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Cognition and Audition: A Deeper Dive

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- Well, good day. Thank you for joining us. This is Dr. Douglas Beck. I am the Vice President of Clinical Sciences at Cognivue, and today I am joined by my offscreen colleague, Dr. Lori Adams, who thankfully knows more about these things than I do. So what we're gonna do is we'll talk for about 50, 55 minutes about "Cognition and Audition: A Deeper Dive." This is a program for the AudiologyOnline audience. It's more or less an overview. I love the AudiologyOnline group because I was originally one of the executive team members on that back in 1999 when we started it. And Bill LaCalle and Aimee LaCalle, it was their idea. They brought me in as president and editor-in-chief, and I worked with them at AudiologyOnline for six years, so this is kind of like coming back home.

So what we're gonna do is I'm gonna lecture. This is my email address and this is my phone or text number, but you're welcome to send me questions, observations. I generally ask people for content analysis. You know, that if I say something that you disagree with, I'd like to know. I'd like to know your opinion. I'd like to know why you think that what I said was right or wrong. You know, all that stuff's really interesting to me. And so I want to invite you to contribute if you'd like to. I always start by going over my relevant and irrelevant financial relationships. So I am a full-time employee at Cognivue Inc. I've been with them almost a year now.

I still consult for Oticon and some other private concerns, and I'm the senior editor for Hearing Review. I would point out shamelessly that the January 2023 edition of Hearing Review will be all on science related to cognition and audition, so you might want to get a copy of that. What else? I am still, oddly enough, an adjunct clinical professor at the State University New York at Buffalo. That's where I got my bachelors and my masters about 112 years ago. And I'm a peer reviewer for many different publications. So I thought what we'd do today is, in an effort to avoid death by PowerPoint, 'cause you know, we all see PowerPoint every day, I'm gonna just try speaking extemporaneously.

And I'm gonna speak about, you know, quite a few topics, and, you know, we'll see how it goes. If it seems to be reasonable, we'll go with it. If not, you'll never see this. We'll delete it. So we're gonna start with hearing versus listening. And the important concept here that many of our healthcare colleagues, many lay people confuse hearing and listening. You know, when somebody has difficulty understanding speech and noise, when somebody has difficulty in conversational speech. Family members, physicians, you know, other people will often say, "Oh, well, you know, it's probably just hearing loss and that comes with aging and blah, blah, blah." And all of these things are kind of silly. We shouldn't say hearing loss comes with aging.

We shouldn't say it's just hearing loss. We shouldn't say any of that. We should be very clear that hearing is just detecting or perceiving sound. That's it. Listening is making sense of sound. Listening is decoding the neural code. Listening is comprehending sound, is applying meaning to sound. So in the United States of America, you have about 330 million people. Of those, only about 38 million have hearing loss. So it's not like everybody has it and that you should necessarily depend on it with aging. It certainly does increase with aging. I mean, the demographics are well known to all audiologists. When you hit age 65 or so, about 1/3 of Americans have hearing loss that's demonstrable on an audiogram. And by the time you hit 75, about 2/3 of all Americans have hearing loss, and that would be shown on an audiogram as well.

But the thing is, those 38 million, only, you know, about 1/3 to maybe 40% will ever, ever, ever seek help, you know, because they are convinced that their hearing loss is not a big deal. They are convinced that people mumble. They are convinced that it comes with aging. So they don't seek help. They say, "Well, that's the way it is, it's fine." And there are peer reviewed papers, I'll be covering them in my January, 2023 article in Hearing Review, where people, 60% of people with mild to moderate loss don't even know they have hearing loss. So the question becomes, you know, with

OTC and with screenings and all this stuff, why on earth would anybody seek relief or seek a solution to a problem they don't perceive?

And the answer is they don't. And then we make it a little bit worse because what we do is we screen people for hearing loss, right? So we might give 'em a 25 dB threshold, 35, 40, whatever we pick, and we screen, you know, maybe 500, 1k, 2k, and 4k. And we base our initial presumptions on that. We'll say, "Well, you passed." And then what they hear when you say, "Well, you passed a hearing screening," they hear, "I have normal hearing." If you say they failed, then, you know, they're not gonna usually act on it unless they perceived it was a problem to begin with. And so what I argued very recently in the November-December '22 edition of ASHA Leader, I don't think we should be doing screenings.

I think the only screenings we should do are newborn infant, you know, ABR, Oto Acoustic Emission hearing screenings for babies. 'Cause that's very, very important that we identify that and we fit them immediately, you know, within three months, so that they have a chance to catch up to language and communication, pronunciation, articulation, vocabulary. You know, if we delay that a couple of years, the chance of them catching up is just not good. Anyway, what I argued in that ASHA Leader 5,000 word editorial is that all people, children, seniors, midlife people, when they have concerns about hearing, they should have a complete audiometric evaluation, not a screening. Because with that screening, you're gonna get maybe the 38 million, you might catch 'em, you might not, but you're definitely gonna miss the 26 million who have no hearing loss whatsoever, but they might have attention deficit disorder, attention deficit hyperactivity disorder, auditory processing disorders, auditory neuropathy spectrum disorder.

