

Special Report

Loudness Recruitment vs. Loudness Hyperacusis

How to Tell Them Apart

Neil G. Bauman



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vs.
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How to Tell Them Apart

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Loudness Recruitment

vs.

Loudness Hyperacusis

How to tell them apart

Introduction

Loudness recruitment and loudness hyperacusis are two often-confused conditions. In this article I will discuss what these two conditions are and how to tell whether you have loudness recruitment, loudness hyperacusis, or both or neither.

What Is Loudness Recruitment?

The major characteristic of recruitment, or more accurately loudness recruitment, although it is commonly just called “recruitment”, is an ear condition where you perceive that sounds increase far more rapidly than they do in people with normal hearing. This is because the underlying mechanism of recruitment is that of “a steeper than usual input-output function on the cochlear basilar membrane”. Thus, a small change in sound intensity input can produce a very large change in the output of your inner ears.

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Thus, in a nutshell, when you have loudness recruitment, sounds get too loud too fast, or you could succinctly say, “With recruitment, your auditory system goes from too little to too much too fast”.

When comparing loudness recruitment to loudness hyperacusis, loudness recruitment may appear to be somewhat similar to loudness hyperacusis, but with the added feature of hearing loss. Consequently, one common wrongly-held belief is that if your hearing loss is significant, you have recruitment. However, if your hearing loss is minimal, you refer to it as hyperacusis. That is how many people, including health-care professionals, often confuse loudness recruitment with loudness hyperacusis. Even worse, they may use these two terms interchangeably.

As a result, when you have both conditions, you may confuse your recruitment symptoms with your hyperacusis symptoms, and then incorrectly ascribe all of them to recruitment even though much of it may be due to any accompanying loudness hyperacusis.

This is unfortunate because recruitment and hyperacusis are two totally independent and unrelated conditions. Consequently, each require totally different solutions, even though the result of both conditions is that

you perceive sounds as being abnormally loud.

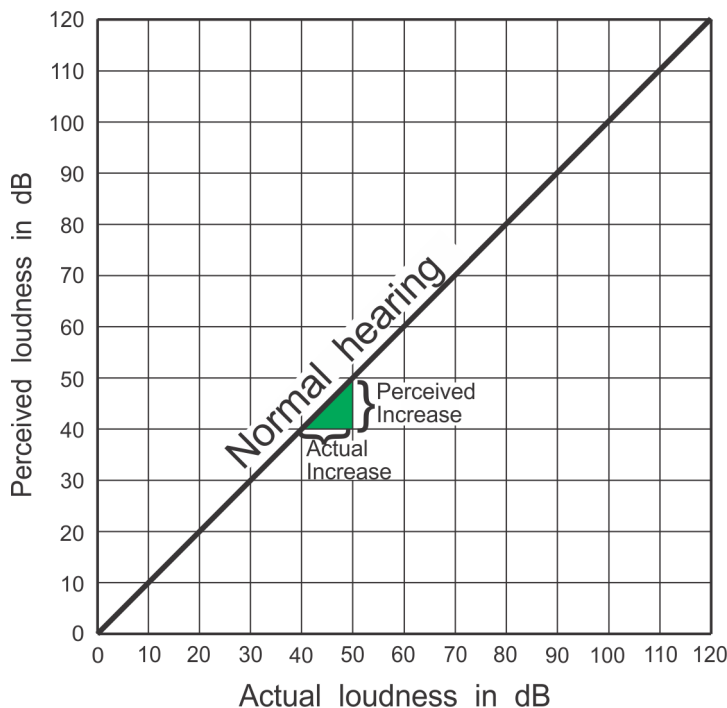


Fig. 1. Actual vs. perceived loudness (sound intensity) with a 1:1 ratio for people with normal hearing.

Think of graphing the slope of a line. The (horizontal) x axis is the actual loudness of a sound, while the (vertical) y axis is the perceived loudness of that same sound. With normal hearing the slope of the line is 45°, that is, there is a 1 to 1 relationship between the actual volume of a given sound and how loud you perceive it (Fig. 1). For example, if the actual sound increases by 10 decibels, you perceive it as twice as loud. This is because you normally perceive a 10 dB increase in sound intensity as twice as loud.

However, when you have recruitment, the slope of the right-hand line in Fig. 2 will be steeper. For example, assume you have an 80 dB hearing loss. Thus, as you can see, the right-hand line on the graph is now much steeper than 45° since it begins at the 80 dB point on the X axis yet rises to the same 120 dB point as it does for a person with normal hearing. Thus, the worse your hearing loss (and accompanying recruitment), the steeper the line becomes.

Notice that now when you increase the actual sound by 10 decibels, rather than perceiving that sound as twice as loud, you'll perceive it as being about 40 dB louder—that is, 16 times as loud.

This means that if you are having your ears tested, you will not hear an audiometric test tone until it reaches a certain loudness—in this case 80 dB. Then the sound rapidly becomes very loud rather than the normal, gradual increase in loudness experienced by people with normal hearing.

A normal ear is not only able to hear extremely quiet sounds (between 0 dB and 20 dB) but can also tolerate very loud sounds without discomfort (up to levels of 115 dB or so).

However, when you have a sensorineural hearing loss, and thus recruitment, you typically no longer hear very quiet sounds, but at the same time, paradoxically you cannot tolerate louder sounds the way you once could.

Here's how it works out in real life. Assume you have the above-mentioned 80 dB hearing loss. With this degree of hearing loss you no longer hear softer sounds.

Let's say you are talking to a friend who is talking at a volume you can comfortably hear. Then for some reason he drops his voice by just 10 dB. As

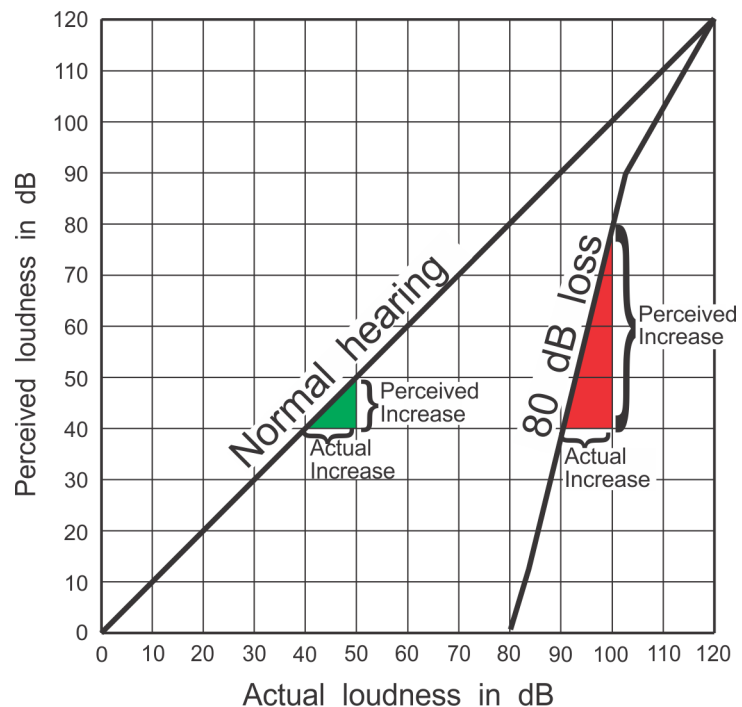


Fig. 2. The right-hand line shows the actual vs. perceived loudness (sound intensity) for a person with a severe hearing loss. The line is much steeper indicating a greater degree of recruitment.

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a result, instead of hearing him speaking half as loud as people with normal hearing would, you now perceive his voice as just one-sixteenth as loud and you basically can't hear/understand anything he says.

Now, let's say this friend increases the volume of his voice by just 10 dB above his normal level. People with normal hearing would perceive him speaking twice as loud, but because of your recruitment, you now perceive his voice as 16 times louder and to you that is painfully loud.

Thus, even though you have a hearing loss, some sounds that people with normal hearing find comfortably-loud rapidly become uncomfortably (or painfully) loud to you, especially in those frequencies of sounds where you have your greatest hearing loss.

In actual fact, both of these scenarios take place simultaneously in most speech—there are both louder and softer components of speech. As a result, you miss the softer components while the louder components are painfully loud.

You have just experienced the somewhat paradoxical, but common, situation of recruitment in action. Let's say you are talking with a hearing friend. Your friend says something and maybe drops his voice a bit. You ask him to speak up, but when he does this and speaks 10 dB louder (twice as loud), you might perceive that change in volume, not as twice as loud, but as 16 times as loud. Immediately you flinch and retort, "You don't need to yell at me. I'm not deaf!"

These scenarios occur because the small increases in speech loudness you request sound like they just shot up along your steeper curve from a whisper to a shout. If you have severe recruitment, one sound may be perfectly comfortable, while another, only slightly louder, may sound like a jet plane taking off right in front of you.

Recruitment is also the reason why hard-of-hearing people so often miss the punch line of jokes. Here's how it happens. When a story-teller comes to the punch line of a joke, he typically lowers his voice for emphasis. Let's assume he drops the volume at which he is speaking from 55 dB to 45 dB, which is still at a normal conversational volume. If you have normal hearing, you have no trouble hearing this—it just sounds about half as loud to you, but it is still well within your hearing capability. However, if you have a severe hearing loss and thus recruitment, although the person is now talking half as loud, you'd only perceive it as about one-sixteenth as loud and you don't catch what he said.

