Hearing Aids and Music: Addressing the Needs of the Casual Listener

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Hello, everybody. Welcome to our talk, Hearing Aids and Music addressing the needs of the casual listener. I'm Brian Taylor and with me today is my friend and colleague Navid Taghvaei. You'll hear from Navid in the second half. I'm going to go ahead and spend about the first 20 minutes introducing this topic and then Navid will get into some of the details a little bit later on.

Thanks for joining us. Just a few more housekeeping slides here. You can pause the video if you're watching this remotely watching the recording. If you want to look at these in detail, here are the learning outcomes. And again, you can pause the recording if you'd like to do that.

And the last housekeeping slide I'll show you is this one right here. We are both employed by WS Audiology and receive a salary from them. Rather than talk about the learning objectives, I put them in the form of the agenda and questions. So here you see them on the slide. They'll pop up as we move along here.

Who is the casual music listener? And then we use that term very deliberately and contrast it with what we call an audio file, which is a little bit different than what we'll classify as a serious or discerning music listener. So more on that in a minute. Why is it important to optimize music with hearing aids? It's another important agenda item.

We'll review some of the essential elements in a hearing aid that are needed to process music effectively, that it's different than trying to reproduce or amplify speech, and how we can go about adjusting some of those parameters to improve the sound quality. We'll review the quality and the accuracy of various music programs that are currently available. I think all of you know that all brands of hearing aids have some form of a dedicated music program that in theory should be processing sounds differently than its default program, which is usually optimized for speech intelligibility. And we'll see if that's actually the case. And then finally, and probably most importantly, we want to provide you with some plans or at least some thinking around how to better verify the quality of both the both streaming

and loudspeaker based music for hearing aids.

And we'll provide you some important reasons why that, why you should be doing that, and how to do that as well. Let's get to the first question here. Who exactly is the casual music listener? Again, this is a term that we use very deliberately.

There's a few data points here that you can find from this is not research, but it's More expert opinion inside the music or recording industry. The first bullet point says that a very small number of individuals in the United States are what we would classify as an audio file. 0.1 to 0.2%. An audiophile, as you may know, is somebody that you could probably say safely, they're obsessed with the sound quality of music. Somebody that might have what we call a golden ear.

Somebody who really spends a lot of time and energy on, on music. And that's a little bit different than another 15% or so of the population that are serious or discerning music listeners who really prioritize new music. They might own a lot of vinyl. They have a real deep emotional connection with music. And I want to contrast those individuals with the casual music listener.

Again, there's really no data on this, but I think it's safe to say that 50% or more of the individuals you see in your clinic probably could be safely classified as a casual music listener. How do they differ from the discerning or the audio file, the discerning music listener or the audiophile? You see some of those differences here. It's usually somebody who listens to music maybe an hour or so a day. It might be for relaxation, casual enjoyment.

They might stream music through their hearing aids or their earbuds while they're taking a walk. They might listen to it while they're having dinner on the back patio at the end of a summer day, those kind of things. So you can kind of see here the breakdown. And again, I think the most important point that I want to make is that the casual music listener we believe is, is about 50% or more of the people that

you're going to see out in the population. Of course, some people don't have any interest in music at all on the other end of the continuum versus those that are sort of in the middle that represent the casual music listener.

So that's the definition of that, of that term casual listener. Let me give you some reasons why we think that this one hour course is important. And the first has to do with just the ubiquity of the Internet and streaming music. We know from one data point that more than 90% of Americans, or about 90% of American Internet users, stream music either with a subscription based service like Spotify or Amazon Music, or they go to YouTube and they stream music. We know that smartphone integration among hearing aid wears has reached a critical mass, meaning the majority of people that have a smartphone based hearing aid are actually using and interacting with that app on their smartphone.

We also know that about 70% of current hearing aid wearers report that they are connecting their hearing aids to their smartphone. I guess that's the critical mass part. And then finally, and this is some data that was published at our, by our friends and colleagues at, I believe, Phonak earlier this year, they did a really nice analysis. I think this was posted on Audiology online, if I remember correctly. That says that the hearing aid wearer spends about 36 minutes per day streaming music, listening to podcasts, or using it for phone calls.

So I think the point here is that more and more people are streaming music with their hearing aids and smartphone interfaces. That's the first reason. In addition to that, I might add, there's a couple of bullet points here that you don't see that I wanted to emphasize. And that is back in 2022, the Oldenburg University, which is an esteemed research lab over in Germany, they reported that only about 40% of hearing aid wearers that they surveyed said that music was discussed with their appointment, during their appointment with a hearing care professional. So less than half of individuals even talked about music as a possibility with their hearing aids.

