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The Impact of a Receiver Module With Canal Microphone & Resulting Benefits for Users and Hearing Care Professionals

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- [Melissa] Welcome to today's course by ReSound, presented by Megan Quilter, Fitting M&RIE: The impact of a receiver module with canal microphone and resulting benefits for users and hearing care professionals. It has been said that innovation is seeing what everyone has seen and thinking that nobody has thought. This month on AudiologyOnline, we're celebrating innovation in the hearing industry with our third industry innovation summit. Thank you for joining today, and we hope to see you in other summit classes, which you will find in our course library. We would like to thank our title sponsor Care Credit and all of the companies who are participating in this 2023 summit. And now it is my pleasure to turn the microphone over to Megan Quilter.

- Thank you, Melissa. I appreciate that. Thanks everyone for joining. I hope you guys are all having a great end to your week. I hope it's warm and sunny where you're at. It is very sunny where I am, but definitely not warm. I am in our Chicago office, and it is two degrees last I checked. So, let's kick off this next summit presentation and hopefully we can start to get our weekend going. So thanks for joining. I'm gonna be talking about our M&RIE receiver and the title, as Melissa said, the impact of a receiver module and with canal microphone and resulting benefit for users and hearing care professionals. To not be so distracted, I'm gonna go ahead and stop my video, but I obviously will continue to talk.

Thanks. So we know that receiver in the ear hearing instruments are dispensed all the time, quite a bit. Actually in 2019, receiver in the ears made up 78.9% of the instruments that are dispensed. There is good reason for this. It's robust, it's comfortable, it's discreet to wear. You often probably hear people say, oh, I want what my neighbor has. It's just a tiny, little invisible tube, and it can offer the most comprehensive collection of features as well. Evidence shows that users are happier overall with the receiver in the ear canal style and for good reason. MarkeTrak 10 actually reported a satisfaction rate of 84% with hearing aids that sit behind the ear,

most of which would be considered a receiver in the canal, versus 79% with custom hearing aids.

But with the good comes the bad, and we know that there are some disadvantages. The brain in particular of an individual person expects, is always expecting to receive sound that has been shaped by the body, the head, and the ear anatomy of that particular person. So when we kind of shift things around, we change things. Hearing sound through a hearing aid that collects sound in the wrong anatomical position, so kind of being at the top of your ear, could potentially interfere with natural hearing processes in the brain, and it may actually almost work against the positive effects of making inaudible sounds audible. So, with the good comes bad. We do have a couple disadvantages. The fundamental disadvantage of maybe or the fundamental disadvantage would be because of the microphone location, so we're looking at sound quality and kind of the naturalness of that.

So we also just need to be really cognizant of that moving forward. But M&RIE just makes sense. It's really that simple. When we think about it, we run real ear measurements because we know that there are individual variances that happen between people's ears and between our own ears that can affect the amount of gain that we need to address people's needs. So in other words, we've come to a point where many of us will not even do a fitting based on average canal resonance, so if given the choice, why would you want to fit to the average pinna? In this industry, we've talked for years and years and years about receiver in the canal devices with microphones on top of the ear and now we finally have M&RIE, so it's a third microphone that's located in the actual ear canal, and you will start to see this as we go along.

This is a over picture of it, so you can kind of see where the receiver and the microphone actually lay. This particular receiver has been out for about two and a half

years or so, and it's definitely been many years in the making. So now that it's been in the field for about two and a half years or so, again, like I said, we continue to see the benefits and hear from tons of different customers and end users that they're very, very happy with this. So, let's go ahead and and explore this a little bit more. We do see some advantages and some benefits of M&RIE. Number one, we've got reduced wind noise, number two, we've got improved sound quality and localization, and then we are also seeing less listening effort.

So, let's jump in with listening effort to start. Why is, first of all, it's a big buzzword in the industry, but why is quantifying listening effort important? Well, it captures information about hearing aid benefit that's not necessarily reflected in measures of audibility or speech understanding. So generally speaking, as signal-to-noise ratio improves, speech intelligibility increases and listening effort would decrease. However, listening effort continues to decrease where you see the speech intelligibility has actually reached its maximum, so we still have more work to do. This is basically indicating that effort must still be put into understand at the maximum level until signal-to-noise ratio is gonna improve further. So therefore, measuring listening effort, it just what it does is it adds a little bit of nuance to our understanding of what the listener is actually experiencing and what they're hearing in a wide range of different listening conditions, so that's why we wanted to take a listening effort route.

There are a number of different ways to test for listening effort, some better than others. We've got pupillometry, we've got EEG, we've got fMRI, dual task paradigms, and then we can also do diaries. The thing about these and some of these tests is that A, some of them are really expensive, and B, some are really just very comprehensive when you're having to do analysis on it, and a lot of this equipment is often found in research sites, not necessarily in your everyday clinic. But we wanna introduce to you a method that came out of Germany and it's called ACALES. It stands for Adaptive

Categorical Listening Effort Scaling Method, and this, again, was out of Oldenburg, Germany, and it was developed by a good friend of mine named Melanie Krueger.

