Habilitation and Management of Auditory Processing Disorders: Overview of Selected Procedures

Frank Musiek*

Abstract

This article describes three management approaches that can be used with children with auditory processing difficulties and learning disabilities. These approaches were selected because they can be applied in a variety of settings by a variety of professionals, as well as interested parents. The vocabulary building procedure is one that potentially can increase the ability to learn new words but also can provide training on contextual derivation of information, which is key to auditory closure processes. This procedure also helps increase language base, which can also enhance closure abilities. Auditory memory enhancement is a simple technique that involves many complex brain processes. This procedure reduces detailed information to a more gestalt representation and also integrates the motor and spatial processes of the brain. This, in turn, more fully uses working memory and helps in formulation and recall of important concepts of the sensory input. Finally, several informal auditory training techniques are discussed that can be readily employed in the school or home setting. These auditory training techniques are those that are most relevant to the kinds of deficits most often observed in our clinic.

Key Words: Auditory rehabilitation, auditory training, central auditory processing disorder

Abbreviations: AME = auditory memory enhancement, AT = auditory training, CAPD = central auditory processing disorder, CV = consonant-vowel, CVC = consonant-vowel-consonant

Recently, habilitation of central auditory processing disorders (CAPDs) and language learning problems have come to the forefront of communication disorders, psychology, and education. Articles by Tallal and Merzenich opened up the possibility of improving auditory abilities through training, and hence have provided a “shot in the arm” to clinicians who manage patients with CAPD (Merzenich et al., 1996; Tallal et al., 1996). The studies by Tallal and Merzenich revealed improvements in the temporal sequencing of acoustic events by language-learning-impaired children with training. Comparisons of pre- and post-training measures indicated marked improvement in the proper ordering of two acoustic stimuli as measured by the change in the interstimulus interval needed to correctly sequence the two stimuli. The training consisted of extensive practice on the sequencing of acoustic events with the interstimulus interval adapted using a computer algorithm. Another type of training involved exposing the children to a time extension of consonant-vowel (CV) transitions. In a second stage, speech transitional elements were differentially amplified by 20 dB. Children were required to listen to this modified speech in order to better allow them to hear the subtle transitions. Pre- versus post-training measures indicated significant improvements in speech discrimination (Goldman-Fristoe Woodcock), language processing (the Children’s Token Test), and grammatical comprehension (Curtis and Yamada Comprehensive Language Evaluation-Receptive). Recently, the work by Tallal and Merzenich has garnered much interest; however, information about management of CAPD has accumulated...
steadily during the last couple of decades. Contributions to CAPD management from many investigators and clinicians have increased our knowledge base and have resulted in the development of viable therapy approaches (Chermak and Musiek, 1997; Musiek and Berge, 1998).

This article describes three management approaches that have been used with success in our evaluation and treatment of children with CAPD. These approaches include the following: (1) a vocabulary building approach directed at helping auditory closure problems; (2) an approach to help the memory, organization, and transfer of auditory information; and (3) an informal auditory training approach. This article will describe these approaches and how they are applied, who can perform these procedures, indications for applying these approaches, a rationale for each approach, and pros and cons based on feedback from a sample of individuals who have used these therapies.

The limitation of our discussion to the management procedures discussed in this article should not be construed to mean that other habilitative procedures are not viable. They are only a portion of a comprehensive management program for CAPD. These procedures have been selected because in our experience they have been useful, are practical, and easily applied. Other management approaches (Chermak and Musiek, 1997) that are often included in a comprehensive management program might include (1) procedures to enhance the acoustic signal, such as assistive listening devices; (2) metacognitive techniques that help plan, monitor, and regulate the judicious use of awareness, attention, and knowledge to increase performance for such things as listening, cognition etc.; and (3) counseling of the child, as well as parents and teachers, about the problem and how it can be helped. It must be remembered that a comprehensive management program will include procedures that interface or intimately involve language and cognition. This is done because audition interfaces with these other processes, and these processes, as well as the manner in which they interface with audition, may not work optimally; hence, approaches that incorporate these aspects of communication should be addressed (Chermak and Musiek, 1997). Therefore, the selected procedures that will be discussed in this paper are only components of a more complete program. The first of these procedures is based on the work of Miller and Gildea (1987) and examines how children learn words.

The research of Miller and Gildea indicates this method to be a valuable approach to vocabulary building. We have modified and embellished the Miller-Gildea approach to achieve a therapy technique that is practical and useful for those with CAPD.

VOCABULARY BUILDING FOR AUDITORY CLOSURE

The key element in this procedure is to place unknown words in an intelligible context for the child. By using contextual cues, the child will deduce the meaning of the unknown word or words (contextual derivation). The procedure involved can be conducted by informed parents, teachers, and speech and hearing professionals. This word learning procedure is best applied to children in the second grade or higher. The description of this vocabulary approach is divided into several main components, as described below.

