Comprehensive Hearing in Any Environment with ReSound All Access Directionality and Ultra Focus

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- [Tammy] Welcome and hello, everyone. My name is Tammy Stender, and I am happy to talk to you today. I hope you're having a good Wednesday so far. Today, I'm going to be talking a little bit with you about what it means to be focused on the person and individualism when it comes to hearing aid technology, and specifically for directionality, localization, and sound quality. So the title is the very long name here of Comprehensive Hearing in Any Environment with ReSound All Access Directionality and Ultra Focus. And that is, indeed, what we will be covering. But I want to take it to a level of thinking about how this technology really applies to each one of your individual patients that you encounter. So as always, please feel free to type in questions, comments in the chat box. In fact, we'll have a little bit of interactive time where you can go ahead and chat some thoughts into that text box to think about how this makes sense to you and to your practice for your patients.

So who are your patients? I actually, probably don't know any of them, but you know them really well. You've gotten to know them on a personal level. You've talked with them. You've shared stories. You've probably seen some pictures. What's important to each one of them? And what will make each one of them feel fulfilled and feel like this hearing aid was all about them, and how it really was designed to help them with their unique struggles? At the same time, we can't just develop hearing aid technology for one person. We know everyone has differences and things that they prefer or don't prefer. Do they prefer sounds to be more loud and crisp? Do they prefer them to be soft? Do they prefer to be able to always hear the person in front of them regardless of the noise level? Or do they prefer to be able to hear all around? Well, in many things in life, there are no absolutes. If I had to answer any one of those questions, I wouldn't be able to do so, because it depends on the situation. So how do we make the situation make sense to that individual at any given time? So let's say that you want to hear this lovely woman talk. She's telling a story, and you're having a lovely outdoor dining experience. But you also know that there's more than just her at the table. And the

whole point of a conversation is that there's more than one person talking, usually, unless it's in AudiologyOnline, like right now. But again, if you have questions or thoughts, please share them, and we won't make this all so one-sided here. Anyway, how do we bring her into focus when you want to hear her but also hear what the other people at the table are talking about? If you've ever been to a ReSound talk before, you might think this sounds like what we've been doing all along. How is this any different with our new product, the ReSound ONE? Well, that is what we're here to talk about today. We are building on our legacy of making the hearing aid technology fit the needs of the user, but we've taken it to a whole different level now. We've taken it to a level that was never before possible. And I'm really excited to share this today. So what are we going to accomplish today? We're going to talk about the concept of biomimicry, which you may already know is the way that products and processes can be developed to imitate or to emulate natural processes that happen in the human body or mind. We're also going to identify three main strategies that people use, their cognitive brain strategies, that help them hear in everyday listening situations. And they're really innate.

They're not things that we have to think about. They're just things that we are already wired to do as human beings. So we're gonna discuss what those things are. And then we're gonna talk about how we can use those strategies and build on them with the technology, using biomimicry, and provide advantages and benefits of our features, specifically today, directionality and localization. And I put some hearts throughout this presentation. They're hearts for helpful hints. And if you are taking the quiz after this presentation, these hearts will guide you to some nice little hints for that quiz. Every person is one of a kind, and we all know this. We all have unique fingerprints. We all have unique likes and dislikes. No one is exactly the same as the other. So that is what our philosophy has been and continues to be. We have now adopted an Organic Hearing title for this philosophy. What is it? It enables people to connect to the world around them in an intuitive and natural way. And how we do this is we develop

solutions that work with the actual anatomy of the ear, the physiology of the ear, to try to emulate, mimic how sounds in the environment are naturally collected and delivered to the brain. So very similar to what we've talked about before, but now we're taking it to that next level. And you see, we have a little heart here. Okay, so biomimicry, if you look it up in the dictionary, it's going to say something like, the design and production of materials, systems that are modeled on biological entities and processes. It sounds like something we probably had to put down in a college exam at one point. And please don't let the mannequins haunt your dreams. They have blank eyes, but they are meant to illustrate how natural processes happen in our brains and how we can utilize this knowledge to expand on our hearing aid technology. I mentioned before that there are a couple different strategies about how people get around in daily life, whether they are wearing hearing aids or not. These are brain strategies that help us make sense of the auditory world around us. The first one, let's say you're taking a walk. She's pulling her friend on this walk, it seems. But they are outside. They seem rather happy and joyful. What are they using to enjoy their auditory environment?

