Managing the Musician with Hearing Loss: Treatment Considerations, presented in partnership with Salus University

Presenter: Brian J. Fligor, ScD, PASC

At this time it is my pleasure to introduce Dr. Fligor presenting managing the Musician with Hearing Loss Treatment Considerations presented in partnership with Salus University. Dr. Brian Fligor is a board certified pediatric audiologist and Chief Audiology Officer at Lantos Technologies in Massachusetts. He maintains a private clinical consulting practice, Boston Audiology Consultants, geared towards diagnosis and treatment of hearing disorders in musicians and audio professionals. Prior to joining Lantos, Dr. Fleiger was director of Diagnostic Audiology at Boston Children's Hospital and Assistant professor at Harvard Medical School. He is also adjunct faculty at Salus University, a consultant, member of the Children's Oncology Group, Chair of the World Health Organization Make Listening Safe Task Force on Manufacturing Standards of Headphones, and founder and past chair of the Music Induced Hearing Disorders Task Force for the National Hearing Conservation Association.

Welcome back Dr. Fligor and thank you for being with us today.

Thank you all for having me. Christy, thank you so much for that introduction. Thank you folks for joining. This is really exciting. I love giving these presentations for Audiology Online and I love that this is a nice connection of, you know, my relationship that I've had with Audiology Online now going back 11 years.

They've been a fantastic platform and then as well my relationship with Salus University where I am an adjunct professor in the International AuD Bridge program. And so I guess here one day before Thanksgiving, I want to just acknowledge my gratitude to both Salus and to Audiology Online and I want to express my gratitude to people who are participating here in this presentation. So thank you so much for that. This is an hour and a half long presentation between this presentation I'm giving today and a 90 minute presentation that I gave last Wednesday. This encompasses a semester's worth of material on working with musicians, taking care of musicians, preventing hearing loss and other music induced hearing disorders as well as treating them well.

So today is about that treatment side. Principally what we are going to talk about here today is prioritizing their condition, their injury. Do we address the tinnitus? Do we address the hearing loss? Do we address their hyperacusis?

We're going to talk about that and go into just a little bit on that treatment side. Just specifically what do we do about it? We are going to be talking about hearing aid fittings. There is not a perfect recipe for fitting musicians with hearing aids. Sometimes the recipe is don't fit them with hearing aids or at least yes for their normal everyday communication.

But no, for some of these people when it comes to their, to their performance or to their listening enjoyment. So we'll be going into that. One thing that I won't be going into today is cochlear implant mapping for musicians. That's something that honestly is just outside of my area of expertise. There are audiologists who are specialized, in fact, have their cochlear implant specialty certification and do work deeply in helping musicians to hear that music better through their implant.

That's something that I encourage you all to go explore, but it's going to be something that I'm not incorporating into today's talk. I have my disclosures here. Please take a look at them on the website if you have any, or on the slides. If you have any questions about this or it calls into question any of the materials that I present here today, send me a message and let me know. I always want to make sure that I'm transparent in what my financial biases might be, my non financial biases.

And this is important for us all just in terms of understanding and considering the content that I'm presenting.

I did mention this. Our learner outcomes is about prioritizing the significance of why the person is coming in to see us. If you have some existing background knowledge on managing tinnitus, I want to build upon that. I hope to. If you don't have a really strong background in tinnitus management, some of

this I'm going to move kind of fast and I do encourage you to come back to it.

But for those of you who do have a strong background in tinnitus management, I want to give you a few extra things to think about and to consider as well. I want to kind of give you a few extra tips and tricks. And as I mentioned, we're going to talk about hearing aid programming and hopefully we're going to get into some deep dives on that.

So last week, last Wednesday, I gave a fundamentals, quote, unquote presentation. And just as a very brief perspective on this, we talked about music as a source of noise, induced hearing loss as a source of auditory dysfunction or the term that I do like to use is the term injury. I don't call it hearing damage. I call it hearing injury. I don't call it an impairment.

There's a lot of negative connotations to the word impairment. It may be medically appropriate, but socially it could be a third rail. And I don't really even call the hearing deficit or how do I put this, that permanent threshold shift that is a noise notch. For instance, I don't use the word loss. It is again, it's factually correct.

But I like to focus on the word injury because I think that it communicates something important for a musician to hear that this is something that is. Is consequent to an injury that they sustained. Whether that injury was something that developed slowly over time or it was something as a result of an acoustic trauma. These are important words to use to help that musician understand what their experience has been and that you're that healthcare provider who's going to address their injury. In that presentation, I talked about the diagnostic process for evaluating their hearing loss, their tinnitus, their hyperacusis, and their diplocusis.

The ways that we approach this is a little bit different. It's a bit more in depth, but there are good, solid ways that we can follow each one of these. I did go into not a ton of detail, but I did go into hearing loss

prevention through the use of custom hearing protection devices. We're going to talk just briefly about some of that again today, and we're going to go into much greater detail literally on the treatment side and last time, and I'm going to repeat it again today, is that when we're working with anybody, frankly, but particularly for this group, treat the patient, not the audiogram. That was this mantra that one of my professors in grad school used over and over again.

And frankly, at the time, it was quite annoying. And I find myself using it over and over again myself. It's almost like, you know, those phrases that my dad used to use when I was a kid making sure that I ate all of my. All of my steak. You know, there are kids starving in China.

And of course, I find myself using these same phrases now that I'm a dad. Well, same thing with this professor. Treat the patient, not the audiogram.

So we're diving right in. Let's. I want to talk about tinnitus first, because tinnitus is the most common reason why a musician comes to see me. They do not come to see me because, well, I have difficulty hearing. 4000 Hz.

They don't see me because, well, I think that I'm going to lose a little bit of hearing or I'm going to lose some hearing. It's. My friend has tinnitus and I don't want to get it. I had a really bad tinnitus experience. Thank goodness it went away.

But I don't want to get that again. And oh, my gosh, I would be terrified if this happened. The most frequently reported problems with bothersome tinnitus is getting to sleep. And I do list that bullet point first, because that's an important one. Getting to sleep.

For tons of reasons that we could go into for the next hour, but we won't. Getting to sleep, the persistence of the tinnitus, that it's there that they can't escape it. To a very large extent, it's the fact that

it is an internally generated perception as opposed to an externally generated perception.

There's the reported problem that, well, the tinnitus interferes with my ability to understand speech. Now that kind of strikes us a little bit interesting because it's like, well, actually, is that a concomitant hearing loss that's actually interfering with your ability to understand speech? I would argue yes and no. For some people, that ability to understand speech, certainly it requires, you know, concentration and cognitive load. And the tinnitus itself may be drawing that cognition over to attention to the tinnitus as opposed to attention to what people are saying.

The comorbidity of depression or anxiety is the underlying point on this. Despair, frustration, depression. Most frequently reported problem, annoyance, irritation, inability to relax. The inability to relax is a really, really big deal. And then of course, that poor confusion, Poor concentration or confusion.

So I'm going to play for you all a sound clip of one of my former students, tinnitus. This gentleman is an audio engineer by background, he's a musician by background turned audiologist. And he has a music induced tinnitus. And given all of his time and experience going through, you know, being able to do loudness and pitch matching for tinnitus specifically, but then also being able to generate signals, he did the service of putting this together and giving me a perspective on what it is that he hears all day, every day. So I do warn you a little bit for those of you who do have tinnitus and that this is something that you struggle with yourself.

You may either just bring the volume down considerably or you may just kind of put it on mute for a little for like about 10 seconds. Okay, but just to play this, what I want, if you are going to listen to it, I want you to listen across how multi tonal this is and where there's some sounds down in very low bass frequencies and then how there's some really high frequency stuff. Okay, so here we go.

