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"Central Auditory Processing Disorder in Children"

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Central Auditory Processing Disorder (CAPD) in Schoolgoing Children

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INTRODUCTION

Auditory processing disorder (APD), also referred to as central auditory processing disorder ((C)APD), is an umbrella term used for defining different types of disorders that affect the process of comprehending perceived auditory information by the higher auditory centers located in the central auditory nervous system. (C)APD is clinically characterized by a difficulty in processing auditory information in the central nervous system. (C)APD is observed widely among children and adults. Schoolgoing children diagnosed with (C)APD often experience numerous difficulties such as asking for repetitions, hyperactivity, poor memory, inability to remember any kind of verbal message; thus, affecting the individual's academic performance. It is very important to refer these children, suspected to be suffering from (C)APD to the audiologists for an early assessment followed by a proper management of the medical condition, in order to reduce the risk of academic failure in the affected population. Studies reveal that in (C)APD children, the central nervous system does not attain complete maturation resulting in their inability to encode the speech stimuli being presented to them.[1] According to a study undertaken by Tomlin and Rance[2], the findings with respect to Mismatch Negativity (MMN) in (C)APD children reveals an increased latency and decreased amplitude relative to that of typically normal developing children thus indicating abnormal waveforms, associated with the poor maturation of the central auditory system. Another current issue of debate is based on the relation between the different aspects of cognition (e.g., intelligence, language, memory, and attention) and APD. As per the British Society of Audiology (BSA)[3], APD has been defined as a non-speech (auditory) disorder in order to differentiate it from linguistic and general (multimodal) cognitive deficits. Despite there being a strong relationship between visual and auditory sensory processing, and between verbal and performance intelligence quotient (IQ),[4-9] very few studies discuss the effects on cognitive abilities and auditory processing across a range of learning disorders.

Rosen[8] based on research findings concluded that non-verbal IQ should be considered specifically while examining auditory and language abilities in order to examine and rule out the effects of any underlying general cognitive deficit. Memory, along with verbal IQ, has also been considered as an underlying factor in defining auditory processing deficits in children who are being diagnosed with non-verbal learning disability and language impairment.[9]

CENTRAL AUDITORY PROCESSING DISORDER IN CHILDREN

Presently, APD has been increasingly reported in children such that about 2-3% of the schoolgoing children are diagnosed with (C)APD these days.[1] Although, the underlying etiology of central auditory processing disorders (C)APD in school aged children is contentious, performance deficits related to school-aged children with (C)APD are well documented and mostly refer to characteristics such as expressing difficulty in comprehending speech with background noise or competing speech; asking for frequent repetitions thus, using "what" and "huh" more often, being highly inattentive and showing a less attention span; showing distractibility and hyperactivity; being symptomatic for deprived memory for auditory and linguistic information for framed complex messages; struggling in perceiving the intended meaning of verbal directions; showing poor academic performance and reading difficulties on

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account of poor knowledge of auditory-phonetic associations.[2-6] The impairment in auditory perception might trigger associated problems like learning disability in school-going children.[6]

ACADEMIC PERFORMANCE OF CHILDREN WITH CAPD

According to a study conducted by Carter and Musher[16], it was understood that auditory-specific perceptual deficit lays the foundation for the understanding of learning and reading disabilities.[7] (C)APD has been reported clinically in children with a medical history of chronic otitis media (reference) thereby, causing auditory performance deficits in children with attention deficit/hyperactivity disorder (ADHD) following the presence of otitis media. However, the relationship between (C)APD and ADHD is complex and controversial. The explanation of one disorder with respect to another is still not possible and more studies are required to understand the association between these disorders. According to National Institute of Deafness and other Communication Disorder (NIDCD), children with (C)APD have poor attention skills and have difficulty in remembering any verbal information. They also face problems in executing commands being presented aurally. NIDCD also stated that school-aged children tend to show low academic performance and behavior problems due to their poor listening skills and inability to process the necessary auditory information. NIDCD also stated that (C)APD in school children causes issues with language skills and tend to show problems in reading, spelling, vocabulary and comprehension.

BEHAVIORAL SYMPTOMS AND CAUSES OF CAPD

In general, (C)APD is marked by a 'deficit in more than one fragment of the entire central auditory processes, which is accountable for evoking the auditory evoked potentials and the behavior of sound localization and lateralization, the process of auditory discrimination, pattern recognition, temporal processing (e.g., temporal resolution and masking, temporal integration and ordering), auditory performance with competing and degraded acoustic signals'.[1] Mishra showed that children with (C)APD experienced more difficulties in listening to situations that are more complex such as the presence of noise.[8] One of the possible reasons for this has been reported to be the insufficient inhibition of the medial olivo-cochlear (MOC). The causes of (C)APD can be either acquired or developmental. With respect to the acquired condition, (C)APD can occur due to head injuries, long duration ear infections or any form of vital damage to the central auditory nervous system. In children, (C)APD is not attributed to a neurogenic disorder largely, rather is associated with an idiopathic central auditory nervous system dysfunction.[9] Though, it has been stated that the central auditory nervous system might be diseased, disorganized or maturationally delayed.[10] recent studies indicate that APD might also be caused due to bilirubin toxicity, which is still a matter of great controversy.[11] Because (C)APD is often a multifaceted problem, clinical intervention for (C)APD typically requires an interdisciplinary approach which should involve an audiologist, speech language pathologist, and other professionals, who would be involved in the broad assessment and diagnosis of the functional deficits experienced by the individuals affected by (C)APD. This approach needs to be implemented as soon as possible so that the various possibilities of intervention can be considered on the basis of the principle underlying the plasticity of the CNS.

