



Children's hearing

A guide for parents



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Building the future

Children are our future. By giving them access to the wealth of sounds that enrich today's world, we can help them to develop the auditory skills they need to build their future.

Phonak has been committed to providing high-tech solutions for children with hearing loss for over 40 years. Innovative technology has enabled us to successfully meet growing needs. Many of the developments in the field of pediatrics have led the way for the progress of Phonak hearing solutions in general. The trail of innovation continues and it remains a priority at Phonak to help prepare today's children for tomorrow, at the same time giving practical support to their parents.

Hearing is one of a child's most precious senses. Through hearing, children develop language and communication skills, marvel at the sounds of our bustling world,

learn to read, appreciate music and are warned of approaching danger. Hearing loss does not put an end to all this if amplification is provided early. By selecting the right technological solutions, your child will have access to all the important sounds to develop speech and language. The information in this booklet is designed to help you understand:

- Children's hearing
- Speech and language development
- Types of hearing loss
- How to protect your child's hearing and prevent hearing loss

How we hear

Understanding the basic anatomy and function of the ear will help you identify conditions that can affect your child's hearing. The human ear has three main sections, which consist of the outer ear, the middle ear and the inner ear.

The outer ear

The outer ear consists of the auricle, also called the pinna. The pinna collects and channels sound into the external ear canal (auditory canal). The ear canal amplifies the sound waves and further funnels them toward the eardrum (tympanic membrane).

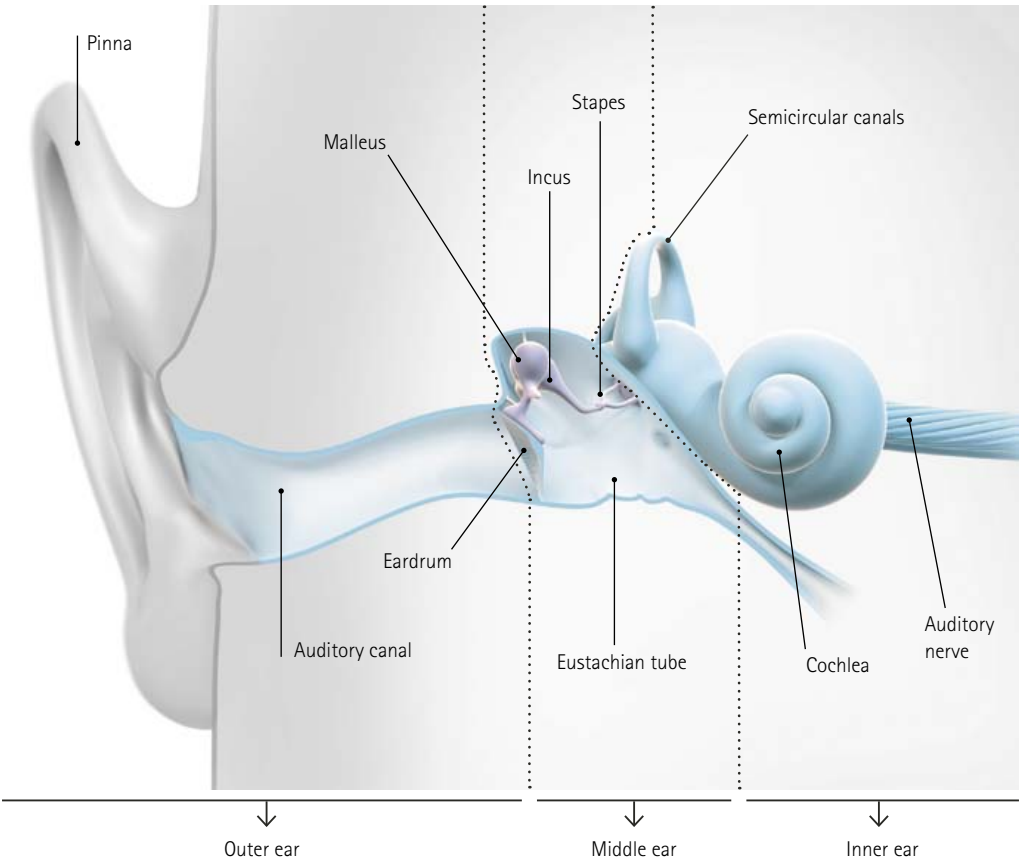
The middle ear

The eardrum vibrates in response to the movements of sound waves entering the ear canal. There are also three small bones (ossicles) in the middle ear. These bones, the malleus (hammer), the incus (anvil) and the stapes (stirrup), vibrate, magnifying the movements of the eardrum and transmitting the motions to the inner ear.