So it's a combination of narrow band noise, a high frequency hiss, a tonal tinnitus as well as like a low frequency. Not a rumble per se, but it's. To me, it almost sounds a little bit like a wind tunnel.

For those of you who don't have tinnitus but have had to manage patients who have tinnitus. The When I, when we talk about how do we diagnose it, how do we address their tinnitus, how do we think through what the experience is for them, how clinically significant it is. I really focus strongly on those self reported questionnaires, particularly the tinnitus Functional Index, the tf, the tfi, which was a questionnaire that's validated. It is the best one we have at this point in time. It was published in Ear and hear in 2011.

Mary Meikle and a slew of other colleagues, if they've done work in tinnitus, their name was almost certainly on the paper. That said that also does not give their loved one the understanding of well, what is it that they hear doing loudness and pitch matching. While it's not necessarily diagnostic or helpful in that way, and to some extent it may cause the person to, to perseverate on their tinnitus and at least temporarily really have their tinnitus front and center, which can be a real struggle for them. If you're able to document it in this way, it may help other people to understand what it is and can give that person who does have the tinnitus and they're, they're bothered by might help them to feel validated.

So dealing with tinnitus, our diagnosis into our management of it. We know that there's a very high rate of comorbidity with anxiety and depression. Okay. If we think about our musicians, if we think about our more kind of right brain dominant creative types, there's a sort of a stereotype around, geez, you know, that musician, they're a little bit flighty and they, they like to, you know, go off in their own little philosophy and in their own little world. And you know, they're also, you know, they abuse medications, they abuse drugs and you know, they're not always in touch with reality.

Well, you know what, it may be that those are all personality traits and just part of that person's cognitive makeup that is part of what allows them to access those super creative sides of their mind

while at the same time putting them, you know, kind of like having a low trigger for having behavioral health issues perhaps may in fact already be depressed before they end up with tinnitus. They may already have generalized anxiety disorder before they have tinnitus. If they now get tinnitus, obviously that's going to exacerbate what is already there.

Something that's incredibly important. This is just on a general review. This came from my training, from my tinnitus mentors. And if you read any of the work, any. Well, if you read just the underlying tenets of the work by Jastreboff and Jim Henry and most any other tinnitus specialist, it's trying to decouple your perception of the tinnitus from your reaction to it.

This is the same approach that psychologists and other mental health professionals take in dealing with chronic pain. People who have chronic pain, you move them over to, in a non judgmental way, experience that pain and sit with it kind of in a mindfulness type of approach. You experience the pain, you know what it is, but you know that it's not physically damaging anything. Right now you, you look at it from an objective, maybe a little bit of a caring perspective and in doing so, experiencing it in a non judgmental way, you separate your reaction to the pain or reaction to the tinnitus from your perception of it. Because we may not be able to cure tinnitus, we may not be able to cause the perception of tinnitus to habituate where you just no longer experience it.

Your brain says that's not an important signal. I know that's not important. It's just going, I'm just going to forget about it. Well, that's habituation of perception. That's delightful.

That's lovely when that happens and that does not happen a lot. And in fact there's very little that we or any other healthcare professional can do to habituate your perception of the tinnitus that would be quote, unquote, curing the tinnitus. What we can do, and this is through combination of treatment options which we're going to talk about today, is we can help the person habituate their reaction to the tinnitus that, well, I hear it, but I don't care anymore. And in fact, I've had patients, and I'll even give that

as a case example today, I've had patients whose reaction to the tinnitus habituated so completely that they forgot that they could hear it to the point that you could truly say that their perception habituated as well. So rather than focusing on getting their perception of the tinnitus to go away, get their reaction to the tinnitus to go away and the perception may follow.

The reaction to the tinnitus is an inappropriate assignment of importance to the tinnitus. This results in the limbic system expressing a fear reaction. Our limbic system is our thalamus, our hippocampus, our amygdala. Those are the three main Structures that are responsible for, for arousal, attention, hunger, desire for sex, desire for cocaine.

That reward system coupled with our emotional center, our amygdala, coupled with our long term memory, our hippocampus, very interestingly, our sense of smell and our sense of hearing do not go through our sensory gating system where I choose to pay attention to it or I won't pay attention to it. Rather than go through sensory gating, our hearing and our sense of smell go directly into our limbic system where it is immediately either assigned good or bad. And where tinnitus is a new experience and it's not altogether pleasant. And in fact oftentimes it would be deemed annoying. Limbic system says what's that?

That's new, that's bad. Danger, danger, danger. And so the panic alarm starts going off. And this is where a person can have a panic attack. Only because of the tinnitus is persistent, it's not going away and it's continuing to trigger this sympathetic response.

That is a panic attack. That is like all the blood is draining out of my gut, my heart is racing, my palms feel clammy. That is a sympathetic response of the autonomic nervous system state or fight or flight that you get locked into. You remain in this hyper anxious state. You might imagine basically walking around all day every day.

Having a panic attack is no way to live your life. And you can appreciate that this causes people outrageous levels of distress. And it's because of this that I say tinnitus is much more important than a permanent threshold shift. So presentation of tinnitus. I've talked about this just a little bit and we got to listen to my former students tinnitus, this.

Does the tinnitus pitch matter? Okay, if it's tonal at all, it's often multi tonal, it may be more well. And if it in fact is tonal, very often it's pitch matched to the just on the low or on the high frequency side of a noise notch. Perhaps it can be centered right on the notch, but frankly we don't do fine enough testing. Like, you know, what's the hearing sensitivity at 3900 Hz?

What's the hearing sensitivity at 3800 Hz? 3400 Hz. Now we don't do quite, I mean we're cutting with a butter knife when we're doing an audiogram. If we did bekochy audiometry we'd actually be able to see like these little dips and recoveries throughout. But anyway, their pitch match is going to be somewhere close to the frequency of their noise notch.

By the way, I will be taking Q and A at the very end for the most part, but here and there I'll keep an eye on the Q and A section. Thank you Stuart for participating in this. Just made a comment about that's a nice sound sample of tinnitus. Stuart, with my former student's permission, I'll send it over to you. He's.

This student is absolutely he's a phenomenal audiologist and I'm so proud that I got to work with him. And he does some really awesome stuff. So perhaps he can hook people up with a few other simulations. Okay. Does the Tinnitus loudness matter?

So according to Snow, which if you want a primer in tinnitus, I recommend that you read the Snow book front to back. Jim, is it Jim Snow? I have to look it up. Published in 2004. Shoot me an email all of you if you have any questions or if you want this reference.

I read this book cover to cover. It actually is really exciting and interesting. If you feel that you need to know and understand tinnitus, oh my goodness. Read this book. So according to Snow, most tinnitus is loudness matched to within 12 decibels of the threshold of hearing sensitivity.

As in the tinnitus may seem like it's quote unquote loud to the individual, but if you do an intensity match. So take the audiometer and you adjust that tinnitus in one decibel or sorry, you adjust this though a comparative signal in one decibel steps, it's typically within 12 decibels of their hearing. Their threshold of hearing sensitivity across individuals. Someone may say oh my tinnitus is like 15 decibels above the auditory threshold. Another person It's 2 decibels of above auditory threshold.

Their reported level of suffering does not correlate with the absolute sensation level. The person who reports their tinnitus as being 15 decibels above their threshold may not care, but the person whose tinnitus loudness matches to 2 decibels above their threshold of hearing, they're devastated by it. Now that's across individuals within individuals. If somebody reports that their tinnitus is 4 decibels above their threshold of sensitivity, if you loudness match to that and then an event occurs and now they loudness match it to 6 decibels above. So it went louder by 2 decibels.