They're listening to birds. They're hearing the crunch of gravel under their feet. They're using a way of keeping awareness around them. And they're doing that by taking cues from the auditory space. So in this strategy, we want to, and the brain attempts to, maintain a time and place for all of the sounds around them. That's what's known as spatial cue preservation. You're trying to maintain that natural sense of moving through the world. So when you think about hearing around you, you want to hear in all directions. Take this situation, where you're at an outdoor cafe, that we already looked at briefly. In this situation, you want to hear somebody telling the main story, but you also wanna hear the interesting comments it looks like that fellow is interjecting into the story that maybe is making people laugh. So you want to be able to divert your attention when you want to, and also keep track of everyone who's even saying the quickest word, just maybe a one-liner that will make the conversation funny. And that's a binaural listening strategy. That's where you want to be able to focus on her, but you

also want to be able to hear around you, too. You don't want one or the other. You want it all. Take this situation. Here, we see a woman picking out, it looks like peaches at a market, at an outdoor market, let's say. And if you've ever been to an outdoor market, unless you're the only one there, there's usually a lot of hustle and bustle. There's people behind you. There's talking. There might even be some music. She wants to know what the price of these peaches are, let's say. How is she going to hear this fellow, the vendor, tell her what the actual price is, or where these peaches were grown perhaps? Well, in this case, she wants to be able to hear a little around her, but she really wants to focus on him. This is a situation where if she doesn't hear the price, or if she doesn't hear where they're from, maybe it'll affect her decision to go forward or not with that purchase. So she's interested. She's looking at them. She wants to focus on speech intelligibility.

So these are natural processes that we as humans use to be able to get around in our worlds. But how can we use hearing aid technology to support these? As I'm sure you all know, when you put a hearing aid on the ear, you do things that are great, like making the world louder and easier to access, but you also sometimes take things away. You take away the natural placement of where that sound is picked up. It's not being picked up at the eardrum anymore. It might be picked up behind the ear or on top of the ear, or even if it's in the ear, it's not at the level of the eardrum. So that's just one example of how technology, while it serves a greater good, sometimes comes with drawbacks. And that's the same kind of illustration in directionality. We don't want to have the hearing aids be always amplifying all around in a spatial cue strategy, because then it's going to fail in the cafe. It's going to fail when she's trying to determine the prices of those peaches. We don't want to have it only be where she can hear in front of her and ignore the rest of her. Otherwise, that walk in the woods is going to be quite monotonous and not as enjoyable for that couple on the left. So we need to be able to let people transition naturally, the way the brain wants to, throughout all of these three strategies. And that's what we're doing. That is our

newest addition to our directional strategy. We are amping it up to make it more in tune, more precise, and more in line with what the brain would expect in these situations. How are we able to do this? Well, we are able to hone in on sounds in a greater way through the use of audio beamforming when we want to focus on a speaker in front. So in that speech intelligibility strategy, what does she wanna do? She wants to hear the person in front of her way more than around. So in this strategy, where it's typically very noisy, and she's facing a speaker because she's interested in knowing the answer, this is where beamforming actually will give you a wonderful signal-to-noise ratio advantage. And that is what we have added into our directionality. However, having beamforming all the time is not going to be beneficial or desired in a less difficult situation, like when you're taking a walk in the woods. You don't want to beamform there. You want to be able to hear as naturally and all around you as possible. And then for all of the times in the middle, when you want to sometimes focus and sometimes hear around, hear when that waiter comes to take your order at the cafe, hear when the lady tells the punchline of her joke, that's when you want the best of both worlds. And that's where we're going to be able to add beamforming directionality. Where we used to only have a directional response, now it can be beamformed to more make that speech pop, make that speech more audible, improve the signal-to-noise ratio in those situations, while at the same time providing auditory awareness.

The technology that allows hearing aids to do that kind of thing is the magnetic induction radio. So we now have a brand new magnetic induction radio inside our devices that works alongside our 2.4-gigahertz radio that connects to our devices and exchanges data between the ears. So this magnetic induction radio is what is running the audio exchange and what allows us to do that binaural beamforming. That binaural beamforming and that magnetic induction radio is just one piece of our puzzle. Remember, we want to preserve spatial cues. We want to make it be so that this scary mannequin can hear all around her, and that the real person can enjoy sounds all

around them. We want to be able to be sometimes focusing more towards the front while also listening around us, like at a restaurant. And especially if we're sitting next to someone, if we're at a long table, then we want to be able to hear the speech of the person next to us by capturing that auditory awareness, having an more omni-response on the side of the person speaking next to us while focusing and getting rid of some of the noise on the other side, which will, again, make it easier to hear in a more difficult situation such as that. That would be our cafe. And finally, we want to be able to really focus. So instead of just the bilateral directional response, now it's going to be a bilateral beamforming directional response that is also pretty unique in the way that we do that. And I'm gonna talk about that in just a minute. This, again, is when you would want to focus on the person in front of you, perhaps maybe just for a couple minutes, but definitely to get a message across. There's one more option that I haven't talked about, and that is the Ultra Focus program.

So there are times in my life where I find that I really need to focus on something, even though there are people talking around me. I just need to hear. For example, if I'm at an airport ticket counter, and I'm trying to see if I can get that last flight back to visit my parents, I wanna hear if that flight, I can get on standby or not, or if I can buy a ticket on the last minute to be able to do so, maybe even at the expense of somebody telling a fun little story behind me in line. That's when I might want to, especially in a very noisy environment, choose a program that is going to put me straight in focus with one person or one sound source right in front of me, a very, very directional beam. And that's when I'm probably going to need to say, you know what? This is something that, yes, in a normal situation, I might wanna hear more around me. I might want to hear what people are saying behind me. But the hearing aids have no way of knowing that. Only I do, as an individual. So I'm going to take out my app, and I'm going to choose my Ultra Focus program that has been programmed into the fitting software by my hearing care professional. And this is going to allow me to really zone in on what I wanna hear. And then I can change it right back out of that as soon as I'm done. Okay,