And less than a third of those same hearing aid wearers surveyed, less than a third, had a dedicated music program. So, again, I think the important point here is music is all around us, and hearing aids might be maybe slightly underutilized. We don't talk about it enough. Not enough people have a dedicated music program. That's the first reason.

The second reason for this short course really has to do with something that I think kind of is understudied and probably flies under the radar, and that is the restorative effects of music. There's, you know, a fair amount of data out there that says that there's some healing and relaxation properties involved with music, and set that aside. And I think all of us would agree that enjoyment is probably the number one characteristic or trait of why we listen to music we just like, as human beings, like to listen to it. But I'll. I'll use this little, uh, anecdote about Joni Mitchell, who, some of you might know, suffered a stroke a few years ago.

And back earlier this year, it was reported that she used music as a big part of her recovery process. So, like I said, the restorative effects of music, I think, is underappreciated and probably a good reason why we want to make sure all of our patients have access to it through their hearing aids. And that brings us to the third and final reason, and that is the acoustics of music are much different than the acoustics of speech, as all of you probably know. Hearing aids and amplification algorithms. The default algorithms in a hearing aid almost always are to optimize speech and speech intelligibility in quiet and in background noise.

Therefore, when we think about the musical acoustic properties being different, that means that these default algorithms are very likely not optimizing sound quality for music, although they because they optimize it for speech. And in general, I think, just to summarize this point, we do know, and you can see this very nicely illustrated on the slide, I think that music has a broader bandwidth and larger dynamic range. And it seems pretty apparent by just looking at this slide. So those are some of the

reasons why this course, I think, is important. Let's talk a little bit before I turn it over to Naveed in a moment or two.

Musical enjoyment and hearing loss. There's been some relatively recent studies that have looked at this more carefully, Both in people that wear hearing aids and cochlear implants. There's a group out of New York, I think it's City University of New York or nyu. The lead author that you see here is Churn. They looked at some of the effects of hearing loss and music enjoyment, both in hearing aid wearers and people that had normal hearing.

And they wanted to see if hearing aids improved their listening experience. They surveyed in this one particular study, 100 hearing aid wearers, you see some of the details there, as well as 20 people with normal hearing. They had the participants listen to music, snippets of music we with and without their hearing aids, and they had them rate them on three different dimensions. You see here, pleasantness, musicality, and naturalness. And what they found was music enjoyment scores for the normal hearing controls was slightly higher across all three of those measures compared to those that wore hearing aids or regardless of hearing aid use.

So even the people that had hearing loss wearing hearing aids, those aided users were still lower, had lower ratings than the people with normal hearing that served as the controls. Another finding in this particular study, those with greater hearing loss had lower ratings of pleasantness, musicality, and naturalness, both with and without their hearing aids. And then finally, the use of hearing aids significantly increased music enjoyment, particularly along the dimension of musicality. That was especially apparent for wearers that had moderate to severe hearing loss. And then just to kind of round out some of these other studies that have looked at musical enjoyment and hearing loss, Another study by that same group, led by Churn, reported that hearing aid wearers had increased Music enjoyment with hearing aids compared to those that were not wearing their hearing aids.

And then another study from another group noted some similar findings. Those with severe hearing loss led to notably lower music appreciation. Hearing aid wearers found music less melodic. So it kind of shows you, especially for greater degrees of hearing loss, how the quality of music through a hearing aid is still a challenge for us to get right. And then finally, here's a nice review article that was published a year or so ago that says about the same thing that people with a hearing loss that wear hearing aids tend to.

It negatively impacts their perception of music and their appreciation of music. And a lot of people with hearing loss experience this diminished enjoyment and they see a decline in their participation in music. So again, I think these are bullet points from some recent studies that illustrate the challenge and, and show sort of the untapped opportunity we have to improve the quality of lives through improving the sound quality of music through hearing aids. So I wanted to kind of go back again before I turn it over to Naveed and remember that there are some pretty important acoustic differences between music and speech and how hearing aids are sort of designed to optimize each. So yeah, here is, here are some, Here's, I think a nice breakdown of some of the key features that in a hearing aid that need to sort of happen for us to, for a patient to experience music in an optimal way.

So you see here several features in the left margin. The high level capacity, which is similar to maximum power output, not quite the same thing. Extended frequency response, compression, noise reduction, the microphone responses. So you kind of see why that matters in this in the center column. And then sort of the best case scenario or the best setting for each one of those particular features.

