Auditory processing disorder

Auditory processing disorder	
Other names	**Central auditory processing disorder**
Specialty	Audiology

Auditory processing disorder (APD), rarely known as **King-Kopetzky syndrome** or **auditory disability with normal hearing** (**ADN**), is an umbrella term for a variety of disorders that affect the way the brain processes auditory information.[1] Individuals with APD usually have normal structure and function of the outer, middle, and inner ear (peripheral hearing). However, they cannot process the information they hear in the same way as others do, which leads to difficulties in recognizing and interpreting sounds, especially the sounds composing speech. It is thought that these difficulties arise from dysfunction in the central nervous system.

The American Academy of Audiology notes that APD is diagnosed by difficulties in one or more auditory processes known to reflect the function of the central auditory nervous system.[1] It can affect both children and adults. Although the actual prevalence is currently unknown, it has been estimated to be 2–7% in children in US and UK populations.[2] APD can continue into adulthood. Cooper and Gates (1991) estimated the prevalence of adult APD to be 10 to 20%. It has been reported that males are twice as likely to be affected by the disorder as females,[3][4] and that prevalence is higher in the elderly and increases with age.[5]

Contents

Signs and symptoms

Many people experience problems with learning and day-to-day tasks with difficulties over time. Adults with this disorder[6] can experience the signs and symptoms below:

- talk louder than necessary
- have trouble remembering a list or sequence
- often need words or sentences repeated
- have poor ability to memorize information learned by listening
- interpret words too literally
- need assistance hearing clearly in noisy environments
- rely on accommodation and modification strategies
- find or request a quiet work space away from others
- request written material when attending oral presentations
- ask for directions to be given one step at a time

Relation to attention deficit hyperactivity disorder

It has been discovered that APD and ADHD present overlapping symptoms. Below is a ranked order of behavioral symptoms that are most frequently observed in each disorder. Professionals evaluated the overlap of symptoms between the two disorders. The order below is of symptoms that are almost always observed.[7] This chart proves that although the symptoms listed are different, it is easy to get confused between many of them.

ADHD	APD
1. Inattentive	1. Difficult hearing in background noise
2. Distracted	2. Difficulty following oral instructions
3. Hyperactive	3. Poor listening skills
4. Fidgety or restless	4. Academic difficulties
5. Hasty or impulsive	5. Poor auditory association skills
6. Interrupts or intrudes	6. Distracted
	7. Inattentive

There is a high rate of co-occurrence between ADHD and APD. An article published in 1994 showed that 84% of children with APD have confirmed or suspected ADHD. Co-occurrence between ADHD and APD is 41% for children with confirmed diagnosis of ADHD, and 43% for children suspected of having ADHD.[8] *more recently published data is needed to support or refute this statement.*

Relation to specific language impairment and developmental dyslexia

There has been considerable debate over the relationship between APD and Specific language impairment (SLI).

SLI is diagnosed when a child has difficulties with understanding or producing spoken language for no obvious cause. The problems cannot be explained in terms of peripheral hearing loss. The child is typically late in starting to talk, and may have problems in producing speech sounds clearly, and in producing or understanding complex sentences. Some theoretical accounts of SLI regard it as the result of auditory processing problems.[9][10] However, this view of SLI is not universally accepted, and others regard the main difficulties in SLI as stemming from problems with higher-level aspects of language processing. Where a child has both auditory and language problems, it can be hard to sort out cause-and-effect.[10]

Similarly with developmental dyslexia, there has been considerable interest in the idea that for some children reading problems are downstream consequences of difficulties in rapid auditory processing. Again, cause and effect can be hard to unravel. This is one reason why some experts have recommended using non-verbal auditory tests to diagnose APD.[11] Specifically regarding the neurological factors of dyslexia, the disorder has been linked to polymicrogyria which causes cell migrational problems. This relates to APD because children that have polymicrogyri almost always present deficits on APD testing.[2] It has also been suggested that APD may be related to cluttering,[12] a fluency disorder marked by word and phrase repetitions.

