Türk Fizyoterapi ve Rehabilitasyon Dergisi

2013 24(3)163-168

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Geliş Tarihi: 15.05.2013 (Received)
Kabul Tarihi: 22.11.13 (Accepted)

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RESEARCH ARTICLE

A COMPARISON OF REACTION TIMES BETWEEN ADOLESCENTS WITH VISUAL AND AUDITORY IMPAIRMENT AND THOSE WITHOUT ANY IMPAIRMENT

ABSTRACT

Purpose: The aim of this study was to compare the auditory and visual reaction times of adolescents with auditory and visual impairment and those of controls without any impairment in order to investigate whether adolescents who lack one sense have an enhanced ability with the other.

Methods: A total of 64 adolescents with auditory impairment, 60 adolescents with visual impairment, and 59 controls without impairment, were included in the study. Visually impaired adolescents simple auditory reaction times, auditory impaired adolescents simple visual reaction time, and the controls visual and auditory simple reaction times were evaluated with the New Test 100.

Results: While no statistically significant difference was found between auditory reaction times of controls and visually impaired adolescents ($p>0.05$), a significant difference was observed in visual reaction times of controls and auditory impaired adolescents ($p<0.05$).

Conclusion: The reason why auditory impaired adolescents have longer simple reaction times could result from peripheral or central stimulation, changes in input processing in the cerebrum and their focus on lip reading and sign language compared to visually impaired adolescents.

Keywords: Reaction time; visually impaired; auditory impaired

ARAŞTIRMA MAKALESİ

GÖRME ENGELLİ, İŞİTME ENGELLİ VE SAĞLIKLI ADELOSANLARIN REAKSİYON ZAMANLARININ KARŞILAŞTIRILMASI

ÖZET

Amaç: Bu çalışmanın amacı görme engelli, işitme engelli ve sağlıklı bireylerde işitsel ve görsel reaksiyon zamanını karşılaştırmak ve bir duyusu eksik olan bireylerin diğer duyusunun daha iyi olup olmadığını araştırmaktı.

Yöntem: Bu çalışmaya 64 işitme engelli, 60 görme engelli ve 59 sağlıklı birey dahil edildi. Görme engelli bireylerin işitsel reaksiyon zamanı, işitme engelli bireylerin basit görsel reaksiyon zamanı ve kontrol grubunda yer alan sağlıklı bireylerin hem görsel hem de basit işitsel reaksiyon zamanları New Test 100 aleti ile değerlendirildi.

Sonuçlar: Sağlıklı ve görme engelli bireylerin işitsel reaksiyon zamanlarında istatistiksel olarak anlamlı fark bulunmazken ($p>0.05$), işitme engelli ve sağlıklı bireylerin görsel reaksiyon zamanlarında fark olduğu ($p<0.05$) gözlendi.

Tartışma: İşitme engelli bireylerin basit reaksiyon zamanlarının daha uzun olması, uyarının periferden veya merkezden verilmesi, serebrumdaki duyu işleme sürecindeki değişikliklerin olması ve görme engelli bireylere göre dudak okuma ve işaret diline odaklanmaları bu farkı yaratmış olabilir.

Anahtar kelimeler: Reaksiyon zamanı; görme engelli; işitme engelli

INTRODUCTION

Whether a person is impaired or not impaired, the quicker the reaction time, the faster they can react to stimuli in the environment. Reaction time has implications for all facets of a person's life, especially for accident prevention and community independence. For instance, self-operated orientation systems, which involved acoustic orientation cues for persons with visual impairment, improved their movement patterns at home and at work (1,2).

Sensory deprivation, such as visual or auditory impairment, can lead to changes in processing of information from remaining sensory modalities (3). Studies have suggested that for people who are visually impaired, the posterior visual areas of the cerebral hemisphere are recruited to enhance auditory functions, thus enabling these individuals to compensate for their lack of vision (4,5). Other studies suggest auditory information processing may be more efficient in persons with visual impairment (6,7). However, Bernard (1979) reported that there was no significant difference in reaction time to auditory stimuli when adolescents with sight and adolescents with congenital blindness were compared (8). Collignon, et al. (2005) reported no significant difference between mean reaction times for participants who were visually impaired and those with sight (9). The study by Nava, et al. (2008) indicated that participants who were auditory impaired had temporal responses (i.e., visual) similar to those of hearing participants (10). Erden, et al. (2004) reported that visual perceptions of auditory impaired individuals were not different from those of individuals without any impairment (11).

Research on visual perception and the reaction time of people with auditory impairment are inconsistent. People with auditory impairment have enhanced visual perception compared with individuals without any impairment (12,13). However, Rettenbach, et al. (1999) reported that visual processing with and without attentional load (i.e., other stimuli presented) of children and adolescents with auditory impairment showed deficits in visual processing when compared to their age and sex matched peers without any impairment (14). In the study (14), visual processing was assessed by RT to a stimulus. Hence, to determine whether people with life-long impairment can react to stimuli at a speed comparable to those who are not impaired is of critical importance. If sensory impairments (i.e., sight/sound) restrict reaction time to other sensory stimuli, an additional disadvantage for those individuals is created.