Yep, they are going to have a very likely anyway, not one for one but highly likely that they will report stronger reaction to their tinnitus not the perception of the tinnitus, their reaction to it. Their reaction will be stronger if the tinnitus is perceived as being louder. And consequently their reaction to the tinnitus will be less if the loudness is perceived as being lower. So within an individual, the sensation level does matter.

Tinnitus oftentimes, but not always, can be masked. You could present pink noise or white noise or speech shaped noise to that individual. When they're in the booth and you work with them, you say, basically, push the button as long as you hear your tinnitus and you slowly bring up your masking noise in that ear. And if they release the button, as in, yeah, I don't hear my tinnitus anymore, cool, let's stair

step this a little bit. Go a little bit louder, A little bit louder.

Like a couple of decibels. Do one DB step sizes. You bring it back down below that minimum masking level they reported and they should push the button again if they hear their tinnitus again and then you slowly bring it back up again. And if they release the button, meaning, oh, I don't hear my tinnitus anymore, you kind of bracket that and that's where you identify their minimum masking level. And that can be really helpful when you work with, say, tinnitus maskers, it can be really helpful if you do some kind of sound enhancement, you know, for instance, to help people to achieve sleep.

Barring sinister medical sources, the problem is not the tinnitus itself, but the patient's reaction to the tinnitus. If you walk out of this talk today knowing nothing else, it is this slide, slide number 12, that as long as they have been medically cleared, that there is not some underlying disease process that needs to be addressed medically. As long as they're not an underlying disease process, it is not the tinnitus itself. The tinnitus is neutral. The tinnitus is technically, it's neither good nor bad.

It is neutral. It's of no. It should therefore be of no consequence. But the person's limbic system has inappropriately assigned a reaction to it, a negative reaction. It activates their sympathetic response of the autonomic nervous system.

That's neurospeak for it triggered their fight, flight or freeze response. And because the tennis is persistent, the person with the tinnitus is locked in that state of hypervigilance and in their anxiety, fear, their dread.

So what do we do about it? Well, as hearing healthcare providers, we have to find something that's going to address their reaction to it. So first and foremost, being able to describe this as, you know, it's an understandable and normal experience that one would have to an auditory injury that something happened. There's injury to your auditory system. And so therefore, one of the responses that your

auditory system had to that, one of the consequences is this, this sensation, it's not a sound.

It's, you know, for lack of a better description of it, and this isn't totally correct, but lacking better description, it's your auditory nerve fibers that are described firing a little bit faster than they're supposed to at rest. It's circuit noise. It's where, you know, if you have, you know, your guitar amplifier turned, the gain turned way up, you can hear the circuit noise in that amplifier. In our hearing aids, we as audiologists, we think about, well, what's the noise floor on the hearing aid? And, you know, is my person's hearing sensitivity in the low frequencies so good that they're going to hear the circuit noise?

That's, that's tinnitus. It's circuit noise in our own neural pathway and it is being perceived in the auditory cortex. We have good PET scan data, positron emission tomography data, showing that people with tinnitus, you. It lights up auditory centers of the brain. It's, it's there.

It's not that it doesn't exist. It absolutely exists. It causes neurons to fire when they shouldn't be firing. If you demystify this, that's a real tenet of tinnitus retraining therapy as the demystification of the tinnitus, that can go a long way to help alleviate the person's reaction. Stress causes tinnitus to be worse.

The stress could have absolutely nothing to do with their tinnitus, but it's going to make it more difficult for them to cope with their tinnitus. So focusing on efforts for stress reduction, whether that be massage, deep breathing, meditation, exercises in mindfulness, acupuncture, you know what? Eastern medicine may not be understood by the FDA as being safe and efficacious for treating disease. One, two, or three. But oftentimes the focus is on reducing stress.

And if you feel less stressed, you feel better, and if you feel better, you are suffering less.

Tinnitus interventions. This is right in our sweet spot. And really where we need to exist and be experts in is in that sound enhancement side. It is not just about fitting with the tinnitus masker or a combo

hearing aid tinnitus masker. Is it about.

It is about identifying something that will take the edge off of their perception of the tinnitus or perhaps even when it's appropriate to mask it all together. There is real benefit in going through tinnitus retraining, therapy training, where you become an expert or certified actually in trt. Myself, I've had a wide background in managing tinnitus and in the work that I got more along the lines of progressive tinnitus management, which does incorporate some of the tenets of trt, but it's a little bit more holistic. Other interventions include behavioral health, including cognitive behavioral therapy or talk therapy or cognitive therapy. There's slight differences in those.

If you as the audiologist are trained as a behavioral health specialist, 100%, you absolutely should engage in it. Obviously, I'm not advocating that anyone step outside of their scope of practice, But I will tell you that my own experience working with tinnitus patients, when I have them also seeing a general behavioral health specialist, such as a social worker with specialization in psychotherapy or a psychologist or a psychiatrist, that they know less about the tinnitus by far than I do. And we've been able to tag team doing cognitive behavioral therapy and people have had much better outcomes as a result.

It is my opinion that people who require high prioritization of their tinnitus therapy should be evaluated by a psychiatrist and considered for anti anxiety or antidepressant medications. Not everyone wants to go on anti anxiety medications. It's personal choice. It's discussion between them and the psychiatrist. That said, there's absolutely 100% a place for it.

Antianxiety medications are the one medication that has been demonstrated and accepted by the FDA as being safe and efficacious for addressing tinnitus. It doesn't address the tinnitus. It addresses their generalized anxiety disorder and therefore makes their tinnitus perception something that they don't react as strongly to. Last piece, and again, this is really right there in our wheelhouse is let's not make

their tinnitus worse. As in, they need to be enrolled in a hearing loss prevention program, which does include earplugs and custom earplugs.

But it also includes other things such as understanding what their sound exposures are, arming them with a sound level meter or a data logging app on their iPhone. And yes, there can be some really good ones out there that can monitor truly what their sound level. And this can empower the individual to know, am I in a dangerous situation, like dangerous to my hearing, or is this loud? But it's perfectly okay. It's really Impressive that people will think that sitting in the cafeteria section of a Whole Foods, they will think that this is going to be something that's going to have a devastating impact on their hearing when in fact the ambient noise levels are around 68 to 72.

And if you listen to my lecture from last week, you will see that that 68 to 72 decibels is below the criterion level for causing hearing loss in anybody. And if it can cause hearing loss, it can cause tinnitus. If it cannot cause hearing loss, it may trigger tinnitus. But that's more of a behavioral reaction. It is not a temporary onset of tinnitus.

So getting right into that treatment side I talked about, you know, the sound enhancement thing, the intent of this sound enhancement is to alleviate at least to some extent their perception of their tinnitus. If the individual's tinnitus can be masked and the tinnitus cannot always be masked, but if it can be masked, then well, we owe it to them as one of those, one of those ways to get some sense of control back. See, it's that whole persistence of tinnitus. I'm out of control. If we get the 10, if, if we give them a sense of control then they, their, their reaction to their tinnitus, their suffering immediately lessens.

So things as straightforward and simple as just putting on music, you know the old Brookstone like water fountain, things like the recycled water going through, they're soft, they're in the background, they're not attention getting. But it can be one of these things that's just super, just like a nice thing to enhance the ambient sound levels in a room. And as particularly when the tinnitus sufferer is in quiet,

that everything is just much more present. Their tinnitus is front and center. Like the analogy of a birthday candle that you have in a room.

