

Hearing Loss—Decibels or Percent?

© December 2000 by Neil Bauman, Ph.D. (Revised February 2003)

Question: From time to time, I see people writing, "I have 78% hearing loss in my right ear and 95% in the left." What does this percent mean? I thought sound was measured in decibels (dB), not percent? If this is the case what percent is 115 dB?—R. D.

Answer: Excellent questions. You have good reason to be confused because you cannot equate decibels to percentages no matter what anyone tells you.

Decibels vs. Percent

Sound intensities are indeed measured in decibels (dB). There are two reasons why you can **never** equate decibels to percentages. First, the decibel scale is open-ended like that of the Richter scale used for measuring earthquake intensities. To calculate a percent you need to know the maximum value possible. In both of these scales there is no limiting maximum value. Therefore, you **cannot** calculate a percentage. Any attempt to do so is just a bunch of meaningless gibberish!

Second, the decibel scale is logarithmic, while the percent scale is linear. Numbers that appear to be similar have vastly differing meanings. They are as different as trying to compare apples to elephants!

When people (ignorantly) talk about having a 50 percent hearing loss they likely mean that they have a 50 dB loss. Where did the idea come from that we can measure hearing loss in percentages? Here is how Brad Ingrao, an outstanding audiologist, explained it.

To measure sound intensity (the way audiologists measure it) you need to do a mathematical calculation that is so strange that $20 + 20 = 26$ dB (SPL).

"To make a scale that makes sense to most people (including us knucklehead audiologists), a different equation is used to convert sound intensity using the Sound Pressure Level (SPL) scale to the Hearing Level (HL) scale that goes from 0 dB HL (normal threshold) to 120 dB HL (pain).

If we forget about hearing losses greater than 100 dB (like most people tend to do), we get 0 dB to 100 dB as the usable (dynamic) range of hearing for the average 'normal' ear.

Since doctors and audiologists tend to under-estimate their patient's ability to understand such things (or they don't understand it themselves), the erroneous concept of $\text{dB} = \%$ evolved."

There you have it folks. It seems health care professionals think we are too stupid to understand much, so they let us believe error rather than teach us the truth.

We can put a stop to this nonsense right now. Let's understand how this decibel scale works and why using a percentage value to describe our hearing losses is so very wrong.

First we need to understand that a decibel is not a given intensity (loudness) of sound, but rather, it is a **ratio** of how many times louder (or softer) a sound is than a given reference sound level.

This means that 0 dB is not the absence of sound, but is an arbitrary zero. We define it as the faintest sound that a young sensitive human ear can hear. Furthermore, because the decibel scale is logarithmic, every 10 dB increase in sound intensity is actually a **ten-fold** increase. Therefore, a sound intensity of 20 dB is not twice as loud as a sound intensity of 10 dB, but is 10 times as loud, and a sound intensity of 30 dB is 100 times as loud as a sound intensity of 10 dB. Similarly, a sound intensity of 50 dB would be 100,000 times as loud ($10 \times 10 \times 10 \times 10$). This is how the decibel scale works. It is totally unlike the linear percent scale.

Now lets see the fallacy of trying to compare this "funny" decibel scale to the percent scale. To illustrate this, let's assume (remember this assumption we're making here is totally wrong) that 0 dB is equal to 0 percent hearing loss and that 100 dB equals a 100 percent loss. This would then mean that 50 percent would equal a 50 dB hearing loss, right? Wrong! Not by a long shot! A **50 percent** hearing loss would equal, believe it or not, only a 3 dB loss! Looking at it the other way, a 50 **decibel** loss is not just half as loud, like it would be in a percentage scale, but would only be one thousandth of one percent as loud!

Here is another example. I have a 70 dB loss. This is not equal to a 70 percent loss by any means. In actual fact it means that the softest sound I can hear needs to be 10,000,000 **times** louder than the softest sound a person with normal hearing can hear. One out of ten million is definitely not a 70 per cent loss but would be a loss of 99.9999999%! Quite a difference, isn't it? Now you can see why we must never use percentages when talking about our hearing losses. They just do not equate. They are absolutely meaningless!

