Aud Vest Res (2015);24(3):152-156.

RESEARCH ARTICLE

Comparison between sustained auditory attention capacity in blind and normal children

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Received: 6 Mar 2015, Revised: 4 May 2015, Accepted: 13 May 2015, Published: 22 Jun 2015

Abstract

Background and Aim: Attention is an important cognitive process that is necessary for educational purposes. Blind people are deprived from the most widely used human sense, the sense of vision. There are reports that blind individuals have a significantly better performance in attentional tasks, as compared with normal subjects. The purpose of this study was to evaluate sustained auditory attention capacity of Persian blind children aged 8 to 10 years.

Methods: This study was performed on 60 blind children (50 boys) aged 8 to 10 years. The control group consisted of 60 normal children (49 boys) at the same age of the test group. In this study sustained auditory attention capacity test (SAACT), otoscopy, Edinburgh and audiometry tests were used. For statistical analysis non-parametric Mann-Whitney U and Chi square tests at p=0.05 significance level were used.

Results: There was a significant difference in total score of sustained auditory attention capacity test (p=0.038) and Impulsiveness error between blind and normal children (p<0.001). Blind subjects had fewer impulsiveness errors and lower total score. Considering inattentive error (p=1.00) and attention reduction span index (p=0.301), there was no significant difference between the groups.

Conclusion: It seems that sustained auditory attention capacity in blind Persian children is larger than age-matched normal group. This can indicate sort of sensory compensation after loss of vision early in life.

Keywords: Sustained auditory attention capacity; children; blindness

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Introduction

The ability to selectively focus on one aspect of the environment and at the same time, to ignore other aspects is called attention that is in relation with complex set of behavioral and physiologic responses to circumferential stimuli [1,2]. Attention is an important cognitive process that is necessary for educational purposes [3]. Sustained auditory attention or the ability to maintain attention on a specific stimulus for a long period of time is one of the most important neurophysiologic models of attention [4]. Being voluntary is the main

feature of sustained auditory attention [2]. Sustained auditory attention can be evaluated through a set of electrophysiological tools and behavioral tests. In 1956, Rosvold et al. clearly demonstrated that continuous performance test (CPT) has high sensitivity for assessing attention. This test is one of the most commonly used measures in clinical practice and research in order to assess attention [5].

Sustained auditory attention capacity test (SAACT) is a new version of CPT that has been developed by Feniman et al. for assessment of sustained auditory attention [6]. It is an auditory alertness task that evaluates auditory attention or the ability to listen and respond to auditory stimuli over a long period of time. Their study showed that SAACT is very helpful for evaluation of sustained auditory attention in children. Although there was a significant difference in test scores between different age groups, they did not find any significant difference between genders [6].

Blind persons are deprived from the most widely used human sense, the sense of vision. Although other senses provide valuable information, it is vision that provide most reliable and most detailed information about the surroundings [7], blindness is defined by World Health Organization (WHO) as visual acuity of worse than 20/400 in a person's better eye with the best possible correction. There are about 300 to 400 million visually impaired people in the Eastern Mediterranean that have variety of eye diseases. Globally an estimated 45 million people are blind and the number of individuals with blindness might reach 76 million by the year 2020 because of a number of factors [8]. Many studies have been done on the topic of attention, memory and localization of the blind people. For instance, Hugdahl in 2003 showed enhanced processing of speech sounds in congenitally and early blind individuals compared with normal individuals by using a dichotic listening procedure with pairwise presentations of consonant vowel (CV) syllables [9].

Considering large population of the blind people and the importance of attention in education and training of blind children, the purpose of this study was to evaluate the sustained auditory attention capacity of Persian blind children aged 8 to 10 years. We used the Persian version of SAACT of reliability and validity of Persian version of SAACT was obtained by Soltanparast et al. [10].

Methods

This study was carried out on 60 blind children (50 boys) aged 8 to 10 years. The control group consisted of 60 normal children (49 boys) at the same age of the test group. For the selection of normal children, we used random sampling between four elementary schools in Tehran, Iran, purposive sampling technique was used for test group.

The inclusion criteria for all children were normal otoscopic results, normal hearing thresholds, equal or better than 20 dB HL at octave frequencies [11], symmetric average hearing thresholds for two ears, no history of neurocognitive problems, epilepsy, head trauma, severe fever, ototoxic drug consumption, brain surgery, underlying disease and behavioral problems. All of the children were right handed (defined by Edinburgh handedness inventory), aged 8 to 10 years and had normal IQ. All of the participants were monolingual and native Persian speakers. In the test group, all of the participants had early peripheral blindness starting by the time they reach age two years old. All participants or their parents singed a printed consent form and this study was approved by the Human Research Ethics Committee of Tehran University of Medical Sciences.

Persian version of SAACT consists of an inventory that has 100 words chosen from a list of 21 monosyllabic Persian words. There is a target word in the inventory that is randomly repeated 20 times during each session. Monosyllabic words have been chosen so that they don't resemble the target word. The participants were asked to report when they heard the target word via a headphone (SHM 900, Philips, Germany). The inventory runs 6 times without interruption and there is just a few

Table 1. Median, minimum and maximum of the performance measures for both groups.

