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Auditory responses and behavioral patterns in children with autism spectrum disorder: A case series

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ABSTRACT

Children with Autism Spectrum Disorder (ASD) are consulted for the audiological assessment because of delayed language development. This study aimed to show auditory responses and behavior patterns in children with ASD and to emphasize the importance of interpreting audiological findings together. Subjective and objective audiological tests were applied to three children diagnosed with ASD. Given responses to the auditory stimulus change in these children. Characteristics of their auditory and behavioral patterns must be known by audiologists and other professionals, who are working with ASD, both to obtain reliable hearing results and to determine suitable consultation and approach in children with ASD.

Keywords: behavioral assessment, hearing, hearing loss, autism spectrum disorder

ÖZ

Otizm spektrum bozukluğu olan çocuklarda işitsel cevap ve davranış örüntüleri: Olgu serisi

Otizm Spektrum Bozukluğu (OSB) olan çocuklar dil gelişimindeki gecikme sebebiyle genellikle odyolojik değerlendirme için yönlendirilir. Bu çalışmanın amacı, OSB olan çocukların işitsel cevap ve davranış örüntülerini göstermek ve odyolojik test bataryasının birlikte yorumlanmasının önemini vurgulamaktır. Otizm Spektrum Bozukluğu ile takip edilen üç olgunun işitme testi bulguları değerlendirilmiştir. Olguların işitsel uyaranlara verdikleri cevaplar değişiklik göstermektedir. Otizmli çocuklarda, gerek güvenilir işitme testi sonucuna ulaşabilmek için gerekse doğru yönlendirme ve yaklaşımın belirlenebilmesi için, otizmli çocukların işitsel cevap ve davranış örüntülerinin alanda çalışan odyologlar ve ilgili diğer meslek grupları tarafından bilinmesi oldukça önemlidir.

Anahtar Kelimeler: davranışsal değerlendirme, işitme, işitme kaybı, otizm spektrum bozukluğu

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INTRODUCTION

The Autism Spectrum Disorder (ASD) is characterized by poor eye contact, absence of mimic, difficulty in concentration, obvious impression of being in a world of one's own, resistance to change, unexpected interest in specific toys or objects, sensual hypersensitivity and stereotypical behaviors (APA, 1994; Darıca, 2005). Clinical experiences have shown that the symptoms appear before thirty months old. However, the diagnosis of ASD can be definite between the ages of 4 and 4.5 years. Although the retardation in social interaction could easily separate children with ASD from the children who have mental retardation and delayed language development, delayed speech and the suspicion of hearing loss are the most common symptoms (Downey et al., 2002).

As a member of the team, the collaboration of all professionals is extremely important in approaching children with autism. Nowadays, clinical experiences have shown that the rate of admission to audiology clinics increases in children with ASD due to hearing loss and delayed speech (Rosenhall, Nordin, Sandström, Ahlsen, & Gillberg, 1999; Tharpe et al., 2006). For the clinicians who follow the child, this situation makes the results of the audiologist more valuable.

This report aimed to evaluate the audiological findings of three children with ASD, to interpret all their results together, and to guide audiologists and other professionals who are interested in their audiological and developmental follow-up.

CASE REPORT

The informed consent was taken from all parents of the participants.

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Case 1

The case is a 2 years 9 months old girl diagnosed with atypical ASD. The patient with the complaint of delayed speech was directed to Audiology Clinic. The otoscopic evaluation revealed bilateral normal auditory canal and eardrum. Regarding the detailed history of the patient given by the family members. Hearing loss risk factors could be listed as premature birth (34th weeks), low birth weight (1240 gr), and family history of retarded language development. Also, although the case was 2 years old, she did not have any meaningful words. Her parents claimed that she did not react to violent sounds, although she often reacted to the low sounds of the cartoons she liked.

Before the audiological evaluation, the case had shown no obvious discomfort with tactile stimulation during the time spent with the case and in the progressive process, she could make limited communication with the audiologist. Before the test, it was noteworthy that she responded to some sounds (door opening-closing, etc.) without visual cues. In the subjective hearing test (Visual Reinforcement Audiometry-VRA) performed with the loudspeakers accompanied by the test assistant, it was observed that the auditory responses were diminished or varied during the test. The case was evaluated by speech audiometry. It was seen that she could draw attention to the speech sound and her name when called upon at supra-threshold levels such as 40–45 dB HL. Her middle ear functions were normal. Acoustic reflexes (ARs) were obtained. Bilateral Automated Transient Otoacoustic Emission (A-TEOAE) was present. Automated Auditory Brainstem Response (AABR) test could not be performed, because she did not permit to be cleaned her skin for the electrode placement. When the patient was sleeping, diagnostic ABR (click and 500 Hz tone burst stimuli) were performed for both ears and ABR thresholds were detected at the level of 20 dB nHL bilaterally. Although the result of the speech audiometry indicated a mild hearing loss, the objective audiological tests showed that her peripheral hearing was normal.