She wanted to take a more pragmatic approach for assessment. She wanted something easy to implement. She wanted something to be able to be done in the clinic. She wanted something really easy to, an easy test setup, and she wanted to capture the entire range of listening effort that could be experienced, so an entire gamut of it. And then she also, and very importantly, she wanted participants to be actively involved in this procedure. So, with that, I wanna kind of give you a little reference of what we're looking at. The ACALES, again, developed in Horzentrum Oldenburg, it requires less than five minutes per condition and what you're basically doing is bracketing out the person's listening effort and how it is rated.

We've got, she's got a 13-point categorical scale, you can see that over to the right-hand side here, and presentation levels are varied adaptively. So as you do better on the test, the test gets more difficult. We can talk more about the ACALES with Melanie Krueger at another time. It's a very interesting test and I know that it has been spoken about to bring it over to the United States and kind of get this more up and running in our clinic, so stay tuned for that, and if you have any questions about this test, I'd be happy to get you in touch with her. But what I do want to take a look at and what I wanna show you first before we dive into this is just exactly how ACALES is plotted out.

You can see the audiograms over here to the left and you can see the plot functions over here to the right. What I wanna point out is that as things are on the left-hand side of the graph, it equals the least or less amount of listening effort. So in this particular example, we've got listener one as the dark black line, we've got listener two which is a little bit more hatched, and then we've got a super hatched line being listener three, and these differences are quantified by signal-to-noise ratio. So everything to the left of

the graph with this would be considered less listening effort, and then things to the right are going to be greater listening effort.

But I think this particular shot right here really illustrates how the ACALES can help to reveal individual differences in listening experiences that wouldn't necessarily be predicted on the basis of the audiograms over there on the left side, so and also how these differences can be quantified by signal-to-noise ratio. So, we dove right in and we thought what else can we investigate? Our research question was will the impact of a receiver module with canal mic have resulting speech intelligibility and listening effort benefits for users and for hearing care professionals? You can see the audiograms over here on the right-hand side and you can also see kind of what our test setup was here and the methods that we used.

We had 24 participants, and 58 to 84 years old. We used experienced hearing aid users and you can see that they had hearing loss for about 15.6 years, they had experience with hearing aids about 6.2 years, and they had been wearing their current instruments for about three and a half years. The hearing aid programming that we used, we did program one with M&RIE, program two with omnidirectional, program three with Spatial Sense, which is that Pinna Restoration. And then we looked at the ACALES, so the listening effort scaling procedure, and we also conducted the Gottingen Sentence Test, which is our German sentence test. We looked at Unaided, M&RIE, and then the SureFit 3 Medium Power receiver, so a standard receiver. The results we have here.

This shows the relationship between signal-to-noise ratio in listening effort categories and the listening condition that it was actually mapped to. So further, again, further to the left the function is on the graph, the less listening effort it is, and when listening with ReSound ONE, participants rated listening effort as less than when they are listening unaided across all listening categories, and then listening under the M&RIE

condition, so that M&RIE receiver, it also promoted less listening effort compared to being fit with a standard receiver or actually being unaided. If we piece out each one of those categories, so going from no effort all the way to extreme effort, you can see the results here, and then we found that the mean listening effort benefit with traditional mic placement was a 1.8 dB, where the mean listening effort benefit with that M&RIE receiver was a 2.6 dB, so these are statistically significant results.

When we take a look at the GOSA results, that got Gottingen Sentence Test, participants showed overall improvement as well, and again, indicating significant, statistically significant results. You can see that M&RIE outperformed the traditional mic placement as well as outperforming the unaided, which we sort of would've predicted. This statistically significant improvement really does illustrate an advantage of picking up sound in the ear canal which is much closer to the way that sound naturally enters the ear. So, we're really happy with the GOSA results. We're also really happy with the ACALES results. We've got more in the works for listening effort, so please stay tuned for that, but basically we're looking at clear and consistent trends when using M&RIE's third mic, and we're also looking clear and consistent trends when ReSound ONE was being observed as well.

Let's take a look over, or yes, take a look over at sound quality, and then we also have a little bit of localization information as well here for you. So, I just wanna throw these three diagram or these three spectrograms up here. The three-dimensional diagrams show the intensity measured in the ear canal in relation to frequency in the angle of the open ear and a compensation algorithm with the new M&RIE receiver type. The blue, if you're not that familiar with the spectrograms here, the blue colors indicate a lower intensity and the red colors indicate a higher intensity. That's how you read that. With the unique microphone positioning of the M&RIE receiver, you can see the spectral filtering in the head of the outer ear is almost identical to that of the open ear.