	Blind			Normal			
	Max.	Min.	Median	Max.	Min.	Median	p
Inattentive error	8	0	1	3	0	1	1.00
Impulsiveness error	5	0	0.5	5	1	2	0.00
Total score	9	0	2	7	1	3.5	0.038
Attention reduction span index	1	-1	0	1	-1	0	0.301

seconds between the runs. The words were played through laptop on a fixed intensity level that was calibrated by sound level meter to meet 60 dB HL at the ears.

The decision criteria were inattentive error: total frequency with which the target word is not recognized in all six stages of test; impulsiveness error: total frequency with which misrecognition of the target word occurs in all six stages of test; attention reduction span index: the number of correct answers in the sixth stage of the SAACT minus the number of correct answers in the first stage and total score of sustained auditory attention capacity test: the sum of the total number of inattentive and impulsiveness errors in the all six stages [6].

Since the type of the test variables and number of errors were quantitative and discrete, for comparison of the medians, we applied non-parametric Chi square test at p=0.05 significance level in order to compare attention reduction span index between groups and Mann-Whitney U test was used for comparisons of other variables.

Results

The SAACT scores in both groups and group comparison results showed in Table 1. Statistical analysis of data showed a significant difference in total score of SAACT between the groups (p=0.038) and blind children had median errors lower than normal children. We also found a significant difference in impulsiveness errors between blind and normal children (p<0.001), blind children had fewer errors. Blind subjects had fewer impulsiveness errors and lower total score of sustained auditory attention capacity test. Lower total scores means that blind subjects had better performances. Considering inattentive error and attention reduction span index, there was no significant difference between the groups (p=1.00, p=0.301, respectively).

Discussion

We aimed to assess the capacity for sustained auditory attention in Persian blind children aged 8 to 10 years old. Findings of this study showed that with respect to total score of sustained auditory attention capacity, there was a significant difference between blind and normal subjects; average errors of blind children were less than normal children. In the case of individual test components, there was a significant difference between the groups in impulsiveness error and considering the averages, blind children had fewer errors. With regard to inattentive error and attention reduction span index, there was no significant difference between the blind and normal subjects. In general, this study showed that early blindness can affect continuous auditory attention capacity in children. The possible reason for this finding could be increased attention and focus in blind children for maximum use of other sensory inputs such as hearing to overcome loss of sensory input caused by vision deprivation. SAACT is a new test and so far it has not been used in different populations. For instance, Mondelli et al. investigated the effects of mild hearing loss on

the SAACT scores in a group of 60 children aged 7 to 11 years. They found that mild hearing loss could affect SAACT scores. They also reported that children with sensorineural hearing loss (SNHL) and conductive hearing loss (CHL) showed lower performance in all of the SAACT results in comparison with the control group and the greatest influence was observed in the presence of SNHL [12]. Seidel and Joschko showed that in normal children CPT results changed with increasing age, although not affected by gender. They also reported data from subjects with attention deficit and hyperactivity disorder (ADHD) and indicated that they perform significantly more poorly than the controls with time on the task. They suggested that the ability to sustain attention, increases with age and does not vary between genders [13]. Sykes et al. examined the ability of hyperactive children to maintain attention on three tasks. One of which was the CPT. They reported that the hyperactive children were significantly inferior to the controls in their ability to sustain attention [14].

According to Darwin, blindness causes an increase in non-visual perceptual abilities [15]. Many researchers performed studies on non-visual perception abilities of blind people and many of them agree with the Darwin's conclusion. For example, Wan et al. found that blind participants exhibited superior performance for auditory pitch discrimination and auditory pitch-timbre categorization than sighted controls [16].

Studies on animals which were deprived of sense of vision clearly shown how visual experiences affect the performance of hearing [17]. It has been reported that while sighted humans and animals locate the sounds from the surrounding environment less accurately [18], blind people and vision deprived animals locate environmental sounds better and more accurate [19]. This is true especially when the sound comes from behind [20]. It is interesting that in people who were blind early in life (early blindness) with peripheral or central vision loss, the effects of auditory experience on the auditory localization was the same. Garg et al. used event-related fMRI to explore activation of frontal eye fields and medial occipital areas in congenitally blind individuals and sighted controls with eyes closed while performing a covert attention orienting task with endogenous verbal cues and specialized auditory targets. They found robust stimulus-locked frontal eye field activation of all congenitally blind subjects, similar to and stronger than sighted controls [21]. Van Velzen et al. used tactile stimuli and showed that the effects of tactile attention on the processing of tactile events were very similar for early blind and sighted participants [22].

In the present study, there was no difference between two genders in the case of inattentive error, impulsiveness error, attention reduction span index and total score of sustained auditory attention capacity test. This is in accordance with reports of Feniman et al. [6]. They performed SAACT on 280 children aged 6 to 11 years (141 boys) and found no difference between two genders in the case of inattentive error, impulsiveness error, attention reduction span index and total score of sustained auditory attention capacity test [6]. However, in the present study inattentive error was considerably different in blind boys and girls and the latter had fewer errors. We think that this could be resulted from more focused attention in blind girls. Though, because of the small number of females in this study, the interpretations should be with caution.

Conclusion

Based on the results of this study, it seems that sustained auditory attention capacity in blind Persian children is better than age-matched normal group. This can indicate a kind of sensory compensation after early loss of vision.

Acknowledgements

This paper is emerged from M. Zia dissertation. The research has been supported by Tehran University of Medical Sciences grant no. 94-04-32-27836.

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