Word Selection

This vocabulary enhancement technique is optimized when the vocabulary words are selected from subjects in the child's school curriculum. For example, words could be taken from science, social studies, or spelling. This word selection requires the involvement of classroom teachers. The unknown words should be concrete in meaning, as the more abstract the word, the more difficult the procedure. The teacher should be asked to select words from future lessons, generally about 2 weeks in advance. This allows the child 1 week to work on the words before he or she is exposed to the new words in class the following week. The timing permits a review of the newly learned word in the classroom situation. The schedule builds self-esteem because the student will already know the words that will be discussed in class. This can result in academic enhancement and better classroom performance for the child.

Visual, Auditory, and Speech Orientation

Once the teacher picks the new words for the week, the child brings them home. The next step is to be sure the child can read the words, understand them when he or she hears them, and can say them properly. This is an important
Management Approaches for CAPD/Musiek

VOCABULARY BUILDING

WORD SELECTION

CONTEXTUAL DERIVATION

REVIEW

REVIEW

CLASSROOM USE

Figure 1  Key steps in the vocabulary building program.

step because sometimes children recognize a word by seeing it but not by hearing it, or vice versa (Fig. 1).

Contextual Derivation

This is a key element of the vocabulary approach. With this technique, the student can use the contextual information based on familiar and known words to deduce the meaning of an unknown word. The greater the number of contextual cues, the easier it is to determine the meaning of the unknown word. The unknown word is placed toward the end of a short paragraph. The child reads the paragraph or has the paragraph read aloud. If ample contextual cues are provided, by the time the child reaches the unknown word, he or she should be able to figure out the word's meaning. Below is an example of such a paragraph:

Vocabulary word = pilfer or pilfered
The robber broke out of jail. He needed some money. He saw a jewelry store and walked into the store. When the clerk wasn't looking, the robber pilfered a gold ring from the jewelry store. He then sold the ring that he had pilfered for some money.

Several contextual cues are provided in the above paragraph, such as robber (someone who steals), gold ring (something a robber would steal), and jewelry store (where a robber may want to steal something). The process of contextual derivation for vocabulary building is similar to, or perhaps the same as, auditory closure, which is a type of perceptual organization (Sanders, 1971). The ability to use contextual cues will enhance the closure process. Hence, our aim in this vocabulary building approach is to make optimum use of cues that carry over to auditory closure processes (Sanders, 1971; Schow and Nerbonne, 1996). Having excellent auditory closure abilities should help minimize auditory difficulties (Schow and Nerbonne, 1996). Training on vocabulary building tasks, such as by using the Miller-Gildea approach, should improve contextual derivation abilities.

Vocabulary enhancement also helps build a more substantial language base (Chermak and Musiek, 1997). An ample linguistic base should help closure skills, perhaps by making the lexicon more applicable. In addition, a child's improved vocabulary in each subject should help his or her academic performance. It is well known that if one knows the vocabulary of a subject, one knows information about that subject.

Deficits in word knowledge have been reported in individuals with CAPD and learning problems (Chermak and Musiek, 1997). A direct approach to ameliorating this problem is vocabulary building. If one wishes to enhance vocabulary, the Miller-Gildea approach has many advantages over most other methods used for gaining word knowledge (Miller and Gildea, 1987). Vocabulary has a critical role in spoken language comprehension; hence, increasing vocabulary and immersing it in meaningful context can improve the total communication process (Perfetti, 1985; Chermak and Musiek, 1997). Even children with adequate vocabulary can profit from this vocabulary building approach (Miller and Gildea, 1987). The improvement of contextual derivation can offset auditory comprehension difficulties.

This vocabulary building approach can be conducted with the material either read aloud to the child or with the child reading the paragraph to him or herself. In our experience, if the child is a poor reader, it is better to have the paragraph read aloud to the child. When the child is read to, it is of value to have the text in
front of the child so he or she can follow or refer to the printed text as needed.

**Error Correction**

In some rare cases, the child will not deduce the correct meaning of the unknown word. When this happens, the paragraph should be read again and a short discussion initiated about the key contextual cues. If after this rereading and focusing on the main cues the child still does not know the word, the child should be told the meaning of the word. Do not have the child look up the word in the dictionary. It is important to move on as quickly as possible, and little advantage is gained by looking up the word in this situation (Miller and Gildea, 1987). If there is a high frequency of errors, the following points should be considered: (1) an insufficient number of contextual cues is provided, (2) the vocabulary level of the word providing the cues is too high, (3) the unknown words are too abstract, and (4) the syntactic structure of the material is too complex.