The result is that you have heard most of the main part of the joke. However, you are totally frustrated because you couldn't catch the punch line and then are deafened by the terribly loud (to you) laughter that ensues.

Unfortunately, if you have never experienced severe recruitment (or loudness hyperacusis), it is almost impossible to understand just how loud and painful these tiny changes to everyday speech can be.

Facts About Loudness Recruitment

Here are some facts about recruitment you may not know.

First, you can only experience loudness recruitment if you have a sensorineural hearing loss. Note: This doesn't just happen sometimes or just with more severe hearing losses. If you have a sensorineural hearing loss, you do have recruitment to some degree or other, whether you realize it or not, or whether it bothers you or not.

Second, and based on the fact above, if you have normal hearing or a conductive hearing loss you **cannot** have recruitment. However, you can have loudness hyperacusis.

Third, if you only have hearing loss in one ear, recruitment only occurs in the ear with the sensorineural hearing loss.

Fourth, recruitment occurs only at those frequencies where you have hearing loss. Thus, frequencies near your greatest hearing loss will recruit the most. This is typically in the higher frequencies since most hard of hearing people have a high-frequency (ski-slope) hearing loss.

Furthermore, since high-frequency hearing losses become more prevalent as we age, there are a lot of elderly people with significant recruitment.

Fifth, if you have normal or near-normal low frequency hearing, but significant high-frequency hearing loss, the sounds that recruit will be more sharply-focused on higher frequency sounds. As a result, when these higher frequencies occur in a word, only that component of the word recruits. If a given word doesn't contain any high-frequency components, then it won't recruit. The same holds true for many everyday sounds. Some have lower-frequency sounds, and some have high-frequency components. You only react to the high-frequency components that recruit. That is why some sounds typically bother you and others don't.

Here's an example. Suppose you have two dogs. A stranger comes to your door. Dog "A" lets out a sudden lower-frequency "woof" and, although loud, this sound doesn't recruit and bother you. However, Dog "B" lets out a sudden higher-frequency "yip, yip, yip", and you go ballistic as the high-frequency component of the "bark" rips through your head.

Sixth, recruitment involves both the outer **and** inner hair cells in your cochlea **and** the auditory circuits in your brain.

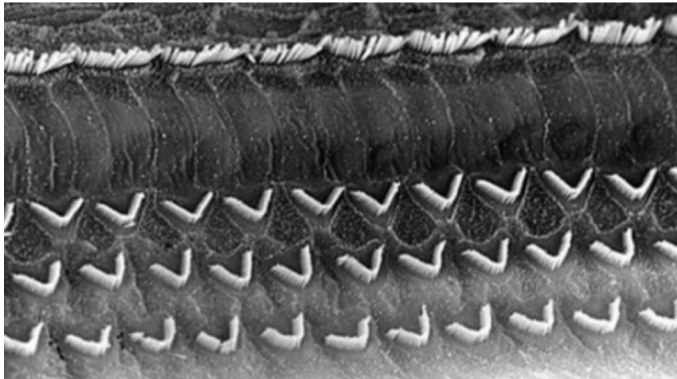


Fig. 3. Part of a cochlea showing healthy hair cells. There is one row of inner hair cells at the top and three rows of outer hair cells (bottom half).

that the patterns of missing and deformed hair cells can be endlessly different. Since recruitment involves both the outer and inner hair cells in your cochlea, this is why two people with similar degrees of hearing loss may have very different degrees of recruitment depending on which hair cells are damaged or missing.

How Recruitment Got Its Name

Recruitment is a strange name for this hearing condition. As one person wrote to me,

Recruitment seems to be such a weird word for this problem. The word means "to enlist." The dictionary doesn't describe anything to do with hearing loss and hearing aids. So how did recruitment get this strange name?

Fig. 3 shows part of a healthy cochlea. Notice the single row of inner hair cells is at the top and the three rows of outer hair cells are at the bottom. Notice also that these hair cells are properly-formed and none are missing.

In contrast, Fig. 4 shows a damaged cochlea. Notice that many of these hair cells are deformed or missing. Furthermore, you can readily see

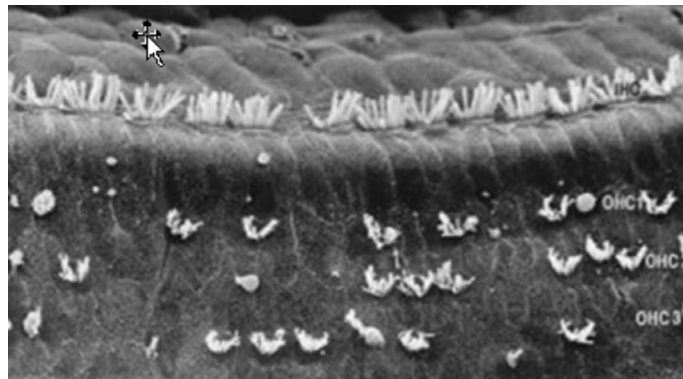


Fig. 4. Part of a cochlea showing damaged/missing hair cells. The row of inner hair cells at the top are mostly damaged. The three rows of outer hair cells (bottom half) are mostly dead (and thus missing) while the remaining ones are mostly damaged.

Probably you think of recruitment when the government runs short of military personnel and puts on a recruitment drive to bring the armed forces back up to normal strength. That's a common usage of the word "recruitment". Well, guess what? In like manner, when some of your hair cells die, your brain puts on a recruitment drive to replace those dead hair cells.

Perhaps the easiest way to understand recruitment is to make an analogy between the keys on a piano and the hair cells in your cochlea.



Fig. 5a shows an octave. on a piano keyboard composed of 8 white keys and 5 black keys.

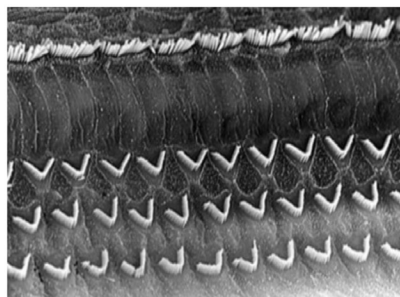


Fig. 5b shows part of a cochlea. The top row of inner hair cells is divided into 24 critical bands.

The piano keyboard contains 88 keys. These keys are grouped into 7 octaves (Fig. 5a) (plus a minor third). In like manner, our brains group all the 3,500 or so inner hair cells (Fig. 5b, top row) into 24 perceptual units called "critical bands". Each critical

band has a given number of hair cells. Thus, each critical band is somewhat analogous to an octave on the piano.

Every key on the piano belongs to one octave or another. In like manner each hair cell also belongs to, and stimulates, only its critical band.

Just as each key on a piano generates a given frequency of sound, so also each hair cell in your ears activates to a given frequency. However, rather than working independently, these hair cells work together in their critical bands.

When you play a chord on the piano—you press two or more keys at the same time, but they blend together and your brain hears them as one sound. Similarly—but yet differently—when any hair cell (or hair cells) in a given critical band is stimulated, that entire critical band sends a single signal (analogous to a chord on a piano) to your brain which you "hear" as one unit of sound at the frequency at which that critical band is sensitive.

When something happens to damage or kill some of your hair cells as you can see in Fig. 4, (such as old age, loud noise, or ototoxic drugs) you obviously lose some of your hearing. When this occurs, each critical band no longer has a full complement of properly-working hair cells. This would be analogous to a piano with some of the white keys yanked out. The result would be that some

octaves wouldn't have 8 working white keys anymore, and such music would sound awful to you.

Your brain doesn't like this kind of situation either. Since your brain **requires** that each critical band has a full complement of hair cells, your brain does something rather ingenious.

In the same manner as the government does when it runs short of military personnel and puts on a recruitment drive, so too, your brain does the same thing. However, since all the hair cells are already "in service" so to speak, there are no spare hair cells to recruit.

To get around this problem, your brain attempts to recoup critical-band signal strength by automatically widening the boundaries of each critical band. When it does this, it recruits the living hair cells on each side of the existing deficient critical band. The result is that now some critical bands overlap each other to some degree. Consequently, some hair cells find themselves not only as members of their original critical bands, but now also members of adjacent critical bands—having been "recruited" into neighboring critical bands.

This results in recruitment causing two separate phenomena. First, the resulting sounds are distorted in volume. Second, the resulting sounds are distorted in pitch. Let's look at each of these in turn.

Volume Distortion

You perceive the **loudness** of any sound based on **how many** critical bands a given sound stimulates.

For example, you perceive a sound stimulating two critical bands as twice as loud as a given sound just stimulating one critical band. This is because your brain decodes loudness by counting the **number** of critical bands that are activated.

Thus, due to a lack of living hair cells in a given critical band, a sound that should stimulate just one critical band may now stimulate 2 or more critical bands depending on the amount of the overlap. This is because the recruited hair cells still function in their original critical bands and also in the adjacent one(s) into which they have been recruited.

The result is abnormal loudness perception. Thus, at the sound level at which these normal hair cells "kick in", perceived loudness shoots up rapidly, causing discomfort. In our piano analogy, it would sound as if you were pounding on some of the keys instead of playing them normally.

