

# Part 2: Hearing Loss, Audiograms, and Speech Intelligibility

## Section 1: Introduction to the Audiogram

How to read an audiogram.

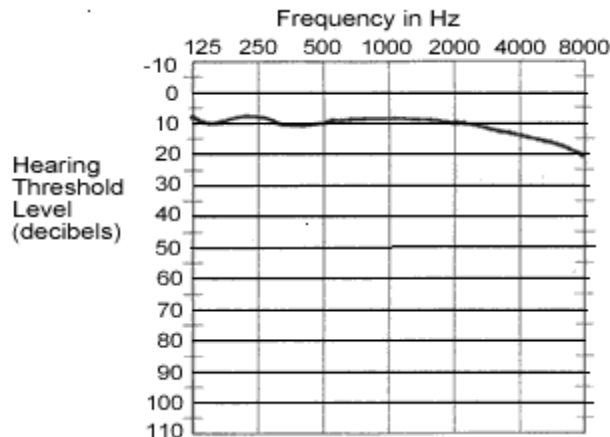
## Section 2: Speech Intelligibility and the Role of Vowels and Consonants

How hearing loss affects our ability to understand speech. ("I can *hear* the words, I just can't *understand* them.")

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### 1. Introduction to the Audiogram: a picture of our thresholds of hearing

The audiogram is a picture of how well we hear. It shows the softest sounds we can hear at different pitches or frequencies. This is known as the **threshold hearing level** for each frequency. In the audiogram below, look at the left-hand column. As we move down the column, the sounds are getting louder and louder. (See "Decibels" in Part 1 for the actual loudness of different decibel levels.)

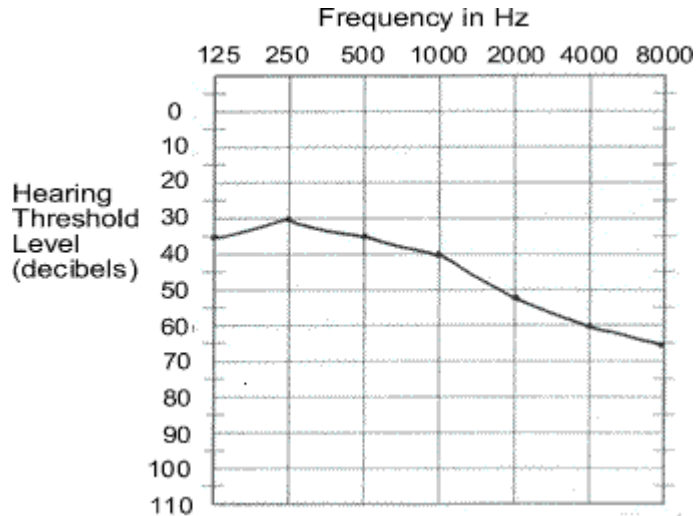


Now take a look at the row of figures on the top (250, 500, 1000, etc.). As we move to the right the sounds are increasing in pitch, like the keys on a piano. We say they are increasing in frequency or cycles per second and they are measured in units called *hertz (Hz)*. Thus, a sound that measures 5000 hertz is much higher pitched than a sound that measures 250 hertz. Children can hear

sounds up to about 20,000 hertz, but as we grow older we gradually lose our ability to hear higher-pitched sounds.

The *subject above* has a 10 dB threshold hearing level for most sounds, meaning he can't hear sounds *below* 10 dB in volume. For higher-pitched sounds above 4000 Hz, his threshold hearing rises to a maximum loss of 20 dB. Any loss up to about 20 dB is considered normal. (See "Ranges of Hearing Loss" in Part 1.)

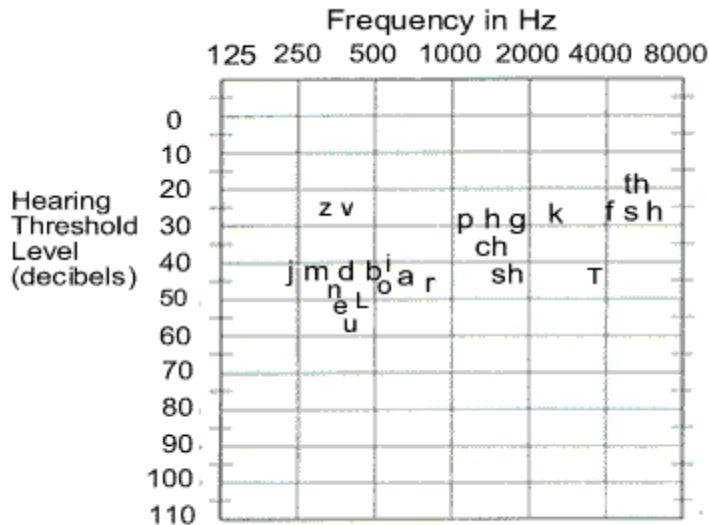
The audiogram below is typical of someone with moderate/severe hearing loss.



What is the significance of this audiogram? What can it tell us about this person's ability to understand speech? We'll see in the next section.

## 2. Hearing Loss and Speech Intelligibility

In the audiogram below, you can see where our basic speech sounds lie when engaging in normal conversation.



