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**"Central Auditory Processing Disorder in Children"**

*Mini Review*

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# Comprehensive CAPD Intervention Approaches

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**ABSTRACT**

**Introduction:** Central auditory processing disorder (CAPD) is defined as the reduced or inefficient perceptual processing of auditory information by the central nervous system (CNS) which is reflected in the form of poor scores or developmental skills such as sound localization and lateralization, auditory pattern recognition, auditory discrimination, temporal aspects of auditory functions and auditory performance in the presence of competing noise. Due to the heterogeneous nature of CAPD, there exists the need of a multidisciplinary approach towards its clinical assessment, differential diagnosis and specific intervention. The three possible comprehensive approaches incorporating the bottom up and top down approaches which can be concurrently used in the treatment of CAPD includes: environmental modification, compensatory strategies and direct skill training. The application of appropriate therapeutic approaches addressing specifically each of the auditory deficits of CAPD as may be necessary, facilitates proper listening, learning, language and metacognitive skills.
**Objective:** The aim of this article is to provide an understanding of the basic principles of therapeutic intervention for CAPD and the detailed knowledge of different comprehensive strategies for CAPD intervention emphasizing on the need of a multidisciplinary approach meeting the requirements of different CAPD patients.
**Review:** Clinical intervention of CAPD has become an interesting and challenging area of research investigation for audiologists and speech language pathologists in the recent times. The diagnosis falls within the perspective of audiologists but medical intervention demands a multidisciplinary input. This article provides an overview of the comprehensive intervention strategies which can be employed to address specific auditory deficits that can facilitate listening, language, learning, and help develop problem solving and metacognitive skills. Top down and bottom approaches have been specifically defined in this study.
**Conclusion:** It is crucial to understand that clinical intervention should begin immediately following appropriate diagnosis and identification of specific auditory deficits for CAPD in adults and children. Intensive training to mediate cortical reorganisation and findings based on neural plasticity in CAPD patients help generalize and reduce functional deficits to support learning and the development of language and metacognitive skills as an important consideration. Individualized intervention of CAPD is of prime importance and must take into account the comprehensive approaches for clinical intervention such as: environmental modification, central resource training and tailored auditory training. As a whole, a multidisciplinary approach to clinical intervention is required to perform complete treatment based on the overall functional requirements and complaints of patients diagnosed with CAPD including adults and children.

**KEY WORDS:** Central auditory processing disorder (CAPD); Bottom up and top down approaches.

**ABBREVIATIONS:** CAPD: Central Auditory Processing Disorder; ADHD: Attention Deficit Hyperactivity Disorder; SLI: Specific Language Impairment; CANS: Care and Needs Scale; SLPs: Speech-language pathologists; CNS: Central Nervous System.

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## INTRODUCTION

Central auditory processing refers to the efficiency and effectiveness of the central nervous system (CNS) to process the auditory information.[1] Central auditory processing disorder (CAPD) is defined as the reduced or inefficient perceptual processing of auditory information by the CNS which is reflected in the poor scores or development of skills such as sound localization and lateralization, auditory pattern recognition, auditory discrimination, temporal aspects of auditory processing and auditory performance in the presence of competing noise.[1-4] Although, the higher order cognitive-communicative and or language related functional skills such as phonological awareness, attention to and memory for auditory synthesis, comprehension and intervention remains unaffected. The neural processing deficits in response to the auditory stimuli are associated with CAPD; however, not attributed to the reduced functioning of higher order language, cognitive or related factors. However, CAPD may coexist with difficulties in higher order language, cognition e.g., attention deficit hyperactivity disorder (ADHD), specific language impairment (SLI) and learning disabilities. Also, it may not be necessary that every language-based disorder associated with a difficulty in listening be categorized under the umbrella term CAPD. For example, children with autism or ADHD are often characterised by listening or comprehensive difficulties; however, it may not necessarily be due to CAPD but due to a global disorder. In other words, CAPD has been considered as a term used for diagnostic purposes rather than as a descriptive term, which signifies that an individual exhibiting listening and related difficulties that mimic CAPD through the application of specific tests sensitive enough to rule out the possibility of CAPD incidence. This clearly illustrates that the diagnostic label for CAPD can only be used when the site of lesion lies under central auditory nervous system and not in areas outside those associated with higher level language, cognitive impairment (including autism, attention deficits, etc.) with concomitant deficits in the care and needs scale (CANS).[3,6] Hence, the diagnosis and differential diagnosis is a key to effective intervention. Due to the heterogeneous nature of CAPD, there exists the need to implement a multidisciplinary approach towards the assessment, differential diagnosis and specific intervention for the condition. Clinical intervention of CAPD has become an interesting and challenging area for investigation by audiologists and speech language pathologists in the recent times.[5] The diagnosis of CAPD as a distinct medical disorder came into existence in 2005.[6] During the same time, the diagnosis of this disorder was considered to lie under the expertise of audiologists whereas speech-language pathologists (SLPs) too play an important role equally in the clinical assessment of the individuals suspected to be diagnosed with CAPD. SLPs predominantly play an important role in assessing the cognitive-communicative or language functions associated with CAPD.[6,7,8,11] A multidisciplinary team approach has been considered best to provide high quality clinical intervention for CAPD which can tap auditory, communicative, language, learning and problems related with CAPD to provide a comprehensive plan for intervention.[5,8,9] The diagnosis of CAPD demands a multitest battery approach to assess the multiple processes and regions associated with the CANS.[3,6]