They might have mild cognitive impairment, they might have Meniere's disease, they might have, you know, neurocognitive disorders such as Alzheimer's or they might

have Parkinson's with dementia. They might have Lewy Body disorders, they might have frontotemporal, they might have blood flow issues, you know, that depress the circulation of blood through the brain. So there's lots and lots of people, 26 million in the USA, no hearing loss whatsoever, but they have supra, S-U-P-R-A, suprathreshold listening disorders. So those people, why would we wanna identify them? Well, because if we identify them, we could help them. I think the vast majority of those people with suprathreshold listening disorders would complain that they can't understand speech and noise or they have hearing difficulty.

And what they generally need is not sounds a lot louder, but they generally need sounds to have a better signal to noise ratio so that their brain can make more sense out of it more easily. You see, when they're in a noisy situation and they have auditory processing disorders, auditory neuropathy spectrum disorder, cochlear synaptopathy, hidden hearing, you know, any of those things that don't necessarily have hearing loss, it's very, very difficult for them to understand individual words, sentences, phrases. But if you improve the signal to noise ratio, you might make it easier. Can I guarantee it? Absolutely not. But I would say that if we're doing a speech and noise test, we would start to identify these 26 million people who are having difficulty.

And if we identify them, then we can give them a trial. It could be as simple as a pocket talker, an assistive listening device. It could be hearing aids, it could be premium hearing aids, it could be mid-level, that's fine as long as, you know, they elect to do it after they've tried it. It's fine with me, that is. But when we are trying to improve the signal to noise ratio for anybody with hearing aids, I think it's really important to demo, you know, of course an FM system and/or a digital remote mic. And digital remote mics, I think, are very underrepresented in our practices. You know, we're all kind of familiar with FM, but digital remote mics, all the major manufacturers make them.

They're rather inexpensive, \$150, 200 bucks wholesale. And they can improve the signal to noise ratio by 15 to 20 dB. Now, I'll talk a little more about signal to noise ratio as we move through this lecture, and I'll give you some specifics on that. But my point is that hearing is perceiving sound, listening is applying meaning to sound. And the fact that somebody has difficulty in hearing and/or listening is an audiology based problem. And I think hearing care professionals should not ignore the 26 million. And you know, that's perfectly consistent with ASHA, with AAA, and with IHS. They all say the same thing, right? That you should do your diagnostics, air-bone speech, otoacoustic emissions, tymps, reflexes, all that stuff, absolutely very important.

But they also all say that you should do a communication and listening assessment. So those would be things like, you know, the APHAB, the Abbreviated Profile of Hearing Aid Benefit, the COSI, Client Oriented Scale, which I think Harvey Dillon wrote 25, 30 years ago. Then you have things like the International Outcomes Inventory, the Hearing Healthcare Inventory for Elderly, Hearing Healthcare Inventory for Adults, the SS2, there's a bazillion of them. Those are the things that determine who needs help and who needs amplification. Pure tones don't really tell you that. They are not particularly good at that because it's not the pure tone that matters. It's the patient's appreciation and understanding and ability to get by in the world that matters.

So you measure those on tests of listening and communication assessment. Pure tones are very important. I'm not dissing them, but I'm saying you have to understand the reason that we even do pure tones, 'cause they don't exist in the real world, right? And not only don't they exist, but for us to test, for us to test people on pure tones, we put a set of TDH39s on 'em or we use insert earphones, so we have this stuff on 'em, we put 'em in a box, we take away all background noise and we give 'em sounds they never hear in the natural world. And we say, you know, let's determine your thresholds for this. Totally cool.

Why do we do that? We do that for the purpose of an otolaryngologic diagnosis, which is step one, you know, who to refer out to ENT or to another physician, and who is okay to be served by us at that point in time. So I'm not dissing it, it's very, very important. But it doesn't tell you who needs hearing aids. There are many people who have absolutely normal hearing, by now, you know, that number's 26 million, but they have difficulty understanding speech and noise. They have difficulty with hearing. They have difficulty recalling what somebody just said. They have difficulty applying meaning to what was just said. So I think for those people, what do we as audiologists or hearing care professionals do that might be useful?

Well, improve the signal to noise ratio, and that would ease the cognitive load. That would ease the stress on the brain. That would, that would make it easier for the patient to perceive bottom-up information, auditory information, and then make sense of it in a top-down manner, applying meaning, memory, vocabulary, language, psychological benefits, you know, and to really make sense of it in the manner in which it was intended. So that's hearing versus listening. It's not trivial. It's extraordinarily important. And very few people actually separate hearing versus listening in their clinical day-to-day stuff. When we see somebody with a mild to moderate sensorineural hearing loss with 72% word recognition, we go, "Aha! That's why you have difficulty understanding speech and noise."

