From Ears to Algorithms: Demystifying REAR, RECD, and Other Hearing Aid Feature Verification

Presenter: Lindsey Jorgensen, AuD, PhD

Thanks Anna and thank you to the team at Audiology Online. My name is Chris Versackley and on behalf of the Hearing and Balance Academy and Natus Sensory, welcome to today's online seminar. I am delighted to introduce today's lecturer, Professor Lindsay Jorgensen. Lindsay is Chair and Professor in the Department of Communication Sciences and Disorders at the University of South Dakota where she also serves as Clinical Director of the USD Speech and Hearing Clinics. With a clinical and research focus on amplification, hearing assistive technology and the intersection of hearing loss with aging, dementia and traumatic brain injury, Dr. Jorgensen brings a holistic and evidence based approach to audiological care.

She earned her Aud and PhD from the University of Pittsburgh and has been a dedicated educator, clinician and leader in the field, contributing to national conversations on best practices in hearing healthcare. Thank you so much for joining us today, Lindsay. Please feel free to start whenever you are ready. Thank you so much for a fantastic introduction. So thank you all for attending today.

It is slightly rainy cloudy here in South Dakota, which makes a fun background of very bright. So I apologize about that from the beginning. So thank you all for coming Today we're going to talk from ears to algorithms. If you do have any questions, please feel free to chat them as well and I'll try to answer them as we go along. There'll also be a little bit of time at the end for some questions.

These are the learning outcomes for today. We're going to talk about some really coupler difference, directional microphones, things like that and then improving patient outcomes. These are the limitations and risks of this course which are the same course, same as every course. So I know that Chris did a fantastic introduction and I just wanted you to have a little bit of information about who I am. So I am Lindsey Jorgensen.

I'm a professor. I am an audiologist. I do research particularly related to hearing aid fittings and best practices related to hearing aids. I am the department chair of an audiology and speech language pathology program. We have multiple clinics that I am the clinic director.

I am a wife as well. This is my husband. He is a 100% service connected veteran. We have two kids. These are Tegan and Gunner.

I just say that my life is the organizer of things. All right. My disclosures are the content is mine and not the Department of Veterans affairs in the United States government. That's because I also hold an appointment at the va, the state of South Dakota, at the South Dakota Board of Regents. I do have various relationships with manufacturing and manufacturers and verification systems for research and Other things.

Alrighty. So a few comments about pro microphone measurements. I like to start out with saying when you're thinking about getting a new pro microphone system, I get asked all the time, oh, what product is the best and, and what one should I get? I, I will say that obviously I have some favorites, but I really want you to think about what equipment that you already have. What equipment would work best in your space.

What are you going to be using that equipment for? You know, is this a system that you can separate the on ear system from the test box? Because that is quite important when you're thinking about, well, I have this much money and so I want the test box in our lab for check in and I want the on ear system, you know, in our, in our clinic. What, how will you fit on not an average pinna. You know, some devices fit more easily on an ear or not.

What signals are available within the system? And particularly when you're thinking about what targets and what signals we're going to use. We'll go a little bit through that today as well. What upgrades you may need through the years. Does the system allow you to upgrade or is it static and then like placement?

What I mean by that is, you know, kind of what works well in your clinic and what does that footprint look, look like? I will say that we have the otometrics equipment and when we got our new desks for our clinic when we moved here in 2021, we realized that the desk was pretty low and so we had to devise using a. It's actually a riser for a monitor that our real air system sits on because that just brought it up a little bit more. So things like that, where you may have to make adjustments and does the system allow you to do that is pretty important as well. So I just like people to think about kind of more what works for you.

So I'm going to talk about real aerated response really quickly. You know, obviously we're going to talk a little bit more about some of those advanced features and how to, how to appropriately fit. But we're talking about real ear aided response. And so when we're talking about real aerated response, it's essential for hearing aid fittings. And I will say that if you're not, you know, completing raided response, I think it is an ethical fitting of hearing aids.

But part of it is I want you to know what you're looking at and what are we doing and what are we fitting and where are we looking at that? What kind of judgments are we making as audiologists talk a little bit about that in a, in a minute on the next slide. But the goal of the hearing aid fitting is audibility. You know, there's been articles after articles that have shown this and there's a recent set of articles out of Boys town with Ryan McCurry that show again that, that under. That audibility is the best predictor of speech and language development in children and it also is one of the best predictors of success for adults, is we definitely need him to be able to hear the sounds, to be able to understand what's being said.

I taught amp1 this morning and that's really what we talked about, is really talked about audibility and how does that impact a person's ability to hear a noise and things like that. Normal hearing, normal loudness perception. I often will talk about that. The soft sounds need to be audible, the moderate sounds need to be comfortable, and the loud sounds need to be tolerable or act. And so that's what I tell my students is I want to make sure that the sounds act correctly.

Comfort, you know, I still want sounds to be loud but not uncomfortable. In our clinic, we do not regularly run ucls as part of our diagnostic evaluation. We do sometimes, but not as regularly. And so I talk to the students about when we run mpo, you look for the face crunch or you know, when the person runs, they kind of squint their eye when you get to those higher frequencies. So paying attention to when they kind of scrunch their face.