CAPD can occur at any age, secondary to any unknown etiology. Both children and adults can be diagnosed with CAPD. The prevalence of CAPD is reported to be 76% in adults and in school aged children as 2% to 5%.[4,10] Even though a larger focus of CAPD is associated with children. In children diagnosed with CAPD, academic, reading, and social deficits are mostly reported.[3,5] But at the same time not all children diagnosed with CAPD may exhibit reading, spelling and academic deficits. At times these children may exhibit difficulties reflecting the abnormal neurophysiological representation of auditory stimuli thus defining a neurobiological basis for CAPD.[11-19] CAPD in adults may occur due to acquired neurologic disorder such as traumatic brain injury, multiple sclerosis etc., secondary to age related processes.[11] Testing of CAPD in both adults and children constitutes a challenging aspect for assessment in the presence of background noise. Hence, for the ease and accuracy of results, these tests are mostly split into many divisions concerning children and adults. The upper age limit for performing the CAPD test in adults is upto 65 years because after this age the natural changes in the brain takes place due to the aging process. However, in children, 7 years is considered as an optimum age to initiate the CAPD testing. This is because these tests can be too challenging for the children and also the normal range for children is too large in extent to perform the diagnosis for APD. However, the screening tests can be still be performed in children upto 6 years of age and can be further recommended for the detailed testing at 7 years, in suspected cases of CAPD. After the detailed assessment, specific treatment options can be appropriately implemented. Thus, the principles underlying clinical intervention may be equally applicable for treating CAPD in adults and children which may need to be specifically addressed by professionals-audiologists and SLP's within their area of specialisation.

Due to the heterogeneous nature of CAPD, individualised intervention programmes work well as compared to generalized approaches of clinical intervention. Since CAPD involves the domains of listening, communication and academic deficits and is associated with language and learning difficulties, it is important to consider the holistic approach for intervention. A multidisciplinary approach will take into consideration the attention, language abilities and memory to plan an effective therapeutic approach towards the treatment of CAPD. Among the different principles underlying the clinical intervention towards the treatment of CAPD, the four basic approaches are described as follows: the first line of intervention focuses on deficit type. This principle emphasizes on the understanding that a tailored or personalized or person-centred approach is critical for medical intervention. It takes into consideration the weaknesses and strengths specific to an individual in terms of auditory deficits, behavioural complaints and functional difficulties.[8,19-21] The second line of intervention focuses on multidisciplinary inputs not confining exclusively to audiology and speech or language-based

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pathological conditions but also from other areas of specialisation encompassing the holistic domain and focusing on analysing the medical improvement on a day to day basis assessing the different perspectives of individual performance.[8] The third principle focuses on the appropriate use of bottom up and top down approaches.[22] The bottom up approaches highlights on acquisition and access to acoustic signals. In order to achieve better reception of acoustic signals, various environmental modification strategies have been emphasized on.[8] On the other hand, the top down approaches target the higher level central resources like cognition, memory, language and other related functions employing the application of environmental modifications to communicative, instructional and other related areas as would be necessary to mediate language learning. The fourth and final principle of intervention focuses on the early commencement of the appropriate therapeutic strategy as soon as possible once the diagnosis of CAPD has been confirmed. The neuromaturation of CANS takes place until the age of 7 to 8 years; hence, before that it may not be possible to perform the complete diagnosis for younger children, who can the be recommended for auditory enrichment activities that address specifically the suspected areas of weakness.[23,24]

The management goals are determined based on the diagnostic test report of the affected patient discussing the case history, speech and language and psychoeducational data obtained after a thorough clinical assessment. This can ensure the management of skill deficits skills and its effect on the performance of the individual.[1] This can be ensured by the use of three comprehensive approaches which can be applied concurrently: Environmental modification, compensatory strategies and direct skill training.

