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Comparison of Sensory Processing between Children with Hearing Aid and Their Normal Peers in Shiraz City (2019)

Sahar Ganbari[1], PhD; Ali Reza Jamali[2]*, PhD student

[1]Department of Occupational Therapy, Shiraz University of Medical Sciences, Rehabilitation School, Shiraz, Iran
[2]Department of Occupational Therapy, Iran University of Medical Sciences, Rehabilitation School, Tehran, Iran

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ABSTRACT

Background: Sensory processing is an important factor in development and affects the function of the senses in daily living activities. Hearing impairment may lead to some difficulties in sensory processing in children with hearing impairment. In this cross-sectional study, the sensory processing of children with hearing impairment and that of their normal hearing peers who were between 3 to 6 years old were compared.
Methods: The study population consisted of 60 normal-hearing and hearing-impaired children with hearing aids in Shiraz who were between 3 and 6 years of age. Dunn's Short Sensory Profile was utilized in both groups. The results were statistically analyzed by SPSS 21, and a p-level of <0.05 was considered significant.
Results: Independent t-test results showed that there was no significant difference between the two groups in total sensory processing (P=0.097), touch sensitivity (P=0.043), olfactory and taste sensitivity (P=0.259), movement sensitivity (P=0.079), sensory seeking (P=0.229), hearing processing (P=0.390), low energy and weakness (P=0.916), or hearing and vision sensitivity (P=0.429). The total mean score was 15.28±4.8 for children with hearing aids and 15.28±4.6 for normal-hearing children.
Conclusions: The results of this study showed that the impact of hearing impairment on sensory processing is unperceivable and needs to be addressed through more research However, it does seem that hearing impairment may affect one area of sensory processing.

Introduction

Sensory processing is a neurological developmental process that begins in the fetus and persists throughout a person's life. With sensory processing, the brain receives, organizes, and perceives sensory stimuli from inside and outside the body, so that it can respond appropriately to the environment [1, 2]. Sensory processing is connected to the five main senses, i.e. visual, auditory, smell, taste, and tactile, as well as two additional vestibular and proprioceptive senses. Research in humans has shown that impairment in one or more of these senses causes abnormal sensory integration and affects human outputs, such as behavior [3]. Sensory processing disorder (SPD) is a neurological disorder characterized by abnormal sensory processing in one or multiple senses. The subcategories of this disorder include impairment of sensory modulation, impairment of sensory differentiation and perception, impairment of bilateral integration, and developmental dyspraxia, each of which has its own subdivisions. Common symptoms of these subcategories include problems in attention and concentration, auditory perception, speech and language, movement and balance, bilateral coordination, physical awareness, eye-hand coordination, and fine hand skills. Furthermore, a

**Corresponding author:* Ali Reza Jamali, Department of Occupational Therapy, Faculty of Rehabilitation Sciences, Shahid Shah Nazari St., Madadkaran St., Mirdamad Blvd., Tehran, Iran. Tel: +98 9210916571; *Email:* jamaliar100@gmail.com

lowered or heightened level of consciousness directly affects a person's life functions such as learning and education, social communication, and play [4-7]. Children with sensory processing disorders are generally identified as maladaptive behavior children compared with their peers. SPD is common in many children with disabilities, including attention deficit hyperactivity disorder (ADHD), autism spectrum disorder (ASD), childhood schizophrenia, fragile x syndrome (FXS), and cerebral palsy (CP) [8-11].

Hearing impairment has been linked to vestibular deficits in physical condition, balance, and visual tracking [12-14]. A 2012 study revealed that hearing-impaired children with cochlear implants performed poorer on tactile and proprioceptive tasks than their normal-aged peers, suggesting poorer processing in the temporal lobe compared to normal-hearing children. Both groups, however, were similar in their visual tasks. The hearing-impaired group performed better after cochlear implantation in space assignments, including touch location, than normal-hearing children [14]. Some studies in adults have shown that there are significant problems with visual processing following hearing impairment [15-18]. Baharadvaj et al. reported that 2 to 10-year-old children with cochlear implants exhibited abnormal behaviors in all sensory processing domains. This study showed that the most impairment of sensory processing was seen in auditory-vestibular, oral, and tactile senses, respectively, and the least impairment was in visual processing in these children. This study evaluated only children with cochlear implants, and the sensory processing status of children using hearing aids was not investigated [4]. In another study, Coulson-Thaker suggested that hearing-impaired and deaf children may be prone to sensory processing problems [19].