Table 1: Recent Studies on Children with (C)APD.

Authors	Year of Study	Aim	Method	Result	Conclusion
Koravand et al[1]	2017	The main objective of the study was to identify markers of neural deficits by recording the latency and amplitude of the auditory cortical responses and mismatch negativity (MMN) responses in children with CAPD.	Twenty-three children within the age group of 9-12 years participated in the study among which 10 children with CAPD were included in one group and 13 who could hear normally without CAPD in another group	Results revealed prolonged N2 latency and reduction in amplitude for both verbal and nonverbal stimuli in children with CAPD as compared to children without CAPD. No significant group differences were observed with respect to MMN findings.	N2 response could be a marker of neural deficits in children with CAPD.
Tomlin and Rance[2]	2016	The current study aimed to utilize cortical auditory evoked potential (CAEP) to assess if there was any kind of maturational differences at the level of central auditory nervous system (CANS) which can be identified in children with and without CAPD	Twenty-seven children of the age group 7-12 years, at a risk of CAPD were age-matched (within 3 months) with children who had normal auditory processing abilities.	Results showed that children diagnosed with APD showed significantly increased latency (~10 milliseconds) and reduced amplitude (~10 μV) in the early components of the CAEP compared with children with normal auditory processing.	The results of this study therefore, indicated that abnormal waveforms are an indication of immaturity of the CANS which could be an underlying cause of APD in children.

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Sanju and Kumar[21]	2016	-	Mini Review	The article highlighted the the present status of CAPD in children by focusing on the incidence, characteristics, site of lesion and also various options for diagnosis and intervention available for a similar population.	Proper diagnosis of the children with CAPD is very important for better management and improving the quality of life in the affected population.
Kumar and Singh[22]	2015	Study was conducted to assess speech-evoked auditory brainstem response (ABR) in children with auditory processing disorders without reading problems	A total of 336 schoolgoing children within the age group of 8-12 years old were screened, among which 51 children were identified to be at a risk of auditory processing deficits and 15 subjects were selected randomly which served as the experimental group. The control group consisted of 15 age matched children.	Overall findings revealed that Speech-evoked ABR is affected in children who are at a risk of developing central auditory processing disorders without reading deficits	Based on the findings it was suggested that there is an abnormality in the encoding of speech signals occuring at the level of the brainstem level in the affected population.
Yathiraj and Maggu[23]	2014	Study focused on the validation of Screening Test for Auditory Processing (STAP) of school aged children in four subsections: speech-in-noise, dichotic consonant vowel, gap detection and auditory memory	STAP was administered on 500 school going children within the age group of 8-13 years. These also consisted of 141 children who were found at a risk of the Screening Checklist for Auditory Processing (SCAP).	The results indicated that the auditory memory subsection of the STAP was the most affected section followed by dichotic CV and speech-in-noise. Gap detection was the least affected among the four subsections in the affected population. It was also suggested that the sensitivity and specificity of STAP in combination with SCAP used for screening were also higher. Similarly, a high and significant correlation was noted between the subsections of the STAP and the APD diagnostic tests as well.	Overall findings suggest that both SCAP and STAP can be administered along with other APD diagnostic tests for better test-retest reliability in these kind of population.
Schochat et al[24]	2010	The purpose of this study was to determine the middle latency response (MLR) characteristics (latency and amplitude) in children with (C)APD, pre- and post-auditory training.	Thirty children with (C) APD within the age group of 8-14 years, were tested using the MLR-evoked potential, pre- and post-auditory training in one group. A control group of 22 children without (C)APD were involved who had undergone, the same test at equal time intervals, but were not included in the auditory training program	Results revealed that (C)APD in the affected group significantly increased, so that there was no longer a significant difference in MLR amplitude between (C)APD group and the control group.	Findings suggest that the use electrophysiological measurements can result in providing better diagnosis and treatment for (C)APD children.
Rosen et al[25]	2010	The aim of the study was to assess and compare the auditory and cognitive abilities in a group of children referred for an auditory evaluation on the grounds of a suspected auditory processing disorder (susAPD), and in normal developing children in order to determine the extent of possibility to relate any deficits in cognitive abilities to auditory deficits.	A battery of auditory and cognitive tests was administered on 20 susAPD school-aged children and on 28 age-matched controls. The auditory test battery consisted of two simple same/different discrimination tasks, one using speech, and one non-speech whereas, the cognitive evaluation comprised of a vocabulary test, a test of grammar and four non-verbal IQ measures.	susAPD children exhibited genuine auditory deficits evidenced by poor performance on at least one of the auditory tasks. Scores were lower than the controls on cognitive measures in both verbal (vocabulary and grammar) and non-verbal sections compared to that of the normal children.	The children suspected of having APD do exhibit, poorer performance on a number of auditory tasks.

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CONCLUSION

(C)APD is one such section which seeks special attention in the field of audiology, speech language pathology and otolaryngology. Professionals mainly 'Audiologists' dealing with a similar population should have a good knowledge regarding the various diagnostic and screening tests available for CAPD assessment and must be able to perform the diagnosis considering the co-morbidity of the related conditions (e.g., ADHD, learning disability, Specific Language Impairment etc.) followed by an appropriate plan for medical intervention. Thus, a child suspected of experiencing (C)APD must be referred to audiologists for an early diagnosis and management to ensure an effective outcome and to reduce the risks of academic failure in school children.

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

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