

## CASE REPORT

# A child with (central) auditory processing disorder: a case report

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### Abstract

**Background:** Subjects with (central) auditory processing disorder (C)APD may manifest a range of complaints including difficulty in speech perception in noise, following directions, and discrimination of similar speech sounds. Other disorders may also have the same behavioral manifestations.

**The Case:** Here we present an 8-year-old boy who was misdiagnosed and mismanaged as a child with learning disability. His speech, language and cognition problems at initial evaluation included semantic problem, a short length of speech, phonological sound disorder, and attention disorder. He showed abnormality in the dichotic digits test with free recall approach and monaural selective auditory attention test. Based on his performance and test results, he was suffering from (C)APD especially in dichotic listening and speech perception in competition. It was suggested that binaural hearing training with differential interaural intensity, informal localization training including localization clock, and auditory training in noise be added to his classic auditory training program.

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**Conclusion:** Studying this subject was important because (C)APD diagnosis needs a team approach. Evidently, the parents, teacher and speech-language pathologist (SLP) did not seek a central auditory processing evaluations early enough but some of his behaviors could potentially be a red flag for (C)APD and could guide SLPs to refer him for central auditory testing. As we may not be able to evaluate central auditory processing in the early childhood, identifying the possible (C)APD signs by a SLP may help them to plan a more suitable program even before reaching a definite diagnosis.

**Keywords:** Central auditory processing; learning disability; auditory system

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### Introduction

The American Speech-Language-Hearing Association (ASHA; ASHA, 2005a) defines central auditory processing (CAP) as how efficient and effective the central nervous system (CNS) makes use of auditory information [1,2]. CAP includes the mechanisms responsible for the following skills/behaviors: sound localization and lateralization; auditory discrimination;

auditory pattern recognition; temporal processing including temporal resolution, temporal masking, temporal integration, and temporal ordering; auditory performance with competing acoustic signals including dichotic listening; and auditory performance with degraded acoustic signals [3,4]. The involvement of one or more of these behaviors is considered as (central) auditory processing disorder (C)APD [5].

Children with (C)APD may manifest a range of complaints like difficulty in speech perception in noise, following directions, and discrimination of similar speech sounds [6]. In school, they may have difficulty with spelling, reading, and understanding auditory information [7].

A multidisciplinary team approach is critical to adequately assess and understand the multiple problems exhibited by children with (C)APD and reach a differential diagnosis [1,8]. Thus, a teacher will notice academic difficulties; a psychologist may evaluate cognitive functioning; a speech-language pathologist (SLP) may probe written and oral language, speech, and related capabilities. None of the SLP's tests are diagnostic tests for (C)APD, and the actual diagnosis is one of audiologist's responsibilities. A child must be at least seven or eight years old for most audiologic (C)APD tests because in younger children test interpretation may not be possible due to highly variable brain function [7,8].

Once a diagnosis of (C)APD is made, the nature of the disorder is determined. There are many types of CAP deficits and because each child is different, (C)APD may have various manifestations. Therefore, the type of auditory deficit for the child should be determined, then customized management and treatment training should be applied to address his or her specific areas of difficulty [8]. Here we present a case with (C)APD. The patient suffered from several speech and language disorders in addition to (C)APD but the focus of the paper is on auditory processing disorder and its manifestations.

### Case presentation

An 8-year-old hyperactive boy with speech sound disorder was referred to an SLP. He had phonological and orthographic difficulties. He

took one Ritalin tablet per day only in school days and based on the psychiatric diagnosis he suffered from attention deficit hyperactivity disorder (ADHD).

Wechsler Intelligence Scale for Children-Revised (WISC-R) IQ test had been performed on him at age of 6, and the raw verbal score, executive score and the total score were 45, 37, 87 respectively. He was categorized in the lower range of the normative data. He gained an unusual low score in short-term auditory memory. Accordingly, he started to receive sound disorder treatment and he was considered as a child with learning disability (LD) for 9 months. After showing no progress, he was referred for more evaluations. His sound disorder was highly resistant to treatment.

In speech evaluation, he had an inability in using long phrases, storytelling, and narration skills as well as auditory phonemic discrimination, working memory (two units), and immediate auditory memory (three units) deficits. About syntax, there was no significant difficulty except for using prepositions and morphologic features in verbs. His phonological awareness was poor especially in syllabic segmentation and blending, phonological segmentation and blending, and onset and rhyming skills. His auditory assessment showed normal hearing threshold and speech understanding in quiet.

In conclusion, his speech-language and cognitive problems at the first evaluation were as follows: semantic problem (narrative and continuous speech), the short length of speech, phonological sound disorder, and attention deficit.

A treatment program was started with particular attention to the following areas: improving sentence production and storytelling (language skills), auditory training, improving auditory discrimination and identification, improving phonological awareness, improving cognitive skills, immediate auditory memory, working memory, and auditory attention.

He was referred for the Integrated Visual and Auditory (IVA), Continuous Performance test (CPT) and Conners test, at the age of seven. Based on the IVA test, he had severe problems in all auditory attention skills,

**Table 1. Results of the integrated visual and auditory test at the age of 6 and 7 months after starting the new training**

Scales	Auditory		Visual	
	Before	After	Before	After
Quickness	114	103	97	83
Readiness	98	97	110	124
Prudent	96	106	76	99
Reliability	87	102	80	99
Acuity	82	72	88	110
Dependability	100	91	98	97
Consistency	71	100	82	99
Stamina	93	91	71	88
Stability	81	Mildly impaired	82	87
Speed	115	105	99	85
Swiftiness	116	101	106	97
Comprehension	46	93	81	86
Steadiness	43	86	89	83
Persistence	105	116	148	95

sustained attention and attention-switching (Table 1). In IVA test, he had difficulty in auditory discrimination as well. The Conners test showed that he had moderately decreased attention and subtle impulsivity.