**Computer Use**

Vocabulary building can be incorporated into a computer program (Miller and Gildea, 1987). Paragraphs with the unknown words can be generated and targeted. If the child can determine the meaning of the word, he or she can proceed. If the child cannot determine the meaning, he or she will need to reread the paragraph. If after reading the segment a second time the child does not derive the correct meaning, the computer defaults to a picture and an explanation of the word. The child then proceeds with the program.

**Timelines**

The vocabulary building program is based on a 1-week training interval. One evening (Monday), the new word list is presented using the aforementioned approach. All words on the list are presented (usually about five words per week) in the first session. The next night (Tuesday) is skipped. The following night (Wednesday), the new words are presented to the child, and he or she is asked to define the meaning of the new words. If any words are missed, they are put back into the contextual paragraphs and reviewed. The next night (Thursday) is skipped. On the following evening (Friday), the words are reviewed a final time. The following week in school, the child should be exposed to the words in the classes from which the words were originally taken. The cycle is then repeated. This procedure can be increased in difficulty by decreasing the number of contextual cues or increasing the complexity or abstractness of the words.

**Indications**

The vocabulary building approach is a management procedure that can help solve different communicative and educational problems. From an audiologic perspective, it can be used with children who have poor auditory closure abilities as shown by low-redundancy speech tests, such as filtered speech and compressed speech (Chermak and Musiek, 1992). Children with learning disabilities, specifically those who have not acquired a grade-equivalent vocabulary, are prime candidates for this intervention. Children with language problems related to word finding difficulties or a poor language base are candidates for this procedure. Vocabulary building could help the perceptual system with word recognition improvement and the production system with word selection. As Miller and Gildea (1987) proposed, this approach to vocabulary building can be used with all students, as it has been shown to be the most optimal way to teach the learning of new words (Fig. 2). This method of learning words benefits the child in that it requires little memorization, words do not have to be looked up in the dictionary, and it is more time efficient than traditional vocabulary methods (Miller and Gildea, 1987).

We seldom use this vocabulary building approach with children under age 7 (second grade). This approach can be used with younger children, but the younger the child, the greater the number of accommodations.

**Effectiveness**

A survey to assess the value of the vocabulary building program was pseudorandomly distributed to school personnel (classroom teachers, speech-language pathologists, special education teachers). This survey required an evaluation of how much the program had been used and whether it was helpful, as well as a written commentary about the program. The commentary detailed likes, dislikes, feasibility, complaints, and suggestions. Twelve respondents used the program and completed the form. Only one respondent did not feel the program helped significantly. This person felt the program was
too difficult to institute, required too much time, and was too demanding. The other 11 respondents related the following comments: the program could be incorporated well with other programs, had resulted in academic growth, had provided gains in word knowledge, had improved reading, had been an all-around asset, and had increased use of new words. Hence, our feedback, although limited, has been very positive.

**AUDITORY MEMORY ENHANCEMENT**

This procedure has expanded and modified the early work of Wittrock (1974). A common complaint of parents and teachers of children with CAPD is that these children have poor memories, or what is interpreted as poor memory or recall (Chermak and Musiek, 1992). Certain language and psychoeducational tests also indicate that auditory memory in children with CAPD is a problem. Our auditory memory enhancement (AME) procedure involves techniques that have been shown in the psychological literature to enhance recall. These techniques include imagery, spatial elaboration, generative processes, multimodality representation, and organizational perspectives (Tulving and Donaldson, 1972; Wittrock, 1977; Ashcraft, 1989; Chermak and Musiek, 1997). The AME technique also can provide a useful strategy for note taking and interpretation of information from demanding auditory lectures, which are often attended by students in the middle and upper grades. In this regard, it is similar to mind mapping techniques, which are drawings that are supplemented by words to enhance relationships among concepts (Chermak and Musiek, 1997).

The AME procedure involves having the child read several paragraphs or pages of information, or having the information read aloud to the child. Each segment, whether a paragraph or a page, should have within it at least one main concept; in more advanced situations, several concepts are incorporated. If the child has considerable reading problems, the segment should be read to the child. After reading the first segment, the child is required to briefly sketch on a piece of paper what the segment was about (the main concept). A time limit is placed on the sketch (usually under 1 minute). This time limit is a key issue because it creates a situation where the child must determine what the main concept is and represent it in a basic form (reductionism). This requires a transfer from a verbal and highly analytic input to a more gestalt and spatial representation. This type of transfer and coding helps memory (Wittrock, 1977; Ashcraft, 1989). When the sketch is completed, the next segment is read and the same process is repeated. Once the story is completed, the child reviews the sketches and tells the story to the therapist. This can be repeated with a different story or additional segments of the same story:
Example of a Segment
Robby and Joe were walking home from school. Suddenly, it started to rain and the boys could hear thunder in the distance. A big, brown, shaggy dog ran past the boys. Robby and Joe began to chase the dog. Suddenly, a bolt of lightning struck a large tree at the end of the street. The tree fell on a parked car and crumpled the car's roof. The boys stopped chasing the dog and ran home to tell their mother what had happened.

