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The Effect of Selected Variables on Auditory Brainstem Responses

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INTRODUCTION

The clinical application of the autitory brainstem response (ABR) has provided a unique diagnostic dimension that has transcended interdisciplinary boundaries (Jacobson, 1985). As a result, the use of ABR in Audiology and Ear, nose & throat clinics is gaining popularity. With the availability of equipment and the simplicity in procedures in recent years many centers are equipping themselves with ABR instruments. It is well known that the ABR is one of the important tools in the test battery of the aud iologist and has become an acceptable procedure.

In spite of the exhaustive literature available to understand and implement ABR procedures, often the clinicians are under pressure to work with the instruments with little chance to foster their knowledge and expertise. Although the recording procedures have been standardized for use, due to the disagreement among normative data apparently due to the differences in instrumentation and the host of stimulus parameters affecting the ABR recordings it has been unequivocally recommended to gather data by each clinical laboratory.

The most common stimulus in ABR audiometry is a broad-band click which can provide important audiometric information such as overall threshold for hearing and some insight into the etiology and audiometric configuration of hearing loss. Considerable research data has emerged regarding the influence of stimulus parameters on ABR. ABR recording from electrodes located ipsilaterally to the side of stimulation have been compared with contralaterally located electrodes. With the introduction of multichannelled instruments such recordings could be done simultaneously with no extra effort and time. It has been reported that certain components of ABR are either uncertain or abscure in ipsilateral recordings which frequently affect the interpretation of results (Mair & Laukli, 1980; Stockard et al., 1978; Horrocks, 1988a). Efforts in this direction date back to 1970's (Horrocks, 1988a) and some studies have reported sig0-nificant differences in ipsilateral versus contralateral recordings (Stockard et al., 1978 [cited in Horrocks, 1988a;] Rosen-hammer & Holmkvist, 1981). Other investigations have failed to observe any significant difference (Ainslie & Boston, 1980 [cited in Horrocks, 1988a]; Peter & Mendel 1974).

Results of many studies in this area are inconsistent and vary for different peaks of BSER wave from. However, separation of wave V in the contralateral wave form has been a consistent observation and often the IV-V complex affects the correct labeling of the peak V (Hughes et al, 1981; Rowe, 1981; Harrocks, 1988a). This application would be extremely useful in determining the Brainstem Transmission Time (BTT) (I-V IPL).

The effect of gender on the ABR is another variable studied by several investigators. Significant latency differences in ipsilateral tracings between males and females have been reported (Jerger & Hall, 1980; McCless and & McCrea, 1979 [cited in Horrocks, 1988b]). Females in general have been reported to have shorter latencies than males. On the other hand no significant differences have been reported (Horrocks, 1988b; Michalewski et al., 1980., [cited in Horrocks, 1988b]). Normative data on the gender effects would be beneficial.

Binaural verses monaural recordings have been reported to yield valuable information in diagnosis. The ABR responses for binaural stimulation have been found to be atleast as larger as & usually larger than those of monaural stimulation (Blegvad, 1975; Gerull & Mrowinski, 1984). Binaural strategy would be helpful when testing time is limited and full evaluation curtailed and when it is more important to define sensitivity in the better ear irrespective of which ear that is. Therefore, with the present day instruments binaural stimulation recordings would be helpful.

Although there are many variable affecting ABR recordings with a standard set of parameters data on ipsilateral and contralateral recordings was thought to be helpful for routine work in the clinic. In addition gender differences and binaural data would also be useful for accurate diagnosis. Therefore, as a first step the present study was planned to investigate into the three major areas described above. The objectives of the study were:

1. To compare the absolute & interpeak latencies of peaks I, **III** and V in ipsilateral and contralateral recordings.
2. To study the effect of gender on the latency measurements of the ABR wave forms.
3. To study the differences in the latencies of peaks I, **III** and V at one suprathreshold level, for use in the clinic.
4. To compare absolute and interpeak latencies of peaks I, **III** and V in monaural & binaural recordings.