And you know what, it may well be, it may well be. It makes good sense, absolutely. But how do you know they don't also have auditory processing disorders? Auditory neuropathy spectrum disorder? How do you know they don't have traumatic brain injury? How do you know they don't have mild cognitive impairment? Because when you're looking at people with, for instance, mild cognitive impairment or neurocognitive disorders, mild cognitive impairment for the group above age 65, this just came out in December of '22, above age 65, it's up to 22% of the population have mild cognitive impairment. And when we talk about people who have full-blown Alzheimer's disease,

if you go to the American Alzheimer's Association, what you would see is that when somebody reaches age 80 to 85 in the USA, about a third of them have Alzheimer's.

So it's remarkably high in its prevalence. And so the people who are going to have hearing loss, most of the people with hearing loss, most of the people with neurocognitive disorders, it's the same group. It's, you know, 65, 75, 85, 95 right? Now, that's not to say it couldn't happen in a younger person, of course it can. But I'm saying the vast majority of people with hearing loss and with neurocognitive disorders, in particular, mild cognitive impairments and we talk about things like Alzheimer's disease and other neurocognitive disorders, mostly older folks, right? Senior citizens. And so these two groups overlap a lot. And it's interesting 'cause Patty Kricos, unfortunately, she passed away probably 15 years ago, she was at University of Florida, and she used to say that people with hearing loss and people with neurocognitive disorders often masquerade as each other, and it's important for us as the professionals to determine who's who and what's what.

And I think that that is a lesson that is so important, and it's almost been lost in our profession to some degree. And I think when we see somebody who clearly has mild to moderate sensorineural loss, I would recommend doing a cognitive screening and just see if there's anything else going on. If the screening is negative, they perform normally, fantastic, then it's an audiology problem. No big, no big deal. We do that all the day. But if they test positively, they have a non-normative result, refer back to their physician. It's just that simple. And you say, "Hey listen, thanks for referring Joe Blow, 72 year old male, mild to moderate sensorineural loss. Here's his audiology, here's what I recommend for that.

But we did run a cognitive screening, he didn't do very well there. So we're referring back to you for further guidance." That's it. That's what I would recommend. And hopefully the physician would take that seriously because some of the cognitive

screeners manufacturers will give you a report for the physician and will show what the different domains mean, like executive function, like visual-spatial, like memory. What does that score mean? It's all laid out, and you don't even really test the patient. You know, if you go to some of the more advanced ones that are self-contained and digital standalone kind of computers, use those screeners, in our case it would be Cognivue Thrive, right? That would be the one we make for hearing care professionals.

You don't even really test the patient. You would tell the patient, you know, "We're going to see how you process information. This is a test that helps me understand how you remember things, how you prioritize things, how you attend to things." And then you sit them down in front of it, you explain how to do it. I mean, it has directions on there, but you might give 'em a cursory overview, and then it's all visual and motoric. So they get stimuli that they kind of trace it with a little ball, you know, kind of like we, that there used to be, right, in the early days of digital gaming, you would have a control stick and you would turn it left, right, up, down, fast, you know, forward, backward, all that stuff.

And so you control it with something like that. It's called a Cogni Wheel. And they just turn this little dial and it goes one way or the other. And they trace things and they have to identify things. They have to remember what pattern they just saw. But none of it's verbal, so their hearing loss doesn't matter. You see, and this is, I think, a very important, very important thing to look for when you're convinced that you should do cognitive screenings, then I think you should use one that people with hearing loss won't be penalized for their hearing loss. And what do I mean by that? Well, when you look at a traditional MOCA or a Mini-Cog or a Mini-Mental State Exam, or the SLUMS, which is the St.

Louis University Mental Scale, when you're looking at those, I have to read the questions to a patient. The patient then responds. So if I haven't done a full

audiometric evaluation on the patient, and we're doing a cognitive screening on a 70 year old, 75, 80, 85, 90 year old, 95 year old, if we're doing those screenings, we don't really know what their hearing and listening level is most of the time, right? Unless we've already done a comprehensive audiometric evaluation. So we're presuming they have normal hearing, normal processing, normal vocabulary, normal everything, and we just don't know that. So Carol Flexer and I wrote a paper, gosh, I don't know, I think it was 2011, where we spoke about this, that all cognitive screenings should be prefaced with a audiometric evaluation so that we could assure ourselves that the patient has the ability to hear and comprehend normally before we read them the questions that are going to be used to judge their cognitive ability.

So the Cognivue Thrive, it doesn't have any sound associated with it, right? Other than the instructions, but even if the patient can't hear the instructions, you can review it with them. But it's so simple. And so they sit down, they take the test themselves, it spits out a report, you're not scoring it. So it takes away the two biases, which is the bias of the tester interpreting what the patient has said and the bias of the patient interpreting what the tester has said. So you get a pretty good reliable score that way. And I would urge you to look at that. Alright, signal to noise ratio. I mentioned this earlier. The gold standard, I think, it depends on who you talk to, right?