[The sketch should include a tree that has fallen on a car. This is the main concept of the segment.]

Key facets of this procedure that must be watched carefully include the points discussed below.

First, one must be sure that the sketch drawn reflects the main concept in the segment. If the main concept is not reflected, a discussion must be initiated to help the child discern the main concept. This is a crucial step because the skills used to determine the key issues in the passage are critical to learning. When studying academic material, students must be able to identify the most important points, whether from a reading assignment or from notes taken in class. If students cannot distinguish the most important information to study from the less important information, they will have difficulty learning. This is an organizational memory technique that helps with recall and helps develop perspective on importance (Bower, 1972; Wittrock, 1977). The sketching maneuver in this situation serves as a generative process. It has been documented that generative processes, such as sketching, increase retention of information (Wittrock, 1977). Sketching also serves to heighten the child's familiarity with the concept, which has been shown to help short-term memory (Miller, 1956). Also, the sketch can be easily viewed as a rehearsal strategy to help retention.

Second, one must be sure that the time limit for the sketch is strictly enforced. The child must realize that he or she will have to quickly draw an abbreviation of what they have read or heard. This aspect of AME is vital because by limiting the time the child has to sketch, he or she should be forced into taking detailed or analytic verbal information (all of the words and phonemes they read or heard) and transferring it to a more general, or gestalt, spatial representation that involves the motor system (drawing the sketch). This gestalt representation is critical for several reasons. First, gestalt representation is helpful to memory processes, including access and recall (Hergenhahn and Olsen, 1993). Also, gestalt representation is key to the formulation of general concepts, which are much easier to remember than large quantities of analytic information (Hergenhahn and Olsen, 1993). The sketching also allows the spatial representation of information, which enacts the use of the "visual-spatial sketch pad," a subsystem of working memory (Schacter and Tulving, 1994). This process also garners additional experience and attention, which helps memory (Kinsborne and Caplan, 1979). In addition, the verbal information in its analytic form enacts another working memory subsystem, the phonologic loop (Schacter and Tulving, 1994).

Hence, the combination of verbal and motor actions provides better access to memory and should improve the memory process because of the multiple representations (verbal spatial, auditory, visual, somatic, and motor processes) involved (Massaro, 1987). Furthermore, these multiple representations create additional associative pathways, which is known to be helpful to memory (Tulving and Donaldson, 1972; Hergenhahn and Olsen, 1993). In addition, the transfer of analytic verbal-based information (primarily left hemisphere) to a more gestalt arena (primarily right hemisphere) requires the use of mental imagery, which has been shown as a way to enhance recall and information processing (Wittrock, 1974; MacInnis and Price, 1987). The mental imagery (which can be defined as a process that represents sensory information in working memory) in this sense is also critical to the generative process mentioned earlier. The sketch may also reduce the memory load, which helps retention of information (Miller, 1956). The memory load is much less for a sketch than for the words needed to describe the sketch; hence, information about the sketch can better be remembered.

Theoretically, when integrating verbal information, CAPD children with associated learning problems may not access as many of the processes that aid memory when compared to normal children. One key problem is that the analytic-gestalt interface, which is associated with many helpful memory subprocesses, such as imagery and associations, often does not function effectively. If this interface is not working appropriately, many processes that help forge
information into a condition to optimize memory are not realized. Integration of analytic information alone does not appear to be the best way to access memory. Evidence shows that the integration of analytic and gestalt (holistic) processing lends itself to optimal information acquisition (Miller, 1987). One may speculate that the combining of gestalt and analytic processes may influence the accuracy of the mental lexicon or other processes in speech perception theory. Gestalt representation is beneficial since it engages visual and motor modalities and thereby activates a larger neural network with its redundancies, interactions, and opportunities to better guide pattern identification and interpretation (Ashcraft, 1989). Many children with CAPD seem to be analytic listeners without the necessary mixture of gestalt processing. These children with CAPD, because of their auditory behavior, are constantly encouraged to listen very carefully. In an attempt to do this, they try to concentrate on every spoken word (or phoneme), giving equal attention to all words. Unfortunately, this is not the way people normally listen (Handel, 1989). Equal listening attention to all words presents an analytic overload, with the integration of much unrelated information that is of little value. This may be because the gestalt processing is either not accessed well or cannot be performed adequately. Evidence of poor contour recognition, a gestalt feature, which is needed in acoustic pattern perception, has been reported in children with CAPD (Pinheiro and Musiek, 1985). The AME method stimulates the analytic-gestalt interface.

