Evaluating Hearing

A number of different tests are used to diagnose hearing loss, none of which tells the whole story. There are three main tests used that do not rely on a child's ability to demonstrate they can hear. These can also help to pinpoint the part of the auditory system that may be causing the hearing loss.

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Middle Ear Tests

The audiologist may also take measurements that will provide information about how the middle ear is functioning. These measurements include tympanometry, acoustic reflex measures, and static acoustic measures.

- **Tympanometry** assists in the detection of fluid in the middle ear, perforation (i.e., a hole or tear) of the eardrum, or wax blocking the ear canal. Tympanometry pushes air pressure into the ear canal, making the eardrum move back and forth. The test measures the mobility of the eardrum. Graphs are created, called tympanograms. These can reveal a stiff eardrum, a hole in the eardrum, or an eardrum that moves too much. Tympanometry is often used when middle ear infections are suspected.
- **Acoustic reflex measures** add information about the possible location of the hearing problem. A tiny muscle in the middle ear contracts reflexively when a loud sound occurs. The loudness level at which the acoustic reflex occurs - or the absence of the acoustic reflex - gives information to the audiologist about the type of hearing loss.
- **Static acoustic impedance** measures the physical volume of air in the ear canal. This test is useful in identifying a perforated eardrum or checking the openness of ventilation tubes.

Otoacoustic emissions (OAEs)

Otoacoustic emissions (OAEs) are sounds given off by the inner ear when the cochlea is stimulated by a sound. When sound stimulates the cochlea, the outer hair cells vibrate. The vibration produces a very soft sound that echoes back into the middle ear. The sound can be measured with a small probe inserted into the ear canal.

People with normal hearing produce emissions. People with hearing loss greater than 25–30 decibels (dB) do not produce these very soft sounds. The OAE test is often part of a newborn hearing screening program. Lack of OAEs may suggest blockage in the outer ear canal, the presence of middle ear fluid, and/or damage to the outer hair cells in the cochlea.

Auditory Brainstem Response

The **auditory brainstem response** (ABR) test gives information about the inner ear (cochlea) and brain pathways for hearing. This test is also sometimes referred to as auditory evoked potential (AEP). The test can be used with children or others who have a difficult time with conventional methods of hearing screening. The ABR is also used when there are signs, symptoms, or complaints suggesting a type of hearing loss in the brain or a brain pathway.

OAEs and/or ABR tests are often part of newborn hearing screening programs.

The ABR is performed by pasting electrodes on the head - similar to electrodes placed around the heart when an electrocardiogram is run - and recording brain wave activity in response to sound. The person being tested rests quietly or sleeps while the test is performed. No response is necessary. ABR can also be used as a screening test in newborn hearing screening programs. When used as a screening test, only one intensity or loudness level is checked, and the baby either passes or fails the screen.

Pure-Tone Testing

An audiologist can also perform a pure-tone test (hearing test). There are several types of measurement methods. Your child's age and ability to co-operate will determine which methods the audiologist chooses to use. A hearing test, especially on smaller children, can take some time and your child's cooperation. Often other tests are required in order to define the degree of hearing loss.

The results of pure-tone testing are plotted on an audiogram.

The audiologist measures the sound level at which your child can or cannot hear different tones. The results are then plotted on a chart called an **audiogram.**

The audiogram shows whether your child actually has a hearing loss, and if so, what kind it is, and how severe it is. This helps the experts decide what treatment is best.

A **pure-tone air conduction hearing test** determines the faintest tones a person can hear at selected pitches (frequencies), from low to high. During this test, earphones are worn so that information can be obtained for each ear.

Sometimes, use of earphones for the test is not possible, such as when a child refuses to wear them. In these cases, sounds are presented through speakers inside a sound booth (called sound-field testing). Since sound-field testing does not give ear-specific information, a unilateral hearing loss (hearing loss in only one ear) may be missed.

The child taking the test may be asked to respond to the sounds in a variety of ways, such as by:

- raising a finger or hand
- pressing a button, pointing to the ear where the sound was received
- saying "yes" to indicate that the sound was heard

Sometimes, young children are given a more play-like activity to indicate response. The most common techniques involve **visual reinforcement audiometry (VRA)** and **conditioned play audiometry (CPA).**

Visual reinforcement audiometry is the method of choice for screening children between six months and two years of age. The child is trained to look toward a sound source. When the child gives a correct response (e.g., looking to a source of sound when it is presented), the child is "rewarded" through a visual reinforcement. Example rewards include getting to watch a toy that moves or a flashing light.

Conditioned play audiometry can be used as the child matures and is commonly used with toddlers and preschoolers (ages 2–5). The child is trained to perform an activity each time a sound is heard. The activity may involve putting a block in a box, placing pegs in a hole, or putting a ring on a cone.

If there is a blockage, such as wax or fluid, in the outer or middle ears, a method called **pure-tone bone conduction testing** may be used. With this technique, the blockage is bypassed by sending a tone through a small vibrator placed behind the ear (or on the forehead). The signal reaches the inner ear (or cochlea) directly through gentle vibrations of the skull. This testing can measure response of the inner ear to sound independently of the outer and middle ears. In these cases, this test helps the audiologist determine the type of hearing loss being measured.

