An opportunity for readers to have technical questions researched and answered.

Three Commonly Asked Questions About Central Auditory Processing Disorders: Management[1]

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Although the etiology and nature of central auditory processing disorders (CAPD) remain unresolved (ASHA, 1992; Musiek, Gollegly, & Ross, 1985), performance deficits associated with this complex group of disorders are well documented. Children with CAPD present deficits in auditory perception and auditory-language processing (Katz, 1992; Keith, 1983; Willeford & Burleigh, 1985). In addition to deficits in dichotic listening, selective attention, and temporal processing, children with CAPD often demonstrate reduced auditory memory and sound-blending skills (Butler, 1983; Ferre & Wilber, 1986; Jerger, Johnson, & Loiselle, 1988; Jerger, Martin, & Jerger, 1987; Katz, 1983, 1992; Lasky & Tobin, 1973; Musiek, Geurkink, & Keitel, 1982; Pinheiro, 1977; Sloan, 1986; Wepman & Morency, 1973; Willeford & Burleigh, 1985). These functional deficits underlie the commonly cited difficulties observed among children with CAPD, including difficulty comprehending speech in backgrounds of noise or competing speech, distractibility, inattentiveness, difficulty understanding verbal directions, and associated reading difficulties due to auditory-phonetic confusion (ASHA, 1992; Chermak & Musiek, 1992; Musiek & Guerkink, 1980; Willeford, 1985; Willeford & Burleigh, 1985).

Similarly, theoretical differences exist about whether auditory processing deficits either underlie or reflect language disorders (Bannatyne, 1971; Keith, 1981a, 1981b; Rees, 1973, 1981; Sloan, 1980, 1986). New assessment strategies, however, may clarify the relationships among auditory processing, cognitive, and linguistic deficits, and may offer greater direction for management (Chermak, Vonhof, & Bendel, 1989; Jerger, Johnson, & Loiselle, 1988; Jerger et al., 1991; Jerger, Martin, & Jerger, 1987).

Although further research is needed to establish the efficacy of both assessment and treatment approaches, aggressive rehabilitative efforts must incorporate strategies and techniques most likely to reduce the communication and learning disabilities associated with CAPD (Chermak & Musiek, 1992). In this paper, we address three questions about the management of CAPD in children that are frequently posed at national meetings and in our practices. By publishing these questions and answers in this forum, we hope to reach a large number of clinicians who struggle with the issues raised in these questions.

Question 1: What type of rehabilitation approach is indicated when a child does poorly on the frequency (pitch) pattern test?

The objectives of central auditory assessment with children are to ascertain the neuromaturational status and integrity of the central auditory nervous system and to quantify functional deficits requiring treatment, particularly as they relate to the child's communication, academic, and social skills (ASHA, 1992; Baran & Musiek, 1991; Keith, 1981a, 1983; Musiek, Gollegly, & Baran, 1984). Because they reveal deficits underlying functional behaviors, some central auditory tests provide data particularly relevant to intervention. For example, outcomes of tests involving competing message tasks may not only imply a site or level of dysfunction, they may also suggest

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treatment targeting selective and divided attention. In contrast, masking level differences offer less useful data for program planning, given the absence of an everyday listening analog (Chermak, in press).