If it's the only light source, that's the only thing you can pay attention to. However, if it's the middle of the day, all the lights are on, curtains are open and sunlight is streaming in that birthday candle. It could be right in the middle of the room and you'd easily walk right past it.

There's white noise or pink noise generators. I have a couple of apps that I put here on the screen. One of them is called Sleep Sounds Light. This is just, it's a free download app that I've used when I actually I do have tenant. It's a high frequency tonal tinnitus.

And I actually personally I liked putting on heavy Cs sometimes I'll put on either a white noise or pink noise. The middle app here that I'm showing, this is an app called Audio Tools. It's a $20 download, but it's actually one of the best apps I've used, both signal generating as well as signal measuring. And I'm a big fan of it. It's just, it's nice to have this.

You can present it through headphones if the person wants to use headphones, or you can just have it in a speaker, just ambient in the room. Some of the hearing aid manufacturers do make tinnitus apps, and I'm a fan of those. I think they're very nice. Some have a little more control than others. Certainly you have to think through what am I presenting here to my patient.

Am I advocating for a certain manufacturer rather than advocating for my own care? But that said, these are some really nice apps, and I think that it behooves us to be prepared to talk about them and have them readily available. Yes, it is appropriate for us to fit patients with tennis maskers. It's appropriate if they have hearing loss. We fit them with hearing aids and the hearing aids will amplify soft sound in their environment that previously was not masking their tinnitus.

And now if that refrigerator hum is one that the person who first gets hearing aids says, oh, yeah, my refrigerator makes a noise, look at that. Or, huh, I didn't realize that my laptop had a noisy fan to it and they now hear it. Well, those environmental sounds that they previously hadn't heard may be perfectly adequate to mask their tinnitus or at least mitigate their perception of it. And it'll cause them to feel less stressed about their tinnitus. And yes, all the major manufacturers include some kind of tinnitus management, you know, a masking that's in them.

My own experience has been that more often than not, I do fit patients who have hearing loss and tinnitus. I fit them with a device that has Bluetooth connectivity so that they can stream an app directly to their hearing aids. Because an app like the sleep sounds or like one of the hearing aid manufacturer apps or a white noise generator app, that there's so much more, so many more options for different sounds for the person to listen to, like multiple different campfire sounds, multiple different summer night sounds sounds, multiple different water sounds, for instance, that you don't have that luxury or that capacity to do that in the hearing aid itself. And sometimes just the quality of it is better. It may chew up battery life, but I'LL tell you going through a battery every day.

But to have your tinnitus mitigated, I mean, it's like $1.50. It's absolutely 100% worth it. And my goodness, as we're getting into, you know, lithium ion rechargeables, sure, they may get like 12 hours of use instead of 16 hours of use. Just. I strongly encourage people to go to Bluetooth connectivity and give the individual some more control over what they're going to deliver into their ears.

The reason for this is, and this I cannot stress enough how important it is that when you approach sound enhancement for tinnitus therapy, that you identify a sound that is more pleasant than their tinnitus is, or at least not as annoying as their tinnitus. Because if you pop on white noise or you pop on a tinnitus, a shaped noise into their tinnitus mask, or they say, and you ask them, okay, well, does this. Do you not really hear your tinnitus this much? And they're like, well, yeah, right? No, I don't.

And if they come back to you and say, yeah, I don't hear my tinnitus as much, but this sound in there is just so annoying. Well, you've literally just exchanged one annoying sound there, tinnitus for another annoying sound, a white noise, you know, in their hearing aid. And you've not addressed their reaction to their tinnitus. You've just given them something else to react to. So some of the things I do on my intake with patients with tinnitus, I asked them a question that actually came out of the National Hearing Conservation association, nhca.

Ask them, what's your favorite sound?

It's an interesting question to ask anybody. I would ask each one of you who's in the audience, what's your favorite sound?

I want you to think about that. I want you to write that down next to you. You just write it down. And here at the end, maybe we'll go through it a little bit. When you ask a person, what's your favorite sound?

And you. You find that sound in an app and you stream that to their hearing aids, they're now going to be able to listen to their favorite sound over their tinnitus or beside their tinnitus, and all of a sudden, instead of this negative, get away from me and I can't escape my tinnitus, you're giving them an auditory experience that is not annoying or disruptive or painful or scary. You're giving them a sound experience that is more enjoyable. There's a lot that goes toward relief when you do that.

So I'm going to ask a really interesting question and I am certain that unless you've heard one other talk that I've given, I've only given this, this kind of information at one other thing. So I am certain that you've not heard this before. And that's really, I don't know. We'll see if you all agree with me or disagree with me.

When we do masking, say for testing hearing. So you know, we mask the contralateral, contralateral ear so that the contralateral ear does not participate in the detection of a signal like a pure tone. For instance, say we have an asymmetric hearing loss and you don't want crossover whether it's by bone conduction or air conduction. When we do that, we present a narrowband noise to the contralateral ear. We do that to keep that other ear busy.

We elevate the threshold of detection in that ear by presenting noise that is centered in 1/3 octave around that test frequency. That is called energetic masking. Energetic masking is literally it's just giving a sufficiently intense sound so that it prevents the peripheral detection or the neural encoding of a target stimuli. Alright, truly this is where you're leaning in and you're shouting to your friend when you're at a rock concert. And you know, because they can't hear you because the sound around is just occupying 2 know that, that those frequency ranges in your, on your cochlea in order for you to actually hear what the person is saying.

That is energetic masking. The 10 test testing for cochlear dead regions that uses energetic masking ipsilaterally. Now, informational masking is different. Informational masking happens all the time. We can think of it a little bit as like that central masking phenomenon that when you present some masking noise and it's audible, the person's detection threshold for pure tone may go up by about 5 decibels and it shouldn't have, but it did.

That's taking cognitive attention away. Informational masking is something like the cocktail party effect where you have speakers who are talking and there's content associated with it and it makes it difficult to, for you to pay attention to the target talker. And if you physically move those talkers off to one side so that it actually, it sounds louder and you know, actually hits your left ear earlier than it does your right ear and the person you're talking to is directly in front, you get this release from masking from that informational masking, you're able to pay attention to and hear out the person who's directly in front of

of you. This is some of the reason why our directional hearing aids work so well. It's not about the energetic masking.

It's the information that these competing bits of content, these words that are competing, are getting in the way. Think of it a little bit as your auditory processing disorder tests. It's a little bit hard to hear and listen if you have no processing disorder. It can be very difficult to listen. We.

Well, informational masking is something that exists. It interferes with our ability to hear and understand what someone is saying. And it turns out that musicians are just as susceptible to energetic masking as the rest of us. But they are highly, they're much less impacted by informational masking. Now I'm going to show you the results of an experiment that I did back when I was in grad school.

This is one of the very first research projects I ever got involved in 1997 in the lab of Gerald Kidd at Boston University. So this was a test to see whether or not musically trained individuals suffered the same negative context or same difficulties as people with non musical training and being able to hear out a target signal. Okay, so this, this experiment here, alright, so there's a non signal interview, non signal interval. And there's a signal interval. And it would be a play interval, a play interval, B.

The subject was supposed to say, okay, in A or in B was there a signal? Here's that signal, I'm gonna play it for you.

Okay? It was a pulsed 1000 Hz tone.

Okay? The two different conditions were this multiple burst, same condition where the competing noises were higher in frequency or lower in frequency. So along the Y axis here, this is frequency, so 200 Hz to 5000 Hz and the target signal was at 1000 Hz and no competing signal existed in 1/3 octave band around 1000 Hz. Okay, so there'd be some signal happening outside in higher frequencies or in

lower frequencies. And every pulsed tone, it would remain the same across that one second presentation that was in that multiple burst same.