Speech Testing

The audiologist will also conduct tests of listening to speech. These results are also recorded on the audiogram. One such test is the **speech reception threshold (SRT).** This is used with older children and adults, and helps to confirm the pure-tone test results. The SRT records the faintest speech that can be heard. The audiologist will also record word recognition or the ability to correctly repeat back words at a comfortable loudness level.

Speech testing may be done in a quiet or noisy environment. Difficulty understanding speech in background noise is a common complaint of people with hearing loss, and this information is helpful.

An annual hearing assessment is recommended for children who are Deaf or Hard of Hearing.

Since their hearing ability can change, children with hearing loss should have their hearing abilities retested on a regular basis: every 3-4 months for babies, every 6 months for 3-5 year olds and every year after that. An annual hearing assessment is recommended for children who are Deaf or Hard of Hearing because not all hearing losses are stable.

Adapted from:

-*Types of Tests used to Evaluate Hearing in Children and Adults, ASHA*

-*Parents' Guide: A Guide for Parents of Children with Hearing Loss, Oticon Paediatrics*

-*Things You Need to Know About Your Child's Hearing, Oticon Paediatrics*

Understanding the Audiogram

The audiogram is a graph that represents a child's responses to sound during a pure-tone hearing test. It is used to document the softest sound a person can detect at a variety of different frequencies (pitches). Sound is measured in both intensity (loudness) and frequency (pitch). Intensity is measured in decibels (dB). Frequency is measured in hertz (Hz). Sounds can be described as loud or soft, and high-pitched or low-pitched.

Frequency (Pitch)

The frequency or pitch of sound is shown by the numbers across the top of the audiogram. Each vertical line from left to right represent a pitch, or frequency, in hertz (Hz) (see Figure 2). Low pitches are on the left-hand side of the graph and high pitches are on the right, somewhat like the keys of a piano, which range from low pitches on one end of the keyboard to high pitches on the other end. The whistle of a bird usually has a high pitch; the growl of a dog has a low pitch. Most sounds are made up of a range of different frequencies.

Speech is usually a mix of high, middle and low frequency sounds.

The frequencies included on an audiogram are chosen because they are important for understanding speech. The range of frequencies tested by the audiologist are 250 Hz, 500 Hz, 1000 Hz, 2000 Hz, 4000 Hz, and 8000 Hz.

Different speech sounds have different pitches, so it is important to know how well a person hears across the frequency range. Speech is usually a mix of high, middle, and low frequency sounds. A good example of different frequencies is the word moose. The /m/ sound is a low-frequency sound, the /oo/ sound is a middle-frequency sound, and the /s/ sound is a high-frequency sound. In order to hear the word completely, a person must have appropriate levels of hearing at low, middle, and high frequencies.

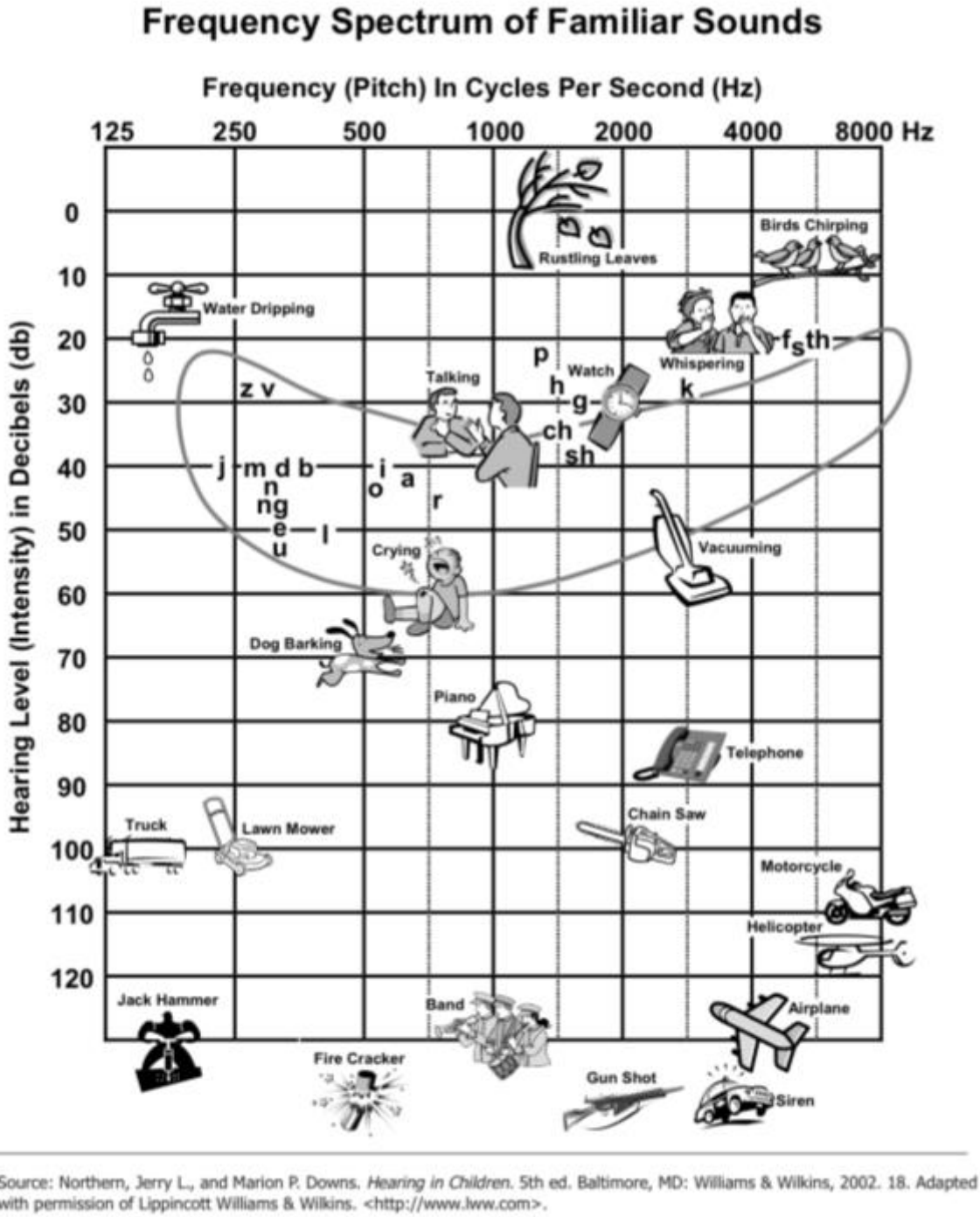
Intensity (Loudness)

