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ORIGINAL ARTICLE

Comparison of Middle Latency Auditory Evoked Potential Results of Congenitally Blind, Partial Vision Deficiency to Normal Vision Aquity Subjects

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Objective: The auditory abilities of "congenitally blind", "partial vision deficiency" and "normal vision" groups were tested using middle latency response test which is an auditory evoked potential test reflecting the primary and secondary auditory area activities. The objective of the Auditory Middle Latency Response Test was to find out differences in wave latency and amplitude among the groups.

Materials and Methods: Eleven congenitally blind people composed the first group, the second group included 10 subjects with "partial vision deficiency". Thirteen subjects with normal vision were in the third group. The age range of the subjects were between 18-30 years. All the participants had normal hearing. Auditory Middle Latency Response (AMLR) test was applied to all subjects and AMLR results were recorded from Fz and Cz electrode localizations.

Results: In the Cz recordings, there was a significant difference between Pa and Nb wave latency values among the groups. Average Pa wave latency of the first group was longer than that of the third group. Average Nb wave latency of the first group was longer than Nb wave latency of the second group. In the Fz recordings, average Pb wave latency of the first group was significantly longer than that of the second group and third group. In Cz and Fz recordings, there were no significant differences between Po-Na, Na-Pa, Pa-Nb, Nb-Pb amplitudes among the groups.

Conclusion: Results of Cz and Fz recordings indicated longer Pa and Nb wave latency in the congenitally blind group than in the other groups. No significant amplitude difference was present among the groups.

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Introduction

It has been a great inquiry about the vision deficient people having keener on other senses than normal vision group. Up to date many observations and studies have been done on the topic.

While normal vision babies are enlightened with visual and auditory stimuli, congenitally blind babies use sense of touch, hearing, smell and taste to learn and understand their environment. They try to compensate their deficiency by using their other senses. Is it possible to enlarge the capacity of the senses by frequent use as we develop our abilities?

This is a topic discussed for many years and the general consensus is that blind people in order to compensate their blindness, use their other senses and as a result they develop their hearing, taste, touch and smell senses. Starlinger and Niemeyer's (1981) study on vision deficient clients verified the indicated topic as the central auditory processing ability of the deaf people being developed [1].

There are two trends in explaining the auditory development of the deaf people [2,3] . In the deficient model; other senses cannot replace effect of visual experiences in the development of hearing[2] . In this model, the development of auditory areas requires visual stimuli. The alternative model is called "compensation model". Jones (1975), Ashmead (1998) states that role of the visual experiences in the development of hearing is not more effective than the experience set forth by other senses as feel, touch, smell and taste. The uniform use of different stimuli is important[3,4] .Vision deficient people develop their

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auditory ability by using their other senses, so their auditory system is better developed than normal[4] .

In our study, AMLR was applied to "congenitally blind", "partial vision deficiency" and "normal vision" groups, and wave latencies and amplitudes were compared to see effects of visual deficiency on hearing.

In order to detect the activities at the auditory cortex and secondary areas, middle latency response test of Auditory Evoked Potentials is used in evaluation.

Materials and Methods

Participants: The participants were 11 congenitally blind Turkish-speaking individuals and 10 partial visual deficiency participants who were compared with Turkish-speaking normal seeing individuals. Of the blind participants including both first and second groups, 13 were congenitally blind, 3 had congenital cataract, 1 had congenital glaucoma, 1 had genetic retinities pigmentoza, 1 had North Caroline maculer distrophy, 1 had tumor when 3 months old and 1 had meningitis when 6 months old. Total of 21 participants were included in the study (Table 1).

The study was performed with the permission of the Marmara University Medical School Ethic Committee.

Overall, mean age was 23.91±3.11. Mean age was 23.09±3.15 and 24±2.86 years in the congenitally blind group (first group) and second group respectively. It was 24.53±3.15 in the normal seeing group.

Before the tests, all subjects were checked for previous or present neurological disorder, ENT, otologic and hearing deficit disorders that would affect the results. All participants were examined in the Ophtalmology department of Marmara University in terms of their visual deficiency. Blind group was classified, and normal seeing group was also tested in the same department to rule out any visual problems.

Pure-tone audiometry: Air and bone-conducted pure-tone audiometry were performed in the range of 250 to 8,000 Hz and 500-4,000 Hz respectively. According to ISO-389 standart, 0-26dB hearing was considered normal. Speech tests at 40dB SL included speech reception threshold and monosyllabic speech discrimination. Marmara University Monosyllabic Word Lists in Turkish were used for evaluating speech discrimination.

Acoustic Immitancemetry: Tympanometry and acoustic reflex measurements were performed. Tympanograms were considered normal when middle ear pressure was >= 75mm H2O. Pure-tone stimuli at 500 to 4,000Hz were used for measurement of acoustic reflexes. The reflexes were measured in both ipsilateral and contralateral conditions and considered normal when acoustic reflex was present.