To recall the story, the child views the sketch, which, through visual processes, triggers the gestalt or conceptual and semantic aspects of memory. The process then accesses the phonologic loop of working memory to supply the verbal (analytic) description of the story that goes along with the sketch. The child tells the story based only on the sketches and memory. The child now has the advantage of a strong gestalt aspect of memory concepts to which details (analytic information) can be associated and recalled. This is in contrast to a situation where only analytic information is available for recall. It should be noted that when only the analytic mode is available, details may be recalled, but there is less chance of these details being orchestrated to form a solid concept than if the gestalt processing was encouraged via sketching (Fig. 3).

Third, the reading material must be selected carefully or composed to provide the main concepts the child must identify and sketch. Reading materials that are vague or obtuse in meaning should not be used for this technique. In the initial phases of training with this technique, it may be useful to have only one main concept in the segment.

Fourth, the idea that the child uses a simple sketch to carry meaning and help memory can be extended into a strategy that will help with note taking in the higher grades. At the middle-school or junior-high level, an adaptation of this technique, such as using a variety of symbols rather than writing words, may help in note taking. Note taking is often difficult for children with CAPD because they are almost totally dependent on the auditory system to integrate the information since they cannot watch the speaker (teacher) when they are writing. These children are also often slow writers and cannot keep up with what is said. Using a symbol representation as a type of shorthand can help.

Indications from central auditory test results are not as specific for AME as for vocabulary building, which is primarily indicated by problems with auditory closure. Therefore, AME is used in situations where previous psychoeducational or metalanguage tests indicate possible memory problems or behaviors that have been attributed to poor auditory memory. The AME

![Diagram](image-url)
may play a role in auditory phonetic, phonologic, and lexical processing of the spoken word. The central auditory test battery we use does not directly assess auditory memory, but auditory memory, especially working memory, plays a role in the completion of most test items of any auditory test. Another indication for AME would be generally depressed scores across the test battery for which a general approach to management may hold some advantages. Also, children who have difficulty across multiple academic subjects may be candidates for AME. This is related to the idea that determining the most important concepts on which to focus can help the learning process in general. Better indications for AME are needed, but this should not preclude the present use of this procedure.

Although efficacy on the use of the AME procedure is lacking at this time, a number of the processes involved in this technique have been shown to help memory. For example, imagery and spatial elaboration, which is needed to make a sketch of something that is read, has been shown to improve recall in experimental studies (Tulving and Donaldson, 1972). Similarly, multimodality representation, which in this technique involves auditory, visual, and motor systems, has also been shown to improve recall (Wittrock, 1977).

**INFORMAL AUDITORY TRAINING**

For the purposes of this article, we make a discrimination between formal and informal auditory training (AT). Formal AT includes procedures performed in our clinic or laboratory using electroacoustic equipment and/or computers under the direction of one who is well versed and experienced in the procedures being used. This formal training is done to provide specific acoustic stimuli and training paradigms that can be worked on by the child. For example, if indicated, auditory discrimination tasks along intensity, frequency, or duration parameters can be generated to improve the difference limen for a given child. In our laboratory or clinic, we can also perform lateralization and localization tasks. Formal AT on temporal processing problems could include training on gap detection and ordering of two or three rapidly presented acoustic elements adapting the interstimulus interval and/or duration of the stimuli. Training speech perception can be accomplished by expanding or compressing words or speech segments. Auditory vigilance training (which can be formal or informal AT) can be accomplished by targeting various stimuli for which a child must listen, while varying the time between presentations. These are just some examples of AT formally performed that requires acoustic instrumentation. Commercially available programs include Fast ForWord (available from Scientific Learning Corporation) and Earobics (available from Cognitive Concepts Inc.), and can be viewed as formal AT training in that they modify acoustic stimuli using a computer and rather elegant software.

Formal AT programs, whether commercial or not, have many advantages. The ability to change acoustic stimuli and use adaptive programs can be helpful. Usually with formal programs, because of the computers or instrumentation, stimuli can be presented rapidly. Also, some computer software simplifies the monitoring of performance. Problems with formal AT programs include the following: many children with CAPD reside too far from the clinic that performs formal AT; the costs of the commercial programs may be beyond the reach of parents or schools, and the formal program may not be a good fit for the child and his or her type of problem. For example, a program such as Fast ForWord is focused on specific types of temporal processing problems. This program is reported to have great potential for those with these types of temporal processing problems but may not be as helpful for a child with CAPD that has other types of auditory processing problems as a basis.

Informal AT can be used to supplement a formal AT program. This can be accomplished in a couple of ways. If the child cannot spend sufficient time in the formal program, an informal program can be undertaken at home to secure additional practice time. Also, an informal AT program can supplement a formal program to supply a wider variety and different orientation of AT.

Although formal AT can be powerful, if a child cannot be enrolled in these kinds of programs, one should not assume AT cannot be done at all. Auditory training can be part of a home or school management program for CAPD. In many cases, informal AT cannot be as specific as formal programs but can tap multiple processes, which can be helpful in training integrative functions.