So you can see the open ear in the microphone in the ear in that M&RIE microphone look almost like mirror images of one another. Pinna Restoration's doing really, really well, but you can definitely see almost a mirror image between open ear and microphone in the ear there. But to prove this or to kind of take this a little bit further, we wanted to do some testing and we wanted to. Let me get that there. Thanks. What we wanted to do was take participants with normal hearing and do an experiment with them. Now, we did normal hearing individuals for a couple reasons. One, people with normal hearing maybe and are usually more sensitive to the nuances in sound quality, and we wanted them to make a more detailed judgment.

And then number two, the main purpose of our GN organic hearing philosophy is to provide listening experiences that are as close as possible to the natural hearing processes, so in this way we thought that normal hearing listeners would be able to help us to identify the potential benefits of our solutions and kind of set the reference value there, just because they are normal hearing individuals. So, you can see this funny guy up here with the pinna compensation and the green ears. The participants wore a pair of headphones and listened to simulations that corresponded to two conditions. The first one was the Pinna Restoration where the pinna, or I'm sorry, where the participants listened with a pair of virtual ears, so this is shown with the green on the ears there.

That's how you can distinguish that. And then number two, the participants also were fit with M&RIE, and so they could kind of listen with their own ears. For the listening test, the participants did evaluate overall sound quality and the spatial sound quality, and I just wanna point out that the stimuli included recordings of an office scene, a cafeteria scene, and jazz music. And for the results, pop these up there. The test was really simple to conduct. Participants listened to the sounds and provided just a rating on a scale according to a particular attribute. So for overall sound quality, they were listening for clarity and timbre and naturalness, and you can see the results there. You

can see that when participants listened to sounds with a Pinna Restoration, so again, kind of those virtual ears shown in green, their experiences were pretty all over the map.

I mean, they're pretty diverse there. Some people rated that they weren't even pleased with the perceived sound quality where others had a fairly good experience, so you can see they're kind of all over the board. However, if you take a look at the participants who listened to sounds through their own ears, the results showed a unanimous preference for M&RIE. So those who are fit with the M&RIE there, you can see that they're definitely more in the eighties to the hundreds. So the results show that the average overall quality rating and the average overall spatial rating for M&RIE was twice as high for the pinna compensation group. What is probably most striking is the lack of variability in the M&RIE rankings quite frankly versus the pinna compensation.

For both the overall and the the spatial sound quality, the ratings of the pinna compensation for individuals range from really, again, all over the map, from poor to nearly as good as M&RIE. This is an expected finding because the pinna compensation is based on average adults, so for people who have very different anatomical characteristics than this average, the sound delivered via pinna compensation would probably be less natural and inferior quality than those that would be picked up at the M&RIE microphone location. So for those who have similar characteristics to the average, the sound via pinna compensation will be quite good sound quality, so that's fantastic there. But taking a little step further here, the group average for overall sound quality was a rating of 48 when listening to sounds with that Pinna Restoration algorithm activated, and an impressive 96 average rating when those were listening with M&RIE, so that is when participants listened through a simulation.

We're really floored by this one. We were not expecting as high of a rating as 96, but we'll definitely take that. And to even get better results, participants also judged the

spatial sound quality, where they had to focus on their ability to localize sounds as well as the spaciousness of the room, and the group average in this case was 53 when listening to, again, that pinna compensation or those green ears, and again, a really impressive 99 when listening to sounds with M&RIE activated. We were very happy with this particular setup and this particular result, obviously. Moving into a little bit of more localization talks, you can see this is our booth setup here. M&RIE allows people with hearing loss to kind of hear the world with their own ears and as natural as they possibly would, so we wanted to see if we could also help them localize sounds more accurately.

You can see from the results here, they look pretty good. Listeners had the best performance in the unaided condition. So let me just point out, the lower the graphs, the better the results, but you'll notice that the listeners had the best performance in the unaided condition, and the worst performance in the omnidirectional condition. So you'll also notice that along with the best performance in the unaided condition, these results were similar for the M&RIE condition. So, I've listed a few key points over here on the right side. Let's just go through those a little bit. M&RIE was the only condition not significantly worse than unaided. Fantastic. M&RIE resulted in significantly less localization error than Omni, so that's also fantastic.

Again, lower on the graph is better. And then you can see that Spatial Sense resulted in significantly less localization error than Omni, so we're doing something right there, and M&RIE and Spatial Sense also resulted in significantly less localization error than the other brands that had been tested. So again, very happy with that result as well. We've got these in white papers. If anyone is interested, please reach out to me. My email is at the end. I'd be happy to get this information over to you. What was really exciting about this with the localization study was something we had kind of stumbled on. As part of a two-year study, we had evaluated localization of users who had been fit with ReSound ONE with M&RIE, and what we did was we tracked them over time.

