



Information about Hearing

Hearing is one of the five senses. It is a complex process of picking up sound and attaching meaning to it. The human ear is fully developed at birth and responds to sounds that are very faint as well as sounds that are very loud. Even in utero, infants respond to sound. The ability to hear is critical to the attachment of meaning to the world around us.



Five Sections of the Hearing Mechanism

1. Outer ear
2. Middle ear
3. Inner ear
4. Acoustic nerve
5. Brain's auditory processing centers

Type, Degree, and Configuration of Hearing Loss

Type

Hearing loss can be categorized by where or what part of the auditory system is damaged. There are **three basic types** of hearing loss: **conductive hearing loss**, **sensorineural hearing loss** and **mixed hearing loss**

- **Conductive hearing loss** occurs when sound is not conducted efficiently through the outer ear canal to the eardrum and the tiny bones, or ossicles, of the middle ear. Conductive hearing loss usually involves a reduction in sound level, or the ability to hear faint sounds. This type of hearing loss can often be medically or surgically corrected.
- **Sensorineural hearing loss** occurs when there is damage to the inner ear (cochlea) or to the nerve pathways from the inner ear (retrocochlear) to the brain.
 - Sensorineural hearing loss cannot be medically or surgically corrected. It is a permanent loss.
 - Sensorineural hearing loss not only involves a reduction in sound level, or ability to hear faint sounds, but also affects speech understanding, or ability to hear clearly.
 - Sensorineural hearing loss can be caused by diseases, birth injury, drugs that are toxic to the auditory system, and genetic syndromes.
 - Sensorineural hearing loss may also occur as a result of noise exposure, viruses, head trauma, aging, and tumors.
- **Mixed hearing loss** is when a conductive hearing loss occurs in combination with a sensorineural hearing loss. In other words, there may be damage in the outer or middle ear and in the inner ear (cochlea) or auditory nerve. When this occurs, the hearing loss is referred to as a *mixed* hearing loss.

Degree of Hearing Loss

Degree of hearing loss refers to the severity of the loss. The numbers are representative of the patient's thresholds, or the softest intensity at which sound is perceived. The following is one of the more commonly used classification systems

Degree of hearing loss	Hearing loss range (dB HL)
Normal	-10 to 15
Slight	16 to 25
Mild	26 to 40
Moderate	41 to 55
Moderately severe	56 to 70
Severe	71 to 90
Profound	91+

Source: Clark, J. G. (1981). Uses and abuses of hearing loss classification. *Asha*, 23, 493-500.

Configuration of Hearing Loss

The configuration or shape of the hearing loss refers to the extent of hearing loss at each frequency and the overall picture of hearing that is created. For example, a hearing loss that only affects the high frequencies would be described as a high-frequency loss. Its configuration would show good hearing in the low frequencies and poor hearing in the high frequencies. On the other hand, if only the low frequencies are affected, the configuration would show poorer hearing for low tones and better hearing for high tones. Some hearing loss configurations are flat, indicating the same amount of hearing loss for low and high tones.

Other descriptors associated with hearing loss are:

- **Bilateral versus unilateral.** Bilateral hearing loss means both ears are affected. Unilateral hearing loss means only one ear is affected.
- **Symmetrical versus asymmetrical.** Symmetrical hearing loss means that the degree and configuration of hearing loss are the same in each ear. An asymmetrical hearing loss is one in which the degree and/or configuration of the loss is different for each ear.
- **Progressive versus sudden hearing loss.** Progressive hearing loss is a hearing loss that becomes increasingly worse over time. A sudden hearing loss is one that has an acute or rapid onset and therefore occurs quickly, requiring immediate medical attention to determine its cause and treatment.
- **Fluctuating versus stable hearing loss.** Some hearing losses change-sometimes getting better, sometimes getting worse. Fluctuating hearing loss is typically a symptom of conductive hearing loss caused by ear infection and middle ear fluid, but also presents in other conditions such as Meniere's disease.

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What causes hearing impairment in babies and children?