After 30 training sessions, parents claimed that a child's progress was outstanding, but from the therapist's point of view, he only had a good progress in the language area and storytelling. He showed some improvement in cognitive skills and phonological awareness, too. The child did not show any significant improvement in auditory skills and sound disorder.

He was referred to an audiologist for central auditory processing assessment. Audiologist selected four central tests mainly based on the multiple auditory processing assessment (MAPA), which included the dichotic digits test (DDT) with free recall approach, the monaural

selective auditory attention test (mSAAT), the duration pattern sequence test (DPST), and the pitch pattern sequence test (PPST). His central auditory test results are summarized in Table 2.

Based on his performance and test results, it was concluded that he was suffering from (C)APD especially in dichotic listening and speech perception in competition (monaural attention). It was suggested that binaural hearing training (differential interaural intensity difference; Persian DIID [9]), informal localization training (localization clock) and auditory training in noise be added to his classic auditory training program. The new treatment plan consisted of the following training:

- Working on phonemic discrimination,
- Storytelling and narration training,
- Onset and rhyming exercises,
- Phonological segmentation and blending skills,
- Phonemes identification in words,
- Improving working memory,
- Sound disorder therapy,
- Training for vigilance in a noisy situation,
- Auditory attention in the presence of background babble noise,
- Sound localization in quiet and in the presence of babble noise,
- Writing (orthography) in quiet and in noise from various distances and different spatial locations (especially 90 and 60 degrees right/left and from front and back),
- Dichotic listening training, and
- Auditory selective and divided attention in the presence of two speakers.

The reason to perform other training (in addition to auditory processing training) was the results of the primary language evaluations. The speech-language pathologist showed that not only there was a phonemic disorder but also there was a significant semantic disorder in using continuous speech. The speech-language pathologist performed a full speech and language evaluations and planned treatments based on their results. As the speech-language pathologist was a psychologist too, cognitive interventions were included as well. The WISC-R IQ test was performed again 6 months after the

**Table 2. Central auditory processing test results before and after new training**

	Right ear		Left ear	
	Before	After	Before	After
<b>DDT</b>	30% (abnormal)	50% (abnormal)	50% (LEA)	60% (LEA)
<b>mSAAT</b>	30% (abnormal)	50% (abnormal)	40% (abnormal)	50% (abnormal)
<b>DPST</b>	90% (normal)	95% (normal)	95% (normal)	95% (normal)
<b>PPST</b>	90% (normal)	90% (normal)	95% (normal)	95% (normal)

DDT; dichotic digit test, LEA; left ear advantage, mSAAT; monaural selective auditory attention test, DPST; duration pattern sequence test, PPST; pitch pattern sequence test

initiation of the new training program. The child showed a total score of 71 which was interpreted as a borderline score. His verbal test was scored the highest (83), and his working memory was scored as the lowest (68). In all categories of IVA test, the child showed significant improvement except for auditory selective attention. The scores are listed in Table 1.

The results of the (C)APD tests are presented in Table 2. There is a slight but significant improvement in DDT and mSAAT results after changing the training plan and focusing on central auditory processing training.

### Discussion

Children exhibiting auditory problems in a school setting are usually referred to speech-language pathologists and audiologists for determining their need for special services. ADHD and (C)APD co morbidity is 41% for children with a confirmed diagnosis of ADHD, and 43% for the children suspected of ADHD. It is hypothesized that children with ADHD show auditory processing deficits, such as auditory attention, poor discrimination in noise, and reduced temporal processing [10]. In the present case, the child had ADHD and (C)APD simultaneously.

The child was diagnosed with LD and went under LD training for 9 months without any significant improvements. The prevalence of (C)APD in children diagnosed with LD is estimated to be as high as 30% to 50% [11]. Due to

high comorbidity between (C)APD and LD, it is recommended that therapists pay particular attention to children's auditory symptoms and carefully monitor their progress and check central auditory processing.

Central auditory tests can evaluate each auditory processing separately and can determine special processing involved in each one, and therapist can decide which trainings must be chosen based on the results. This specialization leads to an effective and efficient training program [5]. The MAPA test battery was used to evaluate the temporal processing, dichotic listening and monaural low redundancy performance of the central auditory system which they can evaluate the most important parts of auditory processing. There are different test batteries for auditory processing disorder. The MAPA test battery has 90% sensitivity and 100% specificity in diagnosing (C)APD [12]. As a result, this test battery was selected in this study.

### Conclusion

Studying this subject was important because of the diagnosis issue in (C)APD which needs a team approach. Evidently, the child's parents, teacher and SLP did not seek an audiology examination for ruling out the (C)APD. However, some of his behaviors which was mentioned in the article could guide the SLP to refer him for central auditory testing. As we may not be able to evaluate central auditory processing of very young children, identifying the (C)APD signs

by a SLP may help them to plan a more suitable training program even before reaching a definite diagnosis.

### Conflict of interest

The authors declare that they have no conflict of interest.

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