Managing Central Auditory Processing Disorders in Children and Youth

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Concepts in cognitive neuroscience fundamental to intervention are summarized. The functional plasticity of the maturing central nervous system offers opportunity to improve auditory processing skills. A comprehensive approach to improve listening comprehension and learning in children and youth with central auditory processing disorders is outlined. The management approach emphasizes development of both specific and general problem-solving strategies in conjunction with self-regulation of strategy use.

Although the underlying etiology of the complex group of disorders known as central auditory processing disorders (CAPD) remains controversial, performance deficits associated with CAPD are well documented and include difficulty comprehending speech in backgrounds of noise or competing speech; distractibility and hyperactivity; inattentiveness and short attention span; poor memory for auditory information, particularly for linguistically complex messages; difficulty understanding verbal directions; and academic underachievement and reading difficulties because of auditory-phonetic confusions (Breedin, Martin, & Jerger, 1989; Ferre & Wilber, 1986; Jerger, Martin, & Jerger, 1987; Jerger et al., 1991; Musiek & Geurkink, 1980; Willeford, 1985). Given theoretical differences of opinion about the extent to which CAPD is related to specific auditory-phonologic deficits rather than linguistic-cognitive deficits or selective attention disorders (Gascon, Johnson, & Burd, 1986; Keith, 1981; Rees, 1981; Sloan, 1986), it is not surprising that identification and evaluation protocols and management approaches have not been standardized or adequately developed.

Notwithstanding the need for further research to elucidate the nature of CAPD as well as establish the efficacy of assessment and treatment approaches, recent developments in cognitive neuroscience provide a compelling rationale for aggressive rehabilitative effort in this area. In this brief paper, we summarize concepts in cognitive neuroscience fundamental to intervention and outline a comprehensive approach to improve listening comprehension and learning in children and youth with CAPD. The management approach emphasizes development of both specific and general problem-solving strategies in conjunction with self-regulation of strategy use. While the efficacy of our comprehensive approach has not been documented, strategies and techniques are outlined to enable clinicians to begin assessing the effectiveness of the program for children and youth with CAPD.

Rationale for Rehabilitative Effort

Considerable evidence reveals the functional plasticity of the maturing central nervous system (Aoki & Siekevitz, 1988). Although the gross structural organization of the brain does not change significantly postnatally, functional aspects remain plastic for some time (Aoki & Siekevitz, 1988). It appears that the plasticity of the brain is related to maturation, although quantification of this process is difficult. The younger brain is generally more plastic than the older brain, as shown poignantly in localization studies with barn owls. Knudsen (1987) reported that localization abilities of a mature barn owl are permanently compromised when one ear is plugged. However, the same treatment with a young barn owl disrupts localization for only a few weeks during which time there is steady improvement in this auditory ability. When the plug is removed, auditory localization worsens again, but only for a few weeks until normal performance is again achieved.

A more clinically relevant example of neural plasticity, but equally as supportive, can be seen in the recovery characteristics of stroke patients. Common neurologic evidence reveals that children recover from cerebral vascular accidents (CVA) more quickly and to a greater degree than (older) adults. Dissimilar recovery patterns are

attributable, in large part, to differences in brain plasticity between young and old patients (Lenneberg, 1967).

Plasticity enables the central nervous system to accommodate and offers the audiologist and speech-language pathologist opportunity to improve auditory processing skills (Musiek, Lenz, & Gollegly, 1991). However, plasticity and maturation are dependent in part on stimulation—stimulation and experience activate and reinforce specific neural pathways and unstimulated pathways fall into disuse and may atrophy (Aoki & Siekevitz, 1988; Cowan, Fawcett, O'Leary, & Stanfield, 1984). Moreover, the neurophysiologic potency of experience decreases beyond the restricted period of time known as the critical period (Arnold, Bottjer, Nordeen, E., Nordeen, K., & Sengelaub, 1987). Hence, neural plasticity affords opportunity for functional change only insofar as intervention is initiated in a timely manner (Aoki & Siekevitz, 1988; Hassmannova, Myslivecek, & Novakova, 1981; Kalil, 1989; Rauschecker & Marler, 1987; Schlaggar & O'Leary, 1991). Delaying intervention beyond the critical period reduces the potential impact of stimulation on brain function as neural connectivity begins to stabilize. Indeed, general animal studies have demonstrated greater effects of auditory deprivation when deprivation occurs during early maturational periods (Trune & Morgan, 1988; Webster & Webster, 1979). Since the absolute time course of the critical period in the mammalian auditory cortex has not yet been established and may extend into adulthood (Merzenich et al., 1984), intervention efforts should never be seen as too late. Rather, a comprehensive approach to managing CAPD must be implemented whenever diagnosis of CAPD is confirmed, with ongoing monitoring and evaluation of progress to insure maximum efficacy.