OAE: An ILO 96 DP Echoport ILO OAE System (Oto Dynamics Ltd., United Kingdom) was used for transient evoked otoacoustic emission (TEOAE). Nonlinear click levels were 80dB pSPL (±3dB). OAE was accepted as present if overall response amplitude was at least 3dB and waveform reproducibility in at least 3 octave bands was >75%.

Evoked responses: Middle Latency Response (MLR) Audiometry were recorded using Bio-Logic Systems Corp. Navigator Pro AEP 2.3.0 with Toshiba laptop (Bio-Logic Systems Corporation, USA). Silver electrodes were used in recording evoked responses. Insert earphones were used in giving the signals. Click

Table 1. Visual acuity degrees of subjects

VISUAL ACUITY	Light-Sensitive Negative P (–)	Light-Sensitive positive P (+) (below 0.1)	Normal Vision Aquity Subjects
GROUP NAME	Congenitally Blind (1st group)	Partial Vision Deficiency (2nd group)	Normal Vision (3rd group)
NUMBER OF EYES	19	23	26
NUMBER OF SUBJECTS	11	10	13

stimuli of 100 ms duration with intensity of 70dB nHL and repetition rate of 7/sec were used in recording. A band pass filter from 10-1,500Hz was applied, and 512 sweeps were averaged and analyzed using a 100 ms time window. Alternating polarity was used and the amplification was 75,000 times.

For forehead recording electroencephalographic electrodes placed on the forehead(Fz) for positive recording and negative electrode to the back of the ear lobe where stimuli is given. Ground electrode placed at the back of the opposite ear lobe.

For central midline recording, positive electrode on vertex(Cz), negative electrode to the back of the ear lobe where stimuli is given and ground electrode to the opposite ear lobe. The impedence of all electrodes was below 3k Ohms. One channel recording was used. (Figure 1)

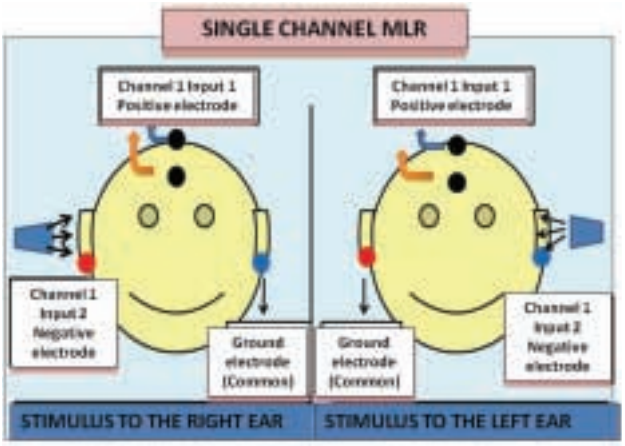

Figure 1. MLR electrode montage.

As to statistical method, ANOVA, Tukey (Post. Hoc. Tukey) and T-tests were used in evaluating average latency and amplitude of MLR recordings of experimental and control groups.

Results

All participants had normal hearing. In the electro-acoustic immitancemetry they all had Type A tympanograms.Ipsilateral-contralateral acoustic reflexes were present. They all had emmissions in all frequency bands in the TEOAE test.

Purpose of our study was to test each participant with Cz and Fz recordings in order to find out the differences between the Po,Na,Pa,Nb,Pb wave latencies and Po-Na,Na-Pa,Pa-Nb,Nb-Pb amplitudes.

Differences between vertex (Cz) and frontal (Fz) recordings:

Cz and Fz recordings were compared by both ANOVA and Tukey methods in terms of their latencies and amplitudes.

Cz recording: Significant difference between the average latency values of Pa and Nb waves was present. Average Pa wave latency of group I and group II was longer than group III latency average. Nb latency average also showed a significant difference between groups I and II as Group II showing shorter latency. Table 2 gives the average AMLR latency values.

Table 2. AMLR waves mean latency values in the Cz recordings.

Groups	Parameters	Latency Values				
		Po latency	Na latency	Pa latency	Nb latency	Pb latency
Congenitally Blind	Number of Ears	12	19	20	20	12
(I)	Mean	12.3325	16.6126	30.2850	44.7550	56.1092
	Std. Deviation	1.4746	2.5726	3.4795	5.6313	4.6479
Partial Vision Deficiency	Number of Ears	12	19	19	19	13
(II)	Mean	12.0392	16.2624	27.9975	40.4574	53.1725
	Std. Deviation	1.6804	1.6040	1.9248	3.5018	3.7357
Normal Vision	Number of Ears	20	25	25	25	19
(III)	Mean	11.7555	15.9724	27.4740	42.6392	55.4047
	Std. Deviation	2.0963	2.3711	3.2381	5.0360	5.7950
Anova	Significance	0.689	0.645	0.008	0.027	0.3

Fz recordings: Pb wave latency average among the 1st, 2nd and 3rd group showed a significant difference. First group wave latencies were longer than the 2nd and 3rd groups latency values (Table 3).