But to me, the gold standard on signal to noise ratio comes from Dr. Mead Killion. And gosh, it was 2001 that he wrote in seminars in hearing about the SNR-50, which is the signal to noise ratio to get half the words right. And this is remarkably important. Some people will say, "Oh, why test speech and noise? Just assume they all have that." That's crazy, that's insane. That's like saying, "Why do an audiogram? Just assume everybody has hearing loss," or, "Why test blood pressure? Just assume that if somebody's in their 70s or 80s they have high blood pressure." It's kind of silly to think that way. Here's the thing about quantifying their SNR-50, the signal to noise ratio they need to get half the words correct.

We know that people with normal hearing, normal brains, normal processing, they need a signal to noise ratio of one, two, or three, okay? And if they have that, they're gonna do great. So that's fantastic. People with mild to moderate loss need about seven or eight signal to noise ratio to do well. So if somebody has a mild to moderate loss, they need seven to eight, and you're only giving 'em one or two, they're gonna not perform well, but it's not because of their cognitive abilities, it's 'cause you didn't apply an appropriate signal to noise ratio. Further, if you know their SNR-50, it kind of tells you exactly what you need to do. If you know somebody's SNR-50 is one, two, or three, they're probably not coming to see you very often.

I mean they might if they have audiometric hearing loss, but they won't come to see you for a listening disorder, 'cause they're doing really well. If somebody with normal thresholds has an SNR-50 of seven or eight, that's a real problem, 'cause they're performing in the real world like they have a moderate sensorineural hearing loss. And by virtue of their audiogram showing that they don't, this is somebody with a suprathreshold listening disorder, probably. And then what can you do that would supply them with that? Well, there are some premium hearing aids that can give you a seven or eight dB advantage, you know, signal to noise ratio in noise. Not all, not even most. Typically, when you're fitting hearing aids like beamformers or directionals with a dome, you're improving the signal to noise ratio by two or three dB.

That's about it. So somebody with an SNR-50 of 11, and you fit 'em and in the office they say, "Oh, well, Dr. Beck, that sounds great, thank you so much." But you're only improving their signal to noise ratio by three, you're also making it louder, so yeah, that's great, that's fine. But the thing is, in the real world, now that they've gone from an SNR-50 of 11 to, let's say, nine or eight, so they're still acting like somebody unaided with a moderate sensor neural loss. So it's not just improving the signal to noise ratio, it's improving it appropriately per their SNR-50. So my response to, "Why

not treat everybody like they have an SNR problem?" is because you need to quantify it.

And that involves something like the BKB, maybe the QuickSIN, maybe the test that I wrote with Lauren Benitez, it's called the Two-Minute Speech-in-Noise Test. You can find that one at the AAA website, I think it was 2018 or 19, or just Google Beck Benitez, B-E-N-I-T-E-Z, and it'll pop up. If you can't find it, send me a note, I'll send it to you. It's free. You don't have to buy anything. You probably have a two-channel audiometer, you probably already have two sound field speakers. It shows you how to set it up. There's an appendix, it shows how to set up the booth, but we didn't even do it in the booth.

We did it outside of the booth 'cause the presentation is gonna be at 70 dB SPL, which is, you know, about 55 HL, and so you don't really care about the HVAC or the fluorescent lights or any of that stuff, 'cause you're at conversational level. So anyway, you could read about that. But the point is, it is important to quantify the signal to noise ratio because that tells you how much help they need, which tells you what type of technology they need. All right, mild cognitive impairment versus dementia versus other stuff. So I have 30 minutes left, so I'm not gonna talk, oh, I will, I was kidding. So mild cognitive impairment means that the individual might have occasional memory deficits or perhaps disorientation, something like that.

It varies in each person. There's no, "This is MCI," it doesn't work that way. And again, once you're at age 65, about 22% of the American population will have mild cognitive impairment. Most MCI, if the person ages for a couple of decades after that, most of it will become worse, you know, and will become a dementia, probably. This is where things get really interesting. So mild cognitive impairment, if you look at "The Lancet" 2020, Gill Livingston and his colleagues wrote a brilliant paper that became kind of a gold standard paper, where they said, "Well, what is your risk of having dementia as a

normal healthy human being?" And it turns out, what they found by looking at three peer reviewed studies and assembling that information, they said, "Your risk of getting dementia is about 60% based on your DNA," deoxyribonucleic acid.

So it's associated with your aging and your DNA. But then they said 40% of your risk of developing dementia is very likely due to 12 modifiable risk factors. I didn't memorize them, but I'll try to tell you most of them. So you have hearing loss, you have social isolation, you have depression, you have diabetes, you have air pollution, you have lesser education, you have stuff like that. You know, environmental things that can be controlled. Alcoholism is one, drug abuse, so that's probably 8 or 9 out of 12. But, and oddly enough, if you were to address all of those 12 modifiable risk factors successfully, you might lower your risk of dementia by about 40%. So what's the difference then between mild cognitive impairment and dementia?