Inducing cognitive change through stimulation is a process critical to enhancement via auditory training. The significant opportunity to instigate permanent changes in listening skills is suggested by studies on long term potentiation (LTP). LTP is defined as a condition wherein the strength of neural transmission at many synapses increases with repetitive use (Bliss & Lomo, 1973). This increase in synaptic potentials is seen in the amygdala and hippocampal areas of the brain that have come to be strongly associated with memory (Gustafsson & Wigstrom, 1988). Changes in synaptic morphology and transmission that underlie LTP can be demonstrated months after the initial stimulation regime, indicating a neurophysiologic correlate to learning (Gustafsson & Wigstrom, 1988).

In summary, recent developments in cognitive neuroscience suggest that the central nervous system is plastic for some time prior to stabilization of neural function (Aoki & Siekevitz, 1988; Knudsen, 1987). Stimulation appears to enable plasticity and may in fact extend critical periods, thereby maximizing potential for successful rehabilitative efforts (Aoki & Siekevitz, 1988; Arnold et al., 1987; Hassmannova, Myslivecek, & Novakova, 1981; Kalil, 1989; Rauschecker & Marler, 1987; Schlaggar & O'Leary, 1991). The finite course of critical periods, however, underscores the imperative for early and comprehensive intervention. Bold and aggressive management approaches must be undertaken knowing that neuromaturational development and neural plasticity depend on stimulation.

A Comprehensive Approach to Management of Central Auditory Processing Disorders

A comprehensive approach to the management of central auditory processing disorders is necessary, given the range of listening and learning deficits that characterize this complex group of disorders. Children and youth diagnosed as CAPD are described as passive or inactive listeners because they fail to attend selectively and invoke comprehension strategies. Deficient internal storage strategies (e.g., verbal rehearsal) and task approach skills (e.g., ability to focus on relevant information) lead to poor listening comprehension.

Interpretation of spoken messages requires coordination of diverse knowledge and skills, including segmentation skills (i.e., the ability to parse the continuous sound stream into constituent phonetic units), word knowledge, general knowledge, and metacognitive knowledge [i.e., monitoring and regulation of attention, memory, learning, and language processes (Flavell, 1976)], and is influenced by experience, expectation, and motivation. Hence, an efficacious approach to the management of CAPD must be comprehensive, integrating specific skills development and general problem-solving strategies. A cognitive functional emphasis is needed to encourage self-regulation of strategy use and motivation in otherwise passive listeners. Alteration of the environment through reduction of noise, preferential seating and/or use of FM or other assistive listening systems may enable the child with CAPD to better utilize the language-based and metacognitive strategies described here.

Strategies and techniques directed to specific functional deficits associated with CAPD are outlined in Table 1. The strategies and techniques support environmental adaptations [e.g., assistive listening devices (ALDs) and acoustic modifications], skills development (e.g., improved memory and vocabulary building), and adaptive compensation (e.g., external aids to benefit memory). These strategies and techniques also involve linguistic (e.g., contextual derivation of word meanings), metalinguistic (e.g., segmentation, mnemonics, and chunking), and metacognitive knowledge and abilities (e.g., schema induction, attribution retraining, and cognitive behavior modification).

Children and youth with CAPD can become skilled listeners who are actively engaged in discovering what speakers are communicating. To achieve this goal, however, these children and youth must use various strategies to guide their listening and extraction of information from the spoken message. As active listeners they should be trained to monitor and check their listening comprehension by employing question formulation, paraphrasing, verbal rehearsal, mental imaging, and summarizing to construct messages. In addition, like skilled listeners, they must use their language knowledge and metalinguistic knowledge of the rules governing language to assist listening comprehension. For example, they should take advantage of informa-