So that's a high level kind of review of how the hearing aids should be performing to optimize music. If you want to go into the details, I can't recommend enough the music and hearing aids book by Marshall Chasen that was published three or four years ago. I think it's a great book and what you see here is kind of a summary of what is in that book. I do want to spend a little bit of time talking about another

study that was published a few years ago at Audiology Today. This comes out of Josh Alexander's lab at Purdue and it's looking at the.

The effectiveness of those dedicated automatic music programs. Many of them are automatic where when the hearing aid signal classifier, recognizing that the listening environment is music, it automatically is steered into the music program. All brands have some form of that, and here they did an analysis of it. So in this study, they rated on a one to seven scale the quality of music, one being poor quality, seven being excellent quality. And in this study, the seven premium brands, they had 70 participants, and half of them, if I recall, half of them were trained in music.

They were basically musicians with. With a number of years of formal music training. And the other half of the participants were non musicians, maybe people that like to listen to music but had minimal training in music, and they had them listen to snippets of music. The control condition that you see on the top is the original music snippet. We'll say they listened to that, you know, whatever it was, 30 seconds of sound without hearing aids, and they rated it on that 1 to 7 scale.

And you see the average was about a 5.5. And then they did the same thing for the seven brands for both the default program and the dedicated music program. So the default music program was on or it was on the speech, or the. I would call the default program the speech program. That's the off condition.

And you can see here, you know, the ratings are all kind of clustered between a 4 and a 5. And there's not big differences between the on and off conditions where on is the default music program. The differences are actually greater or larger between brands than between each individual brand's music and speech program. And I put. So that bar graph comes directly from this paper, and the little blue triangle that you see there, or I guess diamond, that signifies the sort of eyeballing it at the highest rated B and the lowest rate at D, and you notice they're only about one point apart, and all the others are

clustered in between.

So that's kind of an interesting study that kind of shows you that they all pretty much perform in a certain range lower than the control, and that the music program doesn't really offer substantially different or improvement in those ratings. The last thing I'll mention here before my time expires is that there are some important differences that we need to account for. And I think both are equally important, kind of depending on the patient when it comes to streaming music through the hearing aid in their smartphone and loudspeaker music that they might enjoy, say, sitting on the patio at the end of a summer day. Some of the streamed music variables you see here, which Naveed will get into in more detail, the coupling, is it closed or is it open?

What type of Bluetooth connection? And there's, of course, now a large range of those Bluetooth connections. That are available. And then another consideration is the wireless communication between the hearing aids and what impact that might have. Two hearing aids sharing information as it is.

And then of course we have some loudspeaker music variables that you see here on the slide. And of course, you know, and one of the lessons here is that coupling is something that's incredibly important. Then we don't want to dismiss the importance of coupling. And then again back to the paper I just mentioned that was published in Audiology today. We have to account for those automatic programs.

Are they offering anything different than what's in the universal program? So with that in mind, I'm going to go ahead and turn it over to my friend and colleague Naveed, who will go into many of these details. So with that, let's talk about some considerations regarding what we talked about and what we're going to look at. First of all, as Brian noted, several studies indicate that patients prefer different acoustic parameters for music compared to speech. So we have listed some here as far as references goes.

But generally what the findings are that more low frequency gain is desired, less compression to maintain the characteristics of the sound, the spectral characteristics of the sound, and more of a broadband frequency response, that is with perhaps lesser treble, more flatter response for these kinds of fittings for music specifically. So automatic music programs sometimes fall short in terms of what they, what our patients are looking for at default settings. Essentially, based on the research we just reviewed, there isn't a significant difference between how they hear with those programs versus say the speech or the universal or the speech focused programs. And also rising popularity of streaming music, I.e. people streaming music to their hearing aids using their Bluetooth enabled devices, whether those are their phones, mostly phones or other types of Bluetooth enabled devices, tablets, TVs, things of that nature.

So that's, those are some of the considerations going into looking at what we should, we should be putting kind of in the back of our mind, if you will, as we're fine tuning these programs. Again, similar to the 2023 study that Brian mentioned, we wanted to make it kind of simple so that you, you could also do this in your office, if you will. So there was, you know, no real ear verification. We're looking at music response. But what we did here was look at two premium devices, namely Signia Pure Charging Go, their highest level of 7ix and also Allure Rick from Widex 440.