so I don't know if any of you are familiar with the game "Family Feud." It was one that I grew up with and I used to love to watch. I think it was on about 11 o'clock in the mornings. I'm 11 o'clock here in Central Time right now. So I thought maybe it would be fun if we could talk about a time when you might want to use Ultra Focus to improve the SNR. And I've got three answers here, and I thought that we could write in the chat box what the most common answers are in this informal "Family Feud" kind of poll of when you might want to use Ultra Focus. So go ahead. I see some responses coming in. Thank you so much. I'm seeing a cafe, like a Starbucks. I'm seeing date night, busy restaurant, noisy restaurant bar, a restaurant. Absolutely. Fantastic. Thank you for participating. You guys make me feel good. This is great. This is the first time I've done "Family Feud" on here, too, so fantastic. Well, one of them might be a noisy airport ticket counter. Survey says grocery store checkout and loud concession stand or cafe. So you were right on that a cafe... When you're ordering, if you're ordering a triple soy latte with extra foam, you've gotta get your message across. I know, personally, if I'm ordering something at a Starbucks, I totally want to be heard, and I want to hear back what they say back to me. So fantastic. That's absolutely correct.

How do we support this natural hearing experience, though? Because of course, you don't always wanna be in Ultra Focus. You want to be able to maneuver through your life in a natural way. Well, other companies also use beamforming directionality. And other companies also have awareness around them in these kinds of situations. How can we distinguish ReSound technology from these other technologies? Well, we do this in three different ways. Number one, we have a unique application strategy. We are going to apply this technology in a way that is very unique and very designed on research and based in evidence on when people perform best in these environments and when their preferences are aligned to that. So in an outdoor environment, very strong preference for an omnidirectional microphone, but can we make it better? Can we make it sound even better without getting rid of the benefits that you get from hearing around? Because remember, we've still gotta get over some of these trip-falls

that we get from hearing aids, such as mic location placement, compression doing strange things to the signal. Can we take hearing aids to the next level? So we're going to apply a unique way of applying our directional strategy to account for the outdoor situation and to account for the cafe and to account for the ticket counter and account for the marketplace. Another way we're going to do that, distinguish our technology, is we're going to apply this directionality in a very multi-band way, very uniquely. And we're gonna talk a little bit more about that, too, and what that means, and why we would even do something like this. And finally, we're going to use weighted beamforming. If you notice before, those beams that I was showing in the previous slides were a mixture of red and blue lines to signify input from the right ear and the left ear. What does that mean? It means that we're going to be weighting our beamforming from both sides, not just combining the signals to make that narrow beam, but also judiciously weighting it so that we take more of the input from the less noisy side, so we can have a cleaner signal when we do beamforming.

So let's start with the first application. The first way that this is different from other methods on the market today is the way that we select our application. We're going to go into a binaural listening mode when there's noise around us, but there's a speaker on one side or in front. That will derive what side is going to be capturing the auditory awareness in a more omnidirectional pattern and which side's going to be focusing or getting rid of background noise in a directional pattern. We're going to apply these beamformers also in the speech intelligibility mode. And that was where we saw the example of the woman at the marketplace with the peaches. She wants to hear a little bit around her, but she really wants to hear the message that's coming through from the person in front of her that maybe is at least 6 or 10 feet away from her. So we want her to be able to focus. It's not quite to the level of going to Ultra Focus, but if she wanted to, she surely could. She could decide to give it even more of a kick of signal-to-noise ratio benefit by selecting Ultra Focus in that situation as well, or in a cafe like Starbucks. So the way that we're applying beamforming is not universal. It is

very much that the hearing aid will go into a beamforming response only in the situations where we feel very confident that it will be beneficial. And it is also putting the user in the driver's seat to be able to make it be that narrow beamformer for the ultra-focused response that they might want in certain select situations. They don't want that every day, but when they want it, they want it, and they'll be able to get it now with this technology. So that's what makes it really exciting. It's taking the technology, amping it up to the next level, but still keeping the user in charge of what they want to do, when they want to do it. The second way that we are different is that we have this multi-band directional approach. And I know that lots of companies say they use multi-band directionality. So what are we talking about here? How is it different? Okay, so we've got a frequency range from low frequencies to high frequencies. And there are several things that we need to keep in mind for each range of the frequencies.