According to the literature, auditory processing and sensory integration continue to develop during a person's life span [20-22] and differ with age. In addition, it is important to prepare for school at the age of 3 to 6 years, because behavioral manifestations of sensory processing disorder can affect the acquisition of academic skills in school in the future [23]. Therefore, the current study evaluated sensory processing in preschool aged children.

There seems to be a limited number of studies in this area. Other research in this area has focused more on children with cochlear implant, but herein, sensory processing in all children with hearing impairment was examined. In addition, possible differences between typically developed children and children with hearing impairment were compared. Therefore, the purpose of this study was to compare sensory processing disorder in the seven domains of tactile sensitivity, olfactory and taste sensitivity, movement sensitivity, sensory search, auditory processing, weakness and low energy, and hearing and visual sensitivity among hearing-impaired children and their normal hearing peers.

Methods

Research Design and Participants

The present cross-sectional and comparative study was conducted in Shiraz (2019). The study population consisted of normal-hearing and hearing-impaired children using hearing aids in Shiraz in the age group of 3-6 years. Legal guardians filled consent form. Ethical approval was granted by Shiraz University of Medical Sciences.

Convenience sampling was utilized for both groups, and a total of 30 children were recruited in each group. Children with hearing impairment were recruited from speech and language pathology clinics of Shiraz University of Medical Sciences, private hearing impairment centers, and special schools for children with hearing impairment in Shiraz. Normal-hearing children were also selected from the kindergartens and preschools for normal children in the city of Shiraz. Demographic, medical and rehabilitation information about children with hearing impairment was obtained from their records in collaboration with audiology and speech therapists at the centers.

Included in this study were children with hearing impairment who used bilateral analog hearing aids and had hearing impairment of 70 dB or higher (severe and profound hearing impairment) as well as normal hearing children who were between three to six years of age. Those who were diagnosed with other disorders such as autism, attention deficit hyperactivity disorder, mental retardation, motor disorders, blindness, and mild hearing impairment were excluded from the study. The inclusion and exclusion criteria were verified by asking parents and checking school files whenever possible. The preschool files of normal hearing children were searched for any information regarding hearing, visual, physical, or mental impairment.

Tools

The instrument used in this study was the Winnie Dunn Short Sensory Profile, a self-report questionnaire with 38 questions which are asked from caregivers or parents in the seven areas of sensory processing: *touch sensitivity, olfactory and taste sensitivity, movement sensitivity, sensory seeking, hearing processing, weakness and low energy,* and *hearing and visual sensitivity*. The sections consist of seven, four, three, seven, six, six, and five questions, respectively. Caregivers were asked to answer each question with these choices: always (100%), frequently (75%), occasionally (50%), seldom (25%), or never (0%) [24]. The caregivers' answers to each question were scored with numbers from five to one, respectively. The scores from each section were ultimately used to determine whether sensory performance is within the range of typical performance, probable difference to normal function, or definite difference to normal function areas. The cut-off point of this test is presented in Appendix 1. According to the literature, the test validity is 95% [25]. Cronbach's alpha coefficient was calculated to be 0.74, which is acceptable due to the small sample size. The Persian version of this questionnaire was used [26-28].

Procedure and Data Collection

After obtaining written consent from the families of the children, participants were asked to complete the Winnie Dunn Short Sensory Profile. The guidance required for completing the questionnaire was provided by the researcher. The data was analyzed by SPSS 21 software. Statistics were reported in two descriptive and analytical sections. Data was analyzed using the Kolmogorov-Smirnov statistical test. The results showed that the distribution of data was normal in both groups. Therefore, a t-test was used to compare the results of children's performance between the hearing impaired and normal hearing groups in the areas of tactile sensitivity, olfactory and taste sensitivity, movement sensitivity, sensory seeking, weakness and low energy, and auditory and visual sensitivity. The results were analyzed at a significance level of 0.05. The scores were interpreted according to the scoring benchmark.