I'll talk a bit about that again on the next slide. And then safety, you know, making sure that the hearing aids are balanced so that then they can tell where sounds are coming from and knowing that if they only have one ear that then they're not going to be able to tell where sounds are coming from. But then also safety. And to be honest, my goal is better speech understanding or communication competence. For several of my deaf patients, their goal is just to be able to hear that somebody wants their attention and then they have better communication competency.

So Railer aided response. This is, you know, a typical graph of Rayleigh rated response. So I'm just going to orient us on what we're looking at along the Y axis, or sorry, X axis is frequency and along the Y axis is intensity. This is an output or DB SPL graph. What that means is that this is the set, the signal being measured in the ear, but not subtracted.

So what I mean by that is this is the signal going in, being amplified by the hearing aid and this is the output in the ear canal. So the, this is not the gain measurement, this is the output measurement. The shaded area, gray shaded area on the top of the bottom are sounds that the person would not be able to hear or would be too loud for them to understand. So the bottom one would be their kind of where their threshold. So where that bottom line is where this gray and this white meet, this is the person's threshold here at the top, this is their ucl.

And so that's our goal is to fit all of the sounds between the within the person's dynamic range. I also spent quite a bit of time this morning talking about dynamic range and you know I kind of talk about a bit about how hearing aids distort sounds and we have to fit sounds within person's dynamic range. I'm leading up to how to pick a hearing aid and how to do real ear responses with that in this class. But you know, our goal is to fit all as many sounds as we can within this person's dynamic range. The 55dB signal, 65dB signal and 80dB signal.

And then the maximum power output of the hearing aid will run here. And so the shaded purple that is a 55dB signal with the center solid line being the long term average speech spectrum or the LTAs. The number one dotted line is my target. And we're going to talk a little bit about targets in a second. But that's my goal is to hit those.

Now there are some people that actually do not fit to targets and there are some debates about what target really means. But target in general is a prescriptive formula that you have chosen as your kind of your goal. But I really want to say we cannot be like a zombie to that target must hit target. Because I think understanding what those targets mean and where they kind of fall in line also matter. And I did make the mention that some people choose not to use a target and they just fit within the dynamic range.

That's kind of a different talk. But do know that some people choose to do that and they have reasons and research behind. So there are many different stimuli when you think about what stimuli we have. And so you could do swept pure tones. This is the doot doot, right?

Or you know, some kind of like I'm not good at replicating what they are but there are different tones that we can use and we use tones for a really long time. And then we were like oh well what we want people to hear is speech. And so then we created this composite type noise called ikra. I don't know if any of you have heard ikra recently, but to me it sounds kind of like a ghost, like, and I don't really love it. But, you know, then we were like, oh, well, then we should just use speech.

And for a very, very short period of time, we were using just live speech. And then we realized, oh, well, that's not like calibrated. And so then we started using the carrot passage. The carrot passage does have like a cult following. And we still.

You have a lot of people that use the carrot passage and that is fine. The carrot passage was never intended to be used for this and is actually an extrapolated sentence from a test called the connected Speech Test. Like I said, there's a whole, like, group following. There's a bunch of audiologists that have like tattoos of carrots, which is awesome. And you know, we definitely love the carrot passage.

And then we realized that we should probably have a signal that's more fit for hearing aid fittings. And that's where the ISTS signal came from. It is the International Speech Test signal. And so I prefer the ISTs signal 1 because this is the purpose. The purpose of it is raillier responses, but also it is multiple languages put into one.

And I like it because unlike with the carrot passage, it's not English. And. And my patients don't freak out when they don't understand what they're saying. Oh my gosh, I don't understand. There's something about a carrot.

And I say, so what I'm able to say is I want you to face forward. I want you to listen to this signal. You don't have to tell me what it says. I just need you to face forward. And it's not in English.

And they just kind of sit there and relax. It's definitely a lot easier because they're not panicking about being able to hear something. So we've talked a bit about, you know, really related response and that's kind of about all I'm going to kind of go into for real or aided response. But there are a lot more things that we can use, we can, that can be verified in real. Ear measurements, directional microphones.

I'm going to talk a bit about that today. But frequency lowering, you can measure feedback hearing protection. I will tell you that this is something that we've been regularly doing. It's actually quite easy to do. But if people are paying several hundred dollars for hearing protection, I'm not just going to hand it to them.

But what I'm also able to do is put the probe in their ear and put the and make a measurement of a real ear unaided response and then put the hearing protector in and do a real ear occluded response and actually see what the response is of that hearing protection. And it's been very useful for demonstrating to patients that it actually is working. So kind of the reverse of real aerated response. You can actually do some measurements of noise reduction as well as the occlusion effect. So if a patient actually is reporting that their own voice is really loud, things like that, you can record it.

And voice audibility. I should actually put slash other thing audibility. We've had more recently a ukulele in our clinic where the patient was like, I can't hear my ukulele. So I said, bring it on in and you can actually verify that the device is working. All right.

So in our clinic, this is what we do. The first thing that we do is we fit the device right. We have it on, I make sure that it fits. Do we have all the right parts? Do we have all the right pieces?

