

# Understanding the Audiogram

When a hearing test is being done, the audiologist finds the softest sound a person can hear, this is called a hearing threshold or hearing level. The thresholds are written on a form called an audiogram. Hearing tests can be done at any age. For infants it is done using auditory brainstem response. Once children are developmentally ready, usually at six months of age, a behavioral test can be done. Testing is done in a sound treated room or booth, so that noise does not interfere. Hearing loss can come from a problem in the outer, middle or inner ear, the hearing nerve, or more than one part of the ear. During the hearing test, both ears are tested individually because hearing can be different for the right and left ears.

A graph, called an audiogram, shows hearing levels for different sounds. The numbers along the top show low pitches on the left to high pitches on the right. The numbers along the left side show very soft sounds at the top to very loud sounds at the bottom. Speech sounds range in pitch and loudness. To understand speech clearly, all of the sounds need to be heard. Hearing levels for air and bone conduction testing are documented on the graph. Air conduction testing is done using earphones that fit into the ear canal or that are placed over the ear. Sound is presented through the earphone and travels through the entire hearing system from the outer ear up to the auditory cortex in the brain. Bone conduction testing sends a sound through a small bone vibrator placed behind the ear or on the forehead. When sound travels through bone conduction it goes directly to the inner part of the ear, bypassing the outer and middle ear.

Symbols are used on the audiogram to show hearing levels for the right and left ears. For air conduction results a circle is used for the right ear and an X for the left ear. The symbol for bone conduction looks like a less than symbol like the symbol used in math, for the right ear and a greater than symbol for the left ear. Sometimes there is a difference in the degree of hearing loss between the ears and the audiologist needs to use a masking noise to make sure the sound is not heard by the other ear. The symbol for air conduction when masking is used is a triangle for the right ear and a square for the left ear. The masked symbol for bone conduction looks like a bracket opening to the right for the right ear and opening to the left for the left ear. If a person does not respond to a sound at the limits of how loud the equipment can go, an arrow is added to the symbol. This indicates that no response was obtained at the loudest level where the symbol is placed on the audiogram.

The degree of hearing loss is based on air conduction test results and they are measured in decibels. Hearing can range from no hearing loss to a profound level of hearing loss. Hearing that falls between -10 and 15 are within the normal range. A slight hearing loss is between 16

and 25. A mild hearing loss is from 26 to 40, moderate is between 41 to 55, moderately severe from 56 to 70, severe is between 71 and 90, and a profound hearing loss is greater than 90 decibels. The degree of hearing loss can vary at each frequency. A sloping hearing loss is a common configuration. This is when hearing is better in the low frequencies than in the high frequencies. It is a flat configuration when hearing loss is the same for each frequency. It is a rising hearing loss when hearing is better in the high frequencies than in the low frequencies. A trough-shaped hearing loss is when there is better hearing in the low and high frequencies than in the mid frequencies.

The type of hearing loss tells you the part of the ear that is having difficulty sending the sound to the brain. To determine the type of hearing loss air and bone conduction test results are reviewed. It is called a sensorineural hearing loss when the hearing levels are the same for both air and bone conduction. This means the hearing loss is the result of a problem in the inner part of the ear. It is called a conductive hearing loss when bone conduction results are normal, and the air conduction results are not normal. This means the hearing loss is caused by a problem in the outer and/or middle part of the ear. It is called a mixed hearing loss when there is a hearing loss for both air and bone conduction and the results are better for bone conduction by 10 decibels or more. This means the hearing loss is the result of a problem in the outer and/or middle ear and the inner ear. Sometimes hearing loss is the result of a problem beyond the inner ear. This is called auditory neuropathy spectrum disorder. The test results for this type of hearing loss vary widely and additional tests are needed to confirm this type of hearing loss.