Environmental modifications are mainly aimed at improving the access to auditory information in an affected individual by improving the clarity of the acoustic signal and the ease of learning and listening in different setups such as home, work, academic and social environment.[3,4,6] It makes use of both bottom up (e.g., listening environment and enhancement of signal) and top down approaches (e.g., workplace, recreational, classroom and home).[1] The bottom up approaches mainly include the use of signal enhancement devices such as the use of hearing aids, frequency modulated (FM) devices, architectural specifications to reduce reverberation which can help improve the signal to noise ratio, preferential seating to aid in visual cues and ways to remove any sources of mechanical or competing noise within the same premises.[5] The top down approaches mainly focus towards providing a rich redundant listening and learning environment. These environmental modification strategies ensure that the manner in which information is imparted and learnt may employ multimodality cues to facilitate the transmission of the presented information through the visual mode by mediating the use of pauses, repetition, focus on key words while speaking, rephrasing, slower rate of speech and use of less complex linguistic units. This may also involve the use of note taker and preteaching of new information.[23] There is no one-size-fit protocol for implementing these environmental modification strategies which implies that clinicians should not use one set of instructions for treating every adult or child but rather systematically implement modifications as per the individual requirements based on the level of auditory deficits and other presenting difficulties. The entire process needs to be implemented in an ongoing basis rather than one time monitoring.[5]

Compensatory strategies are also known by central resource training. These are top down approaches for treatment.[1] These strategies are aimed to strengthen the higher order top down language, cognitive, and related abilities.[8,23] They focus towards improving the residual CAPD dysfunctions[5] which cannot be treated with auditory training/direct skill training and which can address the deficits in cognitive, language and academic skills. Through the use of these techniques, individuals diagnosed with CAPD strengthen their higher order central resources such as memory, attention and language skills,[5] thereby suppressing the deficits in auditory processing skills. This may enable CAPD affected individuals to be active rather than passive in the sense that they learn to take the responsibility for the success of their learning and listening skills. Thus, these strategies indirectly target the deficits in the central auditory processes by providing benefits, implementing clinical intervention for other functional deficits and providing improved spoken language comprehension and listening.[5,25,26] These strategies aim at improving the utilisation of metacognitive (attention and memory) and metalinguistic skills. These strategies aid a listener to monitor their auditory comprehension and self-regulate their retention abilities by improving their general problem-solving tasks.

Direct skill training or auditory training consists of bottom up treatment approaches to resolve CAPD. They help in facilitating the way the brain processes information and sound.[23] These activities help to improve the neuroplasticity of the brain in a formal (acoustically treated room) and informal (home or school setting) environment.[22] The activities to be chosen to help improve specific auditory processes or mechanisms are based on the results from the diagnostic evaluation of central auditory information. Evidences support that following the auditory training, there is a change in the auditory behaviour.[5] These training programs mainly focus on the procedures that are directed towards mediating an improvement in intensity, duration, frequency, phoneme discrimination, duration discrimination, temporal ordering, temporal gap discrimination, pattern recognition and the recognition of auditory information presented in the presence of background noise. Evidences support that along with auditory training programs, interhemispheric transfer exercises are equally important to facilitate the binaural hearing and binaural processing.[3,27, 28]

Thus, the ultimate approach for the clinical intervention of CAPD includes both top down and bottom up approaches to improve the learning and listening environment, in addition, it helps to improve the higher level central resources to stimulate

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the auditory deficits through the use of auditory training-based activities.[5]

## CONCLUSION

The clinical intervention for CAPD should begin at the earliest following the diagnosis based on the principle of the neural plasticity of the CNS and to provide a successful intervention for therapy. It is important to ensure that the approach for the intervention is comprehensive and broadly defined as the potential impact of CAPD on communication, listening and academic success considering the comorbidities of CAPD with other disorders. Literary evidences support the use of both bottom up (auditory training and acoustic signal enhancement) and top down (cognitive, problem solving, metacognitive and language) strategies for the specific clinical management of CAPD. It is crucial to include intensive training which takes into consideration the cortical reorganisation and neural plasticity findings in CAPD, to generalize and reduce the functional deficits affecting learning and language skills.[29,30] Individualized intervention for CAPD is of prime importance and must implement comprehensive approaches such as environmental modification, central resource training and tailored auditory training. Finally, a multidisciplinary approach for clinical intervention is needed to perform a complete diagnosis based on the overall functional requirements and complaints of CAPD patients among adults and children.

## CONFLICT OF INTEREST

The author declares that there is no conflicts of interest

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