And again, it's not like there's one firm test for this. Those are, oh, that's my dog shaking her head. I have a German Shepherd. I don't know if you just heard her collar rattle but that was it. So between mild cognitive impairment and dementia are activities of daily living. When somebody has mild cognitive impairment, you know, they are independent, they can feed themselves, they can bathe themselves, they can toilet themselves, they can ambulate, they can drive. When somebody can't do those things, that's when a physician might start to think about dementia. About 60 to 65% of all dementias are Alzheimer's disease. That's why you're familiar with that one. Alzheimer's occurs over about a 20 or 30 year span. Pardon me.

And what that means is that you change chemically over a 20 or 30 year span, and as that's happening, you go through the phase of MCI, you eventually might get to where you can't participate fully in activities of daily living. And that's where you might get a diagnosis of dementia. With Alzheimer's, again, it's usually about 20 to 30 years from when chemicals in your cells start to change until you might get a diagnosis. And this is

very, very interesting, because we have attributed, for the last couple of decades, most of the energy, most of the money, most of the time went into amyloid plaques, which, amyloid plaques and tau proteins is what we thought were the, perhaps, etiology of Alzheimer's.

So a lot of the drug research, the pharmaceutical research, the cognitive research went on, well, how do we avoid people producing amyloid? And what happened is, it turns out that's not necessarily the root cause of Alzheimer's or any neurocognitive disorders. You have amyloid regardless. And in fact, there are people who have tremendous amounts of amyloid and tau proteins that do not have any signs or symptoms of neurocognitive disorders. So it's not a one-to-one relationship. There's also, you know, APOE4, which is a protein, A-P-O-E-4, an allele that is highly correlated when people have neurocognitive disorders, in particular Alzheimer's. High correlation between tau proteins, amyloid plaques, APOE4, things like that would seem to perhaps be a fruitful area to look for biomarkers.

A biomarker is when we have a blood test and we can say, "Oh, look, they have this." So that becomes, then, the standard. And if you have that component of blood that signifies dementia and we do a blood test and find that, then you have dementia, right? It's not that simple with cognitive disorders. And as of yet, the pharmaceuticals, about 85% of them were focused in the last 25 years on amyloid, which, now we're thinking amyloid is the result of other things that happened first, and so amyloid is what we see associated with it, but, truly, the etiology could be the chemical reactions before that. I'm not gonna go into those details today 'cause we don't have that time, but I did write an article on this and it's called "A Deeper Dive," and it's in Hearing Review and I think it came out in October of '22.

So if you go to that article, you'll see there's a whole section on biomarkers. The single most successful biomarkers right now are PET scans, and there's three different types

of PET scans. And again, in that article in Hearing Review, I go into that and I tell you how that works. So mild cognitive impairments, about 22% of people over age 65. Dementia in the USA, right now there's about, you know, 6 million people who have been diagnosed with dementia. However, across the globe there's about 55 million. All of those numbers will be times three in the next 28 years. By the time we get to 2050, we're anticipating 155, 160 million people with dementia across the globe, and in the USA, probably 30 million. Now, why do I say 30 if we only have 6?

Well, good question. Because we think that a vast majority of people with dementia and with mild cognitive impairment are not diagnosed. And the number 6 million refers to the people with Alzheimer's, But there are many other types of dementia. So you have, as I mentioned earlier, you have frontotemporal dementias, you have Lewy body disorders. That's what Robin Williams had, unfortunately. You have people who have Parkinson's with dementia, and you have different blood flow dementias, you know, where the brain is not receiving enough nutrients through blood flow, often because the patient has atherosclerosis. You know, and this is a major thing, right, is that your carotid arteries on both sides of your neck, if they're occluded, the blood flow through your brain won't be very good, and then your brain suffers as a result from that in its ability to think and have cognitive responses.

Okay, so that's mild cognitive impairment, dementia, Alzheimer's disease. The demographics we sort of covered already, right? I'm just checking my timing here. Okay, we have 22 minutes, we'll be fine. The point about the demographics of hearing loss and cognitive decline is the two populations who are most susceptible to hearing loss and cognitive disorders are the same. You know, they are older adults. I wouldn't worry too much about cognitive decline, you know, in most people under age 50. It's just not very common. It could occur, and there might be reasons to test people in that age group, absolutely, but it's not gonna be a typical thing. Same with biomarkers. I think all the biomarker work is done on, you know, older adults at this point.

So we'll see how these things develop. But the demographics are that these are the same populations that manifest significant hearing loss and significant cognitive decline. Does amplification improve cognition versus cognitive test scores? So this may seem a little bit weird, but just in the last month there was a brand new paper that came out from "The Lancet." And very important paper. What they pointed out is that yes, people who test poorly on cognitive screenings are more likely to benefit from whether it's amplification, cochlear implant, assistive listening device, you know, hearing aids. But what they found is that people who actually had dementia and they took a cognitive screening, they were not as likely to be helped.

And so what they started to think about was that the cognitive screeners that you may select from will help identify people who are likely in a compromised position. But they said you have to be very cautious about which population you're dealing with, because if it's somebody who's otherwise fine, they are susceptible to benefit from amplification. If it's somebody who is otherwise not fine, they have non-normative results, we don't really know what the benefit will be. And this is a universal, now, that hearing aid amplification and other amplifications seem to be beneficial for many people most of the time, but we don't know how to select which patient will do best with amplification, who does not do well on the cognitive screening or who will do the worst.