We also use the BCT of the charge and Go from Signia to capture the classic Bluetooth responses that you're about to see. And so we essentially change the parameters on the devices which are the phones. We use the Android phone and iPhone to capture the different Bluetooth streaming protocols that that are available. And as you can see here, mild to moderate hearing loss. We use both domes, disposable domes, the most occluded we could find.

And also custom ear molt and used John Coltrane as the jazz music and also Jethro Tull as the rock and roll to capture some of this data. As you can see, this is the real ear measurement setup, very

similar to what you would have in your office, in your clinics. So with that the loudspeaker and streaming output, what we did was we created a streaming test setup and a acoustic, if you will, test setup through the loudspeakers, through the microphones. And so with live speech and the speech map of the audio scanner for two equipment, we went ahead and played the music signal. It was streamed through the smartphone.

If we were streaming, it was a WAV file of that music that we used. So as as clean of a music piece as as possible, recorded it for about 20 seconds. And we adjusted the phone's volume and measured the average SPL in the ear canal to be about 80dB for the most part. For the loudspeaker setup we, as you saw with the picture in the previous slide, essentially used the speech map live speech section of the equipment. The VeriFit2 equipment used same WAV file and test was run as the music was playing through the equipment for about 20 seconds.

Again, again we used the level of 80 db spl average in the ear canal to take these measurements. So here is one comparison that you might be wondering already, how does a loudspeaker response compared to stream? So streaming from the phone versus listening to music through a loudspeaker through the microphones of the hearing aid. So two different kinds of music on the left side of this slide, both rock and roll and jazz. So that's why you see two different curves, the green and the purple there.

So acoustic on the left and then the streaming on the right side. So right, right from the get go you can see more of a low frequency roll off for the streamed signals. This made for iPhone. Stream response that we've captured here on the right side is lacking a lot of low frequency. And you know, with music you want more of a flatter response, more of the low frequencies in the response, in the frequency response.

So you know, a 30 decibels output here in the low frequencies, not very suitable for music lovers. You know, that's, that's why, you know, more bass is a lot of times asked for in the clinic with music

listening. Now here, what you see is the difference of the type of streaming signal. So the difference we captured through streaming to different types of streaming protocols. And as you can see, made for iPhone versus classic Bluetooth made for iPhone here indicated by the green.

We used speech live again from the VeriFit 2 equipment using probe mic measurements to get really aided responses to show you here. And so you can see. And as I mentioned, we use the pure charge and go BCTIX and the Signia IX platform to capture classic Bluetooth. It uses the latest Bluetooth 5.3 right now. And so streaming through the iPhone per the protocol that we already talked about.

And as you can see, the made for iPhone, which is the green same kind of shape compared to a classic Bluetooth streaming signal, which is in purple here. So you could expect the same kind of response regardless of the Bluetooth streaming protocol. And we, we went further, so we wanted to actually show you, you know, what to expect if you're programming and, and connecting the hearing instruments to cell phones, perhaps with other types of Bluetooth algorithms. So as you can see here, made for iPhone versus classic Bluetooth versus Asha protocol versus LE audio protocols. And, and we use the same setup as before.

So everything is identical. We use the, I forgot to mention this, but we used the head and upper torso simulator, ear simulator to capture all of these. And so streaming through the iPhone per these protocols using MFI or classic Bluetooth or LE audio, same kind of shape essentially is captured. You can see the pure charging go7ixt with the green, the pure charge and go BCT, which gives us the classic Bluetooth in purple 7ixt. We turned off LE Audio.

That's the teal, which gives us the ASHA protocol in that particular setup. And pure charging 07ixt with the LE audio on, which is that orange shape. But you know, when you compare the streaming protocols, you can see really doesn't matter the streaming protocol that's being used. They're all having the same kind of response when it comes to streaming. And just as a reminder, you know, in general,

the red box that you see there is where we could expect to see the low frequencies.

If you're listening to this through an acoustic program. So lacking quite a bit of low frequencies, quite a bit of low frequency roll off with all of these streaming protocols.

Brian mentioned this again, you know, customs regardless of the type of streaming protocol. And you can see that Here we've captured a mold fitting. So this is now using a custom mold made for iPhone or classic Bluetooth. And we did some speech mapping. So you can see it already gives you using a custom more lows, a slightly flatter response regardless of the Bluetooth protocol used.

So that's what we're after.