And then we run feedback management. If the company that we're using wants us to run feedback management, which. But we run feedback management first. The reason that we run feedback management first is we don't want to be fighting to get gain, get all our gain and then have it be taken away in a feedback management run. And so we want to be able to try and fit our hearing aid within our available gain before feedback or headroom.

If we can't fit our hearing aid within the available gain before feedback, then we need to think about a different coupling or different way that the sound is being held into the ear. So do we need to go to a closed dome? Do we need to go to a mold, do we need to go to a sleeve mold? Anything like that that can hold the sound in a little bit more, giving us a little bit more available gain before feedback. We then run real eared.

A couple of different. We'll talk about that today. And then we run a real ear aided response. We do a soft, a moderate allowed and a maximum power output. There is some debate on what order to do this.

I'll tell you what order we do it. That doesn't mean that that's the order you have to. But we tend to do a moderate sound of a 65. We tend to then do a soft sound of either a 55 or a 50. We then do a loud one and of either a 75.

Or an 80 and then a maximum power output of a 90. The reason that I, that I kind of say back and the reason I do moderate then soft is. Moderate is what most people want to hear. And so I kind of start with, here's what, you know, the mod average sound. I then do soft and then loud because the fourth run is going to be maximum power output.

And I don't love having a huge distance between soft and maximum power output. It doesn't totally matter. The other thing is that if you fit moderate first, most hearing aid companies actually do a general whole shift of their soft and loud. I do suggest that if you're making any changes to the soft or the loud separately when you run, make those runs, that you go back and rerun the entire thing that's in the otometrics where you click the sequence and you can just run them all again. And so that is our policy that if we're making any changes to the soft or the loud separately, that we go ahead and rerun that sequence at the very end.

So we run a soft, a moderate allowed and mpo. Once we're happy, we rerun that as a sequence. So like I said, what order? And then we validate. So this is okay.

How do things sound? Am I too loud? Am I not loud enough? If I'm just about right, knowing that I live on the loud side of normal, and I always say that and everybody laughs because I do live on the loud side of normal. So, you know, kind of just saying I'm okay with making changes, especially if this is where we, you know, where this is your first set, those kinds of things.

I also always say, is this an okay place to start? That's that counseling part. And I always say that because if I say this is a, an okay place to start, patients actually are a little bit relieved that I am willing to maybe make a little bit of change or I'm okay with backing off in the future. So I think kind of saying, is this an okay place to start? Gives patients a little bit of support, some relaxation, that I'm not stuck in my ways.

This will absolutely be how they have to do it. They're also willing to maybe push themselves a little bit more. So I want to talk now about really a couple of difference. But to do this, we need to first talk about db, HL and dbspl. So I'm going to take us back to that hearing science type conversation and say that this is when we talk about hearing loss, we talk about it in DBHL typically.

So that's the way that we do our audiogram. But DB HL is not really a thing. DB HL is actually a conversion. So I want to talk about that. The DB sound pressure level or DB spl is a physical measurement.

And so what happened is they took a whole bunch of people and they went around and they measured what is the minimum audibility of a whole group of normal hearing people. And that developed this solid line here on the left hand curve. So on the x axis is frequency and and the y axis is dB sound pressure level. And so what happened is that this dark line is the minimum hearing loss or minimum hearing of normal hearing people. And then this would be an example of a hearing loss is this dotted line.

Well, that would be pretty difficult to explain to patients. And especially back when audiology and you know, was, was the audiologists maybe did the diagnostic testing and sent it to someone who then went and sold the hearing aids door to door. So trying to be able to say that this solid line, what we did is we flipped it upside down and we made that solid line flat, and that is DB hl. So we went from the solid line to this solid line here on the right hand side, which we recognize as more of a typical hearing test. So frequency on the x axis and DB HL on the Y axis.

So, so this solid line here on the left is the exact same as the solid line on the right. And so that's kind of how we created this. And this dotted line then is this exact same hearing loss over on the right hand side. So that is how we actually created a dbhl. So DB HL is actually just a conversion of DB spl.

So we just converted it over. All right, so how did we convert it over? And so we look at first. Okay, where did we start? Did we start with TDH 50s?

Did we start with inserts? You know, what are we converting it to, right? Are we using a 6cc coupler or a 2cc coupler? It's still not perfect. And so we're going to talk about how does it actually happen that we then once we have a dbhl, right, when we do our hearing test in, we need to convert back to DB SPL physical measurement, because that's what hearing aids are in.

Hearing aids are in a physical measurement. So all of this is magically done by your verification system. The system that you have magically does this in the background is you put your audiogram and you convert it and then magically it pops up back to that audio grade or the system that magically pops right back into here where we get our threshold. So thank you system for doing that. But how does it do that?

And so, and sorry, is it accurate? And so what is really to coupler different? When is it important? And I'm going to give some examples. So real ear to coupler difference makes sense when you're dealing with different couplers and you want to be exact in your patient, you know, maybe is very different from the coupler real ear unaided response makes sense when you're dealing with insertion gain and all you have is sound field threshold.

So most of the time when we're, when we're working, we actually have a DBHL audiogram that was created using, you know, an actual ear specific information. So I'm going to really focus on real ear to coupler difference. So to validate hearing aids we actually are assuming a 2cc coupler. So what do I mean by that? We have the audiogram in DB HL and our hearing aid is in DB spl.