We don't know the candidacy criteria for doing well with amplification or not doing well. So there are certainly plenty of peer reviewed papers that have shown subgroups that have done well with amplification. And there's some, many papers, as well, that have shown that it didn't make a difference. And that's what this brand new paper addresses, is that this may be a deeper analysis that's required, truly diagnostic cognitive analysis to see who's who and what's what when choosing amplification for some of these people. So this, it's all developing very rapidly, but it underscores the

point that I've been making for, you know, 10 or 12 years now, that it, listen, we feel pretty comfortable saying hearing loss exacerbates cognitive decline.

It looks that way. It certainly does look that way, and some authors have come out and said that. I would say there's strong evidence for that. I don't think it's necessarily one-to-one. It's not causative, but certainly correlational that if you have hearing loss, you're more likely to manifest cognitive decline. But I, the information on how much amplification helps is still mixed. Now, I do anticipate that early in 2023 we'll have the results from the Johns Hopkins ACHIEVE study. And I think that'll go a long way to helping us understand the parameters and the outcomes of these things. But as of yet, I wouldn't promise any patient that amplification is gonna help. I would certainly try most patients who I suspect of having cognitive issues with amplification for a 30 day trial and see if they do better.

Now it gets a little bit difficult because you get a cognitive screening that says non-normative, and they're having a difficult time on speech and noise and maybe their listening and communication assessment is not so good. So you try 'em, and then you'd like to have an evaluation 30 days later, so you do another cognitive screening, but that may be too early to show any results. What you're gonna see at 30 days is the result of having better sound, perhaps better processing, more sound available, all of those things, which are very important, but it doesn't mean there's been a cognitive change. Now the question becomes, well, does it matter? If the patient is doing better, they're doing better.

And that's clinically reasonable, right? If the patient and their loved ones, in particular, their significant others, say, "Wow, he's doing so much better." Take the win, that's okay. But you have to be careful to not necessarily attribute that to a cognitive improvement. The only way that you would know that is with a cognitive diagnostic test, which none of the screeners do. So I'm a little concerned that I've seen people

over interpret a cognitive screening done a week later or 30 days later. I don't think that's enough time. I think you need at least 45 to 60 days, and I'd really like to see 90 days, because, you know, we know it takes about 30 to 40 days for just the brain to adapt to amplification.

And Brian Taylor wrote a brilliant paper on that in 2008 or 2009. And so I think if you test too soon, you're gonna see the benefit of amplification, which again, you know, maybe it doesn't matter. If the patient's doing better, then better is better. So, okay, but what you attribute that to early on, I am not so sure that you could say that was a cognitive improvement. So that's the point about, right, does it even matter? If they're doing better, they're doing better. That's great. I think the other thing that came out in this brand new study is that the loved ones' informed opinions tell you a lot. They are more accurate than the tests that we run.

This goes back to pediatric audiology. When I was studying that 40 years ago, I remember Derek Sanders, University of Buffalo, was one of my professors, and Derek said, "If the mom tells you there's something wrong with the kid, there is something wrong with the kid 99 out of 100 times." And I took that to heart. And I think that this is also true here, that if the loved one, the spouse, the mother, the father, the grandfather, the child, whoever, if whoever is the caretaker or the carer for that person says, "Wow, they're doing much better," they are. I'm pretty convinced of that. So it doesn't matter. Well, the important thing is to not say, "Wow, he's doing better. See, we've protected his cognitive ability."

Hmm, I think that's a little bit unknown at this point. Alright, signal to noise ratio and dementia. Well, we covered a lot of this. Again, it's the SNR-50, the signal to noise ratio to get 50% of the words correct. That's kind of the standard. If you're using the quick standard, the BKB, or the words and noise, or the HINT or whatever, great. If you're using it successfully and you're happy with it, please keep using it. You have no reason

to change. If you are looking at these things for the first time and you're considering what's the quickest and easiest and most accurate, I might say, my opinion, look at Beck Benitez. Costs you nothing and takes two minutes.

And what you wanna do is you want to get an unaided score, speech and noise score, and then you get an aided score. You know, so you take somebody who has OTCs or they have an older set of hearing aids, you bring them in, you get an unaided speech and noise score, and then you get their score with their devices. And the aided is probably worse, unless the hearing aids are really, really good. And then you try them with a premium or a mid-level or an entry level, whatever you think is appropriate. You're the doctor, you pick what you think. But then my point is, test 'em again with SNR-50, 'cause if you haven't improved their SNR-50, then you probably haven't helped, you know?

You made stuff louder, but is that really the goal? And the answer to that is no, the goal is to improve the signal to noise ratio. Of course it has to be audible. I'm not saying don't make it louder. You need to make it louder if they have hearing loss, that's a given. But that's not the goal. The goal isn't, can I hear everything louder? The goal is, can I hear things more clearly? Okay. So cognitive screenings. Let me check my time here. I've got about 13 minutes, okay. So what I would say is that these are all excellent. You know, when you look at the Mini-Mental State Exam, it was a standard for probably 30 or 40 years.