The following are some informal AT methods we recommend. Because we are in a rural region, AT must often be carried out by school personnel and parents, and our orientation takes this fact into consideration.
Vowel Training

A common problem in most children with CAPD is difficulty with identification and discrimination of vowels. We believe one reason vowels are so difficult to learn and use appropriately has to do with classroom acoustics and auditory perception. Usually, vowels are taught in the classroom where there is often considerable background noise. This background or ambient noise has a spectrum that is often similar to many of the low-frequency vowels (Sanders, 1971; Hetu et al, 1990). Because of this, many distinctive acoustic elements that are key to identifying a particular vowel are masked by ambient noise. This ambient noise interference is likely to affect the child with CAPD more than the child without a processing problem. Interference such as noise will also hamper memory processes (Massaro, 1987).

Given the aforementioned, the first principle in AT for vowels is to practice and teach in a quiet environment. The child must also know what long and short vowels mean. The AT for identification specifically should include training that requires the child supplying the sound to each of the vowels as they are written in front of him or her. This is sometimes a demanding process for children in the earlier grades. Next, the vowel sounds must be spoken by the therapist and the child supplies the letter, denoting long or short. Next, consonant-vowels (CVs), consonant-vowel-consonants (CVCs), and words can be presented with the child identifying the vowels.

The discrimination of the vowels should include paired comparisons of vowel sounds only. This can start with same or different judgments and progress to identifying each vowel that is discriminated. This can progress to discriminating three vowel sounds and identifying all three vowels (Fig. 4).

Next, the vowels can be put in a CV or CVC arrangement, or a word, and a similar type of task constructed as mentioned above. When vowels are combined with consonants, their acoustic features change slightly as the transition takes place (Handel, 1989). This concept must be taught carefully.

This AT should be done several times a week, both at home and at school, to achieve the necessary practice time. This informal training should be conducted without visual cues, although in some instances, it may be necessary to provide visual information to help in the discrimination of the vowel(s).

In addition to or instead of the vowel training, other AT on speech and speech sounds can be conducted. Consonant-consonant and CV discriminations, as well as blends and similar-sounding or rhyme words, can be performed. Sloan (1986) provides a logical approach with useful materials to conduct AT with words and speech sounds. Also included in Sloan’s book are score sheets and assessment techniques.

It is worthwhile to develop a discrimination or “confusion” matrix related to vowel, consonant, or word discrimination training. This is done by keeping track of frequent errors and practicing the particular items that resulted in common errors more often than other items. As the child improves, (correct) tokens from the high-error pool are removed, with proportionately more time spent on the items that remain challenging to the child.

Prosodic Training

Another type of informal AT involves the identification of prosodic speech cues. The identification of intonation and rhythm of speech and acoustically stressed parts of words are all closely related. The auditory appreciation of prosody, rhythm, and intonation depends a great deal on temporal processing and is often termed acoustic contour recognition (Bornstein and Musiek, 1984; Handel, 1989). That is, prosody and intonation require the perception of often subtle and rapid changes in intensity and frequency. Timing is critical, not only for speech perception itself but also for interspeech intervals, which can influence the meaning of spoken words (Cole and Jakimik, 1980). Prosody is critical to spoken language in that it links phonetic segments, guides attention to the most informative parts of the phrase, and provides information about lexical, semantic, and syntactic
Informal AT for recognition of rhythm, prosody, and intonation can be accomplished in a variety of ways. Starting at the single-word level, the child can be given words with one segment stressed. For example, a city in Ohio can be said three different ways with stress on three different parts, as follows: Ashtabula, Ashtabula, Ashtabula.

The child must identify the stressed segment and repeat the word. A language master is an excellent device for helping the child hear his or her own speech and compare it to the therapist's speech. (A language master is a modified recorder that uses magnetic tape on a card that can be run through the device quickly. Speech segments can be recorded in a quick manner, allowing the child to compare his or her speech with the therapists.) Sentences with varying prosodic cues can be practiced in much the same way. Demonstration on how prosodic changes can affect the meaning of a sentence is a good approach. For example, the meaning of the following phrase changes as emphasis is placed on different words:

LOOK! out the window
LOOK OUT! the window
Look out the window.

Although the words do not change, the meaning of this sentence does change. These kinds of sentences are worth studying, and the child should mimic them using appropriate prosody. The change in meaning should be discussed and the words emphasized should be identified. Other sentences that are excellent demonstration and training materials come from Cole and Jaminik (1980). These investigators have composed sentences that require segmentation (the identification of word boundaries) to derive the correct meaning of the word in a sentence. Auditory defining word boundaries and intervals between words is in part a temporal task, similar to the work of Tallal et al (1996). Below are examples from Cole and Jaminik (1980).

"The doctor said that nosedrops will help the cold."
"The doctor said that he knows drops will help the cold."
"He just hated forgetting the right number."

