Hearing and hearing loss

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How the ear functions and possible causes of hearing loss

PHONAK
hearing systems

“When you lose your eyesight, you lose contact with things.

When you lose your hearing, you lose contact with people.”

(Helen Keller)

Phonak

Phonak is one of the world's leading manufacturers of hearing systems. Based in Stäfa, Switzerland, the company develops, produces and distributes Phonak high-tech hearing systems dedicated to helping people with impaired hearing participate in everyday life.

The company is committed to improving speech understanding in all environments, especially noisy ones, putting an end to the frequent complaint, "I can hear but I don't understand what's being said!"

Phonak is a driving force in the development of innovative technologies. Find out more about the Phonak product range from your hearing-care professional or visit

http://www.phonak-us.com

How the ear functions and causes of hearing loss

Why we have two ears

Our two ears act as a type of receiving station for the brain. One ear is directed to the left, the other to the right – like radar aerials that register signals coming from different directions. If the ears pick up the sound of a truck approaching, for example, the brain calculates the angle from which the sound has arrived. The brain has this capability since the nearest ear receives the sound a matter of microseconds earlier than the other one.

With only one ear functioning properly, the exact origin of sounds is unclear. Even more important is the fact that the quality of speech is better when it is heard with two ears. Speech received by only one ear sounds flat and devoid of its rich nuances. That is why, in most cases, two hearing instruments are fitted to those with impaired hearing in both ears.

Function and dysfunction of the ear

The ear is a very complex organ comprising three parts: the outer ear, the middle ear and the inner ear. From the inner ear the auditory nerve transmits information to the brain for processing. Hearing loss can result from an obstruction or damage in any of these three parts.

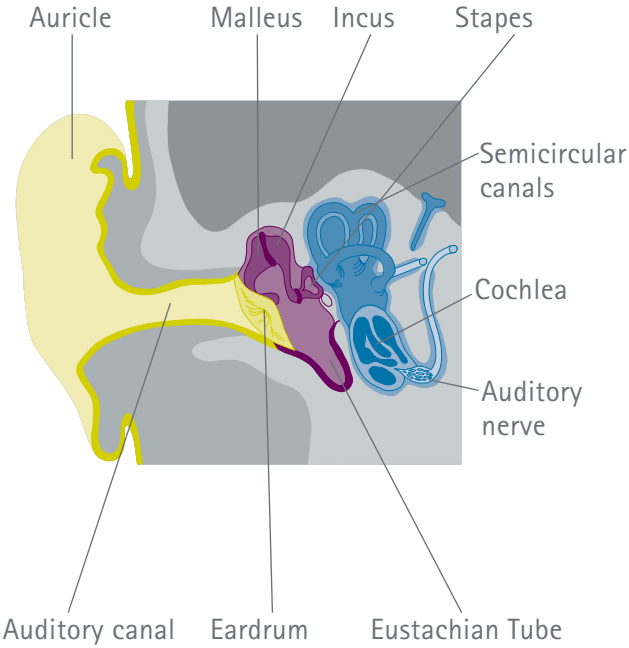
Hearing loss resulting from a problem located in the outer or middle ear is called a conductive hearing loss. A hearing loss caused by a damaged inner ear is called sensorineural. Should the loss be the result of a combination of these, this is known as a mixed hearing loss.

In order to gain a better understanding of hearing loss, it is important to know how the ear functions. The next two pages will describe the three parts of the ear.

Parts of the ear

The outer ear

The outer ear includes the auricle (or pinna), the auditory canal and the eardrum. It channels sounds from the surrounding environment into the hearing system. The auricle helps to gather the sound waves and the auditory canal then directs them to the eardrum.



The middle ear

The middle ear is an air-filled cavity which contains the smallest bones in the human body – the malleus, incus and stapes. These are connected to the eardrum on one side, and on the other side to a thin membrane-covered opening on the wall of the inner ear. The middle ear is also connected to the throat via the Eustachian Tube that keeps the air pressure in the middle ear equal to that of the surrounding environment.

The inner ear

In the inner ear the auditory input is processed by the Cochlea, while information affecting balance is processed by the Semicircular canals. Along the entire length of the Cochlea, which is fluid-filled, there are tiny hair cells. When the fluid in the Cochlea is displaced by sound waves that have been passed on through the action of the middle ear bones, the hair cells bend. This triggers a chemical response which activates the corresponding nerve endings. These then transmit the message to the area of the brain in charge of processing and interpreting auditory input.

Causes of hearing loss in...

... the outer ear

Typical problems include excessive accumulation of earwax and infection of the auditory canal, such as "swimmer's ear."

... the middle ear

Perforation of the eardrum, infection or fluid in the middle ear and otosclerosis (a calcification around the stapes limiting its ability to move) are the most common causes. Many outer and middle ear problems can be treated successfully with medication or surgery. Should this not be the case, remaining hearing loss can usually be helped to a considerable degree by using hearing instruments.