Hearing impairment can be *genetic* (inherited) or *non-genetic*.

Genetic factors are believed to cause 50 percent of cases of hearing impairment in infants and young children (1). Scientists believe that mutations (changes) in as many as 400 genes may contribute to hearing impairment. Genetic causes of hearing impairment can be:

- **Syndromatic:** Syndromatic means that the hearing impairment happens with a specific group of birth defects. It's not the only birth defect a baby has. This type of hearing impairment accounts for about 30 percent of genetic cases (1, 3).
- **Non-syndromatic:** Non-syndromatic means that hearing impairment is the only birth defect a baby has. About 50 percent of cases of non-syndromatic genetic hearing impairment are caused by a mutation in a gene called connexin 26 (3).

Non-genetic causes include illness or injury before, during or after birth. In some cases, the cause of hearing impairment is not known. About 90 percent of babies with congenital hearing impairment are born to parents with normal hearing (1, 2).

About 25 percent of cases of hearing impairment are caused by non-genetic factors (1). These include premature birth (before 37 completed weeks of pregnancy) and illnesses during pregnancy, such as:

- Rubella (German measles)
- Cytomegalovirus infections
- Toxoplasmosis
- Herpes infection
- Syphilis

Non-genetic causes of hearing impairment after birth include:

- Head injuries.
- Childhood infections (such as meningitis, measles or chickenpox).
- Certain medications (such as the antibiotic streptomycin and related drugs).
- Ear infections (otitis media). These usually cause temporary hearing impairment. However, frequent and poorly treated ear infections can cause permanent hearing impairment.

The causes of the remaining 25 percent of cases of hearing impairment in infants and children are unknown (1).

What other conditions are common in children with hearing impairment?

At least one-third of children with hearing impairment have other conditions, including vision problems, learning disabilities, attention problems and autism.

Treatment

Children as young as 4 weeks of age can benefit from a hearing aid (4). These devices amplify sound, making it possible for many children to hear spoken words and develop language. However, hearing aids help some children with hearing impairment more than others. Some children with severe to profound hearing impairment may not be able to hear enough sound, even with a hearing aid, to be able to hear speech.

Providers often recommend a behind-the-ear hearing aid for young children because it is safer and more easily fitted and adjusted as the child grows, as compared to one that fits inside the ear.

Communication

Parents also need to decide how their family and child are going to communicate. If the child is going to communicate with speech, she may need help with listening and lip-reading skills. Many children with hearing impairment also need some type of speech or language therapy.

A child also can learn to communicate using a sign language. A widely used type of sign language is American Sign Language (ASL), which has rules and grammar that are distinct from English. There also are several variations of sign language that can be used along with spoken English.

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Hearing Loss in Adults

Hearing loss in adults has many causes such as disease or infection, ototoxic drugs, exposure to noise, tumors, trauma, and the aging process. This loss may or may not be accompanied by tinnitus, ringing in the ears. *Tinnitus* can occur by itself without any hearing loss.

Some causes of hearing loss in adults are described below:

- **Otosclerosis** is a disease involving the middle ear capsule, specifically affecting the movement of the stapes (one of the three tiny bones in the middle ear).
- **Meniere's disease** affects the membranous inner ear and is characterized by deafness, dizziness (vertigo), and ringing in the ear (tinnitus).
- **Medications** used to manage some diseases are damaging to the auditory system (ototoxic) and cause hearing loss.
- **Noise-Induced Hearing Loss** The prolonged exposure to harmful levels of noise causes damage to the hair cells in the cochlea and results in permanent hearing loss. The noise-induced hearing loss usually develops gradually and painlessly. Hearing loss can also occur as a result of an acoustic trauma, or a single exposure or very few exposures to very high levels of sound.
- **Acoustic Neuroma** is an example of a tumor that causes hearing loss. Acoustic neuromas arise in the eighth cranial nerve (acoustic nerve). The first symptom is reduction of hearing in one ear accompanied by a feeling of fullness.
- **Trauma** can also result in hearing loss. Examples include fractures of the temporal bone, puncture of the eardrum by foreign objects, and sudden changes in air pressure.
- **Aging Process** Loss of hearing as a result of the **aging process** is called *presbycusis*. The process involves degeneration of the inner ear (cochlea). Presbycusis can also involve other parts of the auditory system. The hearing loss is progressive in nature with the high frequencies affected first. While the process begins after age 20, it is typically at ages 55 to 65 that the high frequencies in the speech range begin to be affected.