Case 2

The case with ASD who consulted our clinic because of the delayed speech is a 4-years-old girl. According to the results received by otological examination, she had normal external auditory canals and eardrums. Her family reported that they do not have any complaint about hearing disorders. Regarding detailed patient history, there has been no risk factor and she could recently start uttering disyllables.

Before the evaluation, the clinician observed that the patient did not like to tactile stimuli while playing. Therefore, it was preferred for VRA as a behavioral test without any earphones. VRA test was made in the soundproof room without the test assistant due to fear of the unfamiliar person. The specific responses to the most reliable frequencies were obtained with FM stimuli. The case could draw attention to her name and speech sounds at the level of 30 dB HL; on the other hand, it is observed that she responded to/ba/sound considered as low-frequency speech stimuli, at the level of 25 dB HL; to/sh/sound considered as middle-frequency speech stimuli, with 55 dB HL; and/s/sound considered as high-frequency speech stimuli, with 70 dB HL. Her hearing thresholds were compatible with moderate hearing loss (Figure 1). The thresholds of ARs of the case whose middle ear functions are normal were obtained between 85–90 dB HL. AABR and A-TEOAE tests were tried to perform while the case was sleeping. The tests could not be performed because the patient was agitated and did not sleep. Another day, a diagnostic ABR test could be done during the natural sleep and her thresholds were found at 20 dB nHL. Although the result of the behavioral tests indicated a moderate hearing loss (Figure 1), the results of the received at the end of the objective audiological tests showed that her hearing was normal.

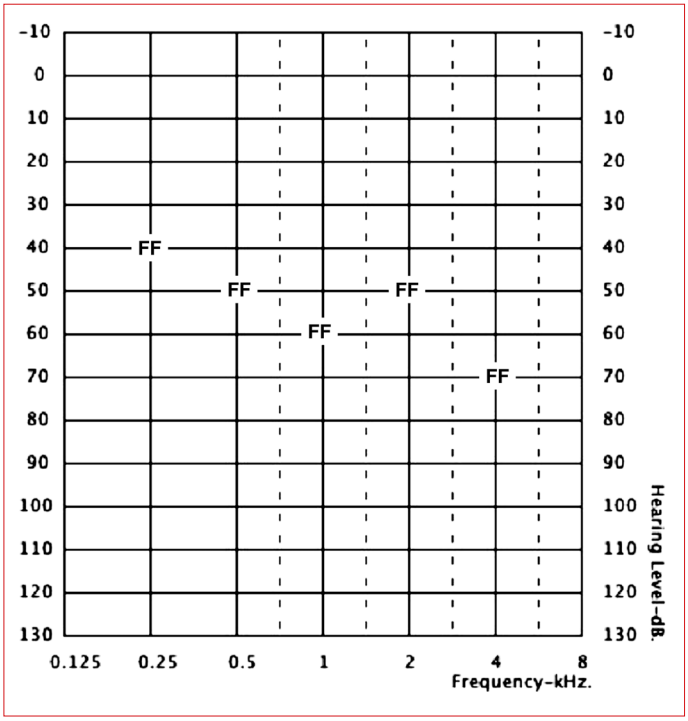

Figure 1. Subjective hearing thresholds belonging to Case 2. The thresholds of the case in the free field indicate a moderate hearing loss. FF: Free Field

Case 3

The case who was tracked due to atypical ASD is a 4-years-old boy. The patient with the complaint of retarded language development was directed to Audiology Unit. The otoscopic evaluation revealed bilateral normal auditory canal and eardrum. Concerning patient history, there have not been any risk factors for hearing loss and he could utter just two words.

At the end of the subjective auditory tests conducted with VRA method using FM stimulus, his hearing thresholds tend to increase at higher frequencies. On the other hand, it was observed that case could draw attention to his name and speech sounds when he was given 25 dB HL and to specific speech stimulus as to/ba/sound, he responded with 20 dB HL; to/sh/

Table 1. Common characteristics of audiological test results for each case

Cases	The results of Behavioral Tests	TEOAE	ARs	Automated ABR	Diagnostic ABR
Case 1	Mild Hearing Loss	+	+	NT	20 dB nHL
Case 2	Moderate Hearing Loss	NT	+	NT	20 dB nHL
Case 3	Mild Hearing Loss	+	NT	+	20 dB nHL