For example, in the low frequencies, omnidirectionality in a... If you have a directional program, but you put part of the low frequencies into the omnidirectional response, you get a lot of nice little advantages here because directional technology in the low frequencies, if it's full band, usually comes with a low cut. If you remember hearing about, in school, directional low cut, it's just a physics problem with directionality, and it will cut out the audibility for low-frequency sounds. And if you've got a person that needs some audibility in the low frequencies, then you need to build it back up with a bass boost. Well, when you add in a bass boost, it's a different kind of processing. Sometimes it can be audible. So we get better sound quality by having omnidirectionality in the lows. We also get some natural protection from another problem with directionality with two mics, which is higher wind noise in the low frequencies when you have full-band directionality. So we choose omnidirectionality here for that other reason of controlling wind noise. And thirdly, you get a preservation of time difference cues around the head as a sound moves from left to right, or right to left, from one side to the other. You get a differential from one ear to the other in the

time of arrival of that sound from the right to the left ear or vice versa. And while it seems very insignificant, it is a cue that the brain has developed to be able to help us know where things are coming from. If we're in a directional response, we're not amplifying sounds all around us equally. And so that cue can be distorted or even lost in a pure directional response. If you have an omnidirectional response, you maintain that cue and are able to take advantage of those time difference cues from left to right, and horizontal, other apps in this as well. Moving into the middle frequencies here, this is the speech frequencies that we learned about in school as well, 500, 1,000, 2,000, 4,000. These are the frequencies that really are the meat and potatoes of the speech signal, the ones that really make it be improved, especially if you can improve the signal-to-noise ratio. So that's where we're going to go full force into the binaural beamforming, because it makes sense to optimize it there. However, once you get above 5,000 hertz, the SNR improvement starts to be a little outweighed by some loss of interaural level differences, when you have an adaptive directional beamformer up there in those higher frequencies.

So studies have shown that if you have independent, each ear, fixed directionality in those very high frequencies, you're going to be able to maintain some of your level difference cues. That's the difference between somebody, again, on one side talking, it'll be louder at the side that they're talking versus the other side. We usually talk about interaural level difference when it comes to compression, but it also has to do with the audibility of the signal. And if the directionality is zooming in and zooming out, that affects the audibility in those high frequencies and can distort that ILD cue. So we want to make that a little more fixed so that we can preserve those monaural spectral cues. So this multi-band directional approach is really something that's designed to give us the maximum signal to-noise-ratio improvement, but to also keep track of the low-frequency and high-frequency spatial cues that give the sound quality more of a natural feel, more of a real feel without some of the things that are drawbacks in traditional hearing aid technology. As before, we still have personalization for that

Directional Mix setting, which is the band split between the omnidirectional and the binaural beamformer. So based on the user's low-frequency hearing loss, that's at 250 and 500 hertz, and also based on the microphone location of the model that they're being fitted with, for example, an ITC versus a RIC would have a much different mic location. We are going to personally set that Directional Mix for them so that we can get the optimal settings of ITD preservation and SNR improvement for their hearing loss and for the kind of hearing aid that they're wearing. The third way that we are distinguishing our beamforming is through weighting, which I alluded to a little bit before. So instead of taking inputs from both sides, the right and the left side equally, we are going to weight the response more to the side that is not as noisy, taking account of that pure and better signal-to-noise ratio that's just naturally there in the environment anyway and making the beamformer more representative of that side's input than the other.

Why is that important? Well, we've just put a couple of interesting distractions in this poor woman's, in this is poor situation, where we're trying to focus on the woman, and let's say on the left, we have a fan, and on the right, we have somebody drilling and using street construction tools, and there's cars. So which side is more noisy? Well, the right side. So if I were to be beamforming for hearing her better, I wouldn't want to have as much input on the right side. I'd kind of wanna be focusing a little more on the left. And it'd be great if the hearing aids could do that for me. And now, of course, they can. So in that situation, we are going to weight whatever side is less noisy so that the signal comes through with better signal-to-noise ratio, even as it's being beamformed to give that same signal-to-noise ratio improvement an extra boost. How much of a boost does it provide? Based on weighted beamforming versus traditional beamforming, where it's 50% on the left side, 50% on the right side, into that beam in front, well, our studies showed a 2-dB improved speech performance when we were weighting the beamformer as compared to not weighting. So depending on... In the study, it was noise on the left more than the right and vice versa, but the speech was in

front. People did to 2 dB better when we used weighted beamforming than traditional, which is what made us focus that this was the direction we wanted to go in for our beamforming when it is applied. So just, like, to summarize, 'cause that was a lot, what do we do here? ReSound beamforming balances signal-to-noise ratio maximization for speech in front of the listener with access to surrounding sounds and spatial cue preservation. It is multi-band and uses weighted e2e audio blending for the less noisy ear to be more emphasized, and can improve the AI-DI by 2 dB compared to non weighted beamforming. All right, so we've just covered a lot of different environments. And I know I only talked about maybe three or four, but as you know, and as you showed in the chat, there are so many different environments that we could be thinking about for when this would be advantageous. That's great, and that's directionality, and that's a new level of directionality.