It has been found that a higher than expected proportion of individuals diagnosed with SLI and dyslexia on the basis of language and reading tests also perform poorly on tests in which auditory processing skills are tested.[13] APD can be assessed using tests that involve identifying, repeating or discriminating speech, and a child may do poorly because of primary language problems.[14] In a study comparing children with a diagnosis of dyslexia and those with a diagnosis of APD, they found the two groups could not be distinguished.[10][15][16] obtained similar findings in studies comparing children diagnosed with SLI or APD.[17][18] The two groups had very similar profiles. This raises the worrying possibility that the diagnosis that a child receives may be largely a function of the specialist they see: the same child who would be diagnosed with APD by an audiologist may be diagnosed with SLI by a speech-language therapist or with dyslexia by a psychologist.[11]

Causes

Acquired

Acquired APD can be caused by any damage to or dysfunction of the central auditory nervous system and can cause auditory processing problems.[19][20] For an overview of neurological aspects of APD, see Griffiths.[21]

Genetics

Some studies indicated an increased prevalence of a family history of hearing impairment in these patients. The pattern of results is suggestive that Auditory Processing Disorder may be related to conditions of autosomal dominant inheritance.[22][23][24] The ability to listen to and comprehend multiple messages at the same time is a trait that is heavily influenced by our genes say federal researchers.[25] These "short circuits in the wiring" sometimes run in families or result from a difficult birth, just like any learning disability.[26] Auditory processing disorder can be associated with conditions affected by genetic traits, such as various developmental disorders. Inheritance of Auditory Processing Disorder refers to whether the condition is inherited from your parents or "runs" in families.[27] Central auditory processing disorder may be hereditary neurological traits from the mother or the father.

Developmental

In the majority of cases of developmental APD, the cause is unknown. An exception is acquired epileptic aphasia or Landau-Kleffner syndrome, where a child's development regresses, with language comprehension severely affected.[28] The child is often thought to be deaf, but normal peripheral hearing is found. In other cases, suspected or known causes of APD in children include delay in myelin maturation,[29] ectopic (misplaced) cells in the auditory cortical areas,[30] or genetic predisposition.[31] In a family with autosomal dominant epilepsy, seizures which affected the left temporal lobe seemed to cause problems with auditory processing.[32] In another extended family with a high rate of APD, genetic analysis showed a haplotype in chromosome 12 that fully co-segregated with language impairment.[33]

Hearing begins in utero, but the central auditory system continues to develop for at least the first decade.[34] There is considerable interest in the idea that disruption to hearing during a sensitive period may have long-term consequences for auditory development.[35] One study showed thalamocortical connectivity in vitro was associated with a time sensitive developmental window and required a specific cell adhesion molecule (lcam5) for proper brain plasticity to occur.[36] This points to connectivity between the thalamus and cortex shortly after being able to hear (in vitro) as at least one critical period for auditory processing. Another study showed that rats reared in a single tone environment during critical periods of development had permanently impaired auditory processing.[37] ‘Bad’ auditory experiences, such as temporary deafness by cochlear removal in rats leads to neuron shrinkage.[34] In a study looking at attention in APD patients, children with one ear blocked developed a strong right-ear advantage but were not able to modulate that advantage during directed-attention tasks.[38]

In the 1980s and 1990s, there was considerable interest in the role of chronic Otitis media (middle ear disease or 'glue ear') in causing APD and related language and literacy problems. Otitis media with effusion is a very common childhood disease that causes a fluctuating conductive hearing loss, and there was concern this may disrupt auditory development if it occurred during a sensitive period.[39] Consistent with this, in a sample of young children with chronic ear infections recruited from a hospital otolargyngology department, increased rates of auditory difficulties were found later in childhood.[40] However, this kind of study will suffer from sampling bias because children with otitis media will be more likely to be referred to hospital departments if they are experiencing developmental difficulties. Compared with hospital studies, epidemiological studies, which assesses a whole population for otitis media and then evaluate outcomes, have found much weaker evidence for long-term impacts of otitis media on language outcomes.[41]

Somatic

It seems that somatic anxiety (that is, physical symptoms of anxiety such as butterflies in the stomach or cotton mouth) and situations of stress may be determinants of speech-hearing disability.[42][43]

Diagnosis

Questionnaires can be used for the identification of persons with possible auditory processing disorders, as these address common problems of listening. They can help in the decision for pursuing clinical evaluation. One of the most common listening problems is speech recognition in the presence of background noise.[44][45] According to the respondents who participated in a study by Neijenhuis, de Wit, and Luinge (2017),[46] the following symptoms are characteristic in children with listening difficulties, and they are typically problematic with adolescents and adults. They include:

- Difficulty hearing in noise
- Auditory attention problems
- Better understanding in one on one situations
- Difficulties in noise localization
- Difficulties in remembering oral information

According to the New Zealand Guidelines on Auditory Processing Disorders (2017)[47] a checklist of key symptoms of APD or comorbidities that can be used to identify individuals who should be referred for audiological and APD assessment includes, among others:

