

Special Edition
"Central Auditory Processing
Disorder in Children"

Review

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Central Auditory Processing Disorder: A Comorbid Condition

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INTRODUCTION

Central auditory processing disorder (CAPD) is common in children. American Speech, Language and Hearing Association (ASHA)¹ has described CAPD as the deficit in one or more of the central auditory processes such as discrimination of auditory stimuli, auditory pattern recognition, lateralization and localization of the sound source, auditory performance with degraded and competing acoustic signal and temporal processing. Individuals with CAPD have been reported to have normal intelligence with normal hearing sensitivity or impaired hearing. It has also been reported that individuals with CAPD may have associated neurological deficit.² In children, CAPD can exist independently or can co-exist. Few disorders with which CAPD co-exists are listed and described below:

1. Attention deficit hyperactive disorder
2. Autism spectrum disorder
3. Specific language impairment.^{3,4}

CAPD in Attention Deficit Hyperactive Disorder (ADHD)

Children with attention deficit hyperactive disorder (ADHD) are likely to present with difficulties in carrying out tasks that challenges the auditory nervous system. Their performance on central auditory processing tasks drops down in comparison with the other children. Cook et al⁵ found that 12 out of 15 subjects with attention disorder had associated auditory processing deficit. The core symptoms of ADHD like Fidgeting, Distractibility and poor attention and concentration are also commonly noted in children with auditory processing deficits.^{5,6} Many other studies have also shown that children with ADHD perform poorly on auditory processing tasks than their normally developing peer.⁷ Ricco⁸ suggested that a characteristic deficit in sustained attention could be the main cause for the auditory processing deficit in children with ADHD. Furthermore, it has been reported that children with ADHD who are under stimulated medication have shown improvement in the auditory processing abilities.^{5,9}

Co-occurrence of the learning disability (LD) with CAPD and LD with ADHD^{10,11} is given as an explanation for the co-occurrence of CAPD and ADHD. Approximately 25-40% of children with ADHD have LD.¹² Gomez and Condon, 1999 suggests that the processing deficits in audition are characteristic of LD than ADHD. Hence, the poor performance in auditory processing tasks in children with ADHD⁶⁻⁹ can be associated to the presence of LD, rather than hyperactivity. Riccio et al⁸ suggested that the co morbidity observed between CAPD and ADHD could possibly reflect the limitations in accurate differential diagnosis using the present criteria and procedures.

The auditory processing deficits has also been reported in children with history of chronic otitis media¹³⁻¹⁹ suggest the presence of auditory processing deficits in children with ADHD subsequent to the presence of chronic otitis media. However, the relationship between CAPD and ADHD is complex and is not clearly understood. The explanation of one disorder as causal to another still remains unclear and more studies are needed to understand the interaction between these disorders.²⁰

CAPD in Autism Spectrum Disorder (ASD)

ASD is one of the common co morbid conditions occurring in coherence with CAPD. Several authors have studied the auditory processing skills of children with ASD as it usually co-exists with CAPD.²¹ Children with ASD are more likely have CAPD than when compared to children without ASD.²² There are about 9% of children with CAPD who have been diagnosed to have ASD.²²

ASD is a neurodevelopmental disorder with impairments in reliance on the routine, communication, engaging in repetitive behavior and social interaction. The use of auditory information is affected in children with CAPD. Whereas, the other central nervous system functions like language processing, attention and memory are affected in children with ASD. However, few features of both the disorders overlap on one another like shorter attention span, poor memory for auditory information, difficulty understanding speech in quiet and difficulty understanding speech especially in the presence of noise.²³⁻²⁵ CAPD might be the result of processing deficit in top-down or bottom-up pathway. However, when it co-exists with ASD it has been reported that the top- down processing which is more affected.²²

Pitch perception of children with CAPD has been reported to be superior to their control peers. However, their ability to decode the acoustical features of the complex stimuli remains affected. This has also been reported to be one of the reasons for their impaired language abilities.²⁶⁻³¹ Pitch discrimination ability has also been reported to be better than their control peers.³² Children with ASD report of hypersensitivity to certain auditory stimuli. This hyperacusis behavior could be for a sudden or any loud sound such as a door bell. Hence, the loudness perception is not constant for all sounds.³³ When compared to their normal peers, children with ASD have good loudness perception and equal loudness discrimination. These are also been reported using other neuroimaging techniques like magnetoencephalography³⁴ and electrophysiological techniques like mismatch negativity (MMN).³⁵⁻³⁷ Hence, it is clear that there is a global processing deficit even though there is a good local processing observed.²²