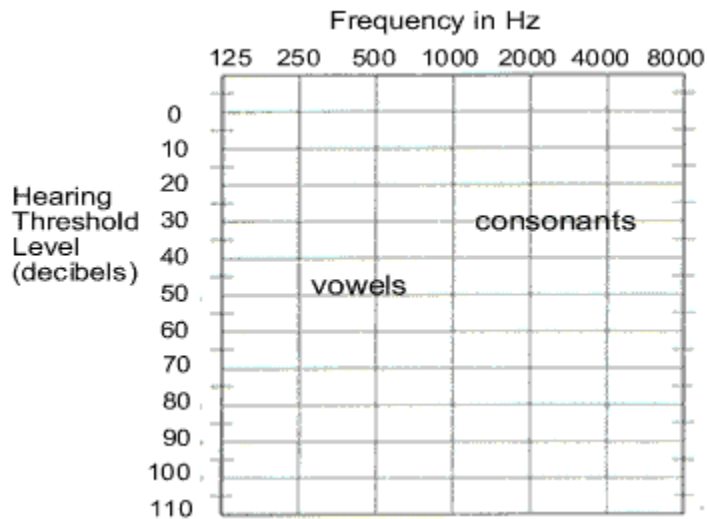
Two things are important to recognize. For the most part:

1. Consonants are higher pitched than vowels (they lie more to the right on the chart).
2. Consonants are spoken more softly than vowels (they lie higher on the chart, in the lower decibel ranges).

These factors play a big role in our ability to understand speech. For one thing, the great majority of people with hearing loss lose it in the higher frequencies, where the consonants lie. This is especially true of hearing loss due to aging. So a lot of older people hear the vowels but not the consonants. In addition, since consonants are spoken more softly, they tend to get drowned out in background noise.

**(Tech note:** Remember earlier (*Decibels* section) that every 10 dB increase doubles the loudness? Keeping that in mind, we can see that the “A” at 40 dB sounds twice as loud as the “P” (30 dB) and four times as loud as the “TH” at 20 dB. The “E” (50 dB) sounds twice as loud as the “A”, four times as loud as the “P”, etc.)

Most vowels and consonants lie in the following regions:



So your typical person with hearing loss will have trouble hearing the consonants in the first place. He may be hanging on by a thread. Add a little background noise and he may lose them altogether. And since we're on the subject of speech intelligibility there is one more fact to consider:

Consonants convey most of the word information; they are much more important to speech intelligibility than vowels.

It is usually possible, for example, to figure out a word if you remove the vowels. But if you remove the consonants, you're lost. Try it yourself. Have a friend copy a line of text, leaving out the vowels. See if you can decipher the words. Then have him copy another line, this time leaving out the consonants. You'll find it's pretty much impossible to reconstruct the original text.

If you or someone you know has ever said, "I can *hear* the words, I just can't *understand* them," this is probably why.

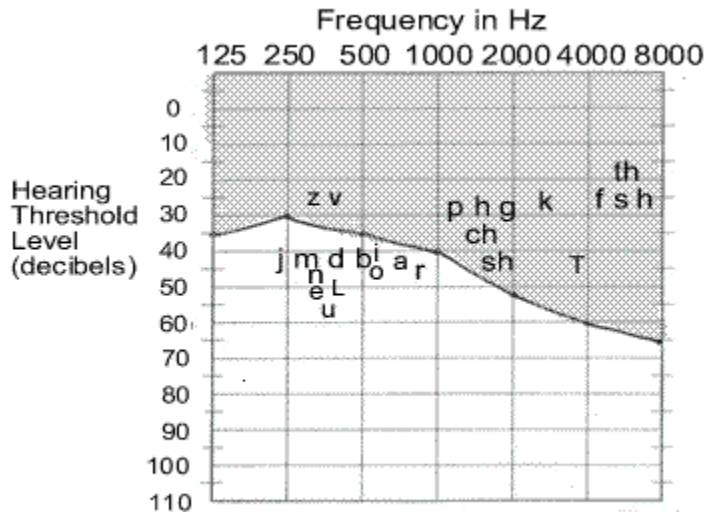
(One additional characteristic of consonants: they act as breakpoints, separating syllables and words from one another. If we can't hear the consonants clearly, the words seem to run together and people sound like they are mumbling. And since women and children have higher-pitched voices than men, it seems like they mumble more.)

Putting it together:

1. Consonants are more important than vowels in understanding speech.
2. Consonants are spoken more softly than vowels, and they tend to get drowned out by background noise.
3. Consonants are higher-pitched than vowels and most hearing loss occurs in these higher frequencies.

It's harder for people with hearing loss to hear the consonants in the first place, and noisy environments just makes it worse. No matter how hard they try, they are just not getting it all. The result is fatigue, frustration, and an increasing reluctance to engage in socially frustrating situations.

To illustrate how a hearing loss affects speech comprehension, we will now superimpose the audiogram above (of the person with moderate/severe hearing loss) over the speech zone. The screened area lies *below* the subject's threshold of hearing, i.e., what he *can't* hear.



As you can see, in a normal conversation this person will simply not be able to hear many of the consonants. The other person will have to speak considerably louder to be understood. That is, he will have to push the loudness of his speech *above* the subject's threshold of hearing. This obviously puts a strain on everybody involved.