The inner ear

The cochlea is the actual sensory organ of hearing and is located in the inner ear. The chambers of the cochlea are filled with fluid. As the bones in the middle ear move in response to sound waves, they cause the fluid in the cochlea to also move. This stimulates thousands of sensory hair cells which produce small electrical charges. These electrical signals travel along the auditory nerve to the brain where they are processed as the "sounds" we hear.

Anatomy of the ear





Children's hearing loss

There are conditions that may occur before birth, during infancy or in childhood that may affect a child's ability to hear normally. Essentially, there are two types of hearing loss: conductive and sensorineural.

Conductive hearing loss (medically treatable conditions)

With a conductive hearing loss, the inner ear functions normally, but something affects the outer or middle ear, hindering sound from reaching the inner ear. Conductive hearing losses are mild to moderate in degree and are usually temporary and treatable.

You can simulate a conductive hearing loss by plugging your ears with your fingers. Sounds from the outside are softer while your own voice actually sounds louder than normal. The following are some common causes of conductive hearing loss.

Earwax (cerumen)

When wax becomes impacted in the ear canal, it acts as an ear plug, blocking sound waves from striking the eardrum. Excessive wax may be softened with wax-softening drops and flushed out or removed by a physician or other trained personnel. Q-tips should never be used to remove impacted wax because they may push the wax deeper into the canal or puncture the eardrum if inserted too deeply.

Foreign objects

Small objects put in the ears, such as beads or food, can block sound or rupture an eardrum.

Otitis media (middle ear infection)

This is the most common cause of conductive hearing loss in children. Otitis media is a general term used to describe a variety of conditions affecting the middle ear. More than 85% of all children will have at least one ear infection in childhood. In fact, ear infections are second only to regular check-ups as the most common reason for a visit to a physician.

There are various forms and causes of otitis media. The single most frequent cause is infected adenoids, which harbor bacteria or obstruct the Eustachian tube that connects the middle ear with the back of the nose (nasopharynx).

Ear infections also may result from upper respiratory infections or exposure to cigarette smoke. The two most common types of otitis media are acute otitis media and otitis media with effusion.

Acute otitis media (AOM) – ear pain, fever, restlessness and some hearing loss are common symptoms of acute otitis media (suppurative otitis media). This type of ear infection may heal by itself or respond to antibiotics.

In some cases, acute otitis media may cause the eardrum to rupture, causing fluid drainage from the ear. If left untreated, this can lead to more severe middle or inner ear conditions.



Otitis media with effusion (OME) –

frequently follows an episode of acute otitis media. OME occurs when fluid remains in the middle ear, impeding eardrum vibrations and middle ear bone movement. This can cause mild to moderate degrees of hearing loss. In very young children, this hearing loss may hinder spoken language development.

The treatment of otitis media with effusion is controversial. Sometimes the infection heals on its own or with the help of antibiotics or myringotomy to drain the fluid, and other times it resists these conventional approaches. If the infection persists and hearing loss is present, ventilation or pressure-equalizing (PE) tympanostomy tubes may be inserted to drain the fluid. This can prevent the pressure build-up which can cause further ear infections. Tubes can restore normal hearing, prevent persistent fluid build-up, reduce the frequency of ear infections and prevent other serious ear complications.

Swimmer's ear

This painful bacterial infection occurs when the ear canal remains wet after bathing or swimming. It can cause the ear canal to swell shut, resulting in a temporary hearing loss.



Sensorineural hearing loss

Sensorineural hearing loss is caused by dysfunction of the cochlea (sensory) or auditory pathways to the brain (neural) and often is present from birth. It can also develop as a result of noise exposure, age or exposure to ototoxic medication (medicines that can damage hearing). Sensorineural hearing losses can range from mild to profound and may affect all or only certain frequency ranges.

Sensorineural hearing loss is permanent and cannot be treated with medicines or surgery. In most cases people with this type of hearing loss can be helped with hearing aids or in some cases by cochlear implants.

Mixed hearing loss

Sometimes a combination of factors occur that affect both the outer or middle ear and the inner ear (cochlea), resulting in a mixed hearing loss.





The cochlea, which is the sensory organ of hearing, attains full adult size and enables a child to hear by the 20th week of pregnancy. This means the child can be exposed to voices, such as its mother's, even before he or she is born.

Communication milestones

After birth, a newborn child's cochlear sensitivity is similar to that of adults, but babies must learn how to use their hearing to form the foundations of communication.

Localization

One of the earliest and easiest auditory skills to observe in your baby is localization – the ability to pinpoint the source of a sound.

Because we hear through two ears (binaurally), we can localize sounds with extreme accuracy.