If only relatively few hair cells die, then adjacent hair cells may just do double duty. However, if many/most hair cells have died, then in order to have a full complement of hair cells in each critical band, any given hair cell may be recruited into several different critical bands at the same time. The result is a large increase in the perception of loudness growth (“loudness recruitment”)

The result is that at one point you cannot hear a sound because of your hearing loss at a given frequency, then, when the sound reaches a certain loudness at that frequency, you are blown away by the perceived loud volume. This is one aspect of loudness recruitment in action.

Pitch Distortion

You perceive the **frequency** of a given sound based on **which** critical band(s) the sound stimulates. Your brain decodes pitch (sound frequencies) by noting **which** critical bands have the most neural (inner hair cell) activity.

Each critical band normally sends one signal at the frequency of that critical band. However, when hair cells get recruited into adjacent bands, they stimulate each critical band of which they are a member to send their signals also. Consequently, instead of hearing just one frequency for a given phoneme, your brain may now receive 2 or 5 or 8 signals at the same time—each one at a somewhat different frequency.

At this point sounds largely become unintelligible because the critical bands are now so wide that your brain is no longer able to accurately decode the pitch of the signals you are hearing.

Thus, another characteristic of recruitment is “fuzzy” (unclear) hearing. This occurs when certain speech sounds are close in frequency and the same sound activates multiple critical bands at the same time. When this occurs, you are not sure whether the person said the word “sun” or was it “fun” or “pun” or “run” or “dumb,” or “thumb”. Consequently, speech, when it is loud enough for you to hear, may seem to be all “smooshed” together and you just hear a lot of incomprehensible gibberish.

This pitch distortion coupled with volume distortion sounds just as bad in real life as it would if you recruited other piano keys into an octave that had some keys missing so you could play a chord.

Thus, not only is recruitment a military term, but it is also a term used for conscripting (recruiting) hair cells for service in additional critical bands in your inner ears. And that is how loudness recruitment got its strange name.

Recruitment Does Not Damage Your Ears or Hearing

If you have recruitment, you may be worried that the painfully-loud sounds, as you now perceive them, must be damaging your ears.

You can set your mind at rest. Here's some good news. Recruiting sounds do not damage your hearing, nor do they kill your hair cells. This is because loud, real sounds only cause damage to your cochlea on their way into the cochlea. Think of someone breaking into your cochlea—smashing the door and wrecking everything in sight. Now some/much of your cochlear equipment—the hair cells—are damaged/killed. This is real physical damage.

Your cochlea cleans up the mess and tries to do its job as best it can with whatever equipment (hair cells) that still function. These signals are not really louder than normal, so they don't cause damage as I just explained. It's just that your brain perceives the increased number of critical bands that are all activated at the same time as louder than normal.

If you have significant recruitment and are worried that a given sound is damaging your ears, here's an easy way to tell whether that sound is likely ear-damagingly loud or not. If a sound is not so loud that people around you with normal hearing wince or jump, then it almost certainly won't physically damage your ears either, no matter how loud you perceive the sound to be.

Loudness Hyperacusis

Now that we understand recruitment, let's briefly look at hyperacusis, then we'll look at the fundamental differences between recruitment and hyperacusis.

Hyperacusis comes from the Greek word “hyper” meaning “over” or “above” and the Greek word “akousis” meaning “hearing. Thus, hyperacusis literally means “better-than-normal hearing”, however, today it is used as meaning “hypersensitive to sound”.

When people talk about hyperacusis they typically throw this term around as though there is only one condition that is called hyperacusis. Surprise! This is just not true. There are actually **seven** different somewhat-related ear conditions that are gathered under the hyperacusis umbrella, namely:

Loudness hyperacusis which we are talking about in this article

Annoyance hyperacusis (also known as misophonia)

Fear hyperacusis (also known as phonophobia)

Pain hyperacusis

Vestibular hyperacusis (due to a “third window” in your inner ear besides the oval and round windows)

Amplification hyperacusis that occurs when your hearing aids or other assistive devices are not adjusted properly

Conductive hyperacusis (can be from three different causes depending on whether it affect your outer, middle or inner ear)

So even though most people just call it hyperacusis, you need to use the proper modifying adjective ahead of the word “hyperacusis” such as “loudness hyperacusis”, “pain hyperacusis”, etc. so people know which “kind” of hyperacusis you are talking about.

Misuse of the generic term “hyperacusis” is very common. This is unfortunate because each of these seven different kinds of hyperacusis have different causes and thus have different treatments. It is not a case of “one size fits all” when it comes to treating the various forms of hyperacusis. However, in this article I’m only going to focus on loudness hyperacusis.

The different forms of hyperacusis have a common thread—they are all somehow related to decreased sound tolerance. In other words, a person is hypersensitive to normal everyday sounds.

Loudness hyperacusis seldom occurs by itself. Typically, it is accompanied by two or more associated conditions such as tinnitus, hearing loss, fear hyperacusis (phonophobia) or pain hyperacusis.

As a result, many people confuse loudness hyperacusis, not only with loudness recruitment, but also with the other kinds of hyperacusis. Furthermore, when people talk about having hyperacusis they almost always really mean loudness hyperacusis.

You may be puzzled by this supersensitivity to sound as was one lady when she asked me a very perceptive question. She wrote,

My sister’s hearing has **increased** so much that she wears earplugs during the day, especially when her children start crying or screaming. Every little sound bothers her ears. If there is inner ear damage, wouldn’t her hearing drop, not increase?

Put another way, you could ask, “How can ear damage cause people to hear sounds louder than they really are?” Logically, you would think inner ear damage would result in hearing loss and not increased hearing, wouldn’t you?

There are a couple of flaws in this lady’s line of reasoning. First, this line of reasoning erroneously assumes that hyperacusis is the result of inner ear damage. The second error is assuming that hyperacusis gives you increased hearing.

In truth, this lady’s sister does not really have increased hearing, and she probably doesn’t have ear damage either. It just seems that way to her.

What has happened is that now she **perceives** normal, everyday sounds as being louder than they really are. People with hyperacusis often describe it as having extremely sensitive hearing, or like having their internal volume control stuck on high!

Thus, to outsiders, it seems this lady’s hearing has greatly improved, when in actual fact, her hearing is the same as it always has been. What has changed is that her **tolerance** to normal sounds has decreased. She now **perceives** the normal sounds she has always heard as being far too loud—often so loud that they hurt. This makes it difficult for her to endure all the normal sounds in our noisy world. No wonder she resorts to wearing ear protectors!

Causes of Loudness Hyperacusis

As we have already learned, recruitment has one and only one cause—having a sensorineural hearing loss. In contrast, loudness hyperacusis has a number of causes.

By far the most common way people develop loudness hyperacusis—around 50% to 60% of the cases—is from exposing their ears to loud sounds. For example, you can develop loudness hyperacusis from exposing your ears to a single, sudden burst of loud noise such as an explosion, a nearby gunshot, fireworks going off too close to your ears, a truck backfiring, a siren blasting, or any other sudden, loud sound that is difficult for normal ears to tolerate, or it could be from exposing your ears to sustained loud sounds.

Note that about a third of the people with loudness hyperacusis—whether they are professional musicians, or attendees at loud concerts or discotheques, or listening to music via earbuds with the volume turned way up—considered that listening to loud music was the cause of their loudness hyperacusis.

Another cause of loudness hyperacusis is a side effect of taking any of

the many ototoxic drugs that can damage your ears such as antidepressants, antipsychotics, anesthetics, anti-cancer drugs and recreational drugs. For example, in my book “Ototoxic Drugs Exposed” (4th edition) there are 281 different drugs listed as being associated with hyperacusis. Furthermore, you can develop loudness hyperacusis if you try to taper off certain psychotropic drugs too quickly. Many doctors taper you off over a period of 2 or 3 weeks. That is much too fast! A typical “safe” taper is to reduce the dose by 10% per month on the reducing balance which takes from 1 to 2 years!

Symptoms of Loudness Hyperacusis

The symptoms of loudness hyperacusis vary from person to person. The main symptom of loudness hyperacusis is a reduced tolerance to everyday sounds. However, typically, it is accompanied by 2 or more associated conditions

For example, in one study, the most prevalent symptoms experienced following the onset of loudness hyperacusis were that 92% experienced tinnitus, 50% felt their ears were clogged up, 49% experienced hearing loss, 40% experienced headaches and 28% experienced pain in the area surrounding their ears.

Incidentally, the more severe your loudness hyperacusis, the more likely you’ll develop these other symptoms.

Looking at it from the perspective of people who already had tinnitus, around 40% of them also have some degree of loudness hyperacusis. This makes sense since the most common cause of both tinnitus and hyperacusis is exposing your ears to loud sounds.

Some Facts About Loudness Hyperacusis

Now let’s look at some of the characteristics of loudness hyperacusis.

First, hyperacusis has nothing whatsoever to do with the amount of hearing you have or don’t have. Hyperacusis can occur whether you have normal hearing, a profound hearing loss, or anything in between. In contrast, recruitment, as I previously mentioned, is always associated with some degree of sensorineural hearing loss.

Second, if you have a sensorineural hearing loss, you can have both recruitment and hyperacusis at the same time. If so, you have to tease these two conditions apart.