I'm gonna play a multiple burst same interval.

Okay, I'm gonna play another multiple burst signal interval.

Oops, sorry, wrong one. I apologize. I just messed that up. Okay, doing multiple burst, same again. Listen for it and I'm gonna play a multiple burst signal again.

Multiple burst, same again.

These two are different. Listen to number. This is A and this is B.

The question I would ask you is in A or In b, in which one was a 1000 Hz tone played. I'm going to play another multiple burst same signal, but with the 1000 hertz louder.

It's in this one and it was not in this one.

The way the experiment ran was the research subject was supposed to say it was this. The signal I'm listening for was either in A or it was in B. And if they got it wrong, the 1000 Hz tone got a little louder relative to the other sounds. They got it wrong again. That signal got louder relative to the other sounds and eventually they'd be able to hear it out really well.

And for non musically trained people, this signal had to be actually fairly loud compared to in this multiple burst different scenario. This is where there was a lot of competing noises. But rather than remaining the same from one pulse to the next, it would change. It would randomly go from one signal

frequency to another signal frequency to another to another. And it sounded like this.

So this one has no signal in it, no signal.

And now this one has the signal.

No signal signal.

And I don't know if any of you are able to actually hear it. You can hear this. I'm going to play that signal even louder, but with that background masker.

Long story short, non musically trained people had to have the signal much louder in this multiple burst same than they had to have it in this multiple burst different. When the signal was the same, but the background noise varied from point to point, it was really easy to pick out the signal. But when that signal didn't vary, it was really hard to pick out the signal. And people had to make it a lot louder in this experiment in this condition than in this condition, musicians oftentimes it didn't matter. They needed this signal to be loud enough to be able to detect it, and then in the multiple burst same just as easily.

They were trained to hear out one signal amongst many other signals, even if those other signals were very similar.

Here were the results. Here on the Y axis, this is the mean difference. How loud did the signal have to be in the multiple multiple bursts same relative to the multiple bursts different. How loud did it have to be? So the more positive this number, the harder it was for the person to hear that 1000 Hz signal in that multiple burst same.

The smaller this number, the more similar it was. They really didn't need the multiple burst same to be much louder than the multiple bursts different condition musicians needed roughly about 9 decibels louder in the multiple same compared to the multiple bursts different. Non musicians needed about 26 decibels louder in that multiple burst same. They really had to have that 1000 Hz tone pushed out. So what does this mean and why do I even mention it?

What does this mean for working with musicians? And they're tinnitus musicians have specifically had ear training to help them to hear out this particular tone, this particular note, this particular pitch in and amongst an array of other musical instruments. The conductor is sitting there listening for who's out of tune, whose timing is off a little bit, who needs to perform a little bit better. Musicians are trained to be able to hear is my instrument in tune? How does my instrument sound?

How well does it blend with the rest of it in order to do so? They really need this. We know that when people with hearing loss go through musical training, their speech and noise testing gets better.

So when a person has musical training, it may end up being that it's, it's, it's not helpful to being able to effectively mask their tinnitus because the tinnitus is a different sound or may even, we may find something so very similar, but they still hear the tinnitus no matter what, because that tinnitus is internally generated, is not external, and so they are in fact able to hear that it is physically or it is perceptually different from anything we try to mask. I have found some musicians I cannot find. There is no minimum masking level for them. We are not energetically masking their tinnitus. We are trying to do informational masking of their tinnitus when we add sound enhancement in.

So just said this tinnitus behaves more like an informational masker than an energetic massacre. It commands attention away from physical sounds. Okay. And given that musicians are specifically apt at listening through competing stimuli for the target one, then they may have, well, they have reduced susceptibility to informational masking effects. And so therefore, when you try to give them a pleasant

sound to listen to or a sound that's less annoying than their tinnitus, and how your typical person is able to really focus in on that more interesting sound or that more pleasurable sound, and their tinnitus just falls to the background, the musician, by way of their training, they have been taught to listen in for those.

So masking may be less effective. I think that that bears understanding when you do, when you do your counseling, when you help them to set some kind of expectations as far as what the masking will do for them.

So to wrap up on tinnitus, some of the things that I Make sure that I do when I'm following these folks, is that we are going to try to focus on habituation of their reaction, as in help them to not care about their tinnitus anymore. One of the first things that I try to tell these people is this isn't your fault. You couldn't have known it was going to do this. Yeah, this was part of your experience, but it doesn't mean that you did this to yourself. You know, where were your, you know, music, your college of music if they were, you know, trained at the college level?

Where were your professors in helping you to understand that this was a potential injury that you might sustain? You know, we can be angry with them. We can be angry that the institution in general, or just musical training as just a overarching umbrella does not do a better job of helping musicians understand that this could happen. This is not something that you would have known in advance. And even if you thought, well, it might happen, there's lots of other people who have been exposed to the same sounds you've been, and they did not sustain this injury.

We don't know why you did, but you did. And so therefore, you know, this is not your fault. You don't bear the blame on this one. Helping people to understand that it's not the actual tinnitus itself, it's not their perception of it, but their reaction to it, and that the tinnitus is, in fact, it's just a neutral sensation. And we have lots of sensations that course through our body all the time.

And happily, our brain is generally very good at just not even letting our conscious become aware of it. Unfortunately, smell and hearing are two things that our brain does latch onto because it likes to do a threat assessment all the time for those particular incoming stimuli. And so hearing is just one of those things. It's an inappropriate overreaction to this sensation. That's not a pleasant sensation, but it need not be deemed as a threat.

Enhance that environmental sound, even if it's a musician who is highly musically trained and informational masking doesn't work on them, silence still isn't any tinnitus patient's friend. So therefore, let's enhance that environmental sound and let's not include silence as part of their experience. I say, in all capitals, ensure that their future exposures are less than 100% dose. Again, if you want to kind of go into understanding what is a noise dose, check out the last presentation, last week's presentation, and I strongly encourage connect with another team of providers in complementary fields as in make sure that there's not some underlying medical condition that's contributing to the tinnitus. Let's make sure that this person is connected to a behavioral health professional who can screen them for some really catastrophic thought processes and make sure that they're not a, you know, at risk for harming themselves or others.

And then you as the audiologist can educate them in helping them to understand what your role is and what you do for the patient. And when you create this teamwork, patients get better really fast. Ah, can't I just take a pill? Well, I did say that there's medications that have been, you know, accepted as being safe and efficacious for treatment of the consequences of tinnitus. And that is our antidepressant medications.

These are ones that it just generally just overall reduces your anxiety and, or depression. And so when the person is reacting to their tinnitus, they're reacting less to everything. And so therefore you have, you have someone who's a little bit better.

Clearly beware of the homeopathic remedies.

Internet cure alls do not work. If there was a cure for tinnitus, those people would probably win a Nobel prize. There is not a cure all, but there are things that can be taken, things that can be done to help alleviate their tinnitus stress.

So let me give you this case study just for presentation, just for perspective on this. So this is a guy, this is a few years back, but it's a rather unique case and this is far from typical, but it helps to illustrate some of the points that I just described. 55 year old musician. He was scheduled to see me, I think like two weeks out for me to fit him with musicians, earplugs. I got a call for him, I got a call, I can't remember what it was.

It was he called on Monday or his sister called on Monday saying, is there any way we can come in? And so basically it's a. I saw him on a Tuesday, which was like a week or something earlier than I had planned on seeing him. But the deal was that he played a loud show on Friday. On Saturday, while his tennis was happening, there was a family thing that, that occurred that was traumatic to him emotionally. His tennis was raging in his ears and he did not sleep on Saturday.