Inter group differences between Cz(vertex) and Fz(frontal) recordings:

T- test was used in evaluating the difference between Po-Na, Na-Pa, Pa-Nb and Nb-Pb wave amplitudes recorded with Cz and Fz electrode locations, and no statistically difference was present.

In the first group there was only a significant difference in Nb wave latency values between Cz and Fz recordings, Fz recordings beeing 2.939 ms shorter.

In the second group only Pa wave latency average showed a borderline difference statistically, Pa wave latency value 1.4614 ms shorter in Fz recording.

No significant difference was present in any of the wave latencies at Cz and Fz recordings in the third group (Figures 2-4).

Discussion

Our results illustrate the importance of visual experience. Several notable changes were seen in AMLR when visual experience was eliminated from birth until adulthood.

In our study average Pa wave latency of the first group was 2.811 ms longer than the Pa results of the third group in Cz recordings which meant significant difference. Also average Nb wave latency of the first group was 4.2976 ms longer than that of the second group.

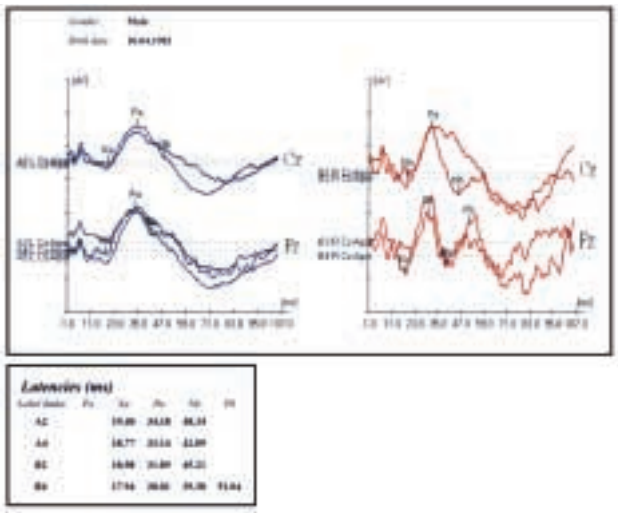

Figure 2. Congenitally blind subject's MLR results. (male)

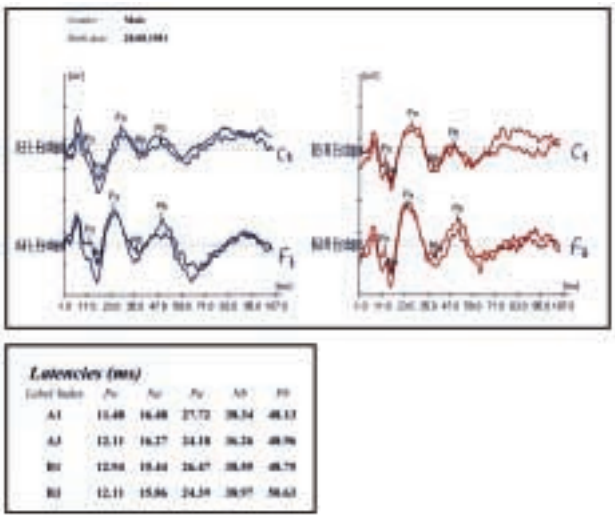

Figure 3. Partial vision deficient subject's MLR results. (male)

Table 3. AMLR waves mean latency values in the Fz recordings

Groups	Parameters	Latency Values				
		Po latency	Na latency	Pa latency	Nb latency	Pb latency
Congenitally Blind	Number of Ears	14	21	22	22	21
(I)	Mean	11.6026	16.0541	28.4045	41.8157	57.6436
	Std. Deviation	2.8783	2.2027	2.7644	2.9349	5.6808
Partial Vision Deficiency	Number of Ears	14	20	20	20	17
(II)	Mean	11.5429	15.5235	26.5361	39.2691	52.0349
	Std. Deviation	1.5045	1.6118	2.4036	3.6828	4.5547
Normal Vision	Number of Ears	22	26	26	26	21
(III)	Mean	11.8518	15.6315	27.1873	41.4562	52.8167
	Std. Deviation	2.0457	2.0742	3.0902	5.3215	5.0602
Anova	Significance	0.902	0.661	0.095	0.113	0.002