Children with ASD were reported to have poor temporal processing. This was studied with speech perception in the presence of fluctuation noise. Hence, it is clear that children with ASD are not able to use the available temporal cues for speech perception. It was also been reported that children with ASD require 2.5 to 3 dB better SNR when compared to their controls.²⁴ Children with ASD have been reported to be right hemisphere dominant. This has been reported as a reason why children excel in spectral perception and vowel perception and at the same time why there is a deterioration of performance for temporal skills. Similarly, the deficits in speech perception could be attributed to the reduced activation of the right hemisphere.³⁸

As CAPD co-exists with ASD, the auditory processing

deficits in different domains and the behavioral problems occurring with ASD has to be cautiously dealt with while diagnosing and intervening. The extent of deficit in each domain of auditory processing varies across children with ASD. The rehabilitation goals are to be focused on the deficits that are being diagnosed to have a better outcome.

CAPD in Specific Language Impairment (SLI)

Difficulty in speech perception is typically seen in individuals with central auditory processing disorders as also has been reported in children with specific language impairment (SLI) which is mostly expressed as deficit in phonemic hearing (eg: deficit distinguishing voiced vs. unvoiced sounds). SLI is the difficulty in acquiring spoken language and reported in approximately 3% of the child population.³⁹ The children with SLI are unable to apply language rules such as syntax, semantics and vocabulary to understand and processes speech.

Younger children with SLI have weak auditory consciousness, and thus cannot employ redundant cues to understand speech. Older children with residual specific language disorder show fewer difficulties in comprehension and expression of spontaneous speech. However, they still exhibit difficulties in phonological level and on the auditory differentiation of phonemic distinctive features: they suffer from developmental learning disorders, dyslexia and dysgraphia. Children with SLI have been reported to perform poor in auditory performance tests. They have been reported to perform poor in pitch perception⁴⁰ and pitch discrimination tasks,⁴¹ poor spatial perception skills,⁴² poor gap detection skills⁴³ and poor performance in backward masking.⁴⁴ However, these rapid processing of auditory information are deficit in only few children with SLI.⁴⁵

Tallal,⁴⁶ suggested that SLI stems from the inability in processing rapidly varying auditory stimulus (temporal processing) which results in poor representation of speech signals. For children with SLI, the temporal characteristics of auditory stimulus are crucial. Furthermore, many studies have reported that children with SLI need longer inter stimulus interval between the 2 tones to accurately tell the pattern in which the tones were presented in a pattern perception testing.^{40,43,47,48}

The difficulty in understanding the stimuli arises when they are rapid and/or brief. However, when the stimuli are increased in duration or when slower rate of presentation is used, this difficulty is not observed. Speech contains rapid transition within them. Hence, the perception of speech is affected in children with SLI when compared to non speech stimuli.⁴⁹ For the recognition of phonemes and identification of similar words, distinctive features of the phonemes are important to be distinguished. Hence, there is a unstable representation of speech resulting in receptive and expressive language disorder.⁴⁶ The development and processing of language rules is crucially dependent on the rapid processing of the auditory stimulus. Hence,

any deficit in the temporal processing of rapid stimuli would eventually lead to poor language development.

INTERVENTION OPTIONS

Proper diagnosis of CAPD and identifying the comorbid disorder has direct clinical utility in selection of the appropriate management options. The management options almost always depend upon the primary disorder. The comprehensive management paradigm is designed to improve spoken language comprehension and improve listening skills.⁵⁰ Generally the management options focus on three main streamlines which includes environmental modification, Direct remediation, Compensatory strategies. Environmental modification includes appropriate seating, appropriate room acoustics and so on. Assistive listening devices like FM system can be used to improve the signal to noise ratio (SNR) and facilitate listening comprehension. Direct auditory training that focuses on the specific deficits exhibited by the child can be used. Along with these, compensatory and coping strategies like whole body listening, self-regulation and problem solving etc, should be taught to the child. Management of the comorbid disorder includes medical treatment or therapeutic training depending on the specific symptoms executed and hence it requires a multi-disciplinary approach.

CONCLUSION

Processing of the auditory information is essential for each individual to understand speech and other complex stimuli. There are about 52% of the population with CAPD has been reported to fit into SLI, Dyslexia or both. In addition, 58% of population with dyslexia also fit into the diagnosis of SLI. Similarly, 46% of population with CAPD has been reported to have hyperactivity/in attention.⁵¹ CAPD can co-exist with other disorder as discussed earlier. This makes it complicated, as the interaction of the disorders comes into play. Hence, care has to be taken to diagnose and rehabilitate the co-existing conditions along with the CAPD for better results. This supports the need to direct the focus towards collaboration of professionals for the diagnosis and the holistic management for these children. The management of CAPD can be using any environmental modification, direct remediation and compensatory strategies. However, in addition to this, slight modifications in treatment methods is required to meet up the specific needs in specific comorbid condition.

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

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