- Difficulty following spoken directions unless they are brief and simple
- Difficulty attending to and remembering spoken information
- Slowness in processing spoken information
- Difficulty understanding in the presence of other sounds
- Overwhelmed by complex or “busy” auditory environments e.g. classrooms, shopping malls
- Poor listening skills
- Insensitivity to tone of voice or other nuances of speech
- Acquired brain injury
- History of frequent or persistent middle ear disease (otitis media, ‘glue ear’).
- Difficulty with language, reading or spelling
- Suspicion or diagnosis of dyslexia
- Suspicion or diagnosis of language disorder or delay

Finally, the New Zealand guidelines state that behavioral checklists and questionnaires should only be used to provide guidance for referrals, for information gathering (for example, prior to assessment or as outcome measures for interventions), and as measures to describe the functional impact of auditory processing disorder. They are not designed for the purpose of diagnosing auditory processing disorders. The New Zealand guidelines indicate that a number of questionnaires have been developed to identify children who might benefit from evaluation of their problems in listening. Examples of available questionnaires include the Fisher’s Auditory Problems Checklist [48], the Children’s Auditory Performance Scale[49], the Screening Instrument for Targeting Educational Risk[50], and the Auditory Processing Domains Questionnaire [51] among others. All of the previous questionnaires were designed for children and none are useful for adolescents and adults.

The University of Cincinnati Auditory Processing Inventory (UCAPI) [52] [53] was designed for use with adolescents and adults seeking testing for evaluation of problems with listening and/or to be used following diagnosis of an auditory processing disorder to determine the subject’s status. Following a model described by Zoppo et al. (2015[54]) a 34-item questionnaire was developed that investigates auditory processing abilities in each of the six common areas of complaint in APD (listening and concentration, understanding speech, following spoken instructions, attention, and other.) The final questionnaire was standardized on normally achieving young adults ranging from 18 to 27 years of age. Validation data was acquired from subjects with language-learning or auditory processing disorders who were either self-reported or confirmed by diagnostic testing. A UCAPI total score is calculated by combining the totals from the six listening conditions and provides an overall value to categorize listening abilities. Additionally, analysis of the scores from the six listening conditions provides an auditory profile for the subject. Each listening condition can then be utilized by the professional in making recommendation for diagnosing problem of learning through listening and treatment decisions. The UCAPI provides information on listening problems in various populations that can aid examiners in making recommendations for assessment and management.

APD has been defined anatomically in terms of the integrity of the auditory areas of the nervous system.[55] However, children with symptoms of APD typically have no evidence of neurological disease and the diagnosis is made on the basis of performance on behavioral auditory tests. Auditory processing is "what we do with what we hear",[56] and in APD there is a mismatch between peripheral hearing ability (which is typically normal) and ability to interpret or discriminate sounds. Thus in those with no signs of neurological impairment, APD is diagnosed on the basis of auditory tests. There is, however, no consensus as to which tests should be used for diagnosis, as evidenced by the succession of task force reports that have appeared in recent years. The first of these occurred in 1996.[57] This was followed by a conference organized by the American Academy of Audiology.[58] Experts attempting to define diagnostic criteria have to grapple with the problem that a child may do poorly on an auditory test for reasons other than poor auditory perception: for instance, failure could be due to inattention, difficulty in coping with task demands, or limited language ability. In an attempt to rule out at least some of these factors, the American Academy of Audiology conference explicitly advocated that for APD to be diagnosed, the child must have a modality-specific problem, i.e. affecting auditory but not visual processing. However, a committee of the American Speech-Language-Hearing Association subsequently rejected modality-specificity as a defining characteristic of auditory processing disorders.[59]

Definitions

in 2005 The American Speech-Language-Hearing Association (ASHA) published "Central Auditory Processing Disorders" as an update to the 1996 "Central Auditory Processing: Current Status of Research and Implications for Clinical Practice".[57] The American Academy of Audiology has released more current practice guidelines related to the disorder.[1] ASHA formally defines APA as "a difficulty in the efficiency and effectiveness by which the central nervous system (CNS) utilizes auditory information."[60]

In 2011, the British Society of Audiology published 'best practice guidelines'.[61]

Auditory processing disorder can be developmental or acquired. It may result from ear infections, head injuries or neurodevelopmental delays that affect processing of auditory information. This can include problems with: "...sound localization and lateralization (see also binaural fusion); auditory discrimination; auditory pattern recognition; temporal aspects of audition, including temporal integration, temporal discrimination (e.g., temporal gap detection), temporal ordering, and temporal masking; auditory performance in competing acoustic signals (including dichotic listening); and auditory performance with degraded acoustic signals".[59]