And we need to convert that so back to this picture here on the right. This is just the same kind of example as the one that I just used. And so we need to convert from DB HL to dvspl. So how do we do that? So I'm going to tell you that this signal here on the bottom or this box here on the bottom is the exact numbers.

And really the only one I have memorized is a thousand hertz. And so what do I mean by that is when the audiometer is playing 60 decibels at a thousand hertz, when they calibrate your equipment. And we were, if we were to put a probe into your ear and put it up against the eardrum within 5 millimeters, the eardrum, then we would actually record if you have a perfectly average ear, 67.5 db spl. So I went from 60db hl to 67.5 db spl. So that's how we converted that direction.

And so we would need to do that with every single frequency. Great. Right. Okay. The average, the average conversion, let's go.

Well, where does that average come from? That average comes from adult white male and actually veterans. So they did a whole bunch of measurements on at the VA or I don't know if it was DoD or the

VA, but it was primarily adult white men. The problem is not all ears are 2 cubic centimeters, not all ears are perfect. So I'm going to give some examples of this.

But you know, we have this hanging on the ear, we have the hearing aid in the ear. And so we're like, okay, well this is great, but how did the manufacturer of the hearing aid know what's going on in the ear is they actually used a coupler, right? And then they actually made that conversion for us. And so they say, oh well, this is what our hearing aid does in the coupler. We know that the average conversion is this, therefore this must be how much the person maybe needs or what the output of that hearing aid is.

So when we do that first fit, it's doing an assumption that the person's ear is average adult white male. And so how does it really know that? So it doesn't. So I'm actually going to show you what happens. So, so we can actually look at this example of a real ear decoupler difference measurement.

So going along the x axis is frequency and going along the Y AIs is well DBSPL and then recd. So I'm going to look at this top one here at first and here is the average recd and here is the measured response recd. So this person's response is louder than the average. What does that mean? It means this person's ear is smaller than the average because their ear is smaller.

There's the sound pressure is louder because the space is, is greater. I'm sorry, smaller. So because the example I give this is all sound is, is movement of air molecules and if we have more energy across a lot of air molecules, you only move those air molecules a little bit versus if we have very, very few air molecules, the same amount of pressure, we're going to move those air molecules more. So if you push a bicycle the same amount of energy that you pushed a very heavy car, that that bicycle is going to go a lot further than the car is because you just have more energy pushing it. So on the bottom what, what has happened is they've made this dotted line flat.

And here is the person's real ear to coupler difference. So now instead of using that 7 decibels of average data, they're going to say oh, at 1,000 hertz we need to add another 10. So for example, so that's an, an example of actually measuring your recd. I'm going to talk about what an example of that in a second. So ideally we would account for residual volume and ear mold effects and microphone placements and eardrum impedance and loss of national resonance.

We don't account for majority of these things in general in any hearing aid fitting, right? We don't. We do account for Residual volume. That's what the real ear to coupler difference is. We don't generally account for most mold effects.

We do somewhat, but, you know, engineers of hearing aid companies try. This would be talking about venting and things like that. We really don't talk much about microphone placement, particularly now that we're using solid core hearing aids where all the devices are actually either put on the face plate or just put in within the hearing aid. You know, it's not really thinking about where the person's body is in space. We are definitely not accounting for air drum impedance.

You know, we just kind of assume that everyone has a peak that's right around 1000 hertz. When we're looking at the tympanic tympanogram, we do somewhat account for loss of natural ear canal resonance, but we use an average natural ear canal resonance. That was actually a study that was done back in like 1999, I think was the study. And what they did is they looked at if they did a measured ear canal resonance versus an average ear canal resonance, and then they used pieces of music. And so they played the music into the person's ear and they said, here's no ear canal resonance, here's your ear canal resonance, and here's an average ear canal resonance.

People did not care if they had an average ear canal resonance or their own. There was no difference between those. But they wanted an ear canal resonance. And so hearing aid companies have taken that data and just applied a general ear canal resonance. But we don't actually account for a person's specific ear canal resonance.

So how do you measure this? The first thing you do is you measure the coupler. So this is a measurement of the coupler. Looking at the recD coupler, the BTE tube adapter, you want to use the BTE tube adapter, and then the BTE coupler and then also the, the tubing and the transducer. So we're measuring the size of the coupler.

So we're saying, here's our coupler, and then we're going to measure the real ear. So measure the ear. You can do this one of two ways, but you use the on ear probe microphone system and you plug that either into tubing of the ear mold or you put an insert on it. I will say most commonly we're putting an insert on it, particularly since, you know, 70 to 80 or, you know, it's probably running right around 70% of hearing aids are ricks at this point. So you're doing inserts.

And so you want to squish the insert up and put the insert in the ear as deep as you did when you measured the hearing. And so then you would measure here is what the real ear is. So now we have the coupler and now we have the real ear. And then the system can do magic math and tell us, great, this is kind of where, this is where, you know, our real ear to coupler difference.

So what if their ear is not average? So as I kind of talked about, the response is louder means that the ear is smaller. So that 7 1/2 DB conversion would not be accurate. So if I presented at 60 the system would convert it to 67. But you know what, if we had an 8 extra decibels because the ear canal was smaller, it would be 75.