But we haven't really talked about taking it to the next level in terms of personalization, how to make it just sound natural, how to make people feel like they can localize as well as they do, or like they remember doing before, before hearing aids came in and started taking over how loud sounds were and where the microphone was located. How can we take it to the next level? In a world full of different environments, we need to take it to that next level so that people can feel that sounds are separated by space and time so that they will adapt to them better, so that they will feel that they want to make them part of their lives instead of they have to make them part of their lives in order to get by. And in order to get to that adoption level, again, we need to go back to biomimicry and think about, what does the brain want? Because the brain is the driver of our wants and needs most of the time. So what is the brain looking for that would make it be happy, that would make it feel like there were going to be an advantage here? So who wants to write in the chat box? And I'm so excited people are writing in the chat box, because that's fantastic. Of the following, which of the following are natural cues that people use to localize sounds around them? Everyone is correct. It is D, all of the above. Very good job, because we're talking about level differences. We're

talking about time differences. We're talking about the natural shape of the external ear, which I haven't talked about yet, but that's where we're going next. Just is a little review of ILDs and ITDs, ILDs, remember, they're helping us localize in the high frequencies so that a sound on one side that comes to your left ear will be heard louder than on the further ear, on the right ear here. And that is something that the brain can pick up on unaided. But when you have WDRC compression, what does it do? Well, it gives more gain to soft sounds, less gain to loud sounds, which means that softer sound coming off across to the farther ear might just have a couple more DB of gain added to it, and that's going to mess up the relationship that the brain was looking for for that difference of the level, causing confusion. If you do not have any way of making up for that error or that problem, you're gonna get confusion in your ILD cues, which leads to unnatural sound quality and hard time localizing. But when you preserve the ILDs via binaural compression or via those high, high frequencies being in an independent, fixed directional response instead of an adaptive beamformer, you're going to preserve more of those level difference cues between the ears. And that's gonna make it sound better. And your patient's probably never going to think about that.

They're just going to think, oh, this hearing aid sounds a little better than the other one. Why? I don't know. And they're going to say they don't know, and that's good. They shouldn't have to know, because this is a brain process that we don't think about, we're born with. So, "It just sounds better," is what we've been hearing in the studies and what I hope you will hear as well. But there's other ways it just sounds better. And that's with time difference cues. The head in auditory space is just a barrier for sound to go around. Lower-frequency sounds have a longer wavelength, and they travel around objects like the head easier. So there is a difference in the interaural time difference from low-frequency to high-frequency sounds, which have a shorter wavelength and tend to bounce off of the head. If you have full-band directionality, you're going to be losing out on some of those time difference cues because of the

directional low cut that would be provided or the addition of bass boost. So if you can keep it into an omnidirectional response, you're gonna get better sound quality than what a bass boost would provide, and you will also preserve those cues. And that's why we're putting those low frequencies in omnidirectionality. And if you've fitted ReSound products before, you know we've been doing this for, oh gosh, probably at least 12 years now to have band-split directionality in all of our directional responses. But what about those pinna cues? Well, everyone's ear is a little different, right? And that has become extremely apparent to me, here's as a little sidebar, as my family and I wear masks in different areas when we go out. I bought masks for all of us, for the kids, for my husband and me. And they're all the same manufacturer in some cases. We tend to like one better than others. But then we find out that even though we're all related, the masks that I bought for my daughter, who, she's 11, they fit beautifully. Like, her ears are just... It's, like, made for her. I don't know. She's just lucky, I guess.

My son, he's nine, and his little ears, they just poke so far out when we put that mask on around his ears. And I'm just like, you know what? We've tried so many different kinds of masks. It's just his pinna. It's just different. It's oriented differently. Everybody's different. So that's just my little illustration about how only you have the pinnas that you do, and even your right and your left pinnas are different from each other as well. But your brain has been uniquely designed for those pinnas that are attached to your head. And they are collecting auditory cues based on the shape and size of those pinnas that you've had forever, and that you've grown up in from the time you were a baby to right today. And these are what's helping you gain those spectral cues that help you localize in every direction. In the past, we've had pinna restoration as part of our Spatial Sense feature. And that is based on averages. How well does average data always work for every person? Yeah, hit and miss, right? I mean, if you've got a person that just happens to fall in the middle of the bell curve of averageness for pinna, then congratulations. Spatial Sense pinna restoration is going to be just fine. They're gonna think it sounds great. And we did notice that Spatial Sense pinna

restoration was much better than not having anything at all for most people. But for some of those people, let's say maybe my son, I don't know, he might find that he's not in the bell curve of that pinna size or shape. And the restoration that is based on averages is not gonna cut it for him. So we need to be able to look at what his needs are as an individual so that he can get the same benefit as his friend who also has that need for technology, for example. How do we do that? Well, Organic Hearing, we gotta go back to the individual. We cannot design technology that is one size fits all when we're talking about things that unique individuals require from their own brains. We need to think about how to better emulate the natural processes for the individual. And that means we're going to need to think a little bit about where we put the microphone and where pick up these pinna cues. Traditionally, where do they go? Right on top or right behind. There's usually two microphones and a RIC or a BTE, and that gives us our directionality.