It was there all day Sunday. He did not sleep Sunday, it was all day Monday. He called in sick to work, he didn't sleep Monday. And then I saw him on Tuesday. Here's what happened.

He plays like at the local bar, you know, like Cover tunes and stuff like that. And his daughter and his son are members of his band and they're like in their mid-20s. So played a loud show. He left his ears, you know, he has tinnitus, as he actually often had tinnitus on that next day. That's when his mother in law, who had been living with he and his wife and his adult kids, she was moving into assisted living.

She became combative and then refused to move to assisted living. Even though they had discussed this, they had had decided this, they had understood this, this gentleman had to physically pick her up and carry her to whatever vehicle they were taking her in and forcibly bring her into assisted living. This woman had lived with him for years and was someone that he loved deeply. And to have to do this to her felt like such an outrageous betrayal. My heart still goes out thinking about what just happened.

This was emotionally traumatic for him, emotionally traumatic for his entire family. It was traumatic of course, for his mother in law. His tinnitus was going on. His tinnitus was present when this major emotional upheaval occurred. His reaction, this is what I'll posit to you all and you'll see if you agree.

His reaction to his tennis was in fact not to the tinnitus. His reaction was to that major emotional trauma that was coincident with his tinnitus being present. So this is just prior to me starting to use the tinnitus functional index. So this was a tinnitus reaction questionnaire. And so you can just see what his responses were.

My tinnitus makes, has made me unhappy, it makes me feel tense, makes me feel irritable, etc. Etc. Led me to cry. He answered a 4 on almost everything except some zeros and a 2 under. My tinnitus has led me to think about suicide.

That was just some of the time, not almost all the time. He scored a total of 94. The criterion for being considered clinically significant tinnitus, the TRQ on this questionnaire is a 17. This is really high score. And yes, this gentleman, I did have him go right over to see psychiatry on an urgent basis.

I had a psychiatrist that I routinely would see adult patients and got him in. And so just so you know, this is where his hearings, where his hearing was this particular day. Normal hearing through 2K. And then he had a mild to moderate sensorineural loss, 100% word recognition. He had normal tympanometry and his loudness discomfort levels were normal.

This is something that I would just do on each of these folks. This is a. I Did not test his acoustic reflexes on this day because yeah, he was a zombie. Meaning he really couldn't manage. He had not slept in three days. Here are his otoacoustic emissions.

You can see that some present emissions in lower frequencies and some reduced or absent emissions in higher frequencies. It all fits the same deal.

So he was scheduled to be fitted for musicians earplugs on his intake. His tennis reaction questionnaire score was a 94. Referred immediately for medical management. His lack of sleep, he had said I can't live like this for long. I appreciate him saying that he was evaluated.

They knew that he needed to just get into a better scenario. His primary care physician was the one who prescribed the Prozac. Turns out it was a low dose Prozac And I fitted him with ER25 musicians earplugs because I expected he's probably going to perform again and I don't want his hearing to go down. If we're successful, he'll perform. Fitted him with combination hearing aid tinnitus maskers obviously for use not during performance.

And his primary care physician referred him to a social worker for cognitive behavioral therapy. And he also saw me once a week for eight weeks as part of that informational counseling. This is where the social worker and I actually did some tag team.

So real ear measures on his hearing aids. Personally I think could have done a little bit better job fitting to target here in the high frequencies but it's where he liked it. We had, let's see in the blue hash. This was his tinnitus mask. This is with no background noise going on.

This is where his tinnitus masking was set. That's where he liked it. Here's his ER25 musician's earplugs. His open ear, no plug in place. Ran an MPO swept tone on the left ear and on the right ear and then the pink.

This is where MPO was presented with the earplug in place. A little bit of like not a lot of attenuation right up Here around around 6000Hz in both years just seemed to be where it was giving a little less attenuation but otherwise it was relatively flat. Good seal in the low frequencies and so there's not, you know we didn't have an acoustic leak from an earplug that wasn't fitted deeply enough. For instance the earplug isn't fitted deeply enough. You have generally have poor low frequency attenuation.

His gave great attenuation. Right here was his outgoing TRQ score. So we know this is a 55 year old musician, has a high frequency hearing loss fitted with tinnitus mask or hearing aids. He's on Prozac, a low dose of Prozac. That was important to him.

He wanted to know I don't have to be jacked up on happy pills, quote unquote is what he said and was getting. Cognitive behavioral therapy. Saw me once a week for eight weeks.

His tennis reaction questionnaire. His response was a four at the end. Now, would he have recovered from his tinnitus if he had done nothing for it? Probably. Would his tinnitus have gone away?

Maybe. Was his recovery really fast? Yes, it was. This is atypical. That said, when we just hit every little piece right in stride and the patient was highly motivated to improve his experience, we had a really, really, really positive outcome.

This is a gentleman that when, when he listened for it, he could tell his tinnitus was there and it was as loud as it ever was. But for the most part because he didn't care, he couldn't hear it anymore.

Hearing aid settings for MUSICIANS Marshall Chasen has gone through a lot of this work in the past. A number, a good bit of this work are things that he and I have talked about. I've got couple a couple of pieces that I add to it and he's got a couple other perspectives.

Big picture thing, hearing aids are really, really effective for helping people to hear and understand speech. Except speech and music are not the same. They are not the same. They are different signals. And in fact they are so different that the hearing aids, when they are set to help you to understand speech really well, they do things to music that cause a person to want to rip the hearing aids out of their music.

And it's principally some of the differences here are that the maximum input for music is greater than it is for speech. The dynamic range for music is greater than it is for speech. The crest factor. So from the root mean squared, so the average signal level to a peak, it is greater in music than it is in speech. The spectral structure of the music is different from speech.

The time domain envelope is different. And then I describe this. Well, the intent is different. I'm going to just mention that intent piece. Now, music, the intent of music is to convey emotion, whereas the intent of most speech is to convey content.

It's exchange of ideas, not necessarily exchange of emotion. Obviously talking to a loved one, obviously a mother quieting her child, you know, that is a communication of emotion using speech. But it has the quality of music in those cases like wow. Your voice is music to my ears. Yeah, you're communicating that.

That person's speech, just the quality of their speech is one that just, it helps. It makes you feel happy.

Our music dynamic range, the maximum input of music is over 100 decibels easily. The dynamic range could be as little as a 60 decibel dynamic range to 100 decibel dynamic range speech, maximum input around 80, 30 to 40 dB dynamic range speech from average speech to the loudest parts of speech ends up being it's about a 12 decibel difference. Whereas with music it's on average about an 18 decibel difference. The reason for crest factor to be different for music than it is for speech is because with speech the signal is coming through a vocal tract which is wet and it's soft and going say through a trumpet or a clarinet. This is a vibration that's traveling through a hard and dry surface.

The peaks are higher spectral structure. Fundamental frequency of voice is between about 82 Hz for the fundamental frequency up to 1046. Fundamental frequency for different instruments. For instance a piano, the lowest note on a piano is 27.5 Hz. Way lower than the lowest fundamental frequency for a voice and higher.

The highest note on the piano, the 88th key over on the right hand side is 4186. Fundamental violin more limited range. But bear in mind this is the fundamental frequency and each. Let's see your first harmonic, second harmonic, third harmonic, they're an integer multiple of this. So the first harmonic of the highest frequency of the 88th key is 4186 times 2.

The second harmonic is 4186. 4186. 4186. So the second harmonic, which gives the timbre of the music some of the coloring is up over 12,000 hertz.