So that doesn't seem like that big of a deal. Except for that, you know, we don't need as much gain of that hearing aid. Right. So if the ear canal is smaller then maybe the thresholds are actually potentially, you know, misrepresented because of the size of the ear canal. We find this when we fit untest children, the parents will see that the hearing is dropping as the child ages.

And we would say yes, like the hearing is changing, the cochlea is not changing, just the ear is getting bigger. And therefore we need more sound pressure to get the same response. So that, you know, so now we want to, I want to give you an example. This is actually an example from a 4 year old is the top one and then a 2 year old and then a 33 year old. This is actually my husband, but I like to show this as an example because the 4 year old is, this is the average, the dark one is the average recd.

And here is the four year old's ear. What does that mean? It means that this person, this four year old has a very, very small ear canal. The two year old has a near average ear canal and so near average adult white male. This is a pretty interesting, these are real people.

And then here is a 33 year old, here was the average and here's his ear. And so as an adult I always joke that my husband is the average adult white male veteran. So looking at him, you know, he's a, he's, you know, pretty big guy. You would see, assume he has probably pretty average ears and he has teeny, teeny tiny ear canals. And so, you know, his ears would actually be pretty small.

So you know, why is this important and what have I really talked about and why would this even be Important at all. Because where do targets come from? Targets come from the ability for a hearing aid to convert from DB HL to dbspl. And so then once we have those DBSPL targets, that's where our target or sorry, SPL thresholds, that is where our targets come from. Our targets that we're trying to match these hearing aids to over and over and over again is based upon our DB HL to DB SPL conversion and threshold.

So we get our targets based on thresholds, but we get our thresholds based on a conversion. And so we want to make sure that that conversion is accurate. So what are the consequences? If I would fit a hearing aid for an adult white male threshold conversion on this four year old, the hearing aid would be providing way more gain than this person actually needs. And if the hearing aid has way more gain than the person actually needs, in theory, we could be hurting somebody, especially a kid, because that's over amplifying.

This actually happened to us in our clinic just a few weeks ago, maybe last week we saw a child that was here internationally and they had just been fit through the, through mail order on an international place. And so we actually measured the hearing and got the hearing tests and this, this child had had a pretty aggressive change in hearing. Now is it possible that it absolutely was due to a change in hearing and maybe it was, you know, CMV and changes in hearing? Absolutely. But when we measured those hearing aids, the hearing aids were way over amplifying this kiddo.

So is it also possible that we were providing way too much gain and potentially hurting this kiddo? That was, that's obviously a fear of mine. I don't want this to happen. So it's too loud. You know, we get that, convert that complaint all the time.

Oh, it's too loud. Well, how do you know it's not too loud? How do you know that this person isn't actually getting too much sound? Because not all ears are 2 cubic centimeters. So, okay, you know, what do we do?

And so, you know, my question is how often do we need to do it? So way back before now I'm going to go all the way back. Sorry. I talked about what our order in our clinic is, is we run feedback manager. Once again, we run feedback manager because I want to make sure that I'm not losing all the gain that I'm trying to get.

Then we run a real ear to coupler difference. We do run a real ear to coupler difference and then our real earning response. So what happens if you don't run it is, the patient may say it's too loud. And you would just be like, oh, well, you, you know, you've never worn hearing aids before. You're fine.

I talked a bit today in class about how, you know, establishing rapport and how my patients like, trust me. So when I say I know it's a little bit loud, but give me a couple weeks and it won't be as loud, you know, I want to make sure that I'm not, you know, totally screwing up something or, you know, that I want to make sure that what I'm doing is truly, you know, a problem. So does, you know. So the question is, does real ear unaided gain take into account the specific acoustics of the clients or ear canal and allow the system to calibrate for this? So really, your unaided gain is really just what is the gain coming out?

And you are measuring real, you're measuring the ear canal resonance, but it is not necessarily doing the conversion because you need to measure what is the coupler. So I would say no, but, you know, maybe one of the other, you know, one of the, the people who own the equipment may have a little bit better say, but I would say running really or a coupler difference is really the only way to truly convert from DB HL to DB split. So I would say that that really unaided gain is giving you what is the ear canal resonance more than that conversion.

So the problem is, like I said, not all ears are 2 cubic centimeters. So what does this mean? You know, practically, practically speaking is if you don't, for adults, if you don't measure, you're going to be okay 80% of the time. So, you know, you're like, oh, okay, well, that's fine. And I will say I in grad school, a 80% is a C I grade on the 93 scale, as many other people do.

And so are you okay with being a C level practitioner? I'm really not. But, you know, I don't like being just average. And so, you know, I'd rather be more accurate. And measuring RECD really does not take much time.

You can use age normed recds. And so I will say that if you're struggling to get a kid, you know, you can use age norms and the data from Susan Scully and the group up north is pretty awesome at that. But once again, you're going to be wrong about 20% of the time. Not all kids grow in the same way. And particularly if you're not seeing kind of average white kids.

I would Suggest kind of thinking about what their size difference is. I did a humanitarian mission in Guatemala, and Guatemalan kids tend to be smaller. And so their rappler difference measurements were much smaller than an average person of that same age here in the United States. And so we kind of had some talks about what did that look like. I will also tell you that my data is in adults which showed that right was equal to left as long as there was no history of ear surgeries or things like that.