Loudness Recruitment vs. Loudness Hyperacusis

Third, unlike recruitment, which is due to physical damage in your cochlea, having hyperacusis does not physically damage your ears no matter how loud you perceive sounds to be. It just alters your perception of how loud sounds are.

Fourth, loudness hyperacusis reflects a decrease in the volume of the loudest sounds you can tolerate. That is why doctors often refer to it as “Decreased Sound Tolerance” (DST).

Thus, when you have loudness hyperacusis, you may find that you now perceive certain sounds, many sounds or all sounds as too loud—so loud, in fact, that they may make you wince, jump, or cry out with pain. Yet these sounds are typically normal, everyday sounds. They may not even be particularly loud sounds. Thus, the same sounds that bother you would not evoke a similar reaction in the average person with normal hearing.

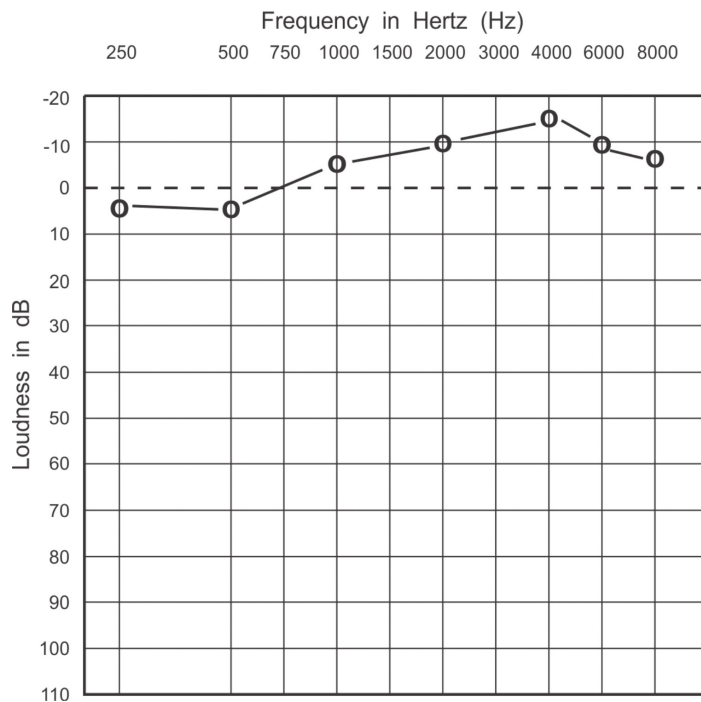


Fig. 6. The audiogram of a person with loudness hyperacusis can show hearing above the 0 dB (dashed) line which looks like they have incredible hearing when in actual fact, they may just have loudness hyperacusis..

Fifth, if you have hyperacusis, your audiogram often seems to indicate that you have better-than-normal hearing. This is shown by your hearing results appearing **above** the 0 dB (dashed) line in the minus numbers such as -10 dB or -15 dB. (Fig. 6.)

Sixth, it is difficult for people who do not have hyperacusis to even imagine what it is like to have loudness hyperacusis since these sounds are neither intrinsically threatening nor uncomfortably loud to a typical person. Thus, often they are not sympathetic towards people with loudness hyperacusis and think they are making a mountain out of a molehill when they say they

can't even stand relatively-soft sounds. Yet you may perceive such sounds as ranging from being mildly uncomfortable, where they are just minor nuisances, to where they are so severe and distressing that they cause you pain and drastically alter your life.

Seventh, basically, loudness hyperacusis is **sound-induced** hyperactivity in your auditory system. It is a dysfunction in your cochlea—principally of the three rows of outer hair cells and basilar membrane—which essentially shifts your cochlear amplifier into high gear, where it “gets stuck”.

Eighth, your ears are more sensitive to sudden changes in volume rather than in sustained higher levels of sounds you are hearing.

Ninth, higher-frequency sounds tend to bother you more than lower-frequency sounds. Particularly-troublesome high-pitched sounds include sounds such as alarms, brakes screeching, silverware and dishes clinking/clattering, children screaming, dogs barking, people clapping, etc.

Thus, when you have loudness hyperacusis, you typically find that social situations are often painfully loud. Sounds that are now unbearable to you once may have been part of an enjoyable night out on the town with your companions.

Tenth, unlike recruitment, loudness hyperacusis is a psychosomatic condition (just meaning it is composed of both a “physical” and a “psychological” component, the same as for tinnitus, not that you are crazy). This is because your auditory system is closely interwoven with your emotional system. Thus, your emotions such as anxiety play a significant role in how you will experience loudness hyperacusis.

Understanding Your Dynamic Range Is the Key to Understanding Recruitment vs. Hyperacusis

Understanding the concept of dynamic range is the key to visually understanding the main difference between recruitment and hyperacusis since both of these conditions have a marked effect on your dynamic range.

Your dynamic range is that area on your audiogram between the softest sounds you can hear and the loudest sounds you can stand without pain.

The green shaded areas in the following graphs indicate your dynamic range (Fig. 7). Red areas indicate sounds above your dynamic range. These sounds are too loud for you to tolerate without considerable distress. Yellow areas indicate sounds below your dynamic range. These sounds are too soft for you to hear.

Think of an analogy to a room. Very soft sounds (0 dB—the threshold of human hearing) are at the floor level and very loud sounds at 115 dB (120 dB—

Loudness Recruitment vs. Loudness Hyperacusis

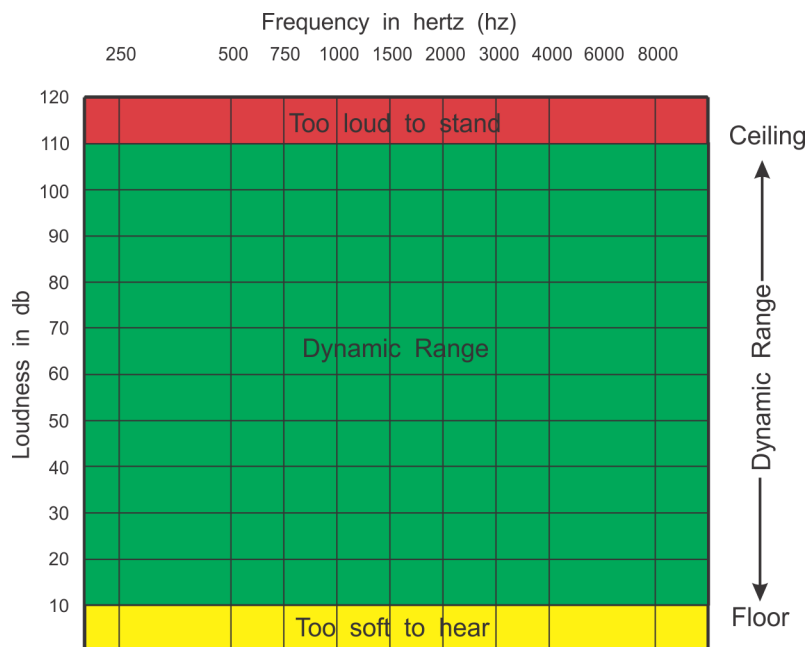


Fig. 7. Audiogram showing the typical dynamic range (green) of a person with normal hearing.

the threshold of pain) are at the ceiling level.

Thus, you just begin to hear very soft sounds at the floor level, and they continue to get louder and louder as you go up the graph until they burst through the ceiling of your dynamic range and cause you distress and hurt because you perceive them as so loud. The area between the floor and ceiling is your dynamic range.

The level of sound where the yellow meets the green indicates the **floor** of your dynamic range, whereas the level of sound where the green meets the red indicates the **ceiling** of your dynamic range.

Note that to make things simple and thus easier to understand, I generally have made these lines straight across (indicating a flat hearing loss) rather than curved lines needed to show a typical ski-slope hearing loss.

If you have good hearing, you may hear very quiet sounds between 0 dB and 10 dB. At the other end of your dynamic range, the loudest sounds you can tolerate without discomfort normally lie around 110–115 dB, but below 120 dB, which is the threshold of pain. Thus, a person with normal (“perfect”) hearing typically will have a dynamic range spanning somewhere around 100 to 110 dB.

However, if you have a profound sensorineural hearing loss, and thus recruitment, you have a raised threshold of hearing (this is audiology-speak meaning you have some degree of hearing loss—i.e. a raised floor). The blue arrow points to your threshold of hearing where the yellow meets the green (Fig. 8). You can’t hear any sounds softer than this threshold.

This means your dynamic range is typically much narrower than is the dynamic range for those with normal hearing). As a result, you only have a narrow range of levels of comfortable hearing. This is because you cannot hear the soft sounds that people with normal hearing can, while at the same time,

sounds above the ceiling of your dynamic range become intolerably loud. For example, in this case you would be unable to hear sounds softer than 90 dB, while at the same time, sounds louder than 110 dB would be too loud for you.

Thus, the **floor** of your dynamic range is **raised** to the level of the softest sound you can hear because of your hearing loss. Notice that the graph shows the floor of a person with severe hearing loss dramatically rises.

In fact, it is up close to the ceiling. This is a characteristic of a person with recruitment, the ceiling stays the same, but the floor rises resulting in a collapsed dynamic range. You can readily see that the dynamic range (green area) of a person with recruitment (right) is dramatically smaller than that of a person with normal hearing (left) (Fig. 9).