And this is just for your own reference. This is a graphic of very low frequency through very high frequency. The fundamental frequency of key number one over here is 27.5 Hz. A above middle C here is the yellow. That's key number 49.

That's 440 hertz. And all the way up here, key number 88. Fundamental frequency is 4186. This is in standard tuning on a piano it's quite the range.

With music, the rise time of the signal is much slower than it is. You know, when you look at voice onset time for a voiced consonant sound like the D versus the T, the spectral or sorry, the time domain envelope is much, much faster. In speech than it is in music. It's a much slower rise time, say for a violin bow. A piano key strike is faster, but it's not as fast as what we're looking at with voice onset time.

Drums. Yes, it's percussive. It is as fast as your voice onset time. But you know, I mean, it's supposed to have a peak to it. When we look at our hearing aid settings and we look at things like fast compression, fast rise, like fast attack time, or what some of the manufacturers, what you'd call syllabic compression, that's pretty good for helping to compress speech into the residual auditory area of a person with hearing loss.

That syllabic compression is awful for listening to music. It needs to be set to a slow reacting and a slow release time.

So, Kim, this is where I want all of my sound. So, guys, we're going to spend a bit of time talking now about fitting this hypothetical music listener. We're going to call him an active male in his late 50s. We're going to spend some time. I've got three different sound song passages.

They're about 20 seconds or so in length. And we're going to listen to his. We're going to listen to this sound through normal hearing. Then we're going to listen to it through this audiogram. So I've done a simulation where I have a recruiting hearing loss of this hearing loss configuration.

And then we're going to fit hearing aids that are set to different gain characteristics. So here's the band, Boys like girls, emo pop, punk stuff. This is just, this is through our normal hearing right now.

All right, so now we're going to listen to his to, to that same song through this gentleman's hearing loss.

Okay, now let's fit him with hearing aids that are programmed to what I'm calling first fit. It's basically I've programmed it to NAL NL1 with a 40db knee point. So a low knee point, wide dynamic range compression.

So there's no bass. Well, guess what? There's not in nal. There's going to be no amplification for low frequency here anyway. And yeah, when your patient says yeah, the hearing aids make the music sound like it's like really, really, really high treble.

Well, yeah, that's because you're trying to accentuate the soft sounds of speech. Okay, well that's not quite right. Now I programmed the same hearing aid to an overall, just more sound. It's basically, it's amplifying loud sound as much as it's amplifying soft sound. And this is more of a music program, kind of more of a linear, but it still has a high frequency emphasis.

So it still is incorporated this higher frequency hearing loss and is giving more gain for 2000 Hz and above than it is for 1000 Hz and below.

So if I were to take this same hearing aid and I were to fit flat 20 decibel gain with a higher knee point, 60 decibel knee point, so a lot less compression and I were to give 20 decibels of gain down in the low frequencies and the same gain in the high frequencies, you might say you're an idiot. Well, give it a listen.

So, Kim, if you could pull up the next set of sound files, that'd be awesome. So I just tested you all in listening through this and saying, Does a flat 20 decibel gain sound better than a prescriptive fitted hearing aid? Let's do this to ourselves again. All right, so here's kind of like a top 40 vocal.

So that's through normal hearing hearing. Now we're going to listen through this gentleman's hearing loss.

Now we're going to do this through NAL NL1, you know, 40 decibel knee point and gain according to what NAL1 prescriptive fitting target would suggest, You can hear the vocal better. I wouldn't say that that's a pleasurable sound. Now this is through the music program, the manufacturer default music program.

Shrug your shoulders, lay down beside me. It definitely sounds better. But what happens again if we just take this and we do a flat 20 decibel gain with a 60 decibel knee point.

Lay down the silence.

All right, so let's say that your patient likes classical music. Kim, if you would bring up our last sound settings. All right, so folks, you'll recognize this one. All right, the reason why I use this last one is the dynamics are phenomenal from like your, your fortissimo to your pianissimo is it's just so proud present and it's obvious.

All right, now through this gentleman's hearing loss.

Yep, you lose a lot down there in that piano smoke. All right, now let's listen through first fit hearing aids.

Okay? What I want you to appreciate from that one. And if you go back and you listen to this presentation again, listen to the compression there. It's just, it's lacking all dynamics. All right, so here's the music program for this sound passage.

Okay? And now again, just to prove my point, I'm doing just straight 20 decibels of gain, low frequency through high frequency and a higher knee point.

So if you're not convinced as I am, go back and listen to these again. Let's take a look at a couple of these pieces. You'll be able to look at this again. This is a lot of the stuff that Marshall Chasen advocates. But basically try to fake this hearing aid into thinking that it's an analog hearing aid.

I'll add to it that I think that we need. I think it's really helpful if we gave the patient the ability to perform some self tuning. These are musicians or music enthusiasts we're talking about. This is not a set it and forget it type of patient. Okay, so this is a patient that I saw, 55 year old attorney.

That's an important point is this is an attorney, he's a trial attorney, but he goes out and he, he, he sees bands like three times a week. And he would bring his teenage son with him to these. Progressive sensorineural hearing loss, genetic origin in fact. And I fit him with IIC hearing aids.

Trial attorney didn't want the opposing counsel to know that he had hearing loss but needed to be able to hear the judge from a distance. So fit him with hearing aids, his IIC hearing aids. And here's his hearing loss. Normal hearing up to about 2k, close to 2k and then it slopes off. Here is his initial program, his program one, you'll notice, at least in this software programming I did have some frequency compression in here.

So I wasn't trying to amplify up above about 3,000 hertz. I brought it down into a more audible frequency range. This is exactly what not to have on when you're listening to music. Frequency compression, sound recover, whatever other buzz term is used by the manufacturer. This makes music sound horrible.

This is the worst thing that you can include in a music program. But it worked really well for him. Here's his probe mic measures. He got some pretty good gain up there in the higher frequencies here in program one. Even though I had frequency transposition that really engaged up here up in this region.

So that's why the gain drops way off for these higher frequencies.

So his hearing aids, I put this particular manufacturer, I don't endorse them per se, but this gave us an opportunity for them to engage in what's called the sound point application where he traced his finger along on an iPad. And each of these reflected some different gain, frequency gain responses as well as some different compression. And so he was just going through and Listen, hey, what does it sound like when I trace my finger over here versus over here? And he settled on whatever the representation would be here. His lower frequency was just like straight.

This was. This was basically. These are predicted real ear levels. This is linear. So like 20 decibels of gain for soft, medium and loud.

So right across higher frequencies fell a bit below what would have been prescribed. So this is loud sound. The prescribed gain for his hearing loss. You would see it's definitely. It's below.

He preferred more bass sound than he did treble. You know, it's not terribly shocking. He absolutely loved his music program. Initial fitting not totally satisfactory. First follow up, we tweaked that program one to reduce how much frequency compression I gave him.

And we did some other. I actually did incorporate a speech in noise at first, but then we switched it over to a comfort in noise program. But at his second follow up, he was just hugely satisfied with the result. And I do think that it has to do with the fact that he was able to keep his hearing aids in. And when he went and listened.

I know I'm a little tight on time, but I want to wrap up on this piece. This is highly illustrative. Retired mathematician turned very active hobby pianist. He was using a hearing aid only in the right ear because the audiologist that he saw before saw a poor word recognition score in the left. Basically just said, let's just aid the right ear.

So I fit him with. To get to it, I fit him with two hearing aids of the same manufacturer, both right ear and left ear. Kept him in btes with canal lock acrylic ear molds. Here's his hearing loss. It's a relatively flat and symmetric sensorineural hearing loss.