To read the audiogram, the first step is to identify the right ear and left ear symbols for air conduction. Circles are used to show the right ear, and are often in red, and X's are used to show the left ear, and they are often in blue. The circles and the X's are used to show air conduction results and are placed on the audiogram at the softest level the person can hear for each frequency. The second step is to determine the degree and configuration of the hearing loss. This is done by looking at the air conduction test results. Let's look at three examples to determine the degree of hearing loss. In this first example, the hearing levels range from 20 to 50 decibels. This is a mild to moderate sloping hearing loss. It is sloping because the symbols are in the mild range for the low frequencies, and then in the moderate range for the higher frequencies. For the second example, the hearing levels range from 50 to 80 decibels. This is a moderate to severe sloping hearing loss. Here you can see in the third example, the hearing levels are at 85 to 90 decibels at each frequency. This is a profound flat hearing loss. The configuration is flat because there is not a difference between the hearing levels from the low to the high frequencies. The third step is to look at where the bone conduction symbols are placed compared to the air conduction symbol for each frequency. This will give you information about the type of hearing loss. Let's look at three examples. The first example shows a sensorineural hearing loss. This is determined by noting the air and bone conduction symbols are the same. That means the hearing level was the same when the sound was delivered through the earphone and when it was delivered through the bone vibrator. The second example shows a mild conductive hearing loss. This is determined by noting the bone

conduction results are normal and the air conduction symbols are not normal. This means the sounds had to be louder when they were delivered through the earphone than when they were delivered through the bone vibrator. This is because of a problem in the outer and/or middle ear. The third example shows a moderate mixed hearing loss. This is determined by noting that both the air and bone conduction thresholds show a hearing loss, however the bone conduction symbols are closer to the range of normal than the air conduction symbols. This means that there is a problem in the outer and/or middle ear and a problem in the inner ear. When looked at together, the air and bone conduction test results show the degree of hearing loss, the configuration, and the type of hearing loss. Hearing can change over time. Keep copies of all test results and compare current results to previous results.

Some audiograms are more difficult to understand than others, and practicing interpreting various examples can be helpful. In this section there are four audiogram examples. Pause the video for each example, and interpret the audiogram by writing down the degree, configuration and the type of hearing loss for each ear. An explanation of how to interpret the audiogram is provided after each example.

The test results for example 1 show normal hearing for the right ear. Note that all of the circles, the symbols for air conduction for the right ear, are less than 20 dB. The results for the left ear show a profound sensorineural hearing loss because the air conduction symbols are all more than 90 dB. The symbol for the left ear is a square, this is because masking was needed to make sure the right ear did not hear the sound presented to the left ear, given the large difference in hearing levels. Both air and bone conduction symbols for the left ear have arrows. The arrow means that the person did not hear the sound. You will note that the loudness level where each symbol is placed varies. This is because the audiometer, the equipment used to do the test, is limited in how loud it can go. The loudness limits are different for each frequency and for both air and bone conduction.

The test results for example 2 show normal hearing for the left ear. Note all of the X's, the symbols for air conduction for the left ear, are less than 20 dB. The results for the right ear show a moderate flat mixed hearing loss. The symbol for the right ear is a triangle, this is because masking was needed to make sure the left ear did not hear the sound presented to the right ear, given the large difference in hearing levels. The hearing loss is mixed because both air and bone conduction thresholds show a hearing loss, that is, some thresholds are more than 20 dB and because the bone conduction thresholds are better than the air conduction thresholds. This means that the person heard the sound better when the sound was presented through the bone vibrator than when the sound was presented through the headphones.

The test results for example 3 show a moderately-severe rising to mild sensorineural hearing loss. Note that the circles and X's for the air conduction test are at 60 and 65 for the lower frequency and rise up to 25 at the higher frequency. The bone conduction symbol is next to the air conduction symbol, showing that there was no difference in how the person heard the



sound when it was presented through the headphone compared to the bone vibrator. This means the hearing problem is in the inner ear. Note the arrow on the bone conduction symbol at 250 Hz. That means the person did not hear the sound at the loudest level that could be presented.

The test results for example 4 show a mild flat conductive hearing loss in both ears. Note the circles and the X's remain in the range of a mild hearing loss for all of the frequencies. The bone conduction symbols show that masking was used to make sure the ear that was not being tested could not hear the sound being presented to the other ear. The bone conduction results are within the range of normal hearing, less than 20 dB for all frequencies. This is a conductive hearing loss because the bone conduction thresholds are normal and there is a hearing loss for air conduction. This means that the hearing loss is the result of a problem in the outer and/or middle ear.