

Understanding auditory processing disorders

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SUMMARY: Yalçinkaya F, Keith R. Understanding auditory processing disorders in children. *Turk J Pediatr* 2008; 50: 101-105.

Auditory processing disorders (APD) are defined as difficulties in hearing and understanding speech in the presence of normal peripheral hearing. Children with APD appear to be uncertain about what they hear, and have difficulties listening in background noise, following oral instructions, and understanding rapid or degraded speech. Suspicious behaviors include: "not listening", "unable to follow direction", or "unable to learn from information they hear". These children are often inattentive. The diagnosis can be complicated because other types of childhood disorders may exhibit similar behaviors (e.g., attention deficit disorders [ADD]). Therefore, results of auditory processing tests are important to differentiate between APD and ADD. In the following report we will briefly review the nature of APD in order to raise clinical awareness of this disorder.

Key words: auditory processing disorders, sensitized speech tests, language disorders, remediation.

An auditory processing disorder (APD) is defined as an observed deficiency in one or more of these behaviors: sound localization and lateralization, auditory discrimination, auditory pattern recognition, and temporal aspects of audition. These include temporal resolution, temporal masking, temporal integration, temporal ordering, auditory performance decrements with competing acoustic signals, and auditory performance decrements with degraded acoustic signals. Children with APD exhibit normal intelligence and normal hearing¹. APD may present against a background of neurological disease or developmental disorders, as well as in isolation. Thus, APD contrasts with cognitive, language-based problems, and/or problems of attention. Children with APD are a heterogeneous group, and not all exhibit the same symptoms. Most children with APD process speech normally in favorable hearing conditions. Therefore, tests that use distorted speech, speech in noise, or competing speech must be used to identify the disorder. Some children who perform poorly on an APD assessment battery have no evidence of speech or language problems. Conversely, some children with APD have significant speech

or language difficulties. Sometimes, APD tests cannot differentiate between problems of language and attention, and they are simply considered to be co-morbid^{2,3}.

The true nature of this disorder is not known. Approximately 2-3% of children are thought to be affected by handicapping disorders known as APD, with a 2:1 ratio between boys and girls⁴. The diagnosis is very complicated because other types of childhood disorders may exhibit similar behaviors. Test performance is often influenced by non-auditory factors (e.g., language, memory, motivation, lack of sustained attention, and lack of cooperation)⁵. Early symptoms include delayed language development, phonologic and reading disorders, problems of learning through the auditory channel, poor auditory memory span, and poor auditory sequential memory. It is crucial that APD be detected at an early age in order to introduce appropriate remediation before the child fails in school^{6,7}.

The Auditory Processing System

The auditory stimulus travels through the peripheral auditory system to the central auditory nervous system (CANS) that extends from the brain stem to the temporal lobes of

the cerebral cortex. The auditory stimulus travels along the neural pathways where it is “processed”, allowing the listener to determine the direction from which the sound comes, identify the type of sound, separate the sound from background noise, and interpret the sound⁸.

Causes of APD

The causes of APD are generally unknown. Birth and developmental histories are often unremarkable and there is no evidence of brain damage⁹. Early and chronic middle ear infection will put the child at greatest risk for a conductive hearing loss and associated problems of auditory processing^{10,11}. Neuro-maturation of the auditory system is often delayed in this population. APD can also occur in the presence of neurological conditions or other developmental disorders that include learning disability, language impairment, developmental aphasia, developmental dyslexia, attention deficit disorders (ADD), and attention deficit hyperactivity disorders (ADHD)^{12,13}. Some known causes of APD include prematurity and low birth weight, genetic histories, head trauma, diseases of the CANS, exposure to lead or carbon monoxide, Landau-Kleffner syndrome, epilepsy, metabolic disorders, cerebrovascular disorders, Lyme disease, and pervasive development disorder^{14,15}.

Resulting Symptoms and Behaviors That Characterize APDs

Children with auditory processing difficulty typically have normal hearing and normal intelligence. They may have normal or impaired language and reading abilities. Some of the typical behaviors of children with APD are listed in Table I¹⁶.

Children who have some of these symptoms require testing for APD. Generally we consider that the symptoms must be present for at least six months, and that recent behaviors of this type are usually associated with other causes. APD cannot be diagnosed from a symptoms checklist. No matter how many symptoms of APD a child may have, only careful and accurate diagnostic testing can determine the underlying cause. However, use of a behavioral checklist can provide differentiation for purposes of screening and referral.