"He was noted for getting the right number."

These words can have their meaning altered by a change in temporal course, which is important to identify in order to obtain the correct meaning. Also, there is change in intensity as well as pitch. Also, contextual or semantic cues help derive meaning as discussed per vocabulary building. Hence, these sentences tap multiple processes important in speech perception. Training on these sentences can help in the overall integration of acoustic cues (intensity, frequency, and temporal).

Rhythmic or intonational cues help bring words or parts of words to the forefront of the sentence, and also help establish auditory memory patterns important to language (Valett, 1983; Handel, 1989). Prosody or intonation can bring emotion (surprise, anger, enthusiasm) to the word or sentence that can change the meaning of the sentence. Because individuals with central auditory nervous system problems often do not have good frequency or temporal or intensity discrimination, prosody and intonation often cannot be appreciated fully (Thompson and Abel, 1992)—hence, the need for training on these kinds of tasks. Practicing reading poetry can be valuable in training for the perception of rhythm in speech.

A useful game that was first used in the 1980s and is available currently in toy stores is Simon. This game requires the sequencing of tones that generate patterns of sounds and flashing colored lights. A tone is added to the sequence every time the pattern is recognized correctly. This game is helpful for temporal ordering, memory, and frequency discrimination training. Most importantly, children often play this game for long periods of time and thus receive a considerable amount of AT. Another informal AT procedure for temporal processing is replicating or describing sequences of notes played on the piano or sequences of simple finger tapping. These sequences can be altered by changing the cadence or the pitch of the individual acoustic elements, making the task either easier or more difficult. These tasks can be altered easily along several acoustic parameters (pitch, interstimulus interval, loudness, length of the sequence, etc.).

The aforementioned types of informal AT could be used in cases where temporal processing, frequency, intensity, and speech discrimination are suspect or have been shown by testing to be less than optimal.
Auditory Directives

The ability to follow auditory directions is a key everyday function that can be practiced. AT on directives can be accomplished in several ways. It is important to be sure that the completion of the directive involves a motor task that can be observed by the therapist. If a motor task must be performed, the therapist can watch step by step for errors. This, in turn, can help in correcting the problem as it helps focus on where the breakdown or error occurs. Also, a motor task associated with a directive usually means an integration and understanding of information. To simply repeat the directive often requires no more than mimicking. Multistep directives are generally more difficult than single-step directives, and this gradient is a good way to determine different levels of difficulty.

Another aspect of directives is to be sure that the listener listens to the complete directive. After hearing the first part of the directive, children often start to carry out the task without listening to the entire directive.

A specific activity is to have the child draw individual directives given by the therapist. For example:

1 step: draw a circle
2 steps: draw a circle with a dot in the center
3 steps: draw a circle with a dot in the center and draw a square on top of the dot.

The therapist could also have the child perform relevant tasks, such as: “Go downstairs, turn off the light, pick up your shoes, and put them in the hall closet.” These types of directives can easily be put into a game format. Any mistakes made on the directive should be discussed, and each step should be examined to find out why the error occurred. Interestingly, the Children’s Token Test, although developed for diagnostic use, can be used as AT on auditory directives. Its format requires following specific directions and can be scored accordingly for feedback to the child.

Auditory directives are a training approach that can be adapted to almost any situation, and their worth should not be underestimated. Directives can be used in an informal setting or while engaged in another unrelated activity. For example, teaching a person how to swing a tennis racket can involve many auditory directives, as well as teaching the game of tennis.

Reading

Reading is often thought of as primarily involving visual processing. However, reading is also an auditory processing task. During reading, visual and auditory areas of the brain become active and interact, as shown with new imaging techniques (Price, 1997). It has been suggested that reading and listening use the same phonetic code (Posner and Hanson, 1980). Reading aloud activates the auditory feedback and monitoring system if one listens while reading. Because reading aloud stimulates the auditory system, it could serve as a form of AT. Specifically, if reading is performed with speed and prosody, the auditory system can get exposure and training for these important acoustic influences on the printed word. The problem is that many children with CAPD do not read well, or read with little prosody, rhythm, or intonation. Perhaps the best way to change this is to have the child read materials that are one grade below their reading level. This will allow them greater speed and rhythm, which also exposes their auditory system to these acoustic features as a form of training. Often, when children with CAPD read at grade level, they struggle and do not witness the acoustic features just mentioned. Reading aloud is a way of obtaining considerable AT without the child becoming bored. Another technique in using reading as AT is to record segments of printed materials that the child has read, focusing on prosody and rhythm. Compare their recordings to samples that demonstrate normal prosodic, intonation, and rhythmic features. This is a worthwhile training method, especially if the child and therapist analyze differences in the two recordings. For younger children, a tracking procedure is sometimes helpful in establishing awareness and training on prosodic features. This is done by the therapist reading aloud and the child following the same passage and listening carefully. The therapist and child then read the passage together. The child then reads alone.