The Committee of UK Medical Professionals Steering the UK Auditory Processing Disorder Research Program have developed the following working definition of Auditory Processing Disorder: "APD results from impaired neural function and is characterized by poor recognition, discrimination, separation, grouping, localization, or ordering of speech sounds. It does not solely result from a deficit in general attention, language or other cognitive processes."[62]

Types of testing

1. The SCAN-C (https://www.pearsonclinical.com/language/products/100000526/scanc-test-for-auditory-processing-disorders-in-childrenrevised.html#tab-details)[63] for children and SCAN-A (https://www.pearsonclinical.com/language/products/100000526/scanc-test-for-auditory-processing-disorders-in-childrenrevised.html#tab-details)[64] for adolescents and adults are the most common tools for screening and diagnosing APD in the USA. Both tests are standardized on a large number of subjects and include validation data on subjects with auditory processing disorders. The SCAN test batteries include screening tests: norm-based criterion-referenced scores; diagnostic tests: scaled scores, percentile ranks and ear advantage scores for all tests except the Gap Detection test. The four tests include four subsets on which the subject scores are derived include: discrimination of monaurally presented single words against background noise (speech in noise), acoustically degraded single words (filtered words), dichotically presented single words and sentences.

2. Random Gap Detection Test (RGDT) is also a standardized test. It assesses an individual's gap detection threshold of tones and white noise. The exam includes stimuli at four different frequencies (500, 1000, 2000, and 4000 Hz) and white noise clicks of 50 ms duration. It is a useful test because it provides an index of auditory temporal resolution. In children, an overall gap detection threshold greater than 20 ms means they have failed and may have an auditory processing disorder based on abnormal perception of sound in the time domain.[65][66]

3. Gaps in Noise Test (GIN) also measures temporal resolution by testing the patient's gap detection threshold in white noise.[67]

4. Pitch Patterns Sequence Test (PPT) and Duration Patterns Sequence Test (DPT) measure auditory pattern identification. The PPS has s series of three tones presented at either of two pitches (high or low). Meanwhile, the DPS has a series of three tones that vary in duration rather than pitch (long or short). Patients are then asked to describe the pattern of pitches presented.[68]

5. Masking Level Difference (MLD) at 500 Hz measures overlapping temporal processing, binaural processing, and low-redundancy by measuring the difference in threshold of an auditory stimulus when a masking noise is presented in and out of phase.[69]

Modality-specificity and controversies

The issue of modality-specificity has led to considerable debate among experts in this field. Cacace and McFarland have argued that APD should be defined as a *modality-specific* perceptual dysfunction that is not due to peripheral hearing loss.[70][71] They criticise more inclusive conceptualizations of APD as lacking diagnostic specificity.[72] A requirement for modality-specificity could potentially avoid including children whose poor auditory performance is due to general factors such as poor attention or memory.[70][71] Others, however, have argued that a modality-specific approach is too narrow, and that it would miss children who had genuine perceptual problems affecting both visual and auditory processing. It is also impractical, as audiologists do not have access to standardized tests that are visual analogs of auditory tests. The debate over this issue remains unresolved. It is clear, however, that a modality-specific approach will diagnose fewer children with APD than a modality-general one, and that the latter approach runs a risk of including children who fail auditory tests for reasons other than poor auditory processing. Although modality-specific testing has been advocated for well over a decade, to date no tests have been published which would allow audiologists to perform a modality-specific evaluation (i.e., no clinical versions of visual analogs to auditory processing tests exist).

Another controversy concerns the fact that most traditional tests of APD use verbal materials.[11] The British Society of Audiology[61] has embraced Moore's (2006) recommendation that tests for APD should assess processing of *non-speech sounds*.[11] The concern is that if verbal materials are used to test for APD, then children may fail because of limited language ability. An analogy may be drawn with trying to listen to sounds in a foreign language. It is much harder to distinguish between sounds or to remember a sequence of words in a language you do not know well: the problem is not an auditory one, but rather due to lack of expertise in the language.