TEOAE: Transient Otoacoustic Emission, AR: Acoustic Reflex, ABR: Auditory Brainstem Response, NT: Not Tested

sound he responded with 30 dB HL, and to/s/sound with 45 dB HL. This case also seemed to be compatible with the threshold values in high frequencies. Because she did not want to get the ear probe, her middle ear functions, thresholds of acoustic reflexes (ARs) could not be evaluated and not be performed diagnostic otoacoustic emission test. However, A-TEOAE was performed and the case passed in the both sides. AABR test could not be performed also, because she did not permit to be cleaned her skin for the electrode placement. Therefore, she spent a bit more time and played a game with the clinician in the test room. Firstly, the AABR test was attempted to perform to a toy and asked the patient to help the clinician. And then, the patient allowed the AABR test and passed from the test bilaterally. Diagnostic ABR was performed to check the results and the patient's ABR thresholds were observed at 20 dB nHL. Although the audiogram as seen in Figure 2 showed that the case has a mild hearing loss, the results of the objective tests support that the peripheral hearing of the case is within normal limits.

Common characteristics of the hearing test results of three cases were shown in Table 1.

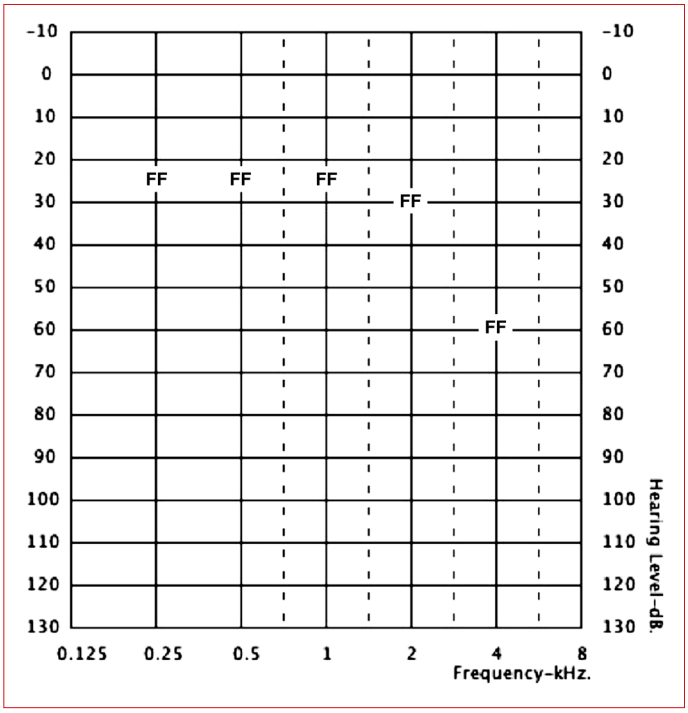

Figure 2. Subjective hearing thresholds belonging to Case 3. According to the audiogram in the free field, the case seems to have a mild hearing loss. FF: Free Field

DISCUSSION

Autism spectrum disorder is one of the neurodevelopmental disorders and audiologists must know its characteristics because both literature and clinical experiences indicate that some of the children with ASD are diagnosed as hearing loss (Rosenhall et al., 1999; Tharpe et al., 2006).

One of the basic features concerning ASD is the abnormal responses to the auditory stimulus. They show extreme sensitivity to sounds and they tend to feel to be disturbed by loud sounds. The prevalence of the mild to moderate hearing loss in children with autism was reported to be 7.9% and the rate of bilateral profound hearing loss was 3.5% (Rosenhall et al., 1999). 32% -81% of the overall parents reported that their children are too sensitive to noises (Tharpe et al., 2006). This data shows that the determination of the characteristics and severity of the stimulus, that the audiologist will use in the audiological evaluation is very important, as well as the importance of the case history taken from the family. Therefore, the intensity level of the stimuli applied during the tests should be taken into consideration in order not to terrorize them and it is important to give the stimulus in ascending method for reliable responses (Madell, 2008).

The children with ASD are typically characterized by a lack of eye contact, avoidance from the tactile stimulus, and display stereotypical behavior. Because of these reasons, the test area must be well organized, while the hearing test is being performed to these children. The child must be placed in a position that does not allow him to get up and go easily from the test environment. If the child avoids the tactile stimuli, the audiologist should reduce the tactile stimuli and should be more careful. The hearing test of a child with ASD who has tactile sensitivity has to be conducted in a free field area with speakers. Because it might be disturbing for the child to be touched to place the earphones and this might result in interruption of the audiological evaluation (Madell, 2008).