Observing your child's localization ability

In general, newborns will move or widen their eyes when they hear a loud sound. This is known as the startle reflex and many loud sounds should induce this reaction. When your infant gets to about five or six months, you can better observe a true localization response by making soft sounds behind or to the side of your infant while he or she is looking straight ahead (be sure you are out

of view when making the sounds).

A soft rattle shake or a whisper should prompt your baby to turn his or her head toward the sound.

While we expect infants to startle when presented with very loud sounds, it is most important to see how well your baby responds to soft sounds (such as the speech sound "s").

During the first year, your baby will refine their listening skills and should alert to and look for the sources of common sounds around the home, such as a ringing doorbell or telephone, slamming door, children playing, musical toys and speech.

Your child's speech and language development milestones



9 months

Demonstrates an understanding of simple words such as "mommy," "daddy," "no," "bye-bye."

10 months

Babbling should sound "speech like," with single syllables strung together ("da-da-dada"). The first recognizable words emerge around this time.

1 year

One or more real words spoken.

18 months

Understands simple phrases, retrieves familiar objects on command (without gestures) and points to body parts. Has a spoken vocabulary of 20 to 50 words and uses short phrases ("no more," "go out," "mommy up").

24 months

Spoken vocabulary should be at least 150 words, coupled with the emergence of simple two-word sentences. Most speech should be understandable to adults who are not with the child daily. Toddlers also should be able to sit and listen to read-aloud picture books.

3 to 5 years

Spoken language should be used constantly to express wants, reflect emotions, convey information and ask questions. A preschooler should understand nearly all that is said. Spoken vocabulary grows from 1,000 to 2,000 words, which are linked in complex and meaningful sentences. All speech sounds should be clear and understandable by the end of this developmental stage.

These milestones are rough "rules of thumb" for the majority of children. If your child is more than 2 to 3 months delayed compared to the above-mentioned age groups, it might indicate hearing loss or delayed speech and language development.



Signs of hearing difficulties

Sometimes a lack of response is attributed to inattention, but it is important to determine if inconsistent responses, or the failure to respond at all, actually stems from an inability to hear.

Common signs that a child may not be hearing normally:

- Not aware that someone who is out of view is talking, especially when there are few distractions
- Startled or surprised look when they realize their name has been called (at a normal or even fairly loud level)
- Saying "what?" or "huh?" frequently
- Intently watching the faces of speakers
- Sitting close to the television set when the volume is sufficient for other family members
- Increasing the volume of the TV or stereo to unreasonably loud levels
- Not responding to voices over the telephone and/or switching ears continually
- Not reacting to intense, loud sounds

The single most important sign of possible hearing loss, however, is a delayed development of speech and language.



Indicators and prevention of hearing loss

The factors below indicate that a child is at risk of hearing loss. If you are unsure about any of these conditions or are worried about your child's hearing, consult a medical practitioner or audiologist.

Newborns – birth to 28 days

- Failure of newborn hearing screening
- Family history of hereditary childhood sensorineural hearing loss
- In utero infection, such as cytomegalovirus, rubella, syphilis, herpes or toxoplasmosis
- Craniofacial deformities including those affecting the pinna and ear canal
- Birth weight less than 1,500 grams (approx. 3.5 pounds)
- Higher-than-normal level of bilirubin in the blood (hyperbilirubinemia) at a serum level requiring transfusion (jaundice)
- Some medications containing aminoglycosides (such as antibiotics like Gentamicin) used in multiple courses or in combination with loop diuretics can damage the auditory system through toxins (ototoxic medications)

- Bacterial meningitis
- General health score (Apgar) of 0–4 at 1 minute or 0–6 at 5 minutes after birth
- Mechanical ventilation lasting 5 days or longer
- Findings associated with syndromes known to include sensorineural hearing loss

Infants – 29 days to 2 years

- Concern regarding communication or developmental delay
- Bacterial meningitis or other infections known to cause sensorineural hearing loss
- Head trauma associated with loss of consciousness or skull fracture
- Ototoxic medications
- Findings associated with a syndrome known to include sensorineural hearing loss
- Otitis media with effusion (fluid) for 3 months or longer

How to protect your child's hearing and prevent hearing loss.

Noise exposure

One of the most common, and yet completely preventable, causes of permanent sensorineural hearing loss is noise exposure. High levels of noise can cause temporary or permanent damage to the sensory hair cells within the cochlea. Vehicles, appliances and MP3 players, all produce noise that may be

detrimental to hearing, depending on the intensity of the noise source and the length of exposure. In addition, some toys or computer games, and certainly music concerts, can be loud enough to damage hearing. Children should be taught the dangers of noise exposure and instructed to use ear protection when necessary.



What to do if you think your child may have a hearing loss?