TABLE 1. Management of Central Auditory Processing Disorders

Functional Deficit	Strategies	Techniques
Distractibility/ inattention	Increase signal to noise ratio	ALD/FM system; acoustic modifications preferential seating
Poor memory	Metalanguage	Chunking, verbal chaining, mnemonics, rehearsal, paraphrasing, summarizing
	Right hemisphere activation	Imagery, drawing
	External aids	Notebooks, calendars
Restricted vocabulary	Improve closure	Contextual derivation of word meaning
Cognitive inflex- predominantly analytic or predominantly conceptual	Diversify cognitive style	Top-down (deductive) and bottom-up (inductive) processing, inferential reasoning, questioning, critical thinking
Poor listening comprehension	Induce formal schema to aid organization, integration and prediction	Recognize and explain connectives (additives; causal; adversative; temporal) and patterns of parallelism and correla- tive pairs (not only/but also; neither/nor)
	Maximize visual and auditory summation	Substitutions for notetaking
Reading, spelling, and listening problems	Enhance multisensory integration	Phonemic analysis and segmentation
Maladaptive behaviors (passive, hyperactive, impulsive)	Assertiveness and cognitive behavior modification	Self-control, self-monitoring, self-evaluation, self-instruction, problem solving
Poor motivation	Attribution retraining: internal locus of control	Failure confrontation, attribution to factors under control

Note: Adapted from *Central Auditory Processing Disorders (CAPD): Key Concepts and Clinical Considerations* by Gail D. Chermak, February, 1992. Paper presented at the American Speech-Language-Hearing Association Workshop on Central Auditory Processing Disorders: Current Concepts and Practical Approaches to Identification, Assessment, and Management, Orlando, FL.

tion conveyed by formal schemata—linguistic patterns that organize, integrate, and predict relationships between ideas within and across sentences (Miller, 1988). Formal schemata include additive, adversative, temporal, and causal connectives (e.g., and, but, before, and because, respectively), and patterns of parallelism and correlative pairs (e.g., not only/but also; neither/nor). The organizing function of schemata is most salient in global patterns such as "in conclusion," "and finally," and "in the beginning." The integrating and predicting functions of schemata demand greater linguistic sophistication: listeners must focus attention on patterns that fuse and foreshadow ideas, facilitating the construction of relationships and message comprehension. Recognizing the causal connective "because," for instance, aids message comprehension as "because" predicts the nature of the relationship between two clauses in a sentence.

The child with CAPD should be encouraged to use visual and auditory input to maximize comprehension. In the classroom, students are often required to take notes, which precludes watching the teacher. This forces children with CAPD to rely solely on their compromised auditory system for all information. In addition, children with CAPD are often poor writers; pedestrian note-taking skills exacerbate an already difficult situation as transcription lags behind the spoken message. The resulting antagonism between writing and listening modes leads to division of attention. Hence, instead of summating information across auditory and visual modes (Massaro, 1987), confusion ensues as attention is diverted from the already less than adequate auditory system. Providing lecture notes to children with CAPD prior to the class presentation, having another student take notes for them, or using a tape recorder for later transcription, enables children with CAPD to attend to and process both auditory and visual information.

In addition to language and metacognitive strategies, specific skills underlying listening comprehension must also be targeted for remediation. For example, chunking (i.e., grouping individual items into superordinate, functional or perceptually salient categories), mnemonics, and verbal chaining strategies (i.e., constructing meaningful sentences or stories from individual items) may be emphasized to improve memory (Wilson & Moffat, 1984). Similarly, using context to derive word meaning, thereby expanding vocabulary and enhancing message comprehension, should be included in a comprehensive management approach. Context clarifies word meaning and motivates children to learn the association between a word and its meaning (Miller & Gildea, 1987). Indeed, a derivational approach to vocabulary development in which word meaning is deduced from context is more effective than consulting a dictionary (Miller & Gildea, 1987). Given the robust correlation between vocabulary and reading comprehension, focus on deducing word meaning from context should enhance both listening and reading comprehension (Perfetti, 1985; Wiig, Semel, & Crouse, 1973).

CAPD children and youth often present motivational problems resulting from repeated comprehension failure and fatigue in attempting to understand auditory messages. Poor motivation often leads to low task persistence (Torgesen, 1980). Attribution retraining whereby causal attributions for failure are assigned to factors under the individual's control (e.g., insufficient effort) rather than sensory or intellectual incapacity, should also be undertaken to promote increased persistence when faced with a difficult task (Medway & Venino, 1982; Thomas & Pashley, 1982).

Conclusion

The goal of a comprehensive approach toward management of central auditory processing disorders in children and youth is to improve performance by enhancing process and skills. Specific listening and related learning strategies and general, executive problem-solving strategies are targeted to facilitate skills development and compensatory adaptive strategies. Inclusion of auditory, language, and metacognitive components maximizes gains and long-term maintenance and generalization of newly acquired strategies. Carefully controlled clinical trials must be undertaken to establish the efficacy of the comprehensive management approach outlined in this article.

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