On the other hand, auditory processing disorder and hyperacusis are two of the important subjects in children with ASD and the audiologist should focus on them. The prevalence of hyperacusis in the ASD group, who generally display extreme sensitivity to sounds (blocking the sound through using their hands and closing their ears, crying, shouting, getting angry,

etc.) or display non-responsiveness, was reported 18% (Danesh, 2015; Ring, 1999; Rosenhall et al., 1999). The children who experience hyperacusis through sounds like toilet flush, fire alarm, vacuum cleaner, do not like these sorts of sounds (a form of mysophobia), or develop fear against acoustic sounds (phonophobia) (Danesh, 2015). The aversive behaviors displayed against sounds reflect atypical auditory processing on a peripheral level (Berard, 1993). The auditory information and its perceptual features (pitch and loudness during a speech in noise) are processed atypically at behavioral and neural levels in ASD (O'connor, 2012).

The decision of the hearing test protocol is very important to obtain a reliability result in the pediatric group. The test protocol is usually determined by the methods which are classified according to chronological age. However, the protocol must be decided by developmental age in special needs children. Because of this reason, VRA, using speakers in the free field, is the most appropriate behavioral test method for children with ASD. Although VRA mostly is used for children between 6–36 months old, it will continue being the best behavioral method for children with ASD in the next years.

One of the most critical points in determining the behavioral responses in these children is the timing of the test stimulus. The most important reason for this is that children with ASD get used to the test stimulus very quickly and do not accept them as stimuli after a while. For this reason, both the interval between each stimulus and the total duration of the test has to be adjusted so that the child does not cause any deterioration of the co-operation. It is suggested that using different stimuli (pure tone, speech stimuli, frequency-specific speech stimuli narrowband noise or FM stimuli) when the child loses his/her interest or giving stimuli with sufficient violence to make the child to re-concentrate is beneficial (Madell, 2008).

Ipsilateral or contralateral acoustic reflex measurements provide significant data for the integration of auditory canals that cross or do not cross afferently in the brainstem. TEOAE and DPOAE measurements are used to explain the functional integrity of the outer hair cells in the cochlea. The usage of the physiological measurements does not necessitate the subjective responses given by children. Moreover, the objective tests which decrease the prejudices of the clinicians are extremely crucial in terms of deciding on the peripheral auditory features of children with ASD. It is stated that no significant difference to ABR, DPOAE, and acoustic reflex thresholds was found between the children who have normal development processes and the children with ASD (Gravel, 2006; Tharpe et al., 2006). The electrophysiological evidence proposes that the variations in the violence level of the sounds are not processed in the auditory cortex of the children with ASD in a normal way (Lincoln, 1995).

The speech thresholds of approximately half of the children tracked due to ASD seem within normal limits in the behavioral tests, but it is stated that average thresholds of pure sound hearings of them are out of the normal limits (>20 dBHL). Although the children with ASD usually have normal results in objective audiological tests, when they are compared with the healthy children in behavioral tests, their hearing thresholds increase and their behavioral responses become less reliable. As shown in our cases, even so, the behavioral audiological tests indicate supra-thresholds in many children with ASD; other physiological measurements that do not need active interests of the children to reveal that their hearings are normal or near-normal. The test-retest reliability of their behavioral responses is relatively low considering the children who have normal development processes (Tharpe et al., 2006).

The children with possible doubt for autism spectrum disorder, at first, are generally brought to audiology units and the clinics which deal with language development disorders by their families with the complaint of hearing problems and/or delayed speech problems. In this respect, firstly, whether the child has a hearing loss or not is detected. For this purpose, the behavioral features of these children who were examined in a silent room such as the absence of eye contact, excessive sensitivity to sounds, discomfort to tactile stimulus, crying, anger, etc. are the prominent features that call the attention of the audiologists. Thus, they are not sufficient in hearing evaluation because of the possibility that subjective behavioral tests are affected by the responses of the children. Since audiological configurations which label hearing loss in audiogram due to the supra-threshold responses could be obtained. In this sense, during the audiological evaluation, it is extremely important to apply objective audiological tests that are not influenced by the responses of the children as much as the subjective audiological tests. These children whose hearing is seen within normal limits are directed to the child and adolescent mental health departments by the behavioral observations of the clinicians during the test. The possibility of the existence of inconsistencies between displayed behavioral responses and the accurate hearing sensitivity in children with ASD have to be reported by the relevant professionals to the parents and the teachers of the children. For this purpose, it is substantially crucial that the behavioral features of the ASD and the children with ASD are known by the professionals working in the field for both reaching reliable hearing test results and for the determination of the most convenient treatment approach on behalf of these children.

CONCLUSION

In this study, we evaluated the audiological findings of 3 patients with ASD. It has stated that these group-specific auditory response patterns should be well understood and well known by the audiologist for reliable and accurate audiological measurements in this study. In addition to this, a multidisciplinary study is extremely important for this group.

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