METHOD & ANALYSIS

Subjects: Thirty young adults (15 males & 15 females) in the age range of 20 to 26 years with a mean age of 23.57 years with no history of hearing or neurological problems served as subjects. Each subject was tested for normal auditory function by pure tone audiometry and impedance audiometry. Pure tone theresholds less than 25 dBHL (Ref: ANSI, 1971) for test frequencies 0.25KHz, 0.5KHz, 1KHz, 2KHz, 4KHz & **8KHz,** static compliance measure between 0.3 & 1.5 c.c, middle ear pressure between + 50 & -50 dapa and the pressure of acoustic reflexes at 60 to 80 dBSL, for 0.5KHz, 1KHz 2KHz & 4KHz were considered as normal.

Procedure: All evaluations were carried out in the sound treated rooms using standard procedures. The pure tone audiometry was carried out using Madsen OB 822 diagnostic audiometer and the impedance measurements were performed using Madsen ZO 174 immittance audiometer. Recording and measurements of the ABR wave forms were carried out using Nicolet Compact Four sites: a common electrode at the forehead, an active electrode on each mastoid bone & a reference electrode at the vertex. Electrical impedance less than 10 Kilo Ohms was achieved for all the subjects and the same was a prerequisite to initiate the testing as recommended by the manufacturer. Auditory clicks of rarefaction polarity were delivered thouth TDH 39 ear phones at 80 dBnHL to one ear. Right ear was tested first in 50% of the subjects selected at random and the rest 50% received the stimulus in their left ear first. The stimuli were presented in runs of 2000 clicks, to one ear at a time. Ipsilateral and contralateral ABR's ie. responses from the vertex-mastoid montage ipsilateral to stimulation and the vertex-mastoid montage contralateral to stimulation using two channels were recorded simultaneously. The ABR data was then stored on a floppy disc for further analysis.

The instrument used had a self artifact rejection facility and wave forms with rejection rate of 10% or less were accepted for analysis. Absolute latencies of I, **III** & V peaks and their interpeak latencies (IPL's) were measured in Msec's from click onset by displaying screen cursor. Latency values were measured at the wave peaks. In cases where peak IV & V formed wave complexes with plateau the Vth peak was taken at the falling shoulder. The 80 dBnHL monaural recordings with the clicks was followed by the recordings for binaural presentation of clicks at 80 dBnHL. The absolute & inter peak latency measurements for binaural recordings were done in the same way as explained for 80 dB monaural presentations. 80 dBnHL was selected for binaural recordings to make the measurements comparable to the monaural data at 80 dBnHL. Better waveform morphology and clear wave forms with identifiable peaks at this level have been reported (Worthington & Peters, 1980). The results were analysed using anslysis of variance (ANOVA) test.

RESULT AND DISCUSSION:

Monaural 80 dBnHL:

The ipsilateral & contralateral waveforms of ABR for 80 dBnHL were analysed. The mean absolute latencies and their SD's of peaks I, **III** & V were compared for males & females separately (Table **1** & 2).

Table 1 : Mean absolute latencies (msec) & SD's of Ipsilateral & Contralateral recordings of Waves I, **III** & V males (80dB nHL).

Ear		li	Ic	IIIi	IIIc	Vi	Vc
Right	M	1.60	1.55	3.69	3.65	5.44	5.49
	SD	0.12	0.11	0.13	0.18	0.18	0.14
Left	M	1.55	1.67	3.64	3.68	5.45	5.52
	SD	0.10	0.12	0.13	0.15	0.12	0.13

N = 15

Note: i - Ipsilateral.
c - Conlraiatcral

Table 2 : Mean absolute latencies (msec) & SD's of Ipsilateral & Contralateral recordings of Waves I, **III** & V females (80dB nHL).

Ear		Ii	Ic	IIIi	IIIc	Vi	Vc
Right	M	1.56	1.60	3.64	3.56	5.46	5.52
	SD	0.14	0.12	0.12	0.30	0.21	0.23
Left	M	1.57	1.56	3.62	3.55	5.42	5.47
	SD	0.13	0.16	0.15	0.13	0.23	0.19

N = 15

Note: i - Ipsilateral.
c - Conlralalcral

Table 3 : Mean interpeak latencies (msec) & SD's of Ipsilateral & Contralateral recordings of Waves I, III & V males (80dB nHL).