That's been great, but it picks up the sound far away from the eardrum. What if we could pick up the sound closer to the eardrum and take advantage of those pinna cues and do it such in a way that was unique to the individual, and still give them a RIC. Let's say that they don't want to wear a CIC, or they can't wear a CIC. If they want to wear a RIC and get all of the benefits of conductivity and feedback control and larger fitting range with that RIC, more gain, then you could potentially put that microphone really close to the eardrum while mixing the benefits of the RIC device and give them the best of both worlds. And by putting that microphone inside their own ear, we can individualize those pinna cues just for them. This is the M&RIE receiver. This is the newest addition to the ReSound ONE product that differentiates it the greatest from everything we've had in the past, because we've never had anything like this before, a RIC with three microphones, one of them located inside the ear canal, picking up and helping to make the sound quality so much better for that individual based on what their brain is used to picking up at their own eardrums. Do we have any evidence for this? Well, of course we do. So we're calling it the M&RIE. It's the mic and receiver in

the ear. So that signifies one, two, three mics. And we've been studying what the advantages and benefits are outside of the theoretical. And what we found through our studies was an improvement in localization, because you're using the actual user's pinna cues instead of some average. And you're getting better sound quality because of it, because it just sounds better when you can actually use what the brain has been used to using. You don't have to acclimatize to something new if it's what the brain has been used to hearing all along. And you also get this nice little added benefit, which actually was something that wasn't necessarily the intent but turned out to be a happy accident. When you put a microphone in the ear and that microphone is active in an outdoor environment where it's usually pretty quiet, you're gonna get some nice comfort in wind, just like you were a CIC user, and the microphone is protected by the structures of the ear from that wind noise. Wind noise is the worst for RICs and BTEs, but it's actually pretty good in the farther you go, the deeper inside of that ear canal. And if you're putting a mic on the inside of that, on the side of that receiver, you're picking it up right close to the eardrum.

There's gonna be very little wind noise. And that was a nice little added bonus to the M&RIE. What does it look like in comparison to what we've had before? Well, in order to know if we're benchmarking to the right standards, we need to look at the open-ear response. So what we're seeing here on the left is, as you move a sound source around the head from 0 to 100, 200 and 300 and 360 degrees around the head, you can see how different frequencies are picked up more or less by the shape of the pinna, the shape of the head, the head and torso effects. This is the natural localization kind of pattern for the open ear. And again, this is going to be slightly different for every single person, but let's just take this one as an example. When we look at this one as an example, which was indeed an average that we used for developing our pinna restoration, we see up on the top right the pinna restoration response, which has some nice characteristics. You see some blue streaks. You see some of that red. But it doesn't look exactly the same as the open ear. It's gettin' there, but it's not that close.

So what does the brain interpreted as? Well, it's like, you know, 50, 60% good. That sounds better than before, not having it at all. It's good. It's somethin'. But then you put the microphone in the ear and you look, and you see these changes that make it so uniquely to that person's open ear. So on the left, an open-ear response should be what we aim for with the mic in the ear, what we aim for if we're trying to preserve the pinna response, and that's very close to what we're getting. If you look at 'em closer together here, we can see the similarities in these, in the spectrum here, that where it should be more intense, it is. Where it should be less intense, it also is, which is providing the brain the cues that it has grown up with. When it comes to front-back localization, there are also very good benefits. This is the percent errors that you would expect from an omnidirectional, a pinna of compensation based on averages, and a M&RIE response, for people with hearing loss in blue, and for people with normal hearing in orange. The number of errors goes up if you're in omnidirectional. Without hearing aids, the number of errors is somewhere around 5%-ish. So anytime you're going to put a hearing aid on, you're going to have more errors in localization because you're picking up the sound someplace different.

You're applying gains. You're applying noise reduction, features. All these things, they're going to make it a little different so that natural localization is inherently going to be different with a hearing aid. Omnidirectional is the worst-case scenario, because you're going to have more errors distinguishing if a sound came from the front or the back when you don't have any pinna restoration or M&RIE. As you move towards pinna restoration, you see it's getting better, fewer errors. And with M&RIE, you see it's definitely decreased significantly. And these, by the way, were obtained at a first time of wearing. We did not allow for acclimatization effects. So over time, this would be something that would be interesting to see as people are getting used to the sound of hearing aids, how that M&RIE continues to get better and better over time with their localization. Their overall localization, not just front to back, follows the same pattern as the front-to-back localization. The percent of errors decreases with the M&RIE

compared to pinna compensation or omnidirectional. Now, of course, people who have normal hearing are obviously not going to have any kind of neural degradation or loss of cues or any of the problems that can sometimes go along with hearing loss that has been there for a while. So that's why we're not surprised to see that people with normal hearing would do even better than people with hearing loss, even though they're all wearing hearing aids. They have more of that integrity to the brain. But that also signifies why we need to very much focus on the brain for people with hearing loss, with hearing aids, because it is a main driver in hearing aid success and satisfaction. So what was we get, natural sound quality, that is the part that your patients are probably gonna pick up on most with the M&RIE. With the M&RIE, their rating of sound quality from 0 to 100, with 100 being the best, was very, very clustered towards the top. With the pinna restoration that we provide in Spatial Sense, it was a more scattered distribution, which of course you would expect, because some of the people were falling in the middle of the curve.