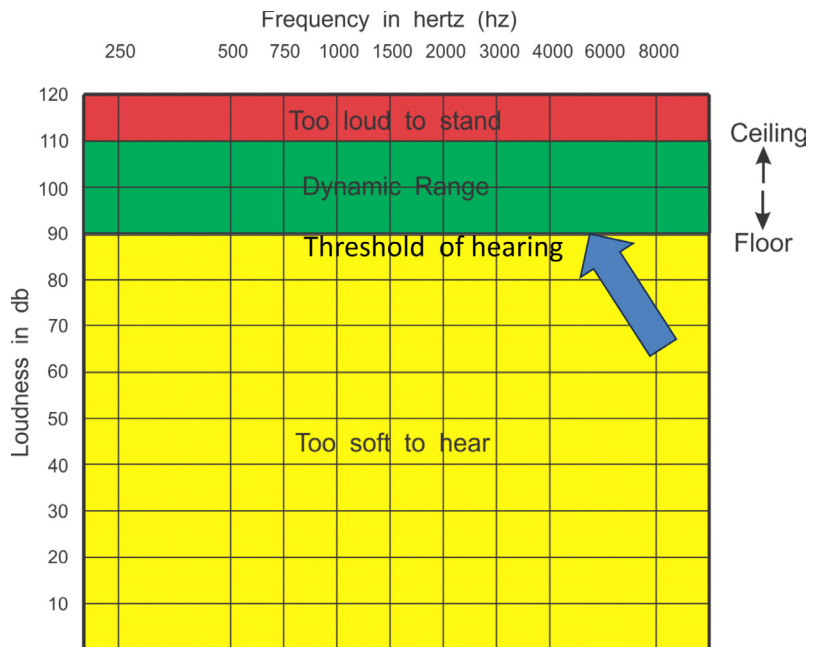


Fig. 8. Audiogram showing the dynamic range (green) of a person with a profound hearing loss. The blue arrow points to threshold of hearing for this person.

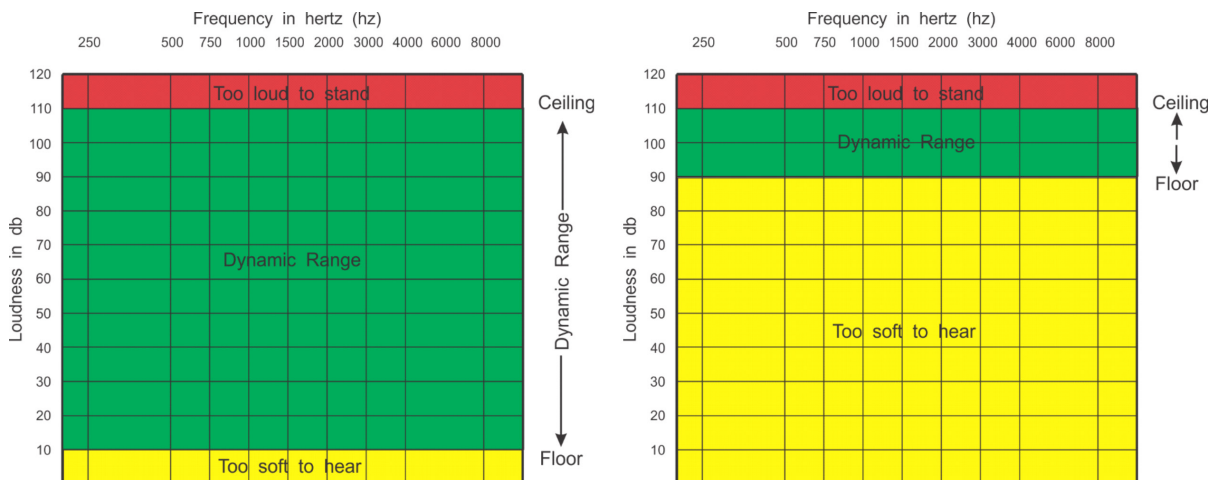


Fig.9. Audiogram showing the dynamic range (green) of a person with a normal hearing (left) vs. an audiogram of a person with a profound hearing loss (right). Notice that due to loudness recruitment, the floor of the audiogram rises.

Loudness Recruitment vs. Loudness Hyperacusis

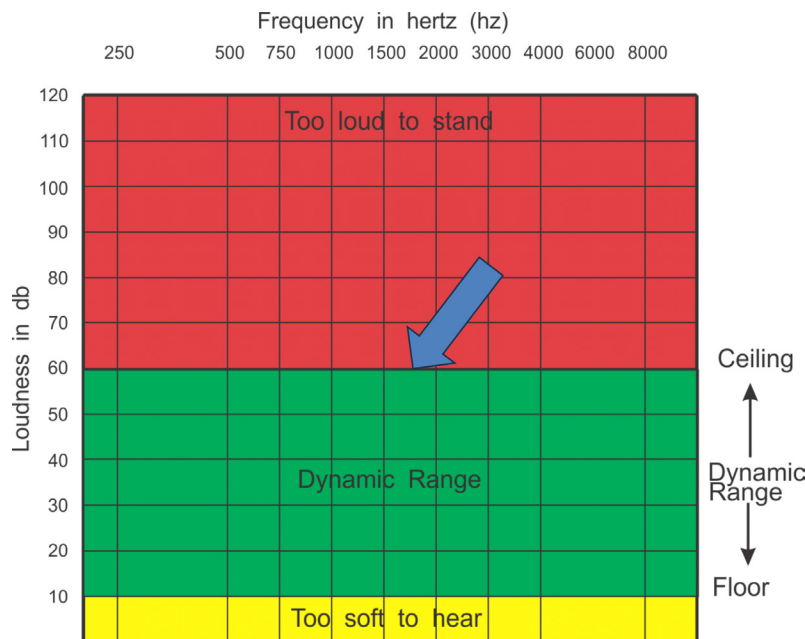


Fig. 10. Audiogram showing the dynamic range (green) of a person with loudness hyperacusis. The blue arrow indicates the level to which the ceiling has dropped.

In contrast to the chart showing severe recruitment, the chart of a person with severe loudness hyperacusis is diametrically opposite.

If you have loudness hyperacusis, instead of the floor rising, notice that it is the ceiling that drops dramatically, also resulting in a collapsed dynamic range (Fig. 10).

Here is an easy way to remember this—if the floor of your dynamic range rises, you have recruitment (associate the two “r” words—“recruitment”

with “rises”) whereas if the ceiling of your dynamic range drops, you have hyperacusis (Fig. 11).

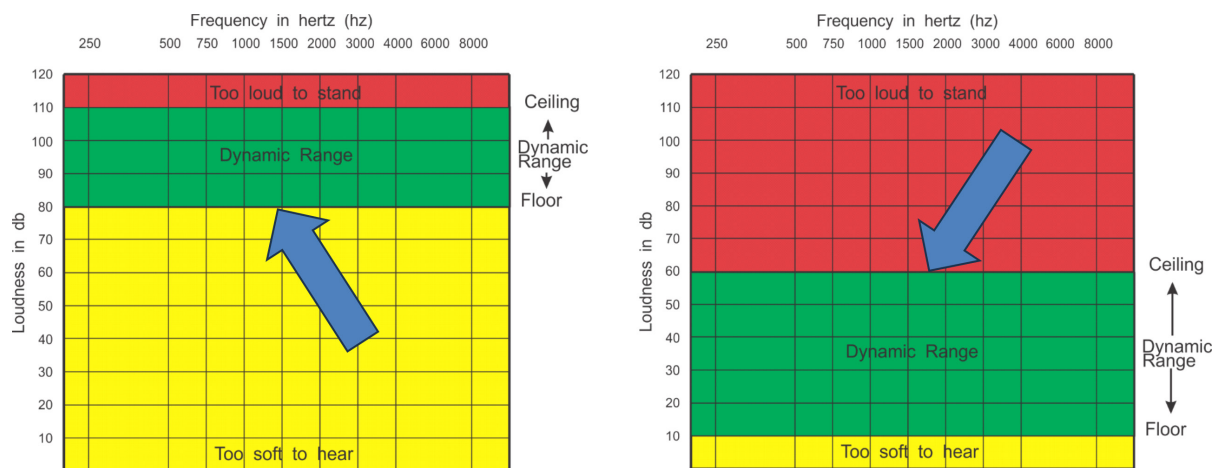


Fig. 11. Audiogram comparing how the floor (blue arrow on left) rises when you have recruitment (left) vs. how the ceiling (blue arrow on right) drops when you have loudness hyperacusis (right).

Furthermore, if you have both recruitment **and** hyperacusis, the ceiling drops and at the same time the floor rises leaving your poor dynamic range

squished between the two. If you have this dynamic range, you have a very small range of intensities where sounds are comfortable. The rest of the time you hear all sounds as either distressingly/painfully loud or they are so faint you can't hear them at all (Fig. 12)!

In cases where the floor and ceiling touch, you have a totally collapsed (0 dB) dynamic range (point "A") rather than the normal dynamic range of somewhere between 100 and 115 dB. This means that by the time a sound is loud enough for you to hear it, it is already too loud for you to stand without distress and pain.