But most notably, when we measured rail ear to coupler difference, their hearing handicap inventory improved significantly more than the group that did not have RECD applied. So we did one group with recd, one group without, and then measured their hhi. It was blinded and so then measured their hhie. And the group that had RECD did have a more improved hearing handicap or a decrease in their hearing handicap. The data from the group out of Ontario suggests the same for children.

If you use the average, you're fine about 80% of the time. If you use the average age and they are a typically developing child, right equals left. As long as there's not a history of ear surgeries or things like that. And like I said, this is a typically developing child. And so I would suggest that if you can't, please make sure that you kind of are looking.

If you say this is not something that we can regularly apply, then think about every time I look in the ears. Is this a pretty close to average ear canal? All right, now we're going to talk about directional microphones. So why do we use directional microphones? Current technology, obviously.

You know, when I think about what can a hearing aid do practically? A hearing aid can really only do a few things. It can make sounds louder, it can improve signal to noise ratio through directional microphones and some digital noise reduction and things like that. And it can connect to other devices. So those are really honestly, you know, when we think about what do, what can hearing aids do is it really can make adjustments to audibility and gain.

It can make some adjustments to where the sound's being picked up and what it's trying to get rid of and then obviously stream from other things. But you know, current technology uses automatic processing to analyze our environment. It does allow for performance in more complex listening situations. But how do I know what hearing aids are doing within the device that I have purchased? And you know, when we think about what is the number one complaint of my patients hearing a noise and if they can say, oh, hearing in noise is the most common complaint, what is the only thing that has been proven to improve speech and noise ability, directional microphones.

Now, digital noise reduction has been shown to have some improvement in perception of noise, like of ability, but it has not been shown to have a significant improvement in ability and noise. That being said, we, you know, my guess is more the cognitive demand and those cognitive resource theory is more related to the digital noise reduction. But, you know, I really want to make sure that those directional microphones are working, since that is the number one complaint on our patients and the solution that's really going to, you know, help with that. So how do we verify this? Should we do it?

So, you know, I will say that our clinic verifies all directional microphones on every hearing aid that comes in the door. This includes hearing aids that are in for, that are new hearing aids, hearing aids that have come in for repair. I want to remind you that 0% of the hearing aids that you mail in for repair are the hearing aid that you get back. You know, it takes too long to diagnose and fix a hearing aid. What they do is they end up just giving you if it's a behind the ear or Rick, they give you a new device with the same serial number most of the time, or if it's a custom product, they pop off the solid state core, put a new core on and mail it back to you.

And so just know that you're not getting the same electronics back. So even if you check the hearing aid as new, I would go ahead and check the hearing aid again as a repair because it is like basically a new hearing aid. So we check the hearing, we check it. Then we also do check the hearing aids at hearing aid services to see if those directional microphones are working and working correctly. So how does a hearing aid directional or how does a hearing aid or how do directional microphones work?

What it does is it looks at that timing difference between the two ports or the two, in this case, two microphones of the hearing aid and does a mathematical calculation. And it says, oh, if the sound hits the front microphone before the back microphone, then the person is in front of them. And if it hits both microphones at the same time, that person's to the side. And. And if it hits the back one first and then the front one, then that person's behind them.

And then obviously all the variations around them. Many, most, many hearing aids are actually talking to one another to help identify where that sound is coming from as well. But it is all a mathematical calculation. And if one of those ports is clogged one of the microphones is not working correctly, it's not sending the information in a sequenced manner, then you're not going to be able to tell where those sounds are coming from. The hearing aid is not going to be able to tell where those sounds are coming from and it's going to make inaccurate decisions.

So because of that, we actually check all hearing aids on repairs as well when the patients come in for routine services. So new hearing aids return hearing aids from repair, any hearing aid service, as well as any routine hearing aid check. We just want to make sure that those hearing aids have not gone out of compliance on directional microphones, when directional microphones are the number one reason that the patients are coming. So what is different about this and traditional directional microphones? I will say that, you know, we're really now in the age of hearing aids having a lot of adaptive features.

And so we used to really go into fixed directional, where it was. I mean, I'm going to amplify what is in front of you and I'm not going to amplify what's behind you or some kind of polar plot that the manufacturer has picked that it's either going to be an omni or it's going to be in this polar plot. Now hearing aids are not really doing that. It's really making, you know, moment to moment decisions about where the noise is and where therefore the null of that polar plot is. They are making, like I said, momentary decisions and they're trying to make decisions about nulls and activating different levels of digital noise reduction as well.

So directional microphones do kind of have more of a curve instead of fixed directional at this point. So what we want to do is we want to make a measurement of the hearing aid, you know, like at 90 or at, sorry, at 0. And then we want to turn the hearing aid to either 45 or 90. It kind of does depend upon the manufacturer of your hearing aid as to what it's going to do. But you know, most of the time there is a null at 45.

And so, you know, you can either turn it to 45, like the person is facing sideways or all the way around where the person is facing away from the speaker. And you want to make another measurement. My suggestion is. Oh, sorry, I'm going to show this picture first and then I'm going to give a suggestion if you see. So what I want to show you here is this is a directional microphone measurement.