That's where the mean and the median did arrive in this data. But some of them are outliers, like the person who rated a pinna compensation 95 and the person that rated it 15. They were on either sides of the distribution of average for their pinna restoration, as it compares to the average ear, so they got varied differences. As a clinician, I want to know exactly how my patient's going to do and not be surprised when they come back at the followup. So with the M&RIE, it takes away that variability to a great degree and allows me to be more confident that they're going to like this sound quality. Same thing goes with spatial sound qualities, too. That's the ability to determine, where did that sound come from? Was the bird up, top of the tree? Or was the bird at the base of the tree, eating seeds? These are the kinds of things for spatial sound quality that help us get along in our lives. And you see this same of pattern with M&RIE clustered to the top of the rating scale and the pinna compensation more widely distributed, just like we would expect. Here's that part about wind. I mentioned that when you put the microphone inside the ear canal, you're going to be able to reduce the wind naturally

because the wind can't get to the microphone, which is, it's like, in a little cave there. It's not gonna get to it. How much is it not gonna get to it compared to having the mics above the ear? Well, at least 15 dB, or up to 15 db reduction in wind noise. And this is even without having to apply a special feature or without reducing the gain, because most wind noise reductions do reduce some gain in order to get that discomfort of the wind noise down. So that's a huge benefit there that comes along with the M&RIE. So again, the M&RIE is the microphone and receiver in the ear. That's how we came up with the name. You can see that it has a different attachment of the receiver to the device of the hearing aid there. And it's abbreviated MM in ReSound Smart Fit for M&RIE receiver, or, I'm sorry, M&RIE microphone. It's available in short to long lengths, zero to four. And it is, at this time, available at a single gain option, 53 dB full-on gain. So here is the fitting range, which you can actually see is pretty large. 53 dB of full-on gain is not very mild, actually.

One thing to keep in mind with fitting a M&RIE is where the input and the output is. In a traditional RIC, of course, the inputs are at the mics behind the ear, and the output is inside the ear. But with a M&RIE, you've got a mic inside the ear, too. So you've got an input and an output, and they're pretty darn close to each other. What does this mean when you're fitting people? Well, it means that if you're fitting them open, you're getting sound that's going into the hearing, into the ear canal, and it is also being picked up at that mic right next to where it's going in, in a small cavity. So if any bells are ringing, you might wonder, how are we going to control feedback when the mic and the receiver are so close together, and especially if you've got a very open fitting? Well, this is why we had to redo DFS Ultra III. Before, we were at DFS Ultra II, and it was designed for two microphones, DFS Ultra III takes it to the next level and adapts our system to be able to help control feedback for that third mic, especially because it is located right next to where the sound is coming from. We've also got a new dome option. It's a closed dome, and it is... It's called a closed dome, but actually it's not like a closed power dome. It's definitely not gonna be as occlusive. But we found in our

trials that this was a nice way of achieving a good compromise between having more gain than what you would get with an open dome without the feedback. And this is a really nice way of doing this while still maintaining an open fitting. 'Cause again, even though we call it a closed dome, it's just that we don't have those little openings like we did before. If you see those little windows in our domes, this dome is the same, except for it doesn't have windows, and it's still considered an open dome. It is a really nice way of getting in some power with that mic, with the M&RIE mic, without having to worry about the feedback. So I would definitely... I definitely like these new domes, too. We talked a lot about binaural fittings, because we talk about binaural beamformers. And most of our fittings probably are binaural. Well, how do we marry in some of the other features of Spatial Sense with M&RIE? Because of course, remember, M&RIE is just for pinna cue preservation. It doesn't do anything about binaural compression. So if you've got a M&RIE fitting, know that you also still have Spatial Sense providing binaural compression.

So Spatial Sense used to, or typically provides pinna restoration based on averages and binaural compression to maintain those ILDs from WDRC degradation. When you have a M&RIE, you have Spatial Sense also providing benefits of binaural compression, even though M&RIE takes care of providing better individualized pinna cues. If you have a binaural fitting without M&RIE, that is an option. You don't have to fit with M&RIE. And if you need to fit a higher gain than what a 53-dB receiver can do, you will not be fitting with M&RIE, but you're also still going to get Spatial Sense, and it's going to provide you average pinna restoration and binaural compression. One thing we never had before was any kind of pinna restoration for a monaural fitting. But now we do. When you fit a monaural fitting with M&RIE, you still get that individualized pinna restoration, individualized pinna cues. But even now, without M&RIE, you can have Spatial Sense pinna restoration based on averages in that monaural fitting. You won't need binaural compression, because you're not fitting two hearing aids. But you would need the spatial cue preservation. And now that is available with M&RIE or without

M&RIE in the form of Spatial Sense. Who's a candidate? Well, these are just some examples. And you can see her audiogram here is mild sloping to severe. This person, for example, is a businessperson, experienced hearing aid user. Of course we're all looking for the best sound quality. I've actually never had a patient saying, "I'm looking for bad sound quality," obviously. She enjoys all kinds of things, sunset walks, wildlife, tennis, book club. Is she a candidate? Yes. Why? Well, she is needing to have that support. In fact, I would go as far to say as everyone needs this support. So it's not really something that is to be deliberated. If they are being able to be fitted by this device, I think it is a great option. And the same is true for someone who might not be as active, a person who's a first-time user, grandfather, and he just lives a more quiet livelihood than what our previous patient did, still benefits from these individualized pinna cues, from the All Access Directionality helping us to apply beamforming directionality when and where it is appropriate, and giving him the opportunity to go into Ultra Focus when he really needs to hear something. Even though people might say, "Oh, I don't leave my house very often. I'm pretty quiet," I'm pretty sure that there are some times when they really need to focus on somebody in a noisy environment. And it might not be all the time, but when they need it, they need it.

