

Central Auditory Processing Deficit in Children Diagnosed with Autism Spectrum Disorder

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Purpose: The study aims to check the presence of auditory processing deficit in children diagnosed with autism spectrum disorder.

Methods: A total of 10 subjects within the age range of 6-10 years diagnosed with autism spectrum disorder were recruited for the study. Buffalo model questionnaire (child form) for CAPD was given to the parents of the children with autism and scores were noted. Auditory cognition which is a sub category of auditory processing was assessed for each subject with the help of Angel sound software version 5.08.03 by Emily Shannon Fu Foundation. Forward digit test was done and the auditory memory of the participant was checked. The result obtained from the subjective perception of parents and objective evaluation was compared and the correlation was checked.

Results: The questionnaire given to the parents had different subsections and questions included in the category of memory revealed poor scores. Similarly, the scores obtained for forward digit test was reduced for the children diagnosed with autistic spectrum disorder when compared to the normative given by the software. The children were able to memorize maximum of only 3 digits.

Conclusions: It can be concluded that there is a relation between and subjective perception of parents of children with autism and objective evaluation of auditory processing. In our study, the scores for auditory cognition test are reduced for children with autism. Autistic people with auditory processing disorders can hear, but they have difficulty understanding what they hear. Auditory processing disorder is a crucial pathology of the autistic disorder.

Keywords: Central auditory processing disorder, Autism spectrum disorder, Angel sound software, Auditory processing



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INTRODUCTION

Autism spectrum disorder (ASD) is a heterogeneous behaviourally labelled disorder that is characterized by limitations in social contact and communication skills and associated with repetitive patterns of behaviours and interests and atypical sensory processing. Autism results from different sets of causal factors, including genetic, neurobiological, and environmental factors. Sensory processing difficulties in ASD individual are numerous affecting almost all senses including the auditory domain. These perceptual disruptions are considered an essential diagnostic finding in ASD and constitute the building blocks for higher order functions specially speech and communication. Abnormal auditory processing is considered one of the main reasons of language weak-

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ness in ASD [1].

The term Auditory Processing Disorder (APD) can be referred as the deficits in the neural processing of auditory information in the CANS not due to higher order language or cognition, as demonstrated by poor performance in one or more of the skills. Children with APD encounter listening difficulties despite displaying normal or near-normal hearing acuity. Depending on the definition used, the prevalence of APD among children and adults varies between 0.5% and 7.0% [2,3], with a 2:1 ratio between boys and girls [2]. After more than 40 years of research, there is still no consensus among speech-language pathologists, audiologists, and researchers regarding the nature and definition of developmental APD and whether the disorder can be considered a distinct clinical disorder [4-7]. One of the main questions among professionals working with children with APD is whether the listening difficulties in children with APD are due to a specific auditory sensory processing deficit (bottom up problem) or to a cognitive deficit (top-down problem). In other words, can we speak about modality specificity in children with APD, or do we need to speak about a multimodal deficit [8].

CAPD may coexist with other disorders and it is not due to peripheral hearing loss which is at the level of the cochlea or auditory nerve, including auditory neuropathy and hidden hearing loss. The etiology of CAPD may be linked to a specific lesion or disorder, or may be unknown. Causes and risk factors for CAPD may include age-related changes in CANS function, genetic determinants, neurological disorder and prenatal/neonatal factors [9]. CAPD can be coexisting with autism.

There are evidences for reduced orientation to auditory information and in particular to speech in ASD [10], impaired processing of speech in background noise [11], impaired processing of affective prosody, and grammatical prosody has also been observed in ASD [1,12-14]. Structural and functional abnormalities that contribute to auditory processing impairments were evident in individuals with ASD [15]. Corpus callosum (CC); a brain structure that is directly involved in inter-hemispheric transfer of auditory information was found to be of small size or even agenetic in ASD [16,17].

Deficits in dichotic listening had been proved to be related to language and learning in children [18]. While performing dichotic listening tasks, some ASD children do not show the usual right ear advantage for speech stimuli [19], instead they prefer to use their left ear when listening to both speech and musical stimuli [20]. Studies of handedness indicated presence of high rates of left handedness in ASD [21,22].

The human brain has the ability to change and to reorga-

nize in response to environmental modifications, which is known as plasticity. Auditory training has been shown to produce long-lasting functional and structural changes in the brain and modify the aberrant connections in ASD, with subsequent enhancement of auditory processing in ASD [23].