The frequency pattern test is a good example of a central auditory test that informs about diagnosis and offers insights to direct intervention. The frequency pattern test is composed of three tone sequences. The tone bursts are either "high" (1122 Hz) or "low" (880 Hz) in pitch, and the patterns are constructed so that one tone is always different from the other two. This permits the generation of six possible patterns (HHL, LLH, HLH, LHL, LHH, HLL). Each of the tones has a rise–fall time of 10 msec, a duration of 150 msec, and a stimulus interval of 200 msec. The patterns should be presented at least 20 dB above the spondee threshold, with 30 patterns presented to each ear after a practice period. The subject can either repeat or hum the pattern presented, according to the clinician's instructions. Performance on the frequency pattern test depends on several central auditory processes (Musiek, Pinheiro, & Wilson, 1980), including contour recognition (dependent on pitch discrimination, sequencing, and aspects of gestalt perception), interhemispheric transfer, linguistic labeling, sequencing of the linguistic elements, and trace memory. Perception of prosody may suffer if acoustic contour recognition is problematic (Blumstein & Cooper, 1974). It may be helpful in such cases for the child to work on rhythm recognition and discrimination. Reading poetry and noting the location of the emphasis and stress in sentences and words may also improve perception of prosody. Changing the stress patterns in multisyllabic words can be used to show how acoustic factors change the meaning of a word or sentence. Heteronyms (e.g., convict, subject, record, project) and temporally cued sentences (e.g., They saw the *cargo* on the ferry vs. They saw the *car go* on the ferry) provide material for such exercises (Cole & Jakimak, 1980). Another technique that may be useful alters the prosody within a sentence to change meaning (e.g., Look out the window vs. Look out! The window!). The client may also benefit from training with a language master to produce appropriate inflection and prosody in the expressive mode.

Attempts to improve interhemispheric processing may be centered on exercises that require verbal identification of similarly shaped objects that are held in the left hand and recognized through tactile sensation in the absence of visual cues. Describing a picture while drawing it also invokes interhemispheric processing, and is enjoyable for children who like to draw. Linguistic labeling and sequencing are targeted through practice in recognizing melodic Morse code and in discriminating temporally similar sound and speech elements.

Arguably, since positive neurologic findings are uncommon in children diagnosed with CAPD, the ultimate goal of central auditory tests with children is to confirm functional deficits to determine appropriate management strategies (Chermak, in press). Although remedial programs cannot be designed on the basis of test results alone, understanding the processes underlying successful task performance is needed to bridge the gap between data collection and management strategies and techniques. The strategies and techniques suggested here are consistent with our knowledge of brain function. Their ultimate value in reducing the deficits confronting the child with CAPD, however, remains largely untested.

Question 2: What kind of rehabilitation procedures can be used for preschool children either diagnosed with or suspected of having CAPD?

Because CAPD can seriously disrupt communication, learning, and social development, aggressive intervention is imperative as soon as a diagnosis of CAPD is confirmed (Chermak & Musiek, 1992). Unfortunately, with the possible exception of the Pediatric Speech Intelligibility (PSI) test (Jerger & Jerger, 1984), a clinically accepted criterion measure of CAPD in preschool-aged children is not yet available, and efficiency data for available screening tests are sparse (Stach, 1992). Since a firm diagnosis of CAPD may be difficult to reach with this age population, it may be prudent to involve preschool children suspected of CAPD in a program designed to promote auditory perceptual skills development. The program for these children should build on the philosophy of whole language, which emphasizes the principles of natural language learning (Norris & Damico, 1990). The development of auditory perceptual and auditory-language skills may be facilitated through planned activities that are interesting to the child and that provide natural opportunities for listening and communication. Collaboration between speech and hearing professionals, preschool teachers, and families will maximize the transfer of skills to daily routines (Chermak, 1993). Because listening is fundamental to learning at all levels, children should benefit from experiences early in life that encourage careful listening. The following activities provide opportunities to reinforce good listening skills, and may be used with older children, as well as with 3- to 5-year-olds.

Listening to Stories

Reading aloud to children serves several purposes, including concept learning, vocabulary building, and practice in selective listening. To encourage selective listening, the adult should, before beginning the story, designate target words for which the child should listen. For example, the child might be instructed to raise his or her hand each time a word is read that represents an animal; however, it is important to ensure that the child listens to the story and not only to individual words. Asking comprehension questions at the end of the story promotes listening for meaning. A story grammar might be used to formulate questions (e.g., where and when did events in the story take place [setting]; what did the main character do [action]; what happened as a result of the main character's action [consequences]). Moreover, posing questions that require tracking of both the story context and the designated target words promotes auditory closure and comprehension. Multisensory integration can be fostered by allowing the child to examine the accompanying pictures and words as the story is read aloud.