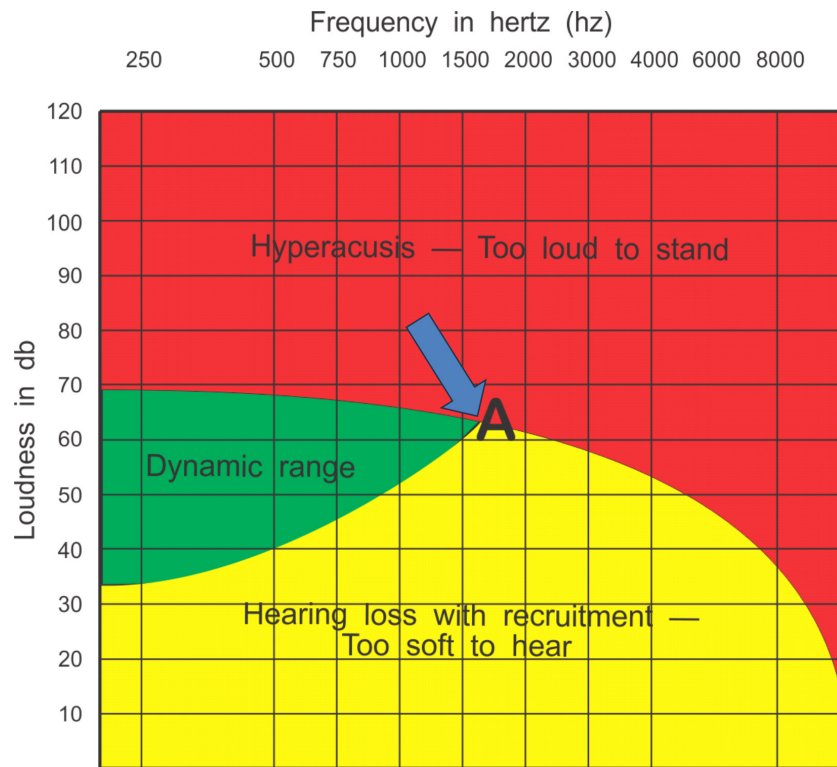


Fig. 12. Audiogram of a person having both significant loudness recruitment and loudness hyperacusis. At point "A" (blue arrow) his dynamic range collapses to zero. At this point when a sound is loud enough to hear it is already too loud to stand and furthermore, it just sounds like gibberish.

According to audiologist Brad Ingrao, Au.D., you need a minimum of 15 dB of dynamic range in order for hearing aids to be useful to you. This is because the normal speech-dynamic-range is around 12 dB. Thus, if you have extreme recruitment (your dynamic range is approaching 0 dB), basically all you will hear is either silence (if the sound is not loud enough for you to hear) or loud noise with little intelligibility in it when the sound is finally loud enough for you to hear it.

Here's an example. Another audiologist explained,

I saw a man this week with bilateral, profound hearing loss since a very young age. Several audiologists have tried testing him and all refuse to fit him with hearing aids. I made a point of increasing the sound level in the smallest increments possible trying to find a threshold, as he had warned me he had severe recruitment. I got to 105 dB at 1,000 Hz on his

Loudness Recruitment vs. Loudness Hyperacusis

first ear and he still heard nothing. Then, when I increased the level to 110 dB he literally jumped from the chair and pulled all the equipment off his head/ears and was in terrible pain.

Note that this man couldn't hear a sound at 105 dB (that's really loud), yet at just 5 dB more (the smallest incremental increase on most audiometers), the sound had already gone through his whole dynamic range and out the top end and was already too loud for him to stand. His dynamic range had collapsed to considerably less than 5 dB!

Thus, any dynamic range less than 12 to 15 dB will cause drastically distorted speech and make it sound more like gibberish than useful speech.

Since recruitment means that the perceived loudness increases much faster as sound levels increase, if you have a bad case of recruitment, by the time a sound become loud enough for you to hear it, just a little more increase in loudness and that sound is already too loud for you to stand and can cause you pain. "That is why certain levels of loudness hurt your ears, even though people with normal hearing are perfectly comfortable with the same sounds."

As one lady with profound hearing loss, and thus extreme recruitment, once told me, "By the time a sound is loud enough for me to hear it, it is already too loud for me to stand. At that point, I can't tell whether it is a person talking or a dog barking!"

Treating Recruitment & Hyperacusis

Treating recruitment is very different from treating hyperacusis. Here's why. Recruitment is basically a cochlear condition due to dead hair cells in your cochlea. In contrast, hyperacusis is mostly a psychological problem in your brain. What this means is that, unlike hyperacusis, recruitment does not have a significant emotional/psychological component. Thus, it is not amenable to treatments designed to get your limbic system (part of your brain that deals with emotional issues) to turn the volume down like you can do for hyperacusis.

To help you understand this better, I'll use the analogy to problems with computer hardware and computer software.

Because it involves dead hair cells, loudness recruitment is analogous to a computer hardware problem. A physical part of the computer is damaged or broken and that is why it won't work.

In contrast, loudness hyperacusis is basically is psychological problem and thus is analogous to a computer software problem where a change/error in the program code causes the computer to give an incorrect response.

Looking at it a different way, if you have recruitment, trying to retrain your brain basically doesn't work because most of the problem is that "distorted" (too loud) signals are being sent to your brain. In contrast, if you have loudness hyperacusis, the source of the loud sounds is due to malfunctioning auditory processing neurons in your brain. Because your brain is plastic, that can be changed.

Unfortunately, "hardware" problems are basically set in stone, so you have little ability to fix them. You basically have to replace the damaged part. And since with recruitment, it is your inner ear that is damaged, this is not possible at this time.

That is why doctors and audiologists can't do much about fixing recruitment. Otologist Dr. Stephen Nagler explained that, in his professional opinion, Tinnitus Retraining Therapy and various other desensitization protocols do not help people with recruitment like they do for people with tinnitus or hyperacusis.

When you have recruitment, you cannot just jump into a noisy situation and expect your ears to adjust. They already did—they recruited! You can't make your brain "un-recruit". It doesn't work that way.

Therefore, when you have recruitment and certain sounds seem to "blow the top of your head off", give you headaches or make you wince or jump, you may respond to the resulting discomfort by avoiding those places you perceive as being "unsafe" for your ears, or you may wear ear protectors, even when the sound levels do not pose a threat to your hearing.

Since there is no specific treatment that can totally overcome the effects of recruitment, you have to learn how to best live with your annoying and, at times, painful recruitment.

However, all is not lost. If you wear hearing aids, your audiologist can try to set the compression on your hearing aids so all sounds stay within your collapsed dynamic range. This can greatly help you deal with your recruitment.

Here's how your hearing aids can do this. When you have a collapsed dynamic range, you no longer hear softer sounds so soft sounds need the volume to be turned up enough so you can hear those sounds. At the same time, loud sounds need their volume turned down so they stay within your dynamic range and do not cause you discomfort/pain.

This needs to be done quickly (in real time). It's conceptually like there are two tiny guys inside your hearing aids. The "soft" guy's job is to keep his hand on the soft volume control and whenever a sound isn't loud enough to at least reach the bottom of your dynamic range he has to instantly turn the volume up—but not so much that it goes through the top of your dynamic range.

The "loud" guy has the opposite job. He keeps his hand on the loud volume control and, whenever a loud sound reaches the top of your dynamic range, he instantly turns the volume down so it is now below the ceiling of your dynamic range, but not so far below it that it sinks through the floor of your dynamic range where you can't hear it.

This has to be done many times per second when you are listening to speech. Every syllable (technically phoneme) typically has both loud and soft components in it. Thus the "loud" and "soft" guys have to make extremely-rapid adjustments as each phoneme is spoken.

(It's actually more complex than I've shown here since you need several sets of these guys, one for each frequency band, but the same principle applies.)

The good news is that modern hearing aids can do this when they are programmed properly. However, the results are still not perfect as much depends on the width of your dynamic range. The more compression is turned on, the less clarity you'll have, while when less compression is used, more loud sounds will blast through the ceiling of your dynamic range causing those sounds to be uncomfortably or painfully loud.

Thus, you have a fine line to tread deciding whether you need more clarity or less volume in any given listening situation. Here's a good rule of thumb to help you make up your mind. The worse your recruitment is, the more likely you'll want to lean towards more compression so sounds aren't uncomfortably/painfully loud. However, the tradeoff will be less speech clarity. And if your recruitment isn't too bad, you'll likely want to lean more towards greater clarity and less compression which unfortunately will more frequently let louder sounds though.

The choice is yours. Instruct your audiologist whether you want to exactly tread that fine line (probably the best place to be), or whether you want to be off it on the compression side or on the clarity side, and by how much.

Here's a way you can have even more control depending on the listening environment. If your hearing aids have two or more programs, have one program set with more compression (and thus less clarity) and a second program set for more clarity (and thus less compression). Then, in any given situation where

more sounds recruit, use the first program, and in situations where fewer sounds recruit, use the second program. That way you get the best of both worlds (just not at the same time).

Now, coming back to our computer analogy as it relates to loudness hyperacusis. Remember, loudness hyperacusis is more analogous to a computer software problem. The good news here is that computer software problems can often be fixed by reprogramming the software. Since loudness hyperacusis is basically your "internal volume control system" out of whack—and since your brain is plastic (flexible), with proper treatment, typically you can slowly reprogram your brain to bring your auditory system back into proper balance again, and thus largely fix loudness hyperacusis although this process can take 1 to 3 years. So much depends on the state of your emotions as you work through this process. Therefore, unlike recruitment, experiencing loudness hyperacusis need **not** be a lifetime sentence.