Percent Used to Describe Discrimination

Although we cannot use percentages to describe our hearing losses, we correctly use percentages to describe our ability to discriminate sounds. To determine our ability to **discriminate** between words, our audiologist sets the volume at our most comfortable listening level. She then has us listen to a list of words and we repeat back what we think we heard. The number we get right,

converted to a percentage, becomes our discrimination score. Therefore, if I understood 80 out of 100 words in my right ear, my discrimination is 80% for that ear. I may have an entirely different result for my other ear. Consequently, we can correctly describe our ability to **understand** what we hear as a percentage. A person could correctly say that his discrimination is 78% in his right ear and 95% in his left ear. But this has nothing to do with the **severity** of our hearing losses as such.

Percentage and Hearing Disability

If your hearing loss resulted from an accident on the job, there is a formula that is used to calculate the percent disability pension for which you may be eligible. Don't get mixed up. This is **not** your hearing loss expressed as a percentage. Rather, this formula calculates how much your degree of hearing loss supposedly impacts your ability to remain employed at full wages.

For example, plunking your hearing loss levels into the formula may yield a result of 75%. This means that with your particular hearing loss, you may be entitled to a 75% disability pension. Again, this is **not** your average hearing loss expressed as a percentage.

Classifying Our Hearing Losses

Hearing health care professionals classify hearing into several categories such as normal, slight, mild, moderate, moderately severe, severe, profound and deaf. Not all of them use all of these categories, nor do they all use the same hearing loss ranges in each one. In the past, most used this simple scale.

Simple Hearing Classification Hearing Threshold

Normal hearing	down to 20 dB
Mild hearing loss	21 to 40 dB
Moderate hearing loss	41 to 60 dB
Severe hearing loss	61 to 90 dB
Profound hearing loss	below 90 dB

Today, research has shown that even hearing losses of only a few decibels can cause significant hearing problems. As a result, many hearing health care professionals have fine-tuned this scale to better reflect this reality. (Note that these ranges are arbitrary and may vary slightly among authorities.)

Today's Hearing Classification Hearing Threshold

Normal hearing	-10 to 15 dB
Slight hearing loss	16 to 25 dB

Mild hearing loss	26 to 40 dB
Moderate hearing loss	41 to 55 dB
Moderately severe loss	56 to 70 dB
Severe hearing loss	71 to 90 dB
Profound hearing loss	91 to 120 dB
Deaf	below 120 dB

Describing Our Hearing Losses

Unless you have a "flat" curve on your audiogram, how can you accurately describe your hearing loss? Your hearing loss could be different at every frequency so one word could be meaningless.

The best way is to be specific. If I have the typical "ski slope" hearing loss, I could describe it as, "I have a 30 dB loss at 500 Hz, dropping to 100 dB at 4,000 Hz." A more general way, but still accurate, would be to describe it as, "I have a mild loss in the low frequencies, dropping to profound in the higher frequencies.

The next best way to describe our hearing losses is to average the 4 frequencies that carry most of the speech information to arrive at a single figure. Use the following four frequencies—500 Hz, 1,000 Hz, 2,000 Hz and 3,000 Hz—and average the hearing loss at these frequencies to come up with one figure. However this method falls down if we only have a bit of hearing left in the very low frequencies. Incidentally, it is not right to take the average of our best and worst figures. That could give a very wrong impression of our hearing losses.

If you want a very simple way to describe your hearing loss, the most accurate (and simple) is to say you have either a mild, moderate, severe, or profound hearing loss. Your audiologist can tell you which category your hearing is generally in. (Remember, you could be mild in the low frequencies and profound in the highs—but to oversimplify, you can reasonably accurately reflect your **practical** hearing loss by using one of these categories.) It is much more meaningful, and far more accurate than trying to use a meaningless percentage. Let's get back to using these standard audiological terms and stamp out this absurd percent business.