Following Directions

In addition to providing authentic contexts in which the child must follow sequenced directives to successfully complete a task, games can be organized that require the child to follow directions presented auditorally. The child can be asked to repeat the directive before acting to enhance reauditorization and transference to a motor activity (the directive should require some motor task). Directives may range from simple to complex, involving one or multiple sequenced actions. Group actions requiring cooperation among children may be used, and children can be given the chance to act as clinicians by generating directives for others to follow, thereby building confidence and self-esteem.

Discriminating Sounds

For most preschool children, discriminating differences among sounds is a challenging, yet energizing, task. Environmental sounds differing in intensity, frequency, duration, and quality can be used to develop auditory discrimination. For example, a child might be asked to state which of three bells of different pitch has the highest, middle, and lowest pitch. Identifying different but familiar voices is also an excellent exercise. To increase task difficulty, the speakers can alter their voices, speak quickly, say short words or consonant-vowel combinations, or use a combination of these three modifications.

Several listening exercises or games are commercially available; however, the professional must be prepared to tailor procedures to the individual child. The best treatment approaches are innovative techniques derived from knowledge of the problem, child, and auditory function.

Question 3: Do children with attention deficit hyperactivity disorder also have CAPD?

The relationship between attention deficit hyperactivity disorder (ADHD) and CAPD is complex and not completely understood. Manifestations of ADHD and CAPD overlap, including inattention, poor listening skills, and distractibility (APA, 1987; Keller, 1992; Willeford & Burleigh, 1985). Moreover, these conditions are not mutually exclusive: children with ADHD may also have CAPD (Keller, 1992). In fact, similarities in deficit profiles have led some to suggest that CAPD and ADHD reflect a single developmental disorder (Burd & Fisher, 1986; Gascon, Johnson, & Burd, 1986).

Since attention is essential for successful listening, CAPD can be related to poor attention abilities. The inability to focus sufficient attention on auditory stimuli can result in auditory processing deficits. At least one study documented a high incidence of central auditory processing deficits in children with ADHD (Gascon, Johnson, & Burd, 1986).

The relationship between CAPD and the hyperactivity component of ADHD is more difficult to ascertain. Magnetic resonance imaging reveals morphologic differences in the brains of children with ADHD, as compared with the brains of normal children (Hynd & Semrud-Clikeman, 1989). The morphologic differences are of special interest, since the comparisons involve auditory or auditory/language areas. In fact, the planum temporale, insula, and auditory area of the corpus callosum were reported significantly smaller on the left or both sides of the brain in children with ADHD, as compared with the control group of children. Hynd (personal communication, 1992) indicated that the morphology of Heschl's gyrus may also differ in children with ADHD, as compared with normal children. Hence, there may be compelling anatomical reasons to expect central auditory deficits in children with ADHD.

The interdependency between attention and processing of auditory stimuli, as conceptualized in top-down and bottom-up processing models, provides a theoretical framework which may clarify the relationship between ADHD and CAPD. According to a bottom-up model, attention may be driven by incoming sensory stimulation. Attention is garnered by properly integrated and processed sensory stimuli. If the acoustic stimuli are not properly processed, as in CAPD, then optimal attention cannot be focused on these stimuli in a timely manner. In contrast, a top-down model posits CAPD as manifestation of some attention deficit. Regarding the stimulus triggering the attention processes, Phillips (1990) proposed, "following from the modern spotlight metaphor of selective attention, it is perhaps more likely that any deficit in selective attention is secondary to the deprivation of attentional processes from normal neural representations of the signal." Perhaps bidirectional interaction between central auditory processing and attention is necessary for optimal listening comprehension.

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