However, his word recognition score in his left ear was about 30%. Word rec in the right ear was about 70%.

Here was his kind of overall program all around program. You'll notice there's some frequency compression here in the very high frequencies in both ears underfitted right here relative to what would have been prescribed gain. It's where we tweaked it. It's where he liked it. It's where he said, that's where I'm going to have it.

And I was not arguing with him. Here is his music program.

So no frequency compression. Soft, medium loud inputs, exactly the same and modest through here. One thing I will say is I wish that I could have given more gain in the very low frequencies. Hearing aids now do not at present deliver very adequate sound done in the very low frequency frequencies. Okay, just the lowest frequencies, the lowest fundamental frequency that they will present is around 80 hertz or so.

And if hearing aid technology, if the receivers could move enough air so that we could get that fundamental frequency on a piano, the 27.5 Hz that we could actually give that an adequate amount of gain, like 20 decibels of gain. Even if hearing is normal down below 100 Hertz, we still want to have a more balanced sound across the entire range. This guy would have been happier. I am convinced of it. What's interesting in this is this guy actually had significant distortions for sound about 2000Hz and above.

He actually has diplocusis, which is part of the. And it's awful in his left ear, which is the reason why he had such poor word recognition scores. So I did try something with him. Spoiler alert. It didn't work.

But I tried something with him. I turned the gain way down at about 1500 hertz and above just to see if I provide amplification only here, you know, is he going to do much better because what if providing amplification for these higher frequencies is actually causing distortions? Again, had I been able to continue to just have gain down here in the ultra low frequencies, this would have been been much better, in my opinion. Well, he didn't like either music program. He would just take them out when he was playing piano or when he was listening to his home stereo.

He really liked the T coil for when he went to symphony. There was an induction looped hall and he loved it for that purpose. Speech intelligibility was way better. He did have a remote microphone that I had for his wife. He didn't use it very often at all.

And he did have some challenges associated with how violin sounded versus his piano. He actually thought that the hearing aids sounded pretty good for violin and for string instruments and for wind instruments. But his own piano playing, it just, it sounded. It had this nasty sound to it. And I do think that there was something around just that time domain envelope where it was a faster rise time that just wasn't able to really adjust it so well.

I actually did rig up an in ear monitor system to be a master hearing aid, quote unquote master hearing aid. Called a sensaphonics 3D active ambient music Enhancement System. It involves using an in ear monitor with a hearing aid microphone or not a hearing aid microphone. A really, really strong mic. Let's see if I can pull it up.

I'll get into that in a second. Just noting. See these, the low Frequency roll off. High frequency roll off. I know some of them go out to 12K.

Now that's great. That's all well and good for high frequencies, but what about the low frequencies? This is where my wish list is. I actually care more about the low frequencies than the highs. I do wonder whether or not we can truly turn off all of this signal processing.

That is lovely and wonderful for speech, but it is a problem for music. And this is where I say let's use some alternative devices. I'll mention some of these alternatives that I did in fact try with this gentleman. You've seen this slide, you get it 27.5Hz up to 4186Hz across the whole 88 keys on the piano. So alternatives, Etymotics, Bean quiet sound amplifier.

Which yeah, it's an over the counter hearing aid if you know, that's what we end up calling it. Well, guess what, if the patient's going to use it and it's going to sound really good, they're going to love you for it. Personally, I always put a custom tip on these and I'm the one that's verifying it. I stick a probe microphone down their ear canal. Yes.

I charge them for the probe mic measures. Ends up working. This is the system that I did try with this 77 year old retired mathematician turned concert pianist. This is the in ear monitor. It has a microphone here that is powered by a 9 volt battery in a belt pack.

If our hearing aids could have a 9 volt battery in them instead of a 1.45 volt button battery, it would be outrageous the kinds of things that we could do with them. Well anyway, this microphone does not saturate until 142dB hits. This is intended to be used by drummers who have their in ear monitors in and you can actually record the sound that's hitting their ears. Left ear to right ear. Alright.

And it can actually tolerate the crash of a cymbal so that it doesn't and without saturating so you don't have peak input clipping. You actually connect this into a personal sound mixer. It's like a four channel sound mixer. We actually have some amplification and the individual can do a little bit of bass mid and treble EQ so that if they do want a little more accentuation in the highs to help overcome their hearing loss. You can add that in this gentleman, when I stuck these monitors in his ears, his face lit up and he said oh my God, I can't Believe how this sounds.

Sounds. Of course he rejected it because, well, it was a ton of outboard electronics and he actually did have a lot of difficulty getting these into his ears by himself. So nice try, it worked, but it was too cumbersome for his particular purposes. Alright folks, I've gone a little over my time, but as I understood from Christy, it was perfectly okay for me to just borrow a little extra. Thank you for hanging in there with me.

Big picture summary. Hearing aid technology is focused on improving speech intelligibility, but with its nonlinear wide dynamic range compression, et cetera, et cetera. However, for music listening, that's not helpful. In fact, we would really much rather have something that's more of a linear hearing aid, give more low frequency emphasis and very high peak input limiting. So the hearing aid, you need it to be able to tolerate about 112dB peak input or more if this person is going use their hearing aids in a live music venue.

So fitting for music perception is obviously challenged by that hearing loss as well as the other issues like their tinnitus, hyperacusis, diplocusis. And so, you know, I would say that we do need to focus on

their, on their tinnitus first. However, if they have hearing loss and they are willing to try using hearing aids for music listening, I do think that we can improve upon it. I think that it's really great if we're able to engage the musician in these experiences. They do like to tinker, they do like to participate in this.

They care so much about their hearing. They care so much about their hearing in ways that perhaps we would wish so many of our other patients would care as well. So this is an opportunity for, for us to engage these folks in their basically like for us to meet them where their value system is. So when you do your music program for these people, omnidirectional mic, make it as linear as you can, all right.

Let the musician tweak it a little bit. If it's an iPhone app that allows them to adjust some of the frequency response, let them go for it. I do recommend turn off feedback management if you can get away with it. Turn, definitely turn off noise reduction and please do not leave like a sound recover or any kind of frequency compression engaged. You got to turn that piece off.

Yeah, there are alternatives. Use some kind of analog circuit if you can. For some of these folks that you know where we are, we're just not there. And the person is willing to pay for your time and your services. You can really, you can help them tremendously from that point.

All right, so folks, I'm actually here. I know we're at the end of our time but if there is any, you know, dire pressing stuff, I'm happy to stick around for as long as audiology online will let me and as long as you folks can. So with that, thank you so much. Thank you Dr. Flagoer. Those are some really helpful tips there at the end.

When comes it comes to programming hearing aids and amplification for musicians. We did have a couple comments from Stuart. He said overall that he did prefer the 20 decibels of gain across all frequencies. I would have to agree with you Stuart. It sounded the best out of all of the other samples that you played.

I'm an experiential learner. I have to listen to it myself and any hearing aid that I fit to somebody, I actually get a demo and I stick it in my ears and I walk around and I use it and I try to see can I make it sound better. My hearing is normal. But you know what? For sound that they, that these people are listening to, it's if I don't like how it sounds, I'll bet you they're not going to like how it sounds.

So I just, I, I follow this approach that I need to convince myself first.

Thank you for hanging in there with us everyone. We hope you guys have a wonderful holiday. Thank you Dr. Fligor for coming back to visit with us for this last two part series and we hope you guys have a great weekend. Awesome. Thank you so much Laura.

Thank you so much for your comment there Stuart. Thank you for your comment folks. Drop me an email if you need anything or are interested or curious about any the of of these. I love talking about it as you can tell. Have a wonderful Thanksgiving.

All take care of.