Unfortunately, there is limited behavioral research on measuring auditory processing skills in ASD children and evaluation of auditory training in these children. Dichotic training had improved dichotic listening and reduced inter aural asymmetry in children diagnosed with speech and language disorders, head trauma, and also had improved language processing in typically developing children.

The lack of clarity about the nature of listening difficulties and controversies related to listening difficulties in ASD, causes confusion at the theoretical level as well as at the clinical level. The problems of children with listening difficulties are diverse, with large inter-individual variation. Because of the lack of clarity and questions from clinicians about how to manage children who suffer from listening problems, this group of children are not always referred to the right discipline or multidisciplinary centre. It is evident that a clinical demand exists for scientific insight into ASD and CAPD.

Aim

The study aims to check the presence of auditory cognition deficit in children diagnosed with ASD.

METHODS

The study was carried out in the Department of Audiology, at MAA Institute of speech and hearing, Hyderabad. A total of 10 children who were diagnosed with ASD within the age range of 6 to 10 years with normal hearing were selected for this study. Subjects having middle ear pathology/dysfunction was excluded from the study.

Initially the parents of the children diagnosed with autism will be presented with a Buffalo model questionnaire given by west coast auditory processing centre. The questionnaire contains total of 8 domains and has 47 questions. The first domain is Decoding and it has 9 questions, second domain is Noise, it has 4 questions, third domain is Memory, it has 6 questions, fourth domain is Various, it has 4 questions, fifth domain is Interaction, it has 6 questions, sixth domain is Organization, it has 3 questions, seventh domain is Auditory, it has 7 questions and last domain is General and it has 8 questions. The parents were expected to mark YES if present and NO if absent towards

each question and a separate space was given for them to note down the specific comments. The total number of YES and NO will be added. More number of YES in each domain will be considered as poorer score and more numbers of NO will be considered as better score in that particular domain. This administration of questionnaire among parents will be measured under subjective evaluation. Out of the 8 domain, the scores obtained for third domain which is memory will only be considered for the present study.

Following the subjective evaluation all the participants will be encountered for objective evaluation. Angel Sound Software version 5.08.03 by Emily Shannon Fu Foundation was used for the same. There are various modules within the software. Out of that auditory cognition test within assess module will be considered. Auditory cognition measures the short term and working memory and it has two tests, i.e., forward digit test and backward digit test. The study focused only on forward digit test. This is a verbal task, patients were presented with random series of numbers and the subject will be expected to memorize and type the number in same sequence as heard. The complexity of the task is increased according to the responses of the patient and scored automatically by the software. The number of digits the child was able to memorize was noted and compared with the normative.

RESULTS

The selected 10 participants were within the age range of 6- 10 years. The majority of the group were at the lower end of the age group and there other counterpart fall in upper end of age limits (Table 1).

Buffalo model questionnaire was given to the parents of the subjects diagnosed with ASD. The third domain which is mem-

ory was more focused on our study. The more the number of questions which answered YES led to the conclusion that child has memory deficit. In the present study, the answers for most of the questions gave the answer YES which reveals that all the participants recruited for the study has a memory deficit (Figure 1). So it can be concluded that, the subjective evaluation showed a memory issue in all the children diagnosed with autism.

When auditory cognition test that is forward digit test was administered among the participants it was found that most of the children were able to memorize and sequence only 2 digits or less than that. Among the group only 1 participant could remember 3 digits (Figure 2). The normative data given by the software, report that an adult should be able to remember 10 digits. When compared to this data, the participants of our study gave a poor correlation.

The overall results show that both the subjective and objective test to assess auditory cognition was affected and both were related to each other in children diagnosed with ASD.

DISCUSSION

Table 1. Shows the demographic data (age) of the participants

Subject	Age (year)
Subject 1	7
Subject 2	6
Subject 3	8
Subject 4	6
Subject 5	6
Subject 6	6
Subject 7	7
Subject 8	10
Subject 9	6
Subject 10	10