And I just put a note up here because this is something I discovered kind of learning as I go preparing for this talk, is that headphone limiting, at least on the iPhone device, doesn't apply to all of the Bluetooth protocols. We found out that this doesn't actually apply to classic Bluetooth and MFI the same way on iPhone devices. So that's part of the reason why we decided to go to capturing our baseline from the ear canal rather than limiting it from the device itself to eliminate that possible bias. This is just a table of made for iPhone LE Audio and Bluetooth Classic and essentially who their owner is, where do they come from, what kind of code do they use, what kind of power efficiency and audio quality you could expect from these codes from these protocols, the streaming type, which platforms support them, their latency, things of that nature. So for example, Ellie Audio being the latest, you can see the owner's Bluetooth SIG main use case is low power, high quality audio, very high proficiency in power and very low latency and etc.

So knowing a little bit about the different kinds of Bluetooth technology, you know, as audiologists we perhaps didn't expect to have to be experts in Bluetooth codec, but it is part of the reality of helping our patients enjoy not just music, but also listening and capturing some of the automatic features of their

hearing instruments through their phones.

Here what we see, and I just wanted to point out, and this is a screenshot of the Connects Signia Connects software for the device that we use, the ix7 ix in this case their highest technology. So you can see the top left is actually these are streaming offsets. So the the software, at least for this particular technology, for this device and for this manufacturer, you're able to offset the streaming signals having to do with whether it's tv. So top left or classic Bluetooth, for example, the top right or the hands free, the MFI response from the iPhone proprietary Bluetooth algorithm. So the offsets may partly explain those differences we saw in real ear aided responses previously in those previous slides.

But again we wanted to capture the raw data without doing any kind of adjustments for you to see that some of these may inadvertently have result and effect on the final fitting and the patient's experience. So with classic Bluetooth you get roll offs, of course, and you do with other types of streaming devices. So that's something that is probably because of the having to control the artifact in, in for low frequencies for hearing aid manufacturers. And that's part of the real dealing with streaming protocols. I think this is another thing to be aware of.

Again, I'm showing that there are, at least for Signia software, there are different streaming offsets. So this is something to be aware of. You can see I've indicated that with the big oval shape in this case for classic audio, for classic Bluetooth streaming. And those can be adjusted to accommodate where we're, if we're talking about, you know, the shortcomings that we saw on the previous slides in terms of, let's say, less of a low frequency response. And this is where you would adjust that in this particular software.

So there are offsets in many manufacturer software to try and adjust some of these issues that we see. And also, as you know, with this particular software, you can have things like adaptive streaming, meaning that the level of the streaming, let's call that signal versus the soundscape processing and let's

call that ambient noise can be adjusted depending on the noise floor. So as the noise floor gets louder, the level of the streaming signal gets louder to a limit to maintain that difference between the soundscape level and the streaming signal to have it, if you will be more of a contrast. But you can adjust that. You can see here not just with the adaptive streaming, but also with the mix of the microphone.

You can change that to have less of a mix from the microphone, hence the ambient environmental amplification of those sounds versus the streaming signal. So that can be done here with the mixed with microphone. I wouldn't necessarily recommend not having any microphone input because then they wouldn't have any awareness of their surroundings per se. So there's another important thing to consider in terms of streaming offsets and how they may affect the outcome as you're measuring this in your verification system. Here is an example of again, you've seen evidence and you've seen research now in terms of the difference, or lack thereof between music listening experiences where you're listening to music programs and speech optimized programs, let's call them universal.

So I use two different genre of music. So that's what you see on the very top, just to make sure that these are being classified as music. So that's why you see the jazz piece and the rock and roll piece. And we also wanted to Compare that. So now you're looking at a custom ear mold versus even the most occluded dome.

Let's call it a tip that we could find here. You can see that the custom has a better, more of a flatter response. There has been no adjustments here. This is, as I mentioned, just raw data. And with the occluded, you have more of a fluctuation in the frequency response.

I'd say pretty significant dip there at about 750Hz or so. So again, showing the value, as Brian mentioned earlier, of the coupling and the most appropriate coupling for specifically for these kinds of adjustments for listening to music as well here, what we did was comparing music processing. So this

is now the universal speech, if you will, optimize program versus the music program. In the IX platform, we use the HD recorded music. That's generally how people listen to music acoustically through the microphones or they use listen to it through the universal program and the technology switches to music processing.

Regardless, we captured both of those for you, the universal and the music programs. And you can see that it's really interesting. They're falling on top of each other in terms of the frequency response, in terms of the shape of the response, and also the level. Meaning that as we mentioned with the previous studies, patients are not noticing a significant difference between these two types of programs. Here I'm showing the same kind of, same kind of response from the Allure 440.