In recent years there have been additional criticisms of some popular tests for diagnosis of APD. Tests that use tape-recorded American English have been shown to over-identify APD in speakers of other forms of English.[73] Performance on a battery of non-verbal auditory tests devised by the Medical Research Council's Institute of Hearing Research was found to be heavily influenced by non-sensory task demands, and indices of APD had low reliability when this was controlled for.[74][75] This research undermines the validity of APD as a distinct entity in its own right and suggests that the use of the term "disorder" itself is unwarranted. In a recent review of such diagnostic issues, it was recommended that children with suspected auditory processing impairments receive a holistic psychometric assessment including general intellectual ability, auditory memory, and attention, phonological processing, language, and literacy.[76] The authors state that "a clearer understanding of the relative contributions of perceptual and non-sensory, unimodal and supramodal factors to performance on psychoacoustic tests may well be the key to unravelling the clinical presentation of these individuals."[76]

Depending on how it is defined, APD may share common symptoms with ADD/ADHD, specific language impairment, and autism spectrum disorders. A review showed substantial evidence for atypical processing of auditory information in children with autism.[77] Dawes and Bishop noted how specialists in audiology and speech-language pathology often adopted different approaches to child assessment, and they concluded their review as follows: "We regard it as crucial that these different professional groups work together in carrying out assessment, treatment and management of children and undertaking cross-disciplinary research."[14] In practice, this seems rare.

To ensure that APD is correctly diagnosed, the examiners must differentiate APD from other disorders with similar symptoms. Factors that should be taken into account during the diagnosis are: attention, auditory neuropathy, fatigue, hearing and sensitivity, intellectual and developmental age, medications, motivation, motor skills, native language and language experience, response strategies and decision-making style, and visual acuity.[78]

It should also be noted that children under the age of seven cannot be evaluated correctly because their language and auditory processes are still developing. In addition, the presence of APD cannot be evaluated when a child's primary language is not English.[79]

Characteristics

The National Institute on Deafness and Other Communication Disorders[80] state that children with Auditory Processing Disorder often:

- have trouble paying attention to and remembering information presented orally, and may cope better with visually acquired information
- have problems carrying out multi-step directions given orally; need to hear only one direction at a time
- have poor listening skills
- need more time to process information
- have low academic performance
- have behavior problems
- have language difficulties (e.g., they confuse syllable sequences and have problems developing vocabulary and understanding language)
- have difficulty with reading, comprehension, spelling, and vocabulary

APD can manifest as problems determining the direction of sounds, difficulty perceiving differences between speech sounds and the sequencing of these sounds into meaningful words, confusing similar sounds such as "hat" with "bat", "there" with "where", etc. Fewer words may be perceived than were actually said, as there can be problems detecting the gaps between words, creating the sense that someone is speaking unfamiliar or nonsense words. In addition, it is common for APD to cause speech errors involving the distortion and substitution of consonant sounds.[81] Those suffering from APD may have problems relating what has been said with its meaning, despite obvious recognition that a word has been said, as well as repetition of the word. Background noise, such as the sound of a radio, television or a noisy bar can make it difficult to impossible to understand speech, since spoken words may sound distorted either into irrelevant words or words that don't exist, depending on the severity of the auditory processing disorder.[82] Using a telephone can be problematic for someone with auditory processing disorder, in comparison with someone with normal auditory processing, due to low quality audio, poor signal, intermittent sounds and the chopping of words.[59] Many who have auditory processing disorder subconsciously develop visual coping strategies, such as lip reading, reading body language, and eye contact, to compensate for their auditory deficit, and these coping strategies are not available when using a telephone.

As noted above, the status of APD as a distinct disorder has been queried, especially by speech-language pathologists[83] and psychologists,[84] who note the overlap between clinical profiles of children diagnosed with APD and those with other forms of specific learning disability. Many audiologists, however, would dispute that APD is just an alternative label for dyslexia, SLI, or ADHD, noting that although it often co-occurs with these conditions, it can be found in isolation.[85]

Subcategories

Based on sensitized measures of auditory dysfunction and on psychological assessment, patients can be subdivided into seven subcategories:[86]

1. middle ear dysfunction
2. mild cochlear pathology
3. central/medial olivocochlear efferent system (MOCS) auditory dysfunction
4. purely psychological problems
5. multiple auditory pathologies
6. combined auditory dysfunction and psychological problems
7. unknown

Different subgroups may represent different pathogenic and aetiological factors. Thus, subcategorization provides further understanding of the basis of Auditory Processing Disorder, and hence may guide the rehabilitative management of these patients. This was suggested by Professor Dafydd Stephens and F Zhao at the Welsh Hearing Institute, Cardiff University.[87]