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Auditory Processing Disorder in Children

What is auditory processing?

Auditory processing is a term used to describe what happens when your brain recognizes and interprets the sounds around you. Humans hear when energy that we recognize as sound travels through the ear and is changed into electrical information that can be interpreted by the brain. The “disorder” part of auditory processing disorder means that something is adversely affecting the processing or interpretation of the information.

Children with APD often do not recognize subtle differences between sounds in words, even though the sounds themselves are loud and clear. For example, the request “Tell me how a chair and a couch are alike” may sound to a child with APD like “Tell me how a couch and a chair are alike.” It can even be understood by the child as “Tell me how a cow and a hair are alike.” These kinds of problems are more likely to occur when a person with APD is in a noisy environment or when he or she is listening to complex information.

APD goes by many other names. Sometimes it is referred to as central auditory processing disorder (CAPD). Other common names are auditory perception problem, auditory comprehension deficit, central auditory dysfunction, central deafness, and so-called “word deafness.”

What causes auditory processing difficulty?

We are not sure. Human communication relies on taking in complicated perceptual information from the outside world through the senses, such as hearing, and interpreting that information in a meaningful way. Human communication also requires certain mental abilities, such as attention and memory. Scientists still do not understand exactly how all of these processes work and interact or how they malfunction in cases of communication disorders. Even though your child seems to “hear normally,” he or she may have difficulty using those sounds for speech and language. In children, auditory processing difficulty may be associated with conditions such as dyslexia, attention deficit disorder, autism, autism spectrum disorder, specific language impairment, pervasive developmental disorder, or developmental delay. Sometimes this term has been misapplied to children who have no hearing or language disorder but have challenges in learning.

What are the symptoms of possible auditory processing difficulty?

Children with auditory processing difficulty typically have normal hearing and intelligence. However, they have also been observed to

- Have trouble paying attention to and remembering information presented orally
- Have problems carrying out multistep directions
- Have poor listening skills
- Need more time to process information
- Have low academic performance
- Have behavior problems
- Have language difficulty (e.g., they confuse syllable sequences and have problems developing vocabulary and understanding language)
- Have difficulty with reading, comprehension, spelling, and vocabulary

What treatments are available for auditory processing difficulty?

Much research is still needed to understand APD problems, related disorders, and the best intervention for each child or adult. Several strategies are available to help children with auditory processing difficulties. Some of these are commercially available, but have not been fully studied. Any strategy selected should be used under the guidance of a team of professionals, and the effectiveness of the strategy needs to be evaluated. Researchers are currently studying a variety of approaches to treatment. Several strategies you may hear about include:

- *Auditory trainers* are electronic devices that allow a person to focus attention on a speaker and reduce the interference of background noise. They are often used in classrooms, where the teacher wears a microphone to transmit sound and the child wears a headset to receive the sound. Children who wear hearing aids can use them in addition to the auditory trainer.
- *Environmental modifications* such as classroom acoustics, placement, and seating may help. An audiologist may suggest ways to improve the listening environment, and he or she will be able to

monitor any changes in hearing status.

- Exercises to improve *language-building* skills can increase the ability to learn new words and increase a child's language base.
- *Auditory memory enhancement*, a procedure that reduces detailed information to a more basic representation, may help. Also, informal auditory training techniques can be used by teachers and therapists to address specific difficulties.
- *Auditory integration training* may be promoted by practitioners as a way to retrain the auditory system and decrease hearing distortion. However, current research has not proven the benefits of this treatment.

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