A.

“ Improved Technique for Detailed Measurements of The MiddleEar Impedance”, Journal of Acoustical Society of America.33 (1961), PP. 168-171.

Moller, A.

“Acoustic Reflex in Man”, Journal of Acoustical Society of

America. 34 (1962), 1524-34.

Nicmyar, W. and Sesterhann, C.

“ Calculating the Hearing Threshold from the stapedial

Reflex for Different Sound Stimuli”. Audiology. 13 (1974), PP.

421.

Ouchi, J.

“Stapedial Reflex Induced by Ipsilateral and Contralateral

pure tones and Contralateral White Noise”, Audiology, (Jap)

20(1977), PP.221-226 (Abstract of this article was taken

From D.S.H. Abstracts 1979).

Peterson, J. and Liden G.

"Somestic Characteristics of the Stapedial Muscle Reflex, Audiology 11, (1972), pp. 97-114.

Peterson, J. et al.

"Reliability of Acoustic Responses by a Relative Measurement Method", Paper presented To The Acoustical Society of America (1965) (Cited by L.E. Lloyd I Impedance Audiometry. Auditory Assessment of the Difficult to Test. Rev. ed. Baltimore M.D.Williams and Wilkins. 1975.

Ransons, J.

"Impedance Measurements Some Recent Developments". Journal of Laryngology And Otology, 91(1971), PP. 655-64.

Reker, U.

"Normal values of the Ipsilateral Acoustic Stepeidius Reflex Threshold", Archieves of Ohr. Nas. Kehlkoptheik, 21561) (1977) PP. 25-34.(Translated abstract of this material is available in DSH abstract 18(1) (1978).

Sheetty, J.L. and Inzer, B.E.

"Acoustic Reflex Test In Neuro Otologic Diagnosis".

Archives of Otolaryngology, 102, (1976) pp. 647-653.

Terkildsen, K. and Thomsen K.A.

" The Influence of pressure veritation on the Impdance of The Human Ear drum". Journal of laryngology and Otology, 73 (1959), 409-415 (cited by Feld man A.S. Tympanomstry. Acoustic Impedance and Admittance – The Measurement of Middle Ear Function. Baltimore M.D., The Williams And Wilkins Co., 1976). PP. 103-55.

Tekildsen, K. et al

" Impedance Measurements : Probe Tone Intensity and Middle Ear Reflexes", Acta Octolaryngology.Supp. CCLXIII (1970). pp. 205-07.

Weiss, H.S. et al.

"The Normal Human Intra Aural Muscle Reflex In Responses To Sound",Acta – Otolaryngology. (Stockh) 55, (1962) pp. 505.

Wilber, L.A. Goodhill, V and Beterworth. A.

Final Report On NINDES Grant No. NS 08195-02. Acoustic Impedance Measurements In Children, 1976.

Wilber, L.A.,

"Acoustic Reflex Measurement Procedures, Interpretations and Veriables". Acoustic Impedance and Admittance. The Measurement of Middle Ear Fuction. Baltimore M.D., Williams and Wilkins Co. 1976.