Other Types of Childhood Disorders

The diagnosis of APD is presently complicated because other types of childhood disorders may exhibit similar behaviors. Examples are ADD, ADHD-predominantly inattentive (ADHD-PI), language impairment, reading disability, learning disability, autistic spectrum disorders, and reduced intellectual functioning^{2,17}. Children

Table I. Deficits and Resulting Symptoms and Behaviors Characterizing Auditory Processing Disorders¹⁶

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1. Behaves as if peripheral hearing loss was present, despite normal-hearing
 2. Difficulty with auditory discrimination expressed as diminished ability to discriminate among speech sounds (phonemes)
 3. Deficiencies in remembering phonemes and manipulating them (e.g. in tasks related to reading and spelling, and phonics, as well as phonemic synthesis or analysis)
 4. Difficulty understanding speech in the presence of background noise
 5. Difficulty with auditory memory, either span or sequence; unable to remember auditory information or follow multiple instructions
 6. Demonstrates scatter across subtests with domains assessed by speech-language and psycho-educational tests, with weaknesses in auditory-dependent areas
 7. Poor listening skills characterized by decreased attention for auditory information; distractible, or restless in listening situations
 8. Inconsistent responses to auditory information (sometimes responds appropriately, sometimes not) or inconsistent auditory awareness (one-to-one conversation is better than in a group)
 9. Receptive and/or expressive language disorder, may have a discrepancy between expressive and receptive language skills
 10. Difficulty understanding rapid speech or persons with an unfamiliar dialect
 11. Poor musical abilities, does not recognize sound patterns or rhythms; poor vocal prosody in speech production
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with APD exhibit symptoms similar to those with ADHD. There have been long debates as to whether APD and ADD are the same or different entities; however, research by Chermak and others¹⁸ indicates that they are different conditions (Table II). One important reason for differentiating between APD and ADHD is that children with ADHD may be treated with stimulant medications but a child with APD is not treated medically¹⁹.

speech in noise, and time compressed sentences as described by Keith. Finally, dichotic listening tests are recommended for testing. During dichotic testing, speech stimuli (including numbers, one-syllable words, two-syllable words or sentences) are presented to both ears either simultaneously or in an overlapping manner and the child is asked to repeat everything that is heard (divided attention) or repeat whatever is heard in one specified ear

Table II. Differential behaviors of ADHD and APD¹⁸

ADHD	APD
Inattentive	Difficulty hearing in background noise
Distracted	Difficulty following oral instruction
Hyperactive	Poor listening skills
Fidgeting or restless	Academic difficulties
Hasty or impulsive	Poor auditory association skills
Interrupts or intrudes	Distracted, inattentive

ADHD: Attention deficit hyperactivity disorder. APD: Auditory processing disorders.

A significant delay in general language acquisition should not be considered an auditory processing deficit, even though the child will probably fail most of the APD test battery. In that situation the child should be considered to have specific language impairment and to be treated as such. Finally, children with low cognitive function may exhibit some of the same symptoms as children with auditory processing problems, but they should not be administered an auditory processing test battery; they should be treated for their primary disorder of impaired cognition.

Assessment of APD

Most of the tests of APD require that a child be at least six or seven years of age before they are tested²⁰. The variability of central auditory maturation in young children is so marked that test interpretation may not be possible. Before central auditory testing is administered, a peripheral assessment is administered to rule out middle ear or inner ear pathology. The peripheral hearing test includes pure tone air-conduction and bone-conduction thresholds, speech recognition, and tympanometry. The central auditory behavioral test battery includes performance intensity functions for word recognition, tests of temporal processing such as the Random Gap Detection Test (RGDT) described by Keith^{16,21-23}, and monaural tests of distorted and degraded speech to include filtered words,

(directed attention). The ear advantage scores of dichotic tests are powerful indicators of auditory maturation, hemispheric dominance for language, and neurologically based language/learning disorders²⁴⁻²⁶. Electrophysiologic tests of central auditory function include auditory brain stem evoked responses, middle latency response, P300 and Mismatch Negativity (MMN). These measures are sometimes useful for identifying disorders of auditory structures in the brain stem and cortex, but they are not in common use for identifying functional disorders of communication^{27,28}. There is much to learn about late potential auditory evoked potentials before they can be routinely used in the assessment of auditory processing.

The team approach to assessing individuals who are at risk for APD should include team members from professions such as audiology, educational audiology, speech-language pathology, neuropsychology, special education, pediatric neurology, otolaryngology, and child development.

Implication for Remediation

Management of APD should incorporate four primary principles^{21,29}:

- (1) Modifications to the speech signal: The parent and teacher or other must use increased loudness, slower rate, smaller language units, frequent language units, and repetition.

- (2) Environmental modifications: Ways to improve the listening environment include improving a room's acoustics, changing seating arrangements, and use of FM systems or other assistive listening devices.
- (3) Remediation (direct therapy) techniques: A range of exercises have been developed to help increase the children's language base and build on vocabulary. Strategies/practices such as writing down verbal instructions and checking them off as they are completed can prove helpful with school- and work-related tasks.
- (4) Compensatory strategies: Compensation includes suggestions for assisting listeners in strengthening central resources (language, problem-solving, memory, attention, other cognitive skills) so that they can be used to help overcome the auditory disorder.

Recent studies have examined the improvement in auditory processing abilities with intensive auditory stimulation and training^{30,31}.

Conclusion

Currently there are limited facilities and tests available in the diagnosis of APD³²⁻³⁴. With increased awareness and research into this problem, children who are affected by problems of auditory processing can be identified and managed before they experience educational and vocational failure.

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