Ear		**I-1i**	**I-IIIc**	**III -Vi**	III-Vc	**I-Vi**	**I-Vc**
Right	**M**	**2.09**	**2.09**	**1.75**	**1.82**	**3.84**	**3.91**
	SD	**0.15**	**0.16**	**0.17**	**0.15**	**0.22**	**0.16**
Left	**M**	**2.08**	**2.01**	**1.81**	**1.84**	**3.96**	**3.86**
	SD	**0.13**	**0.16**	**0.10**	**0.16**	**0.14**	**0.19**

N = 15

Nod:: i - Ipsilatcral.
c - Conlralaleral

Table 4 : Mean interpeak latencies (msec) & SD's of Ipsilateral & Contralateral recordings of Waves I, III & V females (80dB nHL).

Ear		I-Ii	**I-IIIc**	**III -Vi**	III-Vc	**I-Vi**	**I-Vc**
Right	**M**	2.05	1.99	**1.82**	1.92	3.87	3.92
	SD	0.36	0.17	0.17	0.20	0.24	0.19
Left	M	2.04	2.00	1.80	**1.89**	3.85	3.89
	SD	0.17	0.17	0.15	0.17	0.19	0.21

N = 15

Note: i - Ipsilatcral.
c - Contralateral

Table 5 : Mean absolute latencies (msec) & SD's of Ipsilateral & Contralateral recordings of Waves T, III & V (80dB nHL).*

Ear		II	Ic	IIIi	Ilk	Vi	Vc
Right	M	1.58	1.57	3.66	3.60	5.45	5.50
	SD	0.13	0.12	0.13	0.24	0.19	0.19
Left	M	1.56	1.61	3.63	3.61	5.44	5.49
	SD	0.11	0.15	0.14	0.15	0.18	0.16

N = 30

Note: i - Ipsilatcral.
c - Contralatcral
* - Data pooled for Males (N = 15) & Females (N = 15).

In males, the mean absolute latencies of the peak V for contralateral recordings were longer than the ipsilateral recordings for both right & left ears. But for peaks I & III the longer latencies were observed in contralateral recordings for left ear only. However these difference were not statistically significant at 0.05 level.

Similar results were observed in female subjects. The mean absolute latency of peak Vin contralateral recordings was longer for both the ears, and for peak III,the latency of contralateral recordings were shorter for both the ears. For peak I the latency was shorter in contralateral recording for only the left ear. These differences were not found to be statistically significant at 0.05 level. The results of the present study were in agreement with other investigators (Peters & Mendel, 1974; Olphen et al., 1978).

Table 6 : Mean latencies (msec) & SD's of Ipsilateral & Contralateral recordings of Waves I, III & V (80dB nHL).*

Ear		I-1i	I-IIIc	III -Vi	III-Vc	I-Vi	I-Vc
Right	M	2.07	2.04	1.78	1.87	3.86	3.91
	SD	0.27	0.17	0.17	0.18	0.23	0.17
Left	M	2.06	2.00	1.81	1.87	3.87	3.87
	SD	0.15	0.16	0.13	0.16	0.17	0.20

N = 30

Note: i - Ipsilateral.
c - Contralatcral
• - Data pooled for Males (N = 15) & Females (N = 15)

TabIe-7 : Comparision of mean latency (in msecs) of peaks I, III & V in binaural & monaural stimulation.

	Binaurat	Monaural Right	Monaural Left
Peak I	1.58	1.58	1.56
Peak III	3.63	3.66	3.63
PcakV	5.42	5.45	5.44

Many investigators in the past have pointed out to the use of contralateral recordings for separating peak IV & V complex. Some of them have reported significant differences in absolute latencies for ipsilateral & contra-lateral recordings (Horrocks, 1988b; 0Kevanishvili, 1980; Parker, 1981). Though the results of the present study did not yield any significant differences in contralateral recordings, the contralateral recordings did help in proper identification of peak V in ip-silateral recordings of several subjects.