Treatment

Treatment of APD typically focuses on three primary areas: changing learning environment, developing higher-order skills to compensate for the disorder, and remediation of the auditory deficit itself.[88] However, there is a lack of well-conducted evaluations of intervention using randomized controlled trial methodology. Most evidence for effectiveness adopts weaker standards of evidence, such as showing that performance improves after training. This does not control for possible influences of practice, maturation, or placebo effects. Recent research has shown that practice with basic auditory processing tasks (i.e. auditory training) may improve performance on auditory processing measures[89][90] and phonemic awareness measures.[91] Changes after auditory training have also been recorded at the physiological level.[92][93] Many of these tasks are incorporated into computer-based auditory training programs such as Earobics and Fast ForWord, an adaptive software available at home and in clinics worldwide, but overall, evidence for effectiveness of these computerised interventions in improving language and literacy is not impressive.[94] One small-scale uncontrolled study reported successful outcomes for children with APD using auditory training software.[95]

Treating additional issues related to APD can result in success. For example, treatment for phonological disorders (difficulty in speech) can result in success in terms of both the phonological disorder as well as APD. In one study, speech therapy improved auditory evoked potentials (a measure of brain activity in the auditory portions of the brain).[96]

While there is evidence that language training is effective for improving APD, there is no current research supporting the following APD treatments:

- Auditory Integration Training typically involves a child attending two 30-minute sessions per day for ten days.[97]
- Lindamood-Bell Learning Processes (particularly, the Visualizing and Verbalizing program)
- Physical activities that require frequent crossing of the midline (e.g., occupational therapy)
- Sound Field Amplification
- Neuro-Sensory Educational Therapy
- Neurofeedback

However, use of a FM transmitter has been shown to produce significant improvements over time with children.

History

Samuel J. Kopetzky, who first described the condition in 1948. P. F. King, first discussed the aetiological factors behind it in 1954.[98] Helmer Myklebust's 1954 study, "Auditory Disorders in Children".[99] suggested auditory processing disorder was separate from language learning difficulties. His work sparked interest in auditory deficits after acquired brain lesions affecting the temporal lobes[100][101] and led to additional work looking at the physiological basis of auditory processing,[102] but it was not until the late seventies and early eighties that research began on APD in depth. In 1977, the first conference on the topic of APD was organized by Robert W. Keith, Ph.D. at the University of Cincinnati. The proceedings of that conference was published by Grune and Stratton under the title "Central Auditory Dysfunction" (Keith RW Ed.) That conference started a new series of studies focusing on APD in children.[103][104][105][106][107] Virtually all tests currently used to diagnose APD originate from this work. These early researchers also invented many of the auditory training approaches, including interhemispheric transfer training and interaural intensity difference training. This period gave us a rough understanding of the causes and possible treatment options for APD. Much of the work in the late nineties and 2000s has been looking to refining testing, developing more sophisticated treatment options, and looking for genetic risk factors for APD. Scientists have worked on improving behavioral tests of auditory function, neuroimaging, electroacoustic, and electrophysiologic testing.[108][109] Working with new technology has led to a number of software programs for auditory training.[110][111] With global awareness of mental disorders and increasing understanding of neuroscience, auditory processing is more in the public and academic consciousness than ever before.[112][113][114][115][116]

See also

- Cocktail party effect
- Dafydd Stephens
- Hearing loss
- SCAN (Auditory processing disorders)
- List of eponymous diseases
- Amblyaudia
- Auditory verbal agnosia
- Cortical deafness
- Echoic memory
- Language processing
- Spatial hearing loss
- Music-specific disorders

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External links

- Auditory processing disorder: An overview for the clinician (http://journals.lww.com/thehearingjournal/Fulltext/2001/07000/Auditory_processing_disorder__An_overview_for_the.3.aspx)
- American Speech-Language-Hearing Association (ASHA) (https://web.archive.org/web/20110725015810/http://search.asha.org/default.aspx?q=auditory+processing+disorder)
- UK Medical Research Council Institute of Hearing Research) (https://web.archive.org/web/20090629105319/http://www.ihr.mrc.ac.uk/research/apd.php/)

Classification	**ICD-10**: H93.2 (http://apps.who.int/classifications/icd10/browse/2016/en#/H93.2) · **ICD-9-CM**: 388.45 (http://www.icd9data.com/getICD9Code.ashx?icd9=388.45) 388.40 (http://www.icd9data.com/getICD9Code.ashx?icd9=388.40) · **MeSH**: D001308 (https://www.nlm.nih.gov/cgi/mesh/2015/MB_cgi?field=uid&term=D001308)