So how does M&RIE benefit your clients? It provides natural sound quality in a receiver in the hearing aid. It helps personalize the hearing experience to a degree we've never been able to do before, because it's using the individual pinna cues. And it provides that better sound quality from greater depth and direction of sound for helping with immersion and safety in environments. So what do you think? I love this picture because I miss the beach right now. But these pebbles on the beach, they all, at a glance, just seem like they're the same, but when, of course, you look at them, they're all especially unique, just like your patients. We, as hearing care professionals, unite technology with unique individual needs, and that's the art of what we do. So what do you think? In the chat box, what aspect of M&RIE or All Access Directionality do you think will be most beneficial for a potential ReSound ONE candidate in your practice or

location? So is it the improved localization? Is it the natural sound quality? Is it the comfort in wind? If you live in a windy area, that would probably be a big one for you. I think that where I live here in Chicago, it is pretty windy. I think the comfort in wind would be great. But it's hard to choose, because these are all such great things that I would want all of them, all of the above. I'm getting some great responses. Thank you. All of the above, I see M&RIE would be a very big benefit for people. People have bicyclists that they are trying to fit, and if they're experiencing wind noise, this is a must-have, and the mic in the receiver is great. It's benefit for people who enjoy boating and golfing. You guys have been wonderful, by the way. I just want to say thank you. Thank you for participating. For people who are happy, like you guys, I am so thankful for you. And I am thankful for the time we spent here today. At this point, I'd love to open it up to any comments or questions that you have with the last couple minutes. What's on your mind? I appreciate your support, everyone. It has been so great talking with you virtually over this last hour. It went really fast for me. I hope it went fast for you.

If you have questions, of course, ask them, or comments. But you can also email me directly. My email is tstender, S-T-E-N-D-E-R, @gnresound.com. And I would be happy to hear from you and to try to find answers if you need anything. And I wish you all the best of luck in your practices and in your daily lives in these times. I am hoping you're doing well. And we have a question. Is it best for those who have normal low frequency? If low frequencies are 30 to 40 dB, is there more potential for feedback with M&RIE? Okay, so if they have normals in the low frequency, I think you're asking if there's more potential for feedback because you're gonna need to fit it more open, if that's how I understand it. That is something that's going to be... Yes, you are right on point. If a person is very intolerant of occlusion, then you're kind of making a choice here. What should I do? I wanna give them the M&RIE with an open fitting, but I don't wanna... Of course I never wanna have feedback. So that is one of the reasons why we developed that new so-called closed dome. It is a compromise. It's not going to

occlude them nearly as much as any of our closed domes will. It's definitely not occlusive, but it gets you to that sweet spot of not having more occlusion, but also controlling any kind of acoustic leakage that would cause feedback. And as before, you still have DFS Ultra III that are going to be able to... You can set it to mild, moderate, considerable, strong, and that is something you can also work with to get better control over the feedback. So you've got two different options, but I would suggest going for that closed dome if you're in that situation where they're 30 to 40 dB, you don't wanna fit 'em closed, but they need a little bit more protection to get that much gain in the lows. Thank you. That was a great question. Here's another one. The M&RIE is a mic input option in the automatic program. Why is it a mic input? That's a great question. Okay, so if you've looked in the fitting software, you'll see that we have All Access Directionality, and then you also have M&RIE, which is an option, too. That is because, if you have somebody that wants to have a program that's only omnidirectional and keeps that M&RIE mic on all the time... Let's say you're in an outdoor program. I think M&RIE would be perfect for an outdoor program, because it really encompasses that spatial cue preservation. You're not gonna be switching around from things. It's gonna be really nice and clear, great sound quality. So I would put it there if you wanted to have outdoor.

I don't think it's the default for the outdoor program. Although, personally, I think it would be a nice choice for that. Great question. Or it could be an indoor program. That would be like, if you wanted... Like a librarian, somebody who's in a quieter environment, you don't think they're gonna be needing directionality in that environment, M&RIE is, M&RIE's better than omni. I would say that M&RIE is the new omni. So if you're thinking you want an omni program, and you've got a M&RIE fitting, fit 'em with M&RIE instead. Great question. I hope I answered your questions correctly. If I didn't, please feel free to reach out. Again, I enjoyed talking with you all. I know that we're right at time. So I, again, thank you so much. I've got one more question. I'll take it, if we have time. Does the Smart 3D app come in the Apple Watch? And here is

where I have to say I am not sure. I am so sorry. I think that the best thing to do for that would be to look at the website with the compatibility to determine if it's coming in the Apple Watch. I believe it does. I'm pretty sure it does, but I don't wanna tell you wrong. So check out the compatibility section of our website. But it does come... It has come in the Apple Watch in the past. I can say that. I have not heard that it doesn't come in the Apple Watch. So I would say it does, but definitely don't wanna tell you wrong there. Thank you for the questions.