The inter peak latencies (IPLs) of peaks I, III, V were analyzed separately for male and female subjects in both right & left ears. The mean IPL and their SD's were calculated (Tables 3 & 4). In males, the mean III-V IPLs were longer in contralateral recordings than in the ipsilateral recordings for both the ears. But the mean I-III & I-V IPLs in the contralateral recordings were shorter than the ipsilateral recordings only in the left ear. In the right ear, the mean I-III IPL values were same in both ipsilateral & contralateral recordings, where as the mean I-V IPLs in the contralateral recordings were shorter than the ipsilateral recordings. However these differences in IPL values were not statistically significant (0.05 level).

Table 8 : Normative ABR latency data across different laboratories.

Study	Stimulus Intcncy (dBSL)	Peak latency (ms) I	III	V	I-III	IIIV	I-V
Gilory and Lynn (1978)	75	1.55	3.6	5.4	2.05	1.9	3.83
Rowe (1978	60	1.9	3.8	5.8	1.97	1.97	3.94
Stockard and Rossilcr (1977)	60	1.9	4.1	5.9	2.1	1.9	4.00
Data and Kackar (1986)	80	1.46	3.55	5.44	2.1	1.89	3.98
Own Data	60	1.58	3.66	5.45	2.07	1.81	3.87

In female subjects, the mean I-V and **III**-V IPLs in the contralateral recordings were longer than the ipsilateral recordings in both the ears. Mean I-III IPLs in the contralateral recordings were shorter than ipsilateral recordings in both ears. However, as seen in males, these IPL differences were not statistically significant (0.05 level). These findings indicated that there was no consistent difference in IPL's between ipsilateral & contralateral recordings.

Schwartz & Berry (1985) have reported the I-V IPL to be longer and the I-III IPL to be shorter in the contralateral recordings than in the ipsilateral recordings. However, the results of the present study did not support their findings and failed to show a consistent pattern.

The ANOVA test also indicated that the mean absolute latency and the IPL values of the male & female subjects were not significantly different. Therefore the data of the two groups (males & females) was pooled for further analysis (Tables V & **VI).**

Monaural vs **Binaural 80 dVnHL:**

The absolute latencies of peaks I, III & V of ABR waveforms measured with binaural presentation of clicks at 80 dBnHL were compared with the mean latencies peaks I, III & V recorded in ipsilateral condition with monaural presentation of clicks at 80 dBnHL (Table VII). The mean latency value of peak V in the binaural condition was less than the monaural condition in both right and left ears and this findings agreed with earlier investigations (Blegvad, 1975; Gerull & Mrowinski, 1984). But for peaks I & III the mean latency differences between the binaural and the monaural recordings were inconsistent.

The mean absolute and interpeak latencies of the present study were compared with the findings of the earlier studies (Table 8). The latency values of the present study was in a close agreement with the studies which has been reported earlier, although not thesame. The findings justified the need to establesh separate norms for each laboratory for accurate disgnostic measurements.

SUMMARY & CONCLUSIONS:

The purpose of this study was to compare the absolute and interpeak latencies of peaks I, III & V in ipsilateral and contralateral recordings at suprathereshold level in 15 adult males and 15 adult females in the age range of 20 to 26 yrs with a mean age of 23.5 yrs having hearing within normal limits. Further, the absolute and interpeak latencies of peaks I, III & V were compared in monaural and binaural recordings.

Simultaneous ABR wave recordings were carried out through the mastoid electrodes located ipsilaterally and contralaterally to the acoustic stimulation. No significant differences in the absolute and interpeak latencies of peaks I, **III** & V were observed between ipsilateral and contralateral recordings in both male and femasle subjects. Further no significant gender differences for the absolute interpeak latencies of peaks I. III & V were observed at the 80 dB intensity level. The mean absolute latency of peak V in the binaural recordings was shorter than the monaural recordings in both the ears.

Due to the multi-channel nature of modern ABR systems, the recordings of contralateral responses in addition to ipsilateral responses, requires no extra time, both being obtained simultaneously. The contralateral recordings did help in proper identification of V peak were IV & V peak complex was observed in ipsilateral recordings. This strengtherns the argument for routine use of the contralateral recording in ABR testing. It is recommended that contralateral recordings be included in the ABR assessment as an adjunt to ipsilateral recordings, to increase the sensitivity of the ABR as an audiometric procedure.

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