If you think a hearing loss may be present, the first step is to ask your medical practitioner to refer your child for an audiological assessment. This assessment will determine whether a hearing impairment exists and if so to what degree. No child is too young to receive a thorough hearing evaluation. Today's technology even allows newborns to be tested for hearing loss.

While simple hearing screenings may be conducted by nurses or trained volunteers, a complete assessment of a child's hearing should only be completed by an audiologist.

The purpose of this audiological evaluation is to determine if a hearing loss exists, to what degree, and to help discover what type. Test results are recorded on an audiogram. If the results of the tests show that your child has a hearing loss, remember that your child is living in an age where technology ensures that children with impaired hearing can grow up to lead full and successful lives.



Types of audiological evaluations

Behavioral hearing tests

These tests usually require the child to respond to soft sounds in some way (verbally, by pointing at pictures, raising the hand or through a game). These tests can be fun for slightly older toddlers. For infants and toddlers, a head-turn response to a test signal is usually the best and most reliable testing method.

Auditory brainstem response (ABR)

For newborns or infants, and children who cannot reliably perform the behavioral test procedures, other more objective tests, such as ABR, can help determine hearing abilities. Clicks or tonal "pips" are presented to the infant's ears through earphones. The ABR provides information about the function of the auditory pathway to the level of the brainstem. The response to the clicks or tones are recorded, providing an estimate of hearing sensitivity. An ABR is usually performed while the infant is sleeping or in quiet resting state.

Otoacoustic emissions (OAEs)

These tests provide a unique way of examining the function of the cochlea. Sounds are sent to the child's ear via a small loudspeaker, while a microphone records the response to these sounds from the cochlea (known as an emission). This approach offers valuable information about the sensory hair cells in the cochlea.

Tympanometry (acoustic immittance testing)

This test helps determine how well the eardrum and middle ear work. A gentle puff of air is delivered into the child's ear and the amount the eardrum moves in response to the change in air pressure is recorded. If the eardrum does not move, for example, it could mean there is fluid behind the eardrum and otitis media with effusion may be present. If there is negative pressure it could mean that the child is at risk of developing an ear infection.



Hearing Amplification

Today there is virtually no child with a hearing loss that cannot benefit from the use of appropriate technology.

After a clear diagnosis of hearing impairment this technology should be chosen and fitted as soon as possible to ensure that your child can benefit early from auditory experience.

This technology may take the form of a cochlear implant with an electrode that is surgically implanted in the inner ear and an external processor. This option is increasingly utilized in cases of severe to profound hearing loss. In many cases, however, the most appropriate choice may be hearing aids. These amplify sound and can help children of any age.

The right choice of hearing aid can help your child develop good verbal communication skills. A young child is usually fit with behind-the-ear (BTE) style aids. These come in a variety of bright, cheerful colors and can help a wide range of hearing losses – mild, moderate and profound. Older children may be candidates for the in-the-ear (ITE)

style hearing aids which are custom-made to fit inside the ear and help with mild to severe hearing losses. Another option for older children is external receiver style hearing aids. The microphone remains in the BTE casing but the receiver is externally placed in the ear canal. This approach allows the hearing aid to be made smaller and more cosmetically appealing.

The decision whether the child should be fitted with one or two hearing aids depends mainly on the configuration of their hearing loss.

A wide range of hearing aid accessories are available to help children communicate better over the phone, listen to music and TV, communicate with Bluetooth devices, or even just check their hearing aids' status and adjust features.

While this booklet offers some general guidelines for monitoring your child's hearing and communication development, you may need further information or have questions about how to access further child hearing resources.

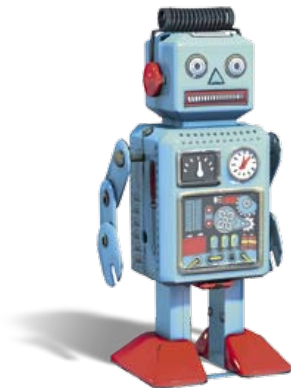
Where to get help

In many countries, federal and state laws exist that mandate services for children who have hearing impairments.

Hearing is not an all-or-nothing phenomenon. Even a mild hearing loss during those crucial first years of language and speech development can cause a child to misperceive speech sounds and may result in a delay of normal communication development.

Your child's hearing is the means through which spoken communication develops and flourishes.

Give your child's hearing the attention it deserves and seek professional help immediately if you are concerned. For further information about children's hearing visit our website at www.phonak.com/kids



Life is on

We are sensitive to the needs of everyone who depends on our knowledge, ideas and care. And by creatively challenging the limits of technology, we develop innovations that help people hear, understand and experience more of life's rich soundscapes.

**Interact freely. Communicate with confidence.
Live without limit. Life is on.**

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