I compared the music processing. So this is acoustic through the microphones via the universal program versus the dedicated music program, as I did previously with the IX platform. And so I've placed the screenshots for you to see here. As you can see, music program is in purple and the universal program is in green. Notably for Allure, in this particular setup, we have this observable jump in the high frequencies for the music program specifically.

So many times this can be done to make music sound richer, fuller, more brilliant, more crisp, if you will. Now here, what we're looking at is again the loudspeaker versus streamed. So I showed you earlier loudspeaker versus streamed in the IX platform for Signia. Now I'm showing you the Allure platform for Widex. And you can see that the same kind of issue.

So the left is the acoustic using the microphones, the soundscape processing of music. I used a jazz piece and you can see when I compare the music program to the universal program. So green is the universal in this situation and purple is music. Again, I have that high frequency emphasis. So something to Note here, I did have to start my baseline instead of the usual 80dB as I did with the previous screenshots, I had to start at 90dB for this particular hearing instrument.

I wasn't able to turn it down enough to, to be at 80dB in the ear canal the way we had the experiment set up. But you can see the same kind of, if you will, roll off in the low frequencies when we're talking about streamed music.

And here again I wanted to show you not just on the IX platform, but also on the Allure Widex platform. We're having the same kind of. So this, these are the different kinds of streamed protocols. So you can see the green is for made for iPhone devices streaming protocol. The ASHA LE audio is off and that LE audio is off.

And that gives us the ASHA protocol when you're streaming from a, from a device. And then we turned on LE audio to capture the LE Audio response that's in teal. Interestingly enough, everything being the same, the location of the hearing aid, all of this stuff, and of course the probe tube, we still saw this jump, particularly for LE audio in the very high frequencies. So you know, a thing to note here in terms of what, what might be the patient complains in these situations, not just for this particular hearing instrument, but for any kind of streamed signal when you have such a low frequency roll off, it leaves something to be desired for the patient when they're listening to music. Streaming especially, you know, complaints may be things like things are muffled, music is muffled, it's too soft.

And so that's why capturing this kinds of information is important. Because, you know, as soon as I see something like this, my first, you know, inclination is to make it more of a flatter response with more low frequencies. Make it, you know, perhaps depending on the hearing loss, less high frequencies. So it's not as tinny, as high pitched, as much treble, whatever you want to choose there. But that's the point is without this kinds of objective measurement in your clinic based on the manufacturer, you wouldn't know this kind of information.

So I'm really happy to bring you this information.

And last but not least, I want to talk a little bit about some strategies. This is just a review of the things that we've been talking about today. So I hope so far you've enjoyed the information we've presented to you. But just to summarize and give you some strategies, some suggestions on how to program hearing aids specifically for music. One is of course to widen input dynamic range.

Brian mentioned this earlier to handle those loud dynamics of music that we know are very, very important, especially for music lovers using slower compression speeds. Those are attack and release times I'm specifically addressing can again help in maintaining the integrity, the fidelity of music and its spectral components that many people love. You know, things like tone and timbre and things of that nature, many times are lost in super high compressed signals. And of course streamed music is already compressed. So now we're, if we compress it even further from a different perspective, that's why a lot of this is, is unsatisfactory music listening for patients through hearing aids.

So with that goes, reducing the number of compression channels or you know, preserving again as I mentioned, natural musical dynamics. You know, one of the things that one of the manufacturers here, Widex, talks about is very little delay in capturing the input, the sound that's coming in. Music lovers tend to really like that because again, it's, it's not touched, it's not processed as much and with very little delay, with very little latency. And that is one of the things that is desired specifically for music and music lovers also with noise reduction and feedback management, if possible, disabling or minimizing the noise reduction capabilities of the hearing instruments. Because again, the harmonics are very important in music, of course, in speech as well.

But we're focusing on music right now. And so minimizing noise reduction will reduce the tinkering, changing of those harmonics that are really important in identifying the kind of sound, the kind of music tone you're listening to. These are. And as you of course have some cochlear distortion because of hearing loss, these become of supreme importance for the patient who's listening to music through

hearing aids. Disabling or if you will, loosening aggressive feedback cancellation will have the same kind of benefits if it's possible.

Meaning that not allowing for constant artifact detection and trying to reduce different parts of music because the hearing aid may perceive it as artifact, only serves to give your patient a cleaner response, more of a satisfactory response. With the fine tuning that we have already mentioned and preventing, if possible, suppression sustaining those notes, the instrument. These are all things that are possible if we minimize or eliminate if possible, noise reduction specifically for music listening.