Results

The mean age of children in both groups was 4.6 and±0.6 years. Sixty children, 30 children in each group, were tested. The statistical indices for both groups are shown in Table 1.

The results of analytical statistics showed that there was no statistically significant difference between the two groups in total sensory processing. It was also found that despite the differences between the two groups, these differences were not statistically significant in most of the sections. Only in the touch sensitivity section, there was a significant difference between the two groups (Table 1).

Although there was no significant statistical difference between the two groups except for touch sensitivity, it was also found that 90% of 30 hearing-impaired children had probable + definite differences of sensory processing disturbances compared with 60% in normal-hearing children (Table 2).

As shown in Table 2, sensory seeking behavior was prevalent in both groups of children, but movement sensitivity is not. The movement sensitivity question includes three items: 1. Becomes anxious or distressed when feet leave the ground; 2. Fears falling or heights; 3. Dislikes activities where head is upside down (for example somersaults or roughhousing). In all three items, children with sensory seeking behaviors, especially those with lowered vestibular and proprioceptive senses, were very bold and fearless. Therefore, considering the results of sensitivity to movement and sensory seeking parts, it seems that most of the sensory seeking behaviors of hearing-impaired children were in the context of vestibular sensation. This indicates that vestibular dysfunction may not show itself in the form of movement sensitivity, but in sensory seeking behavior. In a nutshell, these two concepts need more investigation.

Discussion

The present study found no significant difference between the two groups in terms of total sensory

Table 1: Differences between two groups according to statistical indices

Sections	Groups	Mean	S.D.	SEM	t-test results
Touch sensitivity	1	32.20	6.338	2.004	0.043
	2	28.60	4.559	1.454	
Olfactory and taste sensitivity	1	11.40	4.971	1.571	0.259
	2	13.60	3.306	1.045	
Movement sensitivity	1	15.00	0	0	0.079
	2	14	1.699	0.537	
Sensory seeking	1	20.70	6.532	2.065	0.229
	2	22.80	3.765	1.190	
Hearing processing	1	21.60	3.747	1.180	0.390
	2	23.70	38.02	1.20	
Weakness and low energy	1	24.70	3.973	1.256	0.916
	2	24.90	4.332	1.369	
Hearing and visual sensitivity	1	17.10	2.469	0.781	0.424
	2	18.50	4.813	1.522	
Total	1	133.5	15.282	4.832	0.097
	2	145	15.282	4.640	

Group 1: Hearing-impaired children with hearing aid; Group 2: Normal-hearing children

Table 2: Sensory processing status in hearing impaired and normal-hearing children

Sections	Typical performance		Probable difference		Definite difference		(Probable difference + Definite difference)	
	HI	N	HI	N	HI	N	HI	N
Touch sensitivity	20%	50%	10%	20%	70%	30%	80%	50%
Olfactory and taste sensitivity	30%	30%	20%	40%	50%	30%	70%	70%
Movement sensitivity	100%	80%		20%				20%
Sensory seeking	20%	20%		20%	80%	60%	80%	80%
Hearing processing	40%	80%	30%	20%	30%	10%	60%	30%
Weakness and low energy	50%	60%			50%	40%	50%	40%
Hearing and visual sensitivity	10%	70%	20%	10%	70%	20%	90%	30%
Total score	10%	40%	20%	40%	70%	20%	90%	60%

HI: Hearing-impaired children; N: Normal-hearing children processing. Moreover, except for the touch sensitivity section, sensory processing showed no significant difference between the two groups.