... the inner ear

The majority of hearing problems result from damaged inner ear structures. Typical causes are the natural aging process, excessive exposure to noise, medication that is toxic to the auditory system and head injuries. In such cases the tiny hair cells in the cochlea are damaged, obstructing the transfer of sound signals to the brain. As a rule, this damage cannot be reversed medically but the adverse effects can be overcome, to a large degree, with hearing instruments.

The degree of hearing loss varies from person to person

Between the two extremes of hearing well and hearing nothing, there are many degrees of impairment. The terms used to describe the degree of hearing loss are mild, moderate, severe and profound. Most hearing losses are mild to moderate.

What does the degree of hearing impairment mean?

Mild hearing loss:
Unable to hear soft sounds, difficulty perceiving speech in noisy environments.

Moderate hearing loss:
Unable to hear soft and moderately loud sounds, considerable difficulty in perceiving speech, particularly with background noise.

Severe hearing loss:
Speakers must raise their voice. Group conversation is possible only with considerable effort.

Profound hearing loss:
Some very loud sounds are audible but hearing conversation without a hearing instrument is impossible.

The impact of hearing loss on speech perception

Hearing loss in the inner ear (sensorineural hearing loss) mainly affects high frequency sounds. These high-pitched sounds such as "s," "f," "sh," "t" play a key role in our ability to understand speech clearly. This is why a person with this type of hearing loss will often say, "I can hear but I don't understand what's being said."

Hearing loss drastically reduces the ability to understand speech

The hearing test

The performance of the ear is tested with a special measuring instrument, the audiometer. The object of the test is to precisely register the extent of the hearing loss. This can only be done when there is no background noise to distort the result. Since the extent of the damage may be different in each ear, they need to be tested separately. In order to do this the sound signals are transmitted via headphones. Both the perception of sound and the understanding of speech are tested.

The key observations are "when do I begin to hear the sound" and "when does the sound become unpleasantly loud." This test is usually carried out for several frequencies (or pitches), at a range of different loudness levels. The result is presented in the form of a sound-audiogram (Diagram 1).

The audiogram

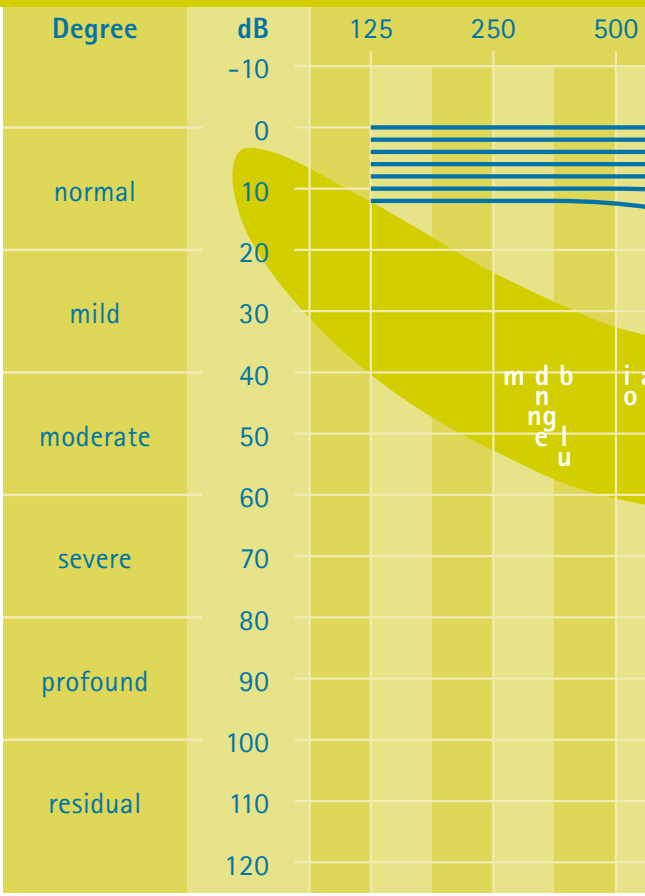
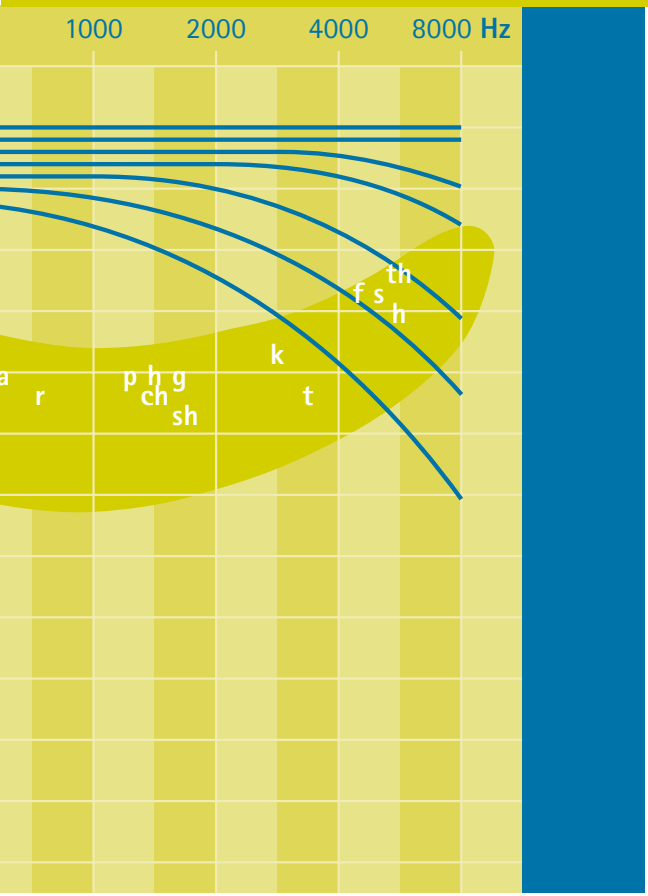