Another thing I want to point out here is frequency response. So as much as possible, a wide bandwidth for clarity and the overtones that music carries. As you know, music is a very complex signal, not as complicated as speech, but at the, the peaks and valleys and the harmonics and the overtones have a very specific and noticeable difference to Those who are music aficionados. And so allowing for more of a low frequency amplification for richness also becomes a very important thing, as we showed, especially for streamed signals, there is a significant low frequency roll off. Of course, the only way you would be able to objectively measure that is with verification.

And also there are some techniques that I'll mention in and the upcoming slide here that allows you to make sure that there is no artifact when you do that. So less prescriptive gain shaping. So not we're not focused on speech understanding, right? We're focused on music listening. So with that hat on, kind of like sometimes you program hearing aids for tinnitus patients differently, this is the same kind of thing.

You're programming the hearing aids specifically for the music listener, perhaps in a dedicated program. And so more of that prescriptive gain shaping, less of the frequency response. And the adjustments that we've been talking about will definitely serve the patient well and serve you well as their advocate in their hearing journey. So the aim should be for a natural, fuller sound quality, flatter response, more of a response that you would expect, and perhaps reducing some of the bumps or the

valleys that you see when you're objectively measuring what's happening in terms of output and loudness. So increasing the mpo, of course, you don't want to increase it in an unhealthy or unsafe way.

You want to increase it under their uc, under the patient's ucls, making sure that you give them the full access to sound that they are looking for, that especially for listening to music. And we want to prevent distortion on louder passages. So playing music, playing loud music, testing streaming, perhaps in the office, in the clinic, before we let the patient go, especially if they're having complaints about music, this is perhaps the best thing to do to adjust avoiding discomfort from sudden loudness. This goes back to measuring uncomfortable levels for the patient so that you can make sure you're always under those curves and making sure that microphones can handle higher input levels. The kind of technology and hearing aid you're fitting on the patient have different input dynamic ranges, have different dynamic ranges specifically for the microphones.

And if those microphones aren't able to handle louder or more dynamic environments, then you're already putting yourself at a disadvantage specifically for adjusting for music.

Okay, one, one other thing here in terms of suggestions, specialized music program and co listening creating, we know that by default, based on the slides that we saw.

Just comparing the universal programs to music programs isn't that much of a appreciable difference from the patient's perspective and you can objectively see it as well. But creating and fine tuning a dedicated music program, based on the suggestions we already mentioned, separate from speech, I think is an excellent option for those patients who are interested in in listening to music specifically with the hearing aids. Streaming will likely, based on the data we presented to you, look very different from the acoustic response. So if you're measuring things from the, you know, loudspeaker through the microphones, very likely that music is going to sound very different as they are streaming that music

through their phone. So something to be aware of and adjust for if your software is able to give you offsets for those specific types of streaming protocols, as we showed through the screenshots, also co listening with your patient, I think it's really important.

This also is a best practice. And I think last but not least, you want to make sure you document those differences, good, bad, so that you can continue to improve the patient's listening experience, not just for music, but documentation, as we all know, is extremely important in healthcare audiology practice. So some conclusions here as we wrap up our music talk today. First, we want to remind that again, many of these are sound files. As I mentioned, they're quite compressed.

So even if your hearing aid is programmed to have a lot of headroom, you know, like a high mpo, the file is compressed, compressing those signals more. You might see a pretty narrow dynamic range through the hearing aid. And then there are venting effects. So, you know, significant degration sometimes depending on the venting effect, how open the fitting is to the quality of the processed music, the clean signal, if you will, that has been processed, that you're trying to deliver to the patient. Things like, you know, filter effects, comb filtering or masking effects with open fittings, artifact capturing through noise reduction or feedback cancellation, these are all things that are working against you when you're trying to give a music program to, to the patient.

So even with a closed tip, the most closed we found you're going to get a lot of low frequency roll off when you're looking at the streamed signal specifically. And so we mentioned that already, but you know, more of a flatter response, as you can see, giving them more of a headroom through MPOs, manufacturers generally reduce the low frequencies to avoid these artifacts. So we just want to be aware of that. This is just inherent in the streaming music through hearing aids and creating more of a linear response, more of a smaller compression ratio for the music processing that is definitely ideal. If possible, deactivating or minimizing those noise reduction features will definitely make the patient

happier when listening to music and make you happier as their provider because you've done right for the patient.