It's a good test. You have to, you know, be trained in any of these. And you know, as far as scope of practice and qualifications, I wrote an article on that that's in, I think I called it "Turf Wars" or "Turf Battles" or something like that, that was in Hearing Review, I wanna say November of '22. And my point here is that whichever one you're gonna use, you have to understand cognitive screeners are not diagnostic. You have to understand you need to be trained on all of them. You can't just do it, you know, you

need to spend the time and learn how to do it properly. You need to learn what words to say to patients.

And you heard me earlier. I don't ever talk about cognitive screenings to patients. I talk about, "I want to assess your ability to process information." And I would never say, "Well, this is how your brain works," or, "Well, that's what your brain is doing." I think that's a little bit too intense. And as an audiologist, as a doctor in audiology, I still don't want to tell patients how their brain works. I might say, you know, "It seems to me that we can improve the way that you perceive sound and that you make sense of sound," but I don't say that I'm gonna try to improve your cognitive or intellectual ability. Nonetheless, cognitive screeners are relatively important in audiology and hearing instruments, because there was a study out of the United Kingdom, it's called the UK Biobank study, and it's based on 80,000 people.

And they found a hazard ratio between speech and noise and cognitive issues. It's about 61%. And so what that means is people who have difficulty understanding speech and noise, that could be a red flag, an early warning signal that they are candidates for cognitive problems later. But if you don't check their speech and noise, you wouldn't know who is within normal limits and who is not. So maybe an appropriate protocol and, you know, we need to have study groups look at this stuff in depth. But maybe an appropriate protocol is to do exactly what ASHA and AAA and IHS say and do a speech and noise test on every single, you know, person. And it's not just adults, you can do them on pediatrics.

There's a, if you go to AudiologyOnline, which is where you are now, and you put in "pediatric speech and noise," you'll see that there are ways you can do this. There are tests that are specific for children. But you know, this is not new. I mean, 53 years ago, in 1970, Ray Carhart and Tillman said that speech and noise testing should be part of every diagnostic audiometric evaluation. And they were right, and AAA adopted that,

ASHA adopted that, IHS adopted that. It's just that only about one out of five audiologists or dispensers has adopted that. And I think, again, we have to get away from screenings and we have to get away from doing half the job. I think every single patient, air-bone-speech, right?

And then if needed, tymps, reflexes, OAEs, ABR, you know, whatever we need to do we need to get the right diagnosis. But then after that, communication and listening assessment, which all of them say, AAA, ASHA, and IHS, and then speech and noise. Now, if the speech and noise is bad, or, you know, not what you would've expected given their hearing loss, I would certainly do a cognitive screening. And if they have no hearing loss, but they have all these difficulties understanding speech and noise, or hearing difficulty, do a cognitive screening and see if you need to refer them back to their physician for further diagnostic assessments in the realm of, you know, cognition. So those are the key points here in section eight.

Oh, going the wrong way. Nine. Well, this is a little self-serving, but I'll get over it. So, cognitive screeners that don't depend on audition. Well, I told you the only one that I'm aware of is the Cognivue Thrive. So you can certainly get in touch with me or my colleagues at Cognivue to find out more about that. And referral criteria. So a lot of people ask, you know, well how much of a change is good? How much of a change is bad? And, you know, we're gonna have really good definitions of that in 2023. Cognivue has engaged studies of, I think we've got about 1500 people that are now finished, looking at all sorts of demographic data, including the fact that we have fantastic integration of upper and lower socioeconomics, mid socioeconomics, Caucasian, non-Caucasian Hispanic, non-Hispanic, all of those things.

We're also looking at gender and sex, we're looking at ages, we're looking at, and ages, we're gonna divide up into decades. So you'll have people like, I may have this wrong, but I think it's 20 to 29, 30 to 39, 40 to, so we're gonna have more and more

finer definitions and information. And I'm hopeful we'll be releasing that stuff about June of '23, maybe May. We'll start to write in-depth reports on that and make them available through Hearing Review or the Journal of Otolaryngology ENT Research. And we may do some more papers on that. We're yet to be determined on that. So referral criteria, so strictly what matters is how do they score, normative or non-normative? And what you'll see on the THRIVE pre-printed results, you know, is you have green, yellow, and red.

And that's useful, that tells you grossly what the categories are. And then you have numbers, and those are good as well. But when we're talking about change, we're talking about which way did it change? Did it get better? If it got better, is five points significant? Well, these are screeners, so I don't think you can have a statistically significant change in a screener. It's like, imagine somebody failed an audiometric screening and they went and then, you know, they failed it less poorly or less bad, right? You know, that's not what a screener does. You don't have that kind of statistical validity in a screener. So what you're looking for is, is the result normative or non-normative?