Diagram 1

The audiogram is a special graphic representation of the evaluation of a person's hearing ability.



The audiogram enables us to establish the degree, type and progression of a loss of hearing. Regular checks give a clear picture of any changes in the hearing system. The next two pages will provide more information on the audiogram.

The audiogram

What do the horizontal numbers in the tone-audiogram mean?

The frequencies (pitches), measured in Hertz (Hz) are marked on the horizontal axis. The pitch of the sound increases from left to right. Lower numbers mean lower-pitched sounds (e.g. bass voices, drums) and higher numbers correspond to higher-pitched sounds (e.g. birdsong, soprano voices).

What do the digits on the left-hand side of the audiogram mean?

The hearing loss for each frequency measured can be seen on the vertical axis. The higher the number, the louder the sound. The level is measured in decibels (dB). 0dB indicates the softest sound normally heard by the healthy ear. 120dB is the loudest sound usually considered tolerable by human beings. For a better understanding of this you can refer to Diagram 1 on page 13, which shows, on the left-hand side, the degree of the hearing loss.

Speech Range

Speech consists of vowels and consonants in specific frequency and loudness level categories. A simplified representation of the speech range can be seen in the kidney-shape in the tone-audiogram (green shaded area in Diagram 1, also referred to as the "speech banana"). A healthy ear registers these sounds easily. With a hearing loss, the threshold is at a louder level. Depending on the degree and progression of the hearing impairment, this threshold intersects the speech range. Those elements of speech that lie above the hearing threshold in the audiogram are not audible, at least when spoken normally.

Diagram 1 shows how high frequency hearing loss is represented on the audiogram. Perception, particularly of high-frequency sounds, decreases as age increases. At the point where the speech range and hearing threshold cross, important elements of speech such as "f" and "s" cannot be heard, particularly in a noisy environment. Speech becomes unclear.

Phonak hearing technology

The correct choice of hearing instruments is influenced by anatomical features of the ear, individual hearing loss and technology. Medical practitioners and hearingcare professionals can advise you on the various solutions available. The following explanations may be useful to you.

Analog, digitally programmable, digital?

Every hearing instrument has at least one microphone which picks up sound from the environment, an amplifier which transforms the signal to compensate for hearing loss and a receiver that directs the signal, which is adapted for the hearing loss, into the auditory canal. This is similar to a hi-fi system although these hearing systems are much smaller and adapted specifically to the needs of the hearing-impaired individual.

Digital technology

Thanks to increasingly small micro-processors, digital technology has been introduced into the most modern hearing systems. Digital hearing instruments are programmed by a hearing-care professional via computer. Acoustic signals are transformed into a binary code at high speed and with great precision. Complex calculations provide the ultimate flexibility in providing individualized solutions to hearing loss. Additional hearing system features can be offered: e.g. various hearing programs, automatic program selection (AutoSelect), noise cancelers and Adaptive digital AudioZoom. Remote control operation is also possible.

Digitally programmable technology

This technology is a combination of analog signal processing and digital programming of the hearing system via computer. It can be used in various combinations to meet individual needs. Multiple hearing programs and remote controls are sometimes available.

Analog technology

Hearing instruments with analog signal processing are not programmed with a computer, but are adjusted manually by a hearingcare professional with a fine screwdriver.

Individualized settings are only possible to a certain degree since innovations such as multi-microphones, the suppression of background noise and convenient remote control operation cannot be integrated into the system.

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The following Phonak information brochures in the series **"Hear better – participate in life"** are available from your hearingcare professional.

1 **Hearing and hearing loss**

2 **Using hearing instruments successfully**

3 **Caring for your hearing instruments**

4 **Two ears are better than one**

5 **Tips for communicating with hearing instrument users**

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