Koester and Coulson-Thaker showed that hearing-impaired children have some patterns of sensory integration dysfunction [19, 29]. Research by Baharadvaj et al. showed that in 70% of hearing-impaired children with cochlear implantation, there is evidence of impaired sensory processing [4]. Baharadvaj et al. noticed that children with cochlear implantation show some abnormal behaviors related to sensory processing in various domains (auditory and vestibular, oral, tactile, visual) [14]. In a study by Rhodes et al., 78% of hearing-impaired children with cochlear implants reported sensory processing disorders [30]. Alkhamra reported findings that pointed out that although sensory processing problems are present in children with hearing impairment, they are more prevalent in children with hearing aids than in children with cochlear implants [31]. We found that 90% of 30 hearing-impaired children have probable + definite differences of sensory processing disturbances in comparison to 60% in normal-hearing children. Only children with hearing aids participated in the current study, and this may explain the non-significant results. Differences in the age range of participants were observed in the studies [20]. Children in the current study were younger than those in studies by Baharadvaj and Alkhamra.

Children with hearing aids in the current study differed significantly from normal hearing children in terms of sensitivity to touch. These findings are somewhat similar to the findings of Leuven et al., who found that people with congenital hearing impairment are highly susceptible to touch [32]. It seems that one reason for hearing-impaired children removing their hearing aids and their restlessness in daily life and rehabilitation programs is their sensitivity to touch. The restlessness during grooming and dressing, and anxiety and phobia during presence in crowded places seen in hearing-impaired children can be due to the tactile sensitivity of these children [8].

Although the statistical results in the current study did not show a significant difference between the two groups in the hearing and visual sensitivity item, a review based on Table 2 revealed that hearing-impaired children with hearing aids showed 90% probable + definite differences in comparison with 30% in normal-hearing children. These percentages are all higher than those of their normal peers and may justify some abnormal behaviors related to the sensory sensitivity in the auditory and visual senses as well. The current study also found that all hearing-impaired children were perfectly normal in terms of sensitivity to movement. This result doesn't seem consistent with previous research in this area [12-14]. Baharadvaj and Brey found vestibular dysfunction in children with cochlear implants, in contrast with the current study. This discrepancy can be attributed to the fact that the hearing-impaired children in this study reported severe sensory seeking behaviors (80%), and vestibular dysfunction may show itself in the shadow of sensory seeking behaviors. In addition, the sample in the current study consisted of children with hearing aids, but other studies evaluated children with cochlear implants. According to a study by Alkhamra, sensory processing problems are somewhat different in these two groups of children [31].

It should be noted that other factors such as the heterogeneity of hearing-impaired children in terms of type of hearing impairment, heterogeneity of normal-hearing children, and low sample size might lead to non-significant results.

This study had some limitations. One of the limitations of this study is the small sample size. Furthermore, the hearing status of the participating children was not considered at birth. Hearing status during embryonic development may influence the processing of auditory and other sensory information in the children`s future. The consumption of ototoxic drugs and maternal disease during pregnancy can also influence auditory development. The lack of Persian fluency of some caregivers who were Qashqai Turkish as well as the low level of education and lack of proper cooperation in some of them made it difficult to obtain proper responses.

It is suggested that this study be conducted in a larger statistical sample to obtain more accurate and generalizable results. It is also suggested to evaluate the status of sensory processing in children with mild to moderate hearing impairment in this age group and compare it with the results of this study. Also, further studies would be improved by an accompanying validated intelligence test to consider the mental age as well as chronological age of children and to investigate how the intelligence of children with hearing impairment impacts sensory processing. It is recommended to compare and evaluate the status of sensory processing in hearing-impaired children who have successfully passed the hearing tests at birth with those who failed them. In addition, in societies where the issue of multilingualism is concerned, the presence of fluent multi-language speakers alongside the researcher seems to be necessary. The presence of multi-language participants can affect sensory processing; thus, it is recommended that this factor be studied in future research.

Conclusion

In conclusion, although there was no significant difference between normal-hearing children and children with hearing impairment in terms of total sensory processing problems, there is a difference between the two groups in terms of touch sensitivity.

Conflict of Interests: None declared.

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