Which way did it go? If it got better, that's certainly a good thing. Is an improvement of 15 points better than an improvement of eight points? Yes. Can you say anything statistically about statistical significance on that? No, it's a screener. So I think we have to keep in mind that for diagnostic purposes, if we want to know did we change or improve somebody's cognitive ability, a screener may offer you a gross look at that, but that's a diagnostic question. It's not a screening question. So, okay. Let me see one more time. Yeah, down to five minutes, okay. So I think that might be about it. Yeah, those are the points. So I hope you enjoyed it. I was intentionally trying to not bore you to death with PowerPoint, although I may have done that with content.

I dunno, we'll see. I wanna point out, this is my new paper coming out in about 10 days in Hearing Review. Well, by the time you see this, it'll be out, I'm thinking. "Cognition and Audition: Perspectives and Review 2023." In this paper, I picked some of the 2022 papers that are lesser known and I reviewed, you know, their primary conclusions and results. So I hope you'll find that interesting, because we all know about Hannah Glick and Anu Sharma's brilliant papers. They get a lot of attention, and rightfully so. We all know about The Lancet 2020, but that's already, you know, three years old, and there have been further advances on those same topics in the Journal of the American Medical Association.

So you're all familiar with, you know, hearing loss was the most significant of the probable modifiable factors, right? For dementia, hearing loss had an 8.2% PAF, which is population attributable factor. But you know what the JAMA said in 2022? The Journal of the American Medical Association had a much larger population than Lancet 2020 involved in the study. And they said the single most modifiable risk factor for dementia was actually obesity. So that doesn't mean that hearing loss is now decommissioned. Hearing loss is still a fantastically important modifiable risk factor, but that's based on the Lancet of 2020. The JAMA in 2022 says obesity. So important, you know, 'cause science is never finished. There's no finished science, science evolves. These are some of the papers that my group and I have published in 2022.

So I'm going to show you those. This is in the Journal of Otolaryngology ENT Research, "The Emerging Relationship Between Cognition and Audition." And this covers in depth why cognitive screenings are beneficial for audiology patients and why comprehensive audiometric evaluations are recommended for people with mild cognitive impairment, cognitive decline, and dementia. This one I did with my buddy Dr. Jed Grisel, where we were writing about otolaryngology should be involved in cognitive screenings. And again, this is peer reviewed Journal of otolaryngology ENT Research, and this was kind of our expansion into the world. We said, you know,

cognitive screenings is not something that's just audiology. I mean, we want otolaryngology, family practice, internal medicine, gerontologists, geriatricians, nurses, chiropractors, dentists, hearing aid dispensers, optometrists, ophthalmologists, we want everybody with a license involved.

It's very much like suicide watch. And if you go back to Catherine Palmer, when she was president of AAA about four years ago, five years ago, sorry Catherine, I don't recall, but, you know, she had this brilliant article, which I think was in JAAA, where she said, you know, "As licensed clinicians we're all part of the suicide watch team, or we should be." And it doesn't mean you're gonna, you know, counsel somebody who is suicidal or expresses suicidal ideations, but the point is that you should be aware that they exist and you should know what to look out for. And if you find it, you should immediately refer the patient for help. And I think it's the same with cognitive disorders.

And you know, you see this in Susan Earhart's work in Colorado. You see this in ASHA, you see this in our professional journals for the last 15 or 20 years. This one I did in the fall of '22, "A Deeper Dive: Cognition and Audition." And if you look carefully, I don't think my, right here, this is the section on biomarkers, which is about, I don't know, 700, 800 words, but a brief review on what biomarkers are and how they work and why we are looking forward to the further and continued development. This is the Turf Wars article, and this is, it gives you a little bit of review, not just in audiology, but I went, my history with Dr. Bill House, who's one of my mentors, about how he, when he started doing skull-based surgery, everybody thought he was, you know, stepping out of his lane and acting beyond his abilities and things like that.

But obviously Bill House prevailed, and he developed the translabyrinthine craniotomy, he developed the middle fossa craniotomy, he pushed forward cochlear implants. His first cochlear implants was 1960, right? He did three of them in Los Angeles. When were they approved by the FDA? 1986. So he was, you know, 20, 25, 26 years ahead

of the curve. And then same with auditory brainstem implants. And then this is the "Whole-Brain Hearing and Listening." This is "Beyond the Audiogram," this is the one that I just did for ASHA in the ASHA Leader, arguing that, you know, screenings are really not in anybody's best interest. That if, again, with the caveat that I am totally in favor of screening newborns for hearing loss. But children and adults, I think instead of screening with pure tones, which tells us only half the story, we have to do a comprehensive audiometric evaluation.

And we need to reevaluate all this stuff, because screeners miss many, many people, and people who pass screeners walk out with the idea that, "Gee, I'm normal, everything's great." Which is not what a screener can possibly tell you, but it's the message that I believe they receive from that. So, questions or comments, you can write to me at doug@cognivue.com and I will look forward to your comments and your concerns. And I want to thank you very much for your time. I wish you a joyous and happy and healthy new year, and I'll look forward to seeing you live and in person, I hope, later in 2023. Thanks so much.