Second, conclusion, as we mentioned through Dr. Alexander's research, in terms of music quality and hearing aids, there are differences. So this is just a screenshot of one of the slides the previous earlier that we mentioned. This is a loudspeaker response versus the streamed response. You can see lack of low frequencies, less of a flat response. So there are small differences between the acoustic music and universal programs as we saw here, but even a bigger difference when you're looking at a stream signal versus acoustic.

And as we talked about, there are perhaps more differences between brands than there are differences within one brand's music programs or universal compared to the music programs. So depending on the signal and the processing that's happening, music may sound very different to the patient's ear. And that should be, that should be definitely noticed. And last but not least, I'd like to leave you with this. You know, co listening during REM to verify sound quality is I think very important.

This makes sure that the fitting isn't just clinically correct, but also musically satisfying. We talked about the enjoyment of music and what it brings to everyone, a significant portion of our listeners, especially those who are interested in music. So giving patients both the measurable accuracy through the real ear measurements and verification validation through personalized listening, I think and co listening will give you a leg up as you're listening to the music. You know, if it's listening to good to you, it's probably listening and, and, and the patient is enjoying and same for the patient. So call listening is a great idea specifically for this situation.

And I'll leave you with this. We have some references here if you'd like to get into some of the research and the articles we mentioned today at the talk. And on behalf of first, let me just wait just a moment, just make sure there's no questions since we have just a few minutes. And then I just want to kind of

close things up here.

David, it does look like you have a question. Oh, how do you handle user with high frequency hearing loss and very open fit who wants to optimize music enjoyment? So you know, this is, this is a tricky situation with high frequency hearing loss, of course, because you're trying to boost those frequencies. But I think when it comes to, you know, this is the same kind of audiogram we had on the screen. And so when it comes to music, first of all, coupling is very Important to try.

And if they are in a more open type of fitting or even with the most closed disposable tip, perhaps having them try it with custom molds and giving them more of a flatter response after some verification may help. So I don't know the details of, you know, what patients would be complaining about, but that would be my starting point is kind of changing and giving them a dedicated program that has a better frequency response different from their speech processing in their universal program.

Naveen, I can take a couple of these questions. Yeah, please. I see Tara has a question. Do you recommend mostly custom fit to have the best listening with music? And my opinion is, yes, a custom.

I call it a sleeve mold that goes with a Rick or just a standard custom mold with a parallel vent is always the best way, I think, for just about any situation, including music. Yep, completely agree. And then there's a question here from Emily. When you're making these specific adjustments, is it just in the music program? I would say more often than not, yes.

Navidi might have a different opinion in this. We're talking about a second dedicated program for music, but there might be cases, especially for the casual music listener, where you sort of have to split the difference and go with a smooth, broadband flatter response that they can use just about anywhere. Naveed, I don't know if you have a. No, that's it. That's exactly right.

You know, sometimes you'll have the opportunity to offset the universal program specifically for music without giving them a dedicated music program based on the acoustic classification of what's happening in the soundscape. As you know, you know, hearing aids have acoustic classifiers. And I know that at least with the Signia software, you're able to do that without giving them a dedicated music program. So that may be another way to go, because once it's. It detects music, then it offsets based on your change.

Yeah, thank you. And I'll just add sort of to round things out here at the end, having fit hearing aids for a long time and, you know, working with different types of music programs. So there's five things that I think you need to leave here with, and that is during the hearing aid evaluation, the intake case history, that kind of thing. I think it's important to develop a music listening plan for the individual. Too many people, according to a couple of different studies that we studied, they don't even talk about music when the patient comes in.

And with streaming available to everybody now, music is probably something that's relatively important for just about everybody in some way. And that leads to the second point, which is you should part of your music listening plan should be a plan that involves streaming music and also live stream or live or loudspeaker music as we talked about. Number three, pay careful attention to the coupling. The more closed usually the better. Of course.

Within reason. Number four, be skeptical of the dedicated music programs one study we cited show that they're not really different or better than the default speech program. And always aim for a smooth broadband response when it comes to optimizing music. And then use REM or real ear measures to verify the performance, including co listening. So that's my five cents worth.

Naveed. I'll let you close. No, that's. That's exactly right. Thank you for that.

On behalf of Dr. Taylor myself, I'd like to really thank you all for joining us today. Hope to see you again on another one of our audiology online talks. And please feel free to reach out if there's any questions. Happy to address those. Thanks again.