You now have a reasonable understanding of what both loudness recruitment and loudness hyperacusis are. However, if you want a much more comprehensive understanding of the various kinds of hyperacusis and the details of treating loudness hyperacusis and the other kinds of hyperacusis, you would do well to read my comprehensive book "Hypersensitive to Sound? Successfully Deal with Your Hyperacusis, Recruitment and Other Sound Sensitivities". It is available as a printed book or an eBook (pdf format) from my website at:

<https://hearinglosshelp.com/product/hypersensitive-to-sound/>

or you can order the printed version of this book from Amazon.com.

Good Books on Hearing Loss

Integrity First Books in the series:

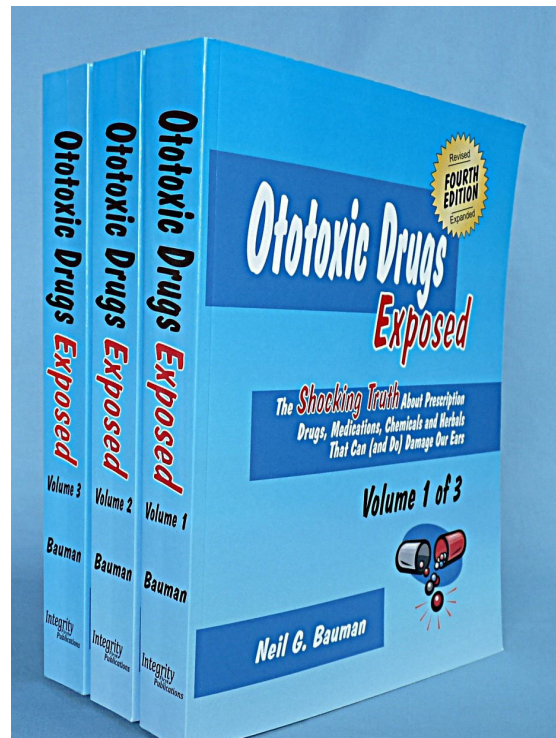
***Everything You Wanted to Know About Your Hearing Loss But Were Afraid to Ask
(Because You Knew You Wouldn't Hear the Answers Anyway!)***

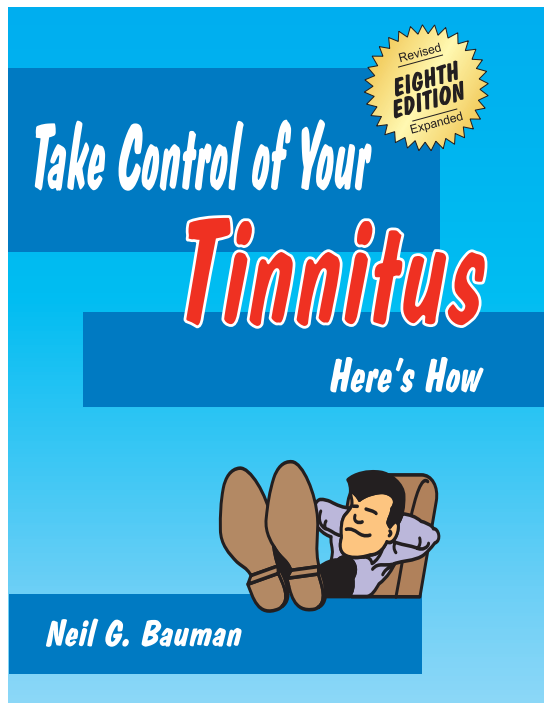
by Neil G. Bauman, Ph.D.

If you have enjoyed this comprehensive article and would like to learn more about hearing loss and how you can successfully live with it, you may be interested in some helpful books by Dr. Neil. Each book is packed with the things you need to know in order to thrive in spite of your various hearing loss issues. The direct link to the following books is at <https://hearinglosshelp.com/product-category/publications/>.

Ototoxic Drugs Exposed—The Shocking Truth About Prescription Drugs, Medications, Chemicals and Herbals That Can (and Do) Damage Our Ears
(3-volume set \$79.95; eBook \$59.95)

This book, now in its fourth edition, reveals the shocking truth that many prescription drugs can and often do damage our ears. Some drugs slowly and insidiously rob you of your hearing, cause your ears to ring or destroy your balance. Other drugs can destroy your ears in one fell swoop, leaving you with profound, permanent hearing loss and bringing traumatic change into your life. Learn how to protect your ears from the ravages of ototoxic drugs and chemicals. This book-set includes comprehensive listings of the specific ototoxic effects for each of the 1,604 drugs, 64 herbals and 144 chemicals in this 3-volume set. (1,662 pages in total.)





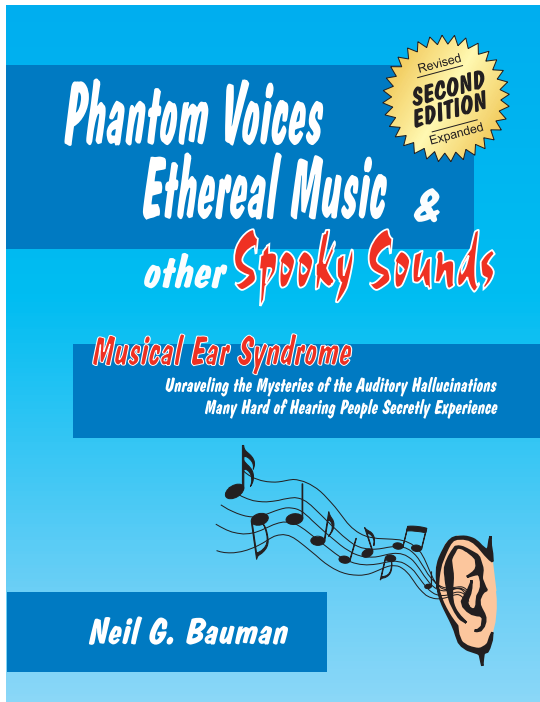
Take Control of Your Tinnitus—Here's How
(\$39.95; eBook \$29.95)

If your ears ring, buzz, chirp, hiss, click or roar, you know just how annoying tinnitus can be. The good news is that you do not have to put up with this racket for the rest of your life. You can take control of your tinnitus. Recent studies show that a lot of what we thought we knew about tinnitus is not true at all. Exciting new research reveals a number of things that you can do to eliminate or greatly reduce the severity of your tinnitus so that it no longer bothers you. This totally-revised, up-to-date and expanded 8th edition contains the very latest in tinnitus research and treatment. In this book you will learn what tinnitus is, what causes tinnitus and things you can do to take control of your tinnitus. (684 pages)

Hypersensitive to Sound? Successfully Deal with Your Hyperacusis, Recruitment & Other Sound Sensitivities (\$39.95; eBook \$29.95)

If some (or all) normal sounds seem so loud they “blow the top of your head off”, or make you wince or jump, or cause you headaches or ear pain, or affect your balance, or result in fear or annoyance of sounds so you feel you have to avoid these sounds, this book is for you! The good news is that you don’t have to avoid noise or lock yourself away in a sound-proof room. This book teaches you to how to successfully deal with your hyperacusis and various other sound hypersensitivities. (544 pages)



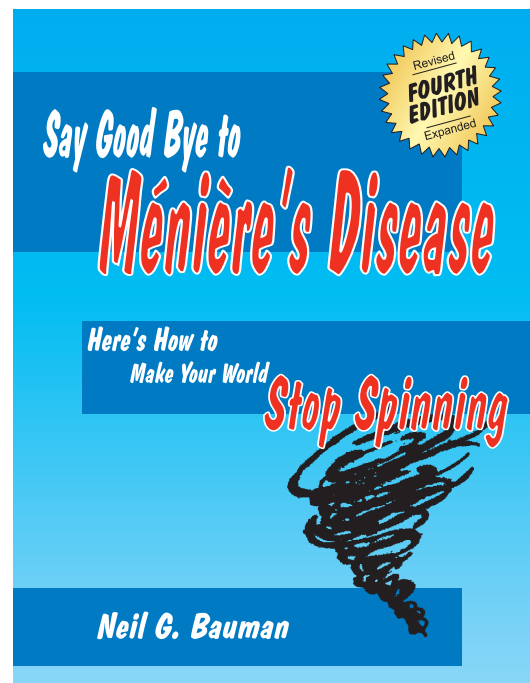


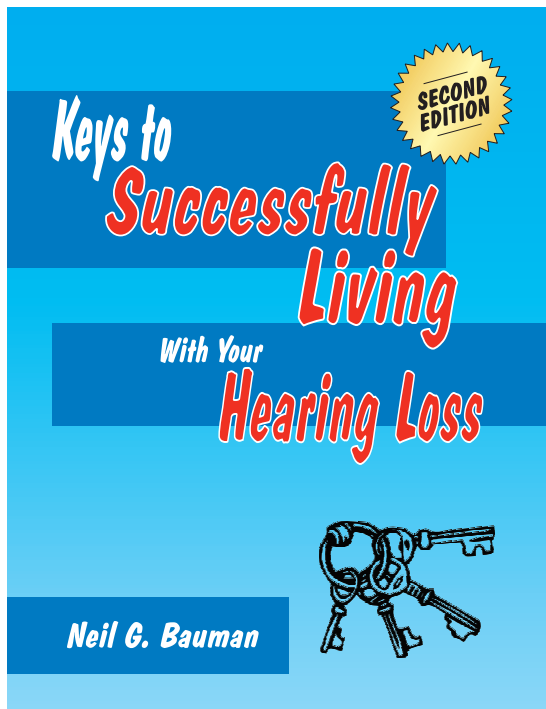
Phantom Voices, Ethereal Music & Other Spooky Sounds (\$22.49; eBook \$16.99)