The aim of this study was to compare the reaction times of auditory and visually impaired individuals to controls without any impairment and to investigate whether individuals who lack one sense have an enhanced ability with the other.

MATERIALS and METHODS

Participants

Participants included 59 adolescents without any impairment (33 males and 26 females), 60 adolescents with visual impairment (32 males and 28 females), and 64 adolescents with auditory impairment (40 males and 24 females). All participants attended schools in Turkey. The participants' physical descriptors are given in Table 1. All participants with auditory impairment were classified as having total auditory impairment; all such adolescents had congenital auditory impairment; and 35 out of 64 were using hearing aid. 31 of the participants with visual impairment were classified according to the World Health Organization standards as having total visual impairment (i.e., no perception of light) and 29 with profound visual impairment (20/500 to 20/1000, visual field of 10°) (15). All non-impaired participants evaluated by school health professionals (i.e., physicians and nurses) were described as people with hearing and sight capabilities within normal range.

The participants' parents or guardians signed the informed consent prior to testing.

Procedure

The reaction time measurement was used to assess participants' reaction times to sound and light stimuli and to record reaction times to 1/1000 of a second. Reaction time measurement began with participants pressing a button at the same instant a stimulus was perceived. If no response was

made after 1 second, a "miss" was tallied. The time between stimuli presentations varied between 1 and 3 seconds. Prior to testing, participants were given instructions and allowed to practice reacting to specific stimuli. Classroom teachers assisted the research staff as they tested the participants with auditory or visual impairment. Participants were asked or prompted by the classroom teacher to place the dominant index finger lightly on a button positioned on the table in front of the participant. As the light or sound stimulus was produced, the participant was instructed to react by pressing a button. No feedback was given during testing. Each participant was tested with 10 separate stimuli. Reaction times were averaged for the first five stimuli as well as the second five stimuli. The average of the second five stimuli was used in data analysis, as recommended by the makers of the new test reaction time measurement tool (16).

To ensure that environmental factors did not interfere with reaction times, tests were conducted in a quiet, isolated room within the school building. Practice time occurred approximately one hour prior to testing.

Statistical Analysis

Means and standard deviations were calculated for all variables. Age, weight and height were analyzed with One Way ANOVA to test homogeneity. An independent t test was used to evaluate differences between groups within each group for the measurements of reaction times to the stimuli. For all analyses, the statistical significance was set at $p<.05$.

RESULTS

Means and standard deviations for each group's physical descriptors are found in Table 1. There were no significant differences between groups for age ($F=2.61$; $p=0.07$), height ($F=1.45$; 0.23) and weight ($F=1.02$; $p=0.36$).

Mean Reaction Times

Means and standard deviations for reaction times by all groups are found in Table 2. There were significant differences between reaction times to light stimuli between participants with auditory impairment and the controls ($t=3.01$; $p=0.00$). It was found that participants with auditory impairment have longer visual reaction times than the controls. There was no significant difference between participants with visual impairment and those without ($t=0.91$; $p=0.36$). Auditory reaction times of visually impaired participants and the controls were close to each other.

DISCUSSION

The aim of this study was to compare the auditory and visual reaction times of individuals with auditory and visual impairment and those of controls without any impairment in order to investigate whether individuals who lack one sense have an enhanced ability with the other.

The results of the analysis suggest that reaction times of auditory impaired adolescents were longer than the controls and no difference was found between the reaction times of visually impaired adolescents and the controls.

Interaction and integration of stimuli from various senses develop cognitive, mental, social and lan-

Table 1: Means and Standard Deviations for Physical Descriptors of all Groups

Groups	Age (yr)		Height (m)		Weight (kg)	
	X±SD	p*	X±SD	p*	X±SD	p*
Without Disability (n=59)	11.72±1.09		1.47±0.10		43.39±3.81	
With Visual Impairment (n=60)	12.25±1.46	0.07	1.44±0.13	0.23	41.64±13.67	0.36
With Auditory Impairment (n=64)	12.23±1.62		1.47±0.12		45.15±10.96	

*: t test

Table 2: Means and Standard Deviations for Reaction Times (sec) for all Groups

Groups	Sound X±SD	Light X±SD
Without Disabilities	0.26±0.07	0.26±0.08
With Visual Impairment	0.28±0.11	
With Auditory Impairment		0.32±0.11*

* : t test, p<0.05

guage domains. The loss of one or more sensory systems affects the organization and functions of other senses (17). There are two theories on how the loss of a sense affects the remaining senses. In disability theory, it is explained that senses complement each other, and that maximum performance occurs when the senses are complete; thus, the lack of a sensory system negatively affects other systems. Contrary to the disability hypothesis, the compensation theory states that, in case of the loss of any senses, another system or systems show increased development (18-21).