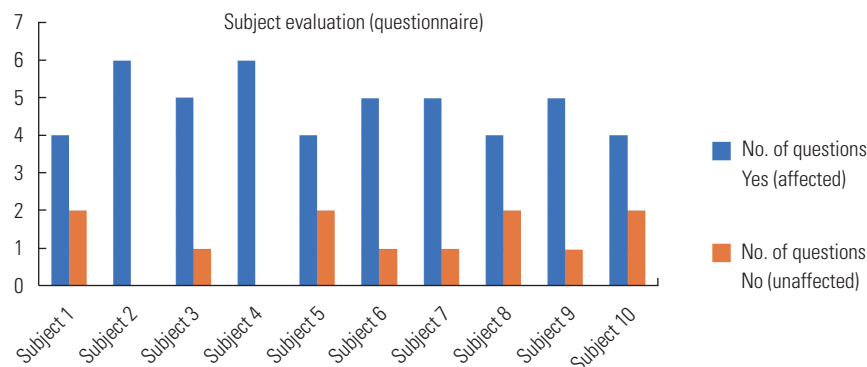


Figure 1. Illustrates the response for each question of all participants.

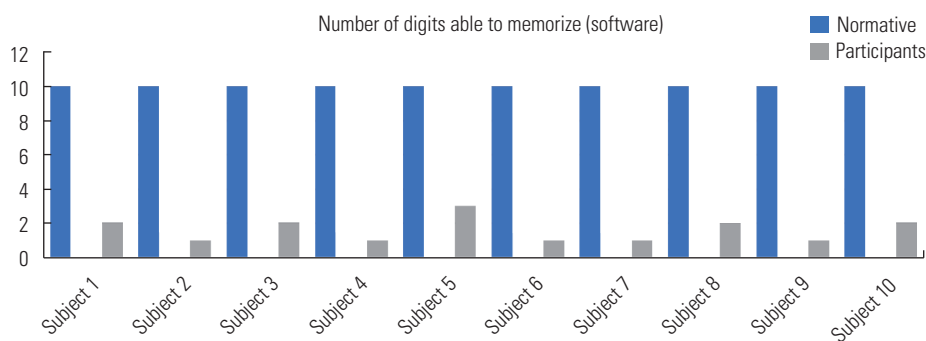


Figure 2. Illustrates the number of digits each subject was able to memorize in comparison with the normative data given by the software.

This research examined the link between real-life functional difficulty and auditory cognition skill deficits. Subjectively reported memorising ability and objectively tested auditory cognition scores were collected as outcome measures. In the present study, the number of digit a child with ASD could memorise was less when compared to the normative data provided by the software. Relative to typically developing children, we found that children with ASD were impaired on auditory cognition tasks. In general, even though this group of subject's thresholds for sound detection were within normal limits, short-term memory and working memory were found to be affected.

One of the major characteristics of ASD is communication and language impairment. Numerous studies have reported decline in speech perception in patients with ASDs. It has been advocated to be a component of the global sensory deficit [24-26]. One interesting hypothesis regarding this issue is the integration deficit of the auditory and visual speech information. The diminished capacity of autistic children to integrate sensory inputs across visual and auditory systems causes impairment in speech perception, especially in noisy environments where the visual signals, such as seeing the speaker's mouth, enhance the ability of speech perception [27]. Although theories about the speech perception impairment have been discussed in several reports, there are very limited data regarding the speech expression deficits in patients with ASDs. A recent study advocated that the impairment of the speech output may be a primary deficit [28]. That study reported that infants at high risk for autism produce fewer speech-like vocalizations and syllable shapes than those produced by the neurotypical infants.

The underlying reason for auditory processing problems in ASD may originate in a part of the child's brain. Research has

shown that the hippocampus is neurologically immature in children on the autism spectrum. The hippocampus is responsible for sensory input, learning and memory. Information is transferred from the senses to the hippocampus where it is processed. Then, the information is transferred to the cerebral cortex for long-term storage. Due to the fact that auditory information is processed in the hippocampus, in children with autism spectrum disorder ASD, the information may not be accurately transferred to long-term memory. In addition, auditory processing problems may be linked to other autistic spectrum traits such as anxiety, confusion in social situations and inattentiveness. The hypothesis is that, due to the behavioural characteristics of acoustic hypersensitivity, together with the language deficits the ASD individuals present, this population may process sound information differently in relation to typical development individuals and that these differences can be reflected in the results [29].

CONCLUSION

It can be concluded that there is a relation between the subjective perception of parents of children with ASD and objective evaluation of auditory cognition. In our study, the scores for auditory cognition test are reduced for children with autism. Autistic people with APDs can hear, but they have difficulty in understating what they hear. APD is crucial pathology of the autistic disorder and this should be taken care during the diagnosis and management.

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