When you realize you are hearing phantom sounds, you immediately think that something has gone dreadfully wrong “upstairs”—that you are going crazy. Because of this, few people openly talk about the strange phantom voices, music, singing and other spooky sounds they hear. This book, the first of its kind in the world, lifts the veil on “Musical Ear syndrome” and reveals numerous first-hand accounts of the many strange phantom sounds people experience. Not only that, it explains what causes these phantom sounds, and more importantly, what you can do to eliminate them, or at least, bring them under control. (178 pages)

Say Good Bye to Ménière's Disease—Here's How to Make Your World Stop Spinning (\$21.95; eBook \$16.49)

Ménière's disease is one of the more baffling and incapacitating conditions a person can experience. If you suffer from your world spinning, have a fluctuating hearing loss, tinnitus and a feeling of fullness in your ears, this book is for you. It details what Ménière's disease is like; explains the recent breakthrough into the underlying cause of Ménière's; and shows you how, at last, you can be free from the ravages of this debilitating condition. Each page is packed with practical information to help you successfully conquer your Meniere's disease. Join the hundreds and hundreds of people whose worlds have now stopped spinning (128 pages).



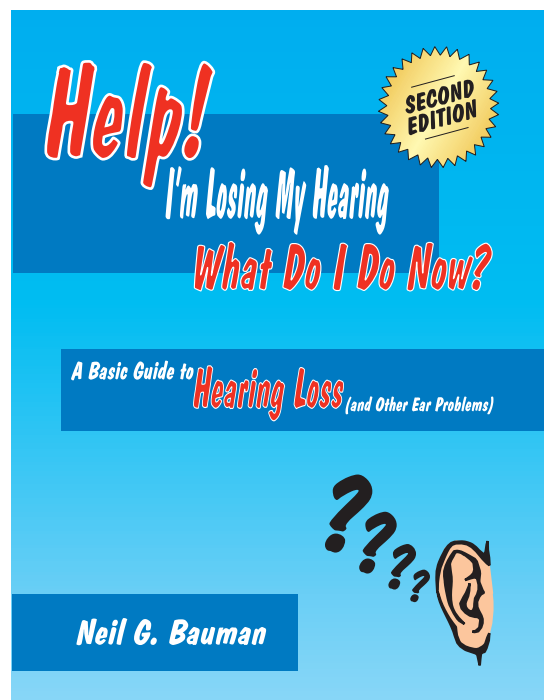


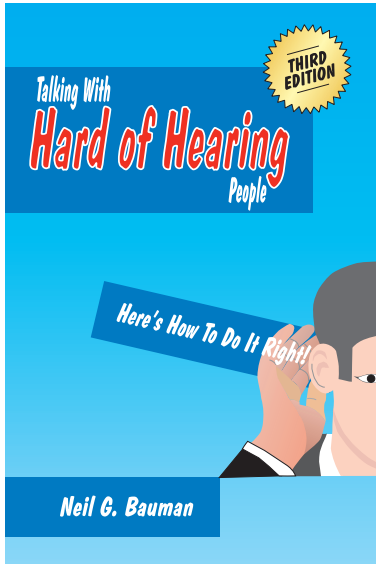
Keys to Successfully Living with Your Hearing Loss (\$19.97; eBook \$15.49)

Do you know: a) the critical missing element to successfully living with your hearing loss? b) that the No. 1 coping strategy hard of hearing people instinctively use is wrong, wrong, wrong? c) what the single most effective hearing loss coping strategy is? d) how you can turn your hearing aids into awesome hearing devices? This book addresses the surprising answers to these and other critical questions. Applying them to your life will put you well on the road to successfully living with your hearing loss. (84 pages)

Help! I'm Losing My Hearing—What Do I Do Now? (\$18.95; eBook \$14.49)

Losing your hearing can flip your world upside down and leave your mind in a turmoil. You may be full of fears, wondering how you will be able to live the rest of your life as a hard of hearing person. You don't know where to turn. You lament, "What do I do now?" Set your mind at rest. This easy to read book, written by a fellow hard of hearing person, is packed with the information and resources you need to successfully deal with your hearing loss and other ear conditions. (116 pages)



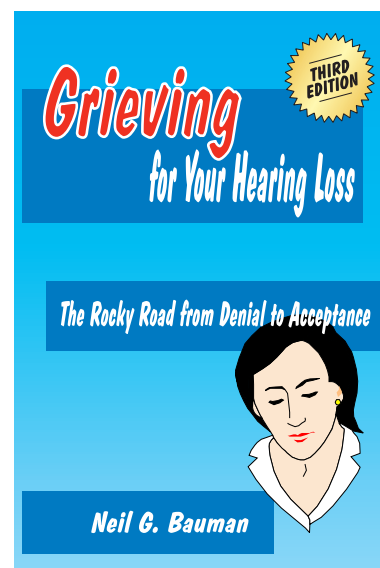


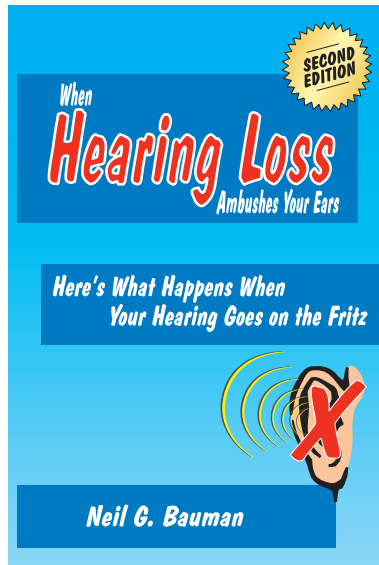
Talking with Hard of Hearing People—Here's How to Do It Right! (\$9.95; eBook \$7.95)

Talking is important to all of us. When communication breaks down, we all suffer. For hard of hearing people this happens all the time. This book is for you—whether you are hearing or hard of hearing! It explains how to communicate with hard of hearing people in one-to-one situations, in groups and meetings, in emergency situations, and in hospitals and nursing homes. When you use the principles given in this book, good things will happen and you will finally be able to have a comfortable chat with a hard of hearing person. (38 pages)

Grieving for Your Hearing Loss—The Rocky Road from Denial to Acceptance (\$12.95; eBook \$9.95)

When you lose your hearing you need to grieve. This is not optional—but critical to your continued mental and physical health. This book leads you through the process of dealing with the grief and pain you experience as a result of your hearing loss. It explains what you are going through each step of the way. It gives you hope when you are in the depths of despair and depression. It shows you how you can lead a happy vibrant life again in spite of your hearing loss. This book has helped many. (56 pages)



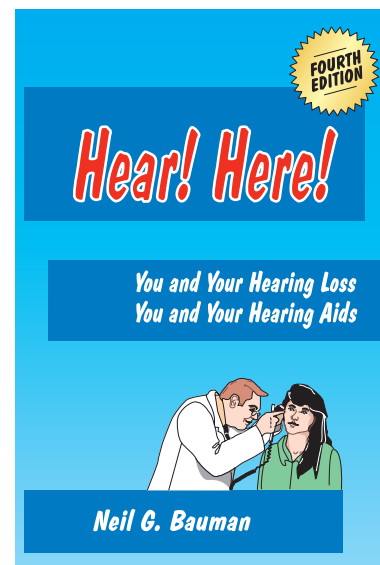


***When Hearing Loss Ambushes Your Ears—
Here's What Happens When Your Hearing Goes
on the Fritz*** (\$14.95; eBook \$11.95)

Hearing loss often blind-sides you. As a result, your first step should be to learn as much as you can about your hearing loss; then you will be able to cope better. This most interesting book explains how your ears work, the causes of hearing loss, what you can expect to hear with different levels of hearing loss and why you often can't understand what you hear. Lots of audiograms and charts help make things clear. You will also discover a lot of fascinating things about how loud noises damage your ears. (88 pages)

***Here! Here! You and Your Hearing Loss/
You and Your Hearing Aids*** (\$12.95; eBook \$10.95)

Part I of this book contains a series of my newspaper articles on hearing loss such as, "Hear Today. Gone Tomorrow?" "Hearing Loss Is Sneaky!" "The Wages of Din Is Deaf!" "When Your Ears Ring..." "Get In My Face Before You Speak!" "How's That Again?" "Being Hard of Hearing Is Hard" "I'm Deaf, Not Daft!" Part II contains articles on hearing aids such as, "You Better Watch Out..." "Before Buying Your First Hearing Aid..." "Please Don't Lock Me Away in Your Drawer" "Good-bye World of Silence!" "Becoming Friends with Your Hearing Aids" "Two's Better Than One!". (56 pages)



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