Alho, et al. (1993) and Lecleric, et al. (2000) reported that posterior visual areas of the cerebrum are used for auditory functions in visually-impaired individuals, which suggests that there is a compensatory mechanism that might enhance sensitivity to sound (4,5). Similarly, Niemeyer, et al. (1981) reported that visually-impaired individuals process auditory information more efficiently (6,7). However, Bernard (1979) reported no differences in reaction time to auditory stimuli between non-impaired adolescents (8) and those with visual impairment, which suggests that these cerebral compensatory mechanisms improve processing of auditory information and show faster reaction time (4-7). The present findings complement and extend the findings of Bernard (1979) since no differences were seen in reaction time to auditory stimuli between participants with visual impairment and the controls.

Previous studies that compare the visual performance of individuals with auditory impairment and those without suggest that the lack of auditory function negatively affects all sensory and developmental domains (22), whereas other findings support the compensation theory (19,23). Some previous studies reported no difference between auditory impaired subjects and those without any impairment (23,24). In the evaluation we performed in our study, auditory reaction time was an evaluation that focuses on speed rather than attention. The present study did not use stimuli that stimulate attention.

Parasnis and Samar (1982) suggested that since individuals with auditory impairment rely mostly on visual modality to alert and analyze functions, they might have a different mechanism for organization of visual attention compared to those without any impairment (25). Parasnis and Samar (1985) later reported that singers who were auditory impaired were better than singers without any impairment at redirecting visual attention to stress the performance of the attention system, which supports this hypothesis (26). Early experience with sign language and fluency in sign language can be among the important factors for the development of visual spatial skills in individuals without any impairment (27).

Neville and Lawson (1983), and Neville, et al. (1983) suggest that individuals with auditory impairment had superior visual perception skills compared to those without any impairment (12,13,28). On the other hand, Rettenbach, et al. (1999) reported no difference between the visual processing capacity of children and adolescents with auditory impairment compared with their peers without any impairment (14). Similarly, Seitz and Rakerd (1997) reported that the visual reaction times of young adults without and young adults with auditory impairment were similar (29). The present study supports the findings of Rettenbach, et al. (1999) and Seitz and Rakerd (1997) in that there was no difference in reaction times between adolescents with and without auditory impairment (14,29). The reaction times of the participants in the present

study were similar to those reported by Seitz and Rakerd (29).

Smith, et al. (1998) reported that the visual abilities of individuals with auditory impairment were better than those of individuals without any impairment, and that the reason for this was that individuals with hearing loss used their visual attention skills for lip reading or to read sign language (30). The findings of Smith, et al. (1998) differ from our study, which involves sending stimuli with a central and non-verbal stimulant.

Studies on reaction performances among individuals with auditory impairment to visual stimuli reported varying results (14,30). Analysis of the methodologies of these studies revealed that although they evaluated reaction times to visual stimuli, the stimuli were sent from the periphery and center, whereas other studies used verbal and non-verbal stimuli. We believe that the differing methodologies used in these studies influenced the findings.

In the present study, visual reaction times of individuals with auditory impairment were evaluated with central and non-verbal stimuli and visual reaction times were found to be longer than those of the controls. While participants without any impairment followed the events around them both aurally and visually, the participants with auditory impairment needed to use only visual stimuli to continue their communication. Recent research reveals that changes in visual cognition following congenital deafness were selective. In some studies (31,32) children with auditory impairment showed better attention to peripheral than central stimuli than children without any impairment. Other studies showed that the differences between auditory impaired groups and groups without any impairment were specific to particular visual spatial tasks such as motion processing (32,33). In addition, Rettenbach, et al. (1999) concluded that individuals with auditory impairment exhibited enhanced peripheral attention compared with individuals without any auditory impairment. Furthermore, they found that this visual compensation did not develop until adulthood (14). Finally, for individuals with auditory impairment, rather than the speed of a reaction to a stimulus, it is important to give correct and meaningful reactions. Since the adolescents with auditory impairment in our study gave their visual attention to perception of both tests, stimuli and also environmental stimuli, their reaction times were found to be longer than those of the controls.

CONCLUSION

In conclusion, individuals with auditory impairment have to receive non-verbal stimuli rather than only using lip-reading or sign language clues to continue their communication. In addition, rather than giving quick reactions to visual stimuli, they should focus on providing accurate reactions. For these reasons, we believe that in addition to changes in the cerebrum, the reaction performances of individuals with auditory impairment to visual stimuli can also be affected by the quality of the stimuli sent during the evaluation (central or peripheral stimuli, verbal/non-verbal stimuli).

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