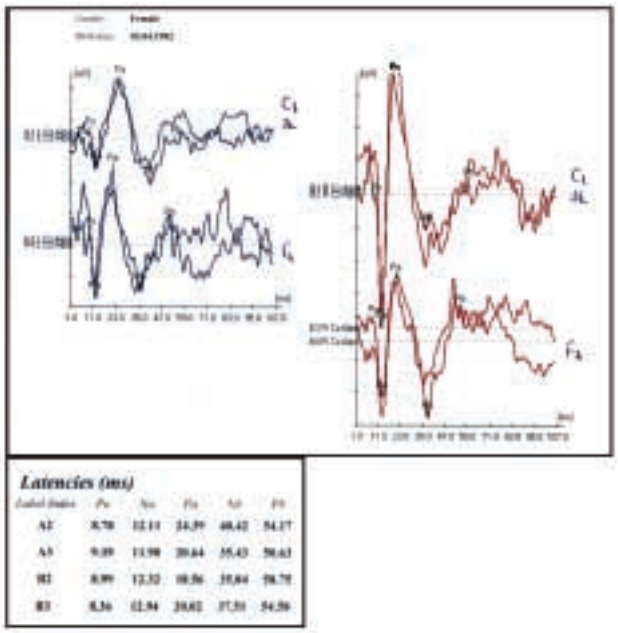

Figure 4. Normal seeing subject's MLR results. (female)

In Fz recording an important difference for the role of visual experience was detected in average Pb wave latency. First group had 5.6087 ms longer than 2nd group and 4.827 ms longer than 3rd group values. Pa and Nb values in Cz recording and Pb wave latency values in Fz recordings of 1st group were longer than the other groups. These differences illustrate the role of visual experience. AMLR test recordings of auditory stimuli took longer time in the congenitally deaf group than in the normal seeing group. It is hard to make any comment, but at least one can assume that visual deficiency participants did not show a better performance in central auditory processing.

Current study results do not verify Niemeyer et al's study. In Niemayer and Stalinger's (1981) study on congenitally blind and normal seeing subjects, Nb wave latency values in AMLR were shorter in that blind population. Author's interpretation was that posteromedial area of primary auditory complex works more effectively in the blind population in central auditory processing activities.[1]

Naveen's (1997) study on blind subjects and normal seeing subjects indicated shorter Nb wave latans values in the former group, but they could not find a significant difference in Pa values among groups.[5]

In a study on blind and normal seeing subjects, Pa and Nb wave latency values were extremely shorter in the blind group. Wave amplitude values of the vertex(Cz) and occipital (Oz) recordings showed higher Pa amplitude in both groups in Cz recordings. Nb amplitude was the same in both recordings.[6]

Because of the methodogical problems and different methods used in the studies (in terms of stimuli, age, etiology of blindness, one or two channel test procedure) it becomes hard to compare MLR results of different studies.

Roder and Rosler (2003) indicated that auditory memory of the blind subjects who became blind in the first stages of life was keener than that of the normal seeing subjects in their study. It was declared that the blind group have exceptional auditory attention and verbal memory.[7,8]

Awareness of auditory stimuli, localization of auditory stimuli and frequency discrimination ability of the blind was a major interest. So, many studies on attentional-orienting mechanism was made. Chen et al. (2006) worked on this topic, and their article was published in Neuro report [9]. Their results indicated that localization of peripheral signals was more rapidly perceived by blind participants than in normal seeing subjects. But their frequency discrimination took longer time than normal seeing subjects. Also Roder (1999) reported the same results in his article.[10]

Gougoux and friends (2004) studied the same parameters and concluded that the blind is more concerned with the location of the auditory signals rather than with the content of the stimuli because localization of auditory cues is crutial for them. [11]

In our study different Pa and Na wave latency values of Cz and Fz recordings supports the importance of electrode localization during evoked potential test.

The contradictions between our results and other studies made on human subjects directed us to animal researches.

A research Research on blind Spalax Ehrengi (kind of mole rat) showed that they use somato sensory signals as well as auditory stimuli, but they give priority to

auditory stimuli[12]. In another study on blind Spalax ehrengi showed good agreement throughout the test with typical mammalian hearing. It was observed that their central auditory area besides "lateral superior olive", was functioning normally.[13]

Another study on blind cats on enchancing processing of visual, auditory and somatosensory central areas enlightened us about the numbers of neurons activated in the cortical areas. Findings showed us that the number of neurons activated at the tail of anterior ectosylvian sulcus to auditory and somato sensory stimuli varies between blind and normal seeing cats. It is caused by more neurons activated in blind cats due to auditory and somato sensory stimuli via limited neuron activity in the visual area to visual stimuli as expected[14]. Enlargement of central auditory and somato sensory areas which are adjacent to each other, helps the blind cat to perceive environmental stimuli[14].

In our study on congenitally blind, partial visual deficiency and normal seeing participants, results of MLR showed significant long wave latency values in congenitally blind subjects. Possibly in this group, input signals are perceived by the neurons in the auditory and somatosensory areas, so we see prolonged wave latency values in MLR recordings.

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