As mentioned earlier, however, the child must listen to himself or herself read aloud. If the child does not, the training loses much of its value. To ensure self-monitoring, we suggest periodic checks on the child’s reading comprehension. An interesting technique is reading aloud with speech babble as competition. If the child does not monitor his or her own reading, the background competition will have little influence on the reading. However, if the child monitors himself or herself closely, the background noise will compromise the reading.
Auditory Vigilance Training

Auditory vigilance (sometimes used synonymously with sustained attention) is the process of maintaining a high level of auditory attention for necessary periods of time in anticipation of a target stimulus. Many children, when not engaged in an activity, drift away and do not listen. This is the prime time period when they miss information. It is important to listen for the next message even if the next message may not be presented for a period of time. There are several approaches to training auditory vigilance (Musiek and Chermak, 1995). The key elements in most training approaches involve a target stimulus and a random or pseudorandom presentation interval of the target stimulus.

An example of vigilance training could involve reading a story to a child (or group of children) and designating a target, such as all words that end in the “d” sound, or any word that has to do with food. The target stimulus is presented randomly, that is, it occurs at various time intervals so that the child must maintain vigilance for various periods of time. The more random the target, the more challenging the task. This kind of activity is helpful for children in preschool or early elementary grades. This approach can also be adapted for detecting prosodic elements in speech, which would be better suited for older students. The flexibility to use this task with a wide variety of target stimuli, ranging from subtle to obvious, makes this task valuable, if the therapist is innovative.

Effects of Auditory Training

In Figure 5, four of our recent cases that received informal AT are shown. Central auditory testing was done before and after AT. The improvement or lack thereof is shown as percentage increase or decrease on each of the central auditory tests. As can be seen, in this limited sample, scores improved for practically all situations. Also, a 10-item questionnaire was completed by teachers or parents evaluating communication and academic improvement over the training period (Musiek and Schochat, 1998). The findings on this questionnaire were also positive. Factors such as natural variances in test–retest of these central auditory tests need to be considered in the interpretation of these kinds of results. In addition, the inclusion of a control group would be useful. Nonetheless, it is noteworthy that the changes are almost all in the positive direction, with some changes rather marked. Certainly, some of the test changes were greater than would be expected by test variance. It is important, however, to realize that more of this type of work must be done before the benefit of these types of training programs can be appropriately evaluated.

COMMENTS

The vocabulary building, AME, and informal AT procedures are only parts of a comprehensive management program for CAPD. These three approaches can be performed with the combined efforts of school personnel and parents. Critical to the success of these procedures is the detailed explanation of the procedures to those who will work with the child. We require that parents and teacher(s) meet with us to learn about instituting these procedures. At this conference, we provide literature, descriptions of the techniques, examples, and, if necessary, a tape recording of the discussions. We answer questions and brainstorm ways in which these procedures can be integrated into school
and home schedules. This type of meeting is also valuable in increasing rapport between parents and school personnel.

It is important that school personnel and parents work together. Often, because of economics and lack of personnel, the school cannot spend enough time on these procedures to make a difference. However, the combination of time at school and time at home gives the child a better chance at achieving the necessary time in therapy. One critical concept derived from the research by Tallal et al (1996) is an idea of the amount of time in therapy needed to make a difference. It is this author's opinion that therapy approaches such as discussed here must be worked on 5 of 7 days, even if only for 10 to 15 minutes per day. There is little empirical evidence that helps in determining how much and how long therapies must continue. Certainly, there is probably great individual variability as well as economic, time, and motivational constraints on how much therapy can be supplied.

The question of how long therapy continues is a difficult one. In many situations, duration of therapy is influenced by finances rather than need. It is difficult to set guidelines, but some indicators can help. For example, before starting therapy, the child should be evaluated using central auditory tests and speech and language measures. These should then be periodically evaluated and compared to preintervention test results, which can give an idea of progress or lack of it from a communication standpoint. It is important to obtain feedback from teachers and parents on the child's progress. Also, the informal AT probably cannot be continued for more than 2½ to 3 months before it must be changed or discontinued (and perhaps resumed at a later time). This is because the procedures, in our experience, become too laborious, and it is difficult for the child to remain motivated. The vocabulary building can be modified and continued. It is the best way to learn words and should be used when necessary. As mentioned earlier, the AME also can be modified and used continually as a study technique.

Three selected techniques for the management of CAPD have been described. The rationales and theories as to why these techniques can be of value have also been reviewed. Indications for these procedures have been offered. Although much more practical and basic research needs to be done on these as well as other management techniques, advances are taking place, and soon there will be a variety of avenues available to the well-trained clinician to help in the habilitation of individuals with auditory processing difficulties.

REFERENCES


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