Going along the x axis is frequency. Going along the Y axis is intensity. And so in this example, what you. What I'm going to show you is that curve one and curve two, there's a difference. And honestly, that's what I'm looking for, is, is there a difference?

Yes. You can see how much directionality you're getting. Absolutely. You could actually compare that to what the manufacturer says. You know, I will say that we're definitely one of those.

One of those places that, like, we recognize that hearing aids are doing a lot more than just flipping in and out of directional microphones. So if you see the. The same, you should see it return to the same point, though if you hold it there for a long time, it will actually come back because it's speech. So don't do it. You have to do it kind of fast, but not really, really fast.

Another option is actually to put the hearing aid into a fixed directional setting and force it into a speech and noise setting. And so do keep that in mind that you can absolutely force it if you need to. If you really want to see that separation, you should, you know, see it. It should come back. That does depend upon your manufacturer.

And your manufacturer may have a set period of time that it utilizes to actually do a analysis. So all hearing aids do an analysis of the scene. And so some of them do an analysis and make changes very quickly. Some are like, we're going to hold on to the sound and kind of see how long we have going. You can always ask your manufacturer how long of a window it makes for sampling before it starts to make some decisions.

So this is kind of where I would say, like, know what your hearing aid is doing and know what your goal is. My goal is, I want to see a difference because then I know the directional microphones are working. If I don't see a difference, I'm going to say, did I set it up correctly? What is the hearing aid doing? And maybe call my manufacturer, call the audiology line, or talk to my outside sales rep, or inside sales rep, but more my outside sales rep and say, can you explain to me how those decisions are being made?

Because then I know, okay, do I need to force this hearing aid into directional microphones or not? I will say that we, you know, we have kind of some cheat sheets and things like that about how to force hearing aids into directional microphones within our clinic. I will say that I do have workbooks for otometrics and how to do a lot of these things. What buttons to push, where to click. Jeanette helped me on that.

And so if you all want any of those Please email me. And so I'm very willing to answer any questions, any concerns. I really appreciate it. Any questions, I'd love to answer. If I don't know the answer, I'll find out the answer for you.

And so, yeah, I appreciate it. Thank you. Here's my email. It's Lindsay jorgensensd. Edu and.

And I can always email you the workbooks on how to do all these things. I have both a test box workbook and an on ear workbook. As, as Chris knows, I also have how to get hearing aids into directional microphones. I'll give you our check in clinic process, anything like that that you guys would like.

Thank you so much, Lindsay. That was absolutely brilliant. I always love it when you teach. You're such a joy to watch. And thank you for a really good overview of that.

I actually have a question before I even check the questions and answers section, which I'd encourage anyone to use. You should have access to the Q and A box. Please feel free to submit any questions you have. I have one.

Can I just check? Do you make sure there's a 20dB advantage for directional mics? No. No. Okay.

I don't. I mean, I'd love to be able to say I do, but I think it's because we don't deactivate all the other features of the hearing aids that may be utilized by the hearing aid companies. Hearing aid companies anymore are not just using directional microphones alone. They're using, you know, some computer, a proprietary combination of, you know, directional microphones and, you know, the, like, directional microphones, digital noise reduction, you know, some kind of AI polar plot thing that they won't really tell us what they're doing. So I don't.

So I'm really just looking for a difference because I just want to make sure that those directional microphones are functioning. And what I do then is we kind of run it through a protocol and we compare it back to when we originally got that hearing aid. So as long as we use the same protocol and compare it back to when we got the hearing aid, that's kind of what we're going with. Okay, cool. Sorry.

I wish it was a better answer, but this is that one. I actually see patients. I'm not going to tell you. Like, yes. I mean, I know you guys say it should be a 20dB.

I just don't think that I actually in reality see that very often. No, that's what I wanted to know. Thank you very much. Very interesting. We have had somebody who's asked, could you please recap the sequence of test box remote mic testing.

Sure. So the, the sequence of test box remote mic testing. So I think it's quite easy. And so what what I did, what we do is we. There are a couple ways to do it.

So it depends on if you want to leave the hearing aid in your in like it's just kind of automatic setting or if you want to force it into directional. Some hearing aids are easier to force into directional. If you are going to force it into directional, I do suggest that you force the hearing aid into a fixed directional. If you force the hearing aid into fixed directional, I would suggest knowing what the polar plot that that manufacturer utilizes. Okay, so now I have the hearing aid.

I'm going to go with the example one of not forcing the hearing aid in. So with both of this example, the first thing you want to do is run the hearing aid like the person is looking at the speaker so facing forward like you would run any other test box measurement. You then want to turn the hearing aid to either 45. So like the person is facing the side or backwards like the person is facing backwards. And then you want to run the measurement again.

You're going to need to run that pretty quickly depending upon what manufacturer you use. Because that sampling time window in some manufacturers is only about 2 seconds. In other manufacturers it may be as long as six. But you still what you would see if you let it run and run and run is you would actually see, oh, hey, here was the speech. I'm going to pull it down and then you're going to see it force itself back up if you run it that way.