The intensity or loudness of sound is shown by the numbers down the side of the audiogram. Each horizontal line on the audiogram from top to bottom represents loudness or intensity in units of decibels (dB). The small numbers at the top are soft sounds (–10, 0, 10 decibels), and the large numbers at the bottom are loud sounds (90, 100, 110 decibels). Examples of sounds in everyday life that would be considered soft are a clock ticking, a voice whispering, and leaves rustling. Examples of sounds in everyday life that would be considered loud are a lawnmower, a car horn, and a rock concert.

The speech banana represents the area of pitch and loudness in which the majority of speech sounds will occur.

If we were to compare "normal conversational loudness level" (typically 60 dB) with whispering (typically 30 dB), we'd say that whispering is softer than conversation. In Figure 2, "Frequency Spectrum of Familiar Sounds," the pitch and loudness of several environmental sounds and typical speech sounds are shown. The shape these speech sounds make on this audiogram is commonly called the **speech banana**. The speech banana represents the area of pitch and loudness in which the majority of speech sounds will occur when a person is talking in a normal conversational voice.

With a complete audiogram, an audiologist can determine the type, degree, and configuration (or shape) of the hearing loss. The audiologist uses a red O to indicate the right ear and a blue X to record the left ear. The farther down the audiogram the Xs and Os appear, the louder the sound needs to be in order to hear it. Other symbols may also appear on the audiogram. The meaning of these symbols can be interpreted or explained by your audiologist.



* Source: Northern, Jerry L., and Marion P. Downs. *Hearing in Children*. 5th ed. Baltimore, MD: Williams & Wilkins, 2002. 18. Adapted with permission of Lippincott Williams & Wilkins. <http://www.lww.com>.

Figure 2. Frequency Spectrum of Familiar Sounds
(from the *Educators' Resource Guide, Manitoba Education, 2009)*

Adapted from:

-*The Audiogram, ASHA*

-*Educators' Resource Guide, Manitoba Education, 2009*

-*Parents' Guide: A Guide for Parents of Children with Hearing Loss, Oticon Paediatrics*

-*Things You Need to Know About Your Child's Hearing, Oticon Paediatrics*

Hearing Loss Configurations

The configuration of a hearing loss refers to its shape. The shape of the hearing loss depends on the degree and pattern of hearing loss across frequencies (pitches) on the audiogram. For example, a hearing loss that only affects the high pitches would be described as a high-frequency loss. Its configuration would show good hearing in the low pitches and poor hearing in the high pitches. In this case, you might hear speech, but it would sound muffled and unclear.

The configuration of a hearing loss refers to its shape.

On the other hand, if only the low frequencies are affected, the configuration would show poorer hearing for low pitches and better hearing for high pitches (low-frequency loss).

Some hearing loss configurations are flat, indicating the same amount of hearing loss for low and high pitches. If you have hearing loss at all pitches, you might have difficulty hearing any speech.

If both ears are affected, it is known as a **bilateral hearing loss**. If only one ear is affected, it is referred to as a **unilateral hearing loss**.

Symmetrical hearing loss means the degree and configuration are the same in each ear. **Asymmetrical hearing loss** means the degree and configuration are different in each ear.

Adapted from:
-*Configuration of Hearing Loss, ASHA*