That's why I would suggest that you force the hearing aid into a fixed directional and know what polar plot that is. Because then you would know I'd run it and I'd turn it to either 45 or 60 or 90. I'd run it again and I would see that difference. Do recognize that it also is activating things like digital noise reduction, things like that to try and get rid of the signal as well. Hope that was helpful.

Thank you. The next question is do you have a preferred prescription for fitting real ear versus coupler or is it just ESL for peds and now for adults? Oh, that's a can of worms. Okay, so is there a preferred fitting? So in general I really base my so I will say that both of them in are really based on audibility, but they have different philosophies.

So the philosophy of NAL is really audibility and the philosophy of DSL is really that we want to make soft is more comfort and equal loudness perception. And so the, you know, kind of separation of those is pretty interesting. But you know, I think that it's really what is your goal. So obviously that is why in general pediatrics are tend to go more toward DSL and adults tend to go more toward nal. That is kind of why is based upon those philosophies.

That being said, I am not a I must hit the target kind of person because I like to know what does it mean. Which is why I really appreciate kind of saying this is the person's dynamic range. This is everything that I can use, right? Everything that's white I can use that whole range. And so how do I say this is the whole range of the system.

And so therefore I want the soft sounds to be soft. I don't want the moderate sounds to be moderate. I want the loud sounds to be loud. And I want the you know, 90 to be not uncomfortable. So I think I really tend to fit 65 and then going up and down based upon that, you know, is really interesting, you know, when you're thinking about.

So I guess I'm not like I must fit to the target kind of zombie thought I much more. Let's look at the dynamic range which you know, the system really allows you to very clearly see that that's within the white range. So the question was about remote microphone testing in the test box, not about directional microphones. I can address that procedure as well, thank you. I do have step by step directions in this workbook if you want.

But doing direct remote microphone testing is actually quite similar to be honest. But what I do is I run, I run it in a three step process. A three step process you don't have to do, but this is the way I do it. And the first thing that I do is I run. I have the hearing aid set up face forward.

Everything's fine. Run a 65 DB curve. So now I just have a curve of the hearing aid alone. I then move the reference microphone away and run it again. So my hearing aids on the post, I tend to just put it kind of down away from the hearing aid.

Because what is the reference microphone? The reference microphone is, hey, the signal's coming out of the speaker and it's hitting the hearing aid. Right. But we're now doing a difference measurement. We're doing a.

This is how much is hitting the hearing aid because that's where the reference microphone is. And here's what the hearing aid is doing into the coupler microphone. So that's a difference measurement. If I move the reference microphone away from the speaker and away from the hearing aid, I'm going to see that line drop. That second step is not necessary, but I do it to make myself feel better that I have moved that microphone away enough to be able to see a difference.

I then turn on the remote microphone and the remote microphone, then I make sure that it's paired and all of those things. If I'm doing this, I actually make it so that it's none of the signal from the microphones of the hearing aids are going in and 100% of the signal is coming from the remote microphone. And so then what I do is I put the remote microphone speaker, sorry, the reference microphone next to the remote microphone speaker. So now what I'm doing is I'm getting the signal coming out of the speaker of the test box, hitting the reference microphone. That is the same intensity as going into the remote microphone that then is transferring to the hearing aid that then is being traveled down to the coupler microphone for the measurement.

So remember that the reference. It's all about where your reference microphone is. So the reference microphone is saying, this is how loud the signal is going into the microphone of the device. So if I put the reference microphone near the microphone of the remote mic, that will then say, this is how loud it needs to be to hit the remote microphone. The reason that I adjust the intensity or the distribution of how much is coming from the mic and how much is coming from the hearing aid, the remote mic for the hearing aid is that if you leave the hearing aid microphones on, you will actually get even more of a boost.

So when you run this, you'll now have three lines. The hearing aid alone, the reference microphone pulled away, which should go down, and then the remote microphone, which should go back up to the first line. Because what I should get is I should get the same signal coming out of the coming from the remote microphone as it was with the hearing aid alone, because I don't want it to be softer because then it's not transmitted correctly. I hope that makes sense. What do I think of act?

I think ACT is a very interesting program. I think that it can actually really help us. I do think that that is a whole conversation about how to apply the ACT measurements within our real ear systems. Sorry, so I'm not really going to answer you. That would be a whole different talk.

Well, the last question that's come in is, would you recommend Quicksin as a good speech test. You know, I think really, honestly, any speech and noise test really helps you. I think that speech and noise test is that the speech and noise test will really help you be able to have conversation with the patient about what you are doing. I think the quicksand's great. I think it's fast.

But I do think that the quicksand also relies on some cognitive load. And so I do use the quicksand. But I recognize that the patient's having to hold that entire sentence in their brain. The same thing goes with the AZ bio that they have to hold that entire sentence in their brain. So I will just say that any speech and noise test is going to help you.

If you did not understand all the steps that I just made and all the conversations about how to do this, please feel free to reach out. I can give you the information. I can also give you step by step directions that I've already developed. Okay. And just for everyone.

That's why I think Lindsay's very kindly put her email address on the slides for you in case you need any further clarification. But we are nearly at time, so I'm going to call it there and hand back to Anna from Audiology online. But, Lindsay, I love working with you. Thanks so much for your time and thank you. I'll hand you back to Anna.

Thank you.