The localization test was repeated after four months of wear time, and the results were not necessarily what we had been expecting. This research revealed that it was that people performed better and had more localization benefit the longer that they actually were wearing the M&RIE receiver. So we knew in the beginning that M&RIE increased individual's ability to localize, the error was reduced at the time of the fitting, but what we didn't really know and didn't really expect was that they would have the ability to improve even further with time. So even four months of wear time, you can see that it's 57% better. Oops, sorry. I should have clicked on those a little bit earlier. And again, we also have this white paper if anyone is interested in this as well.

This is an ongoing study. And last but not least, and actually which is super exciting for us is reduced wind noise. We decided to take out our, take this particular study and farm it out, and so we went to Macquarie University where John Newell PhD and Harvey Dillon PhD work and they did some wind tunnel measurements for us. This was really exciting because Harvey Dillon had created a brand new wind tunnel and made this all for their lab, and so we were signed on to use his new wind tunnel setup. The wind tunnel setup in terms of how windy things were. You can see they used the Beaufort Wind Scale and they used a rated number four.

They used a moderate breeze. That would be 11 to 16 knots or equivalent to about 13 to 18 mile-an-hour winds, which would generate small waves as well as raised dust and loose paper. This is a published scale that they were using. In terms of acoustics, they used tulip dome and they used an acoustic mannequin that was bilaterally fitted. They used program one being M&RIE, program two, Omni, program three, our all access directionality, and then program four, synchronized soft switching. So I just wanna quickly play some of the wind files for you and you can kind of take a guess in which one you think it is. But this is head on, so zero azimuth. All right, that's A.

See how windy B is. Still sounds pretty windy, but definitely sounds better. Definitely clear in the lead. And D. I'll spare you the wind in your ear on a Friday, but you can see kind of the results from this. In program A, we used soft switching, B, they used all access, and then C was at M&RIE 'cause you can tell it was much quieter, and then D was Omni. So that was with head on zero azimuth. Let's go ahead and look at back to 180 azimuth. So see if you can tell a difference here. Sounds pretty good. Sounds a little windier. Also pretty crackly windy. And super windy on that last one. So, take a moment just to kind of reflect and think what you think that is.

And here are our answers. M&RIE is A, Omni is B, soft switching is C and all access is D. And you can see the wind noise levels by the direction of wind. So this is averaged across all frequencies, and you can see that M&RIE is a clear winner when we're looking at the left ear as well as the right ear, and that's averaged across all frequencies. You can also see the wind noise level by frequency, again, averaged across angle of incidence of wind, and you can really see M&RIE stand out here again for the left and for the right ears here. We were very happy with this particular study. Subjective reports of improved performance in windy conditions were clear and significant when M&RIE was compared to directional microphones, and what we had concluded or what they had concluded in the report was that M&RIE technology provides a significant benefit in windy conditions and should be considered for all clients with mild to moderately severe hearing loss and an active outdoor lifestyle.

So with that, we were taking that and we were very excited. So when you're trying to fit your patients who are runners, patients who are golfers, people who just like to be outside, people who live in Chicago obviously, the windy city where I live and it's very cold, definitely consider going for this M&RIE route technology because it definitely will improve their performance in their active outdoor lifestyle. So to kind of wrap it up 'cause I know we're getting towards the end of your time here, sound is definitely

shaped by our pinna depending on the direction and arrival of frequency of the sound, and our M&RIE receiver results are outstanding for us. M&RIE reduces listening effort.

We've shown that speech results when fit with M&RIE show improvement for the end user. Overall an advantage of picking up sound in the ear canal is a much closer way of hearing naturally. M&RIE and Spatial Sense resulted in significantly less localization error than the other brands that had been tested, and don't forget, it actually resulted in less localization error over time as well, so that four months really made a big difference, so we'll see what the two year looks like shortly, and reduction in wind noise across all angles for the M&RIE microphone location versus the front and the microphone location. So we've got further improvements are being shown with the ReSound with M&RIE when they're allowed to acclimate for longer periods of time and we should be releasing that study shortly, so definitely keep an eye out for that or send me an email and I'd be happy to get the information out to you.

Thanks so much for your quick attention on a Friday. I know it was a fast 30 minutes. My email is up here at the top or in the middle of the screen a little bit there. If you have any questions, feel free to reach out. I can always be reached easily via email, or you can call the ReSound office and ask for me directly. Thanks so much and I hope that you guys all have a great Friday. I'm going to go into the Q&A here, see if we've got some time to get some questions going. And let's see. In the M&RIE, the first question is in the M&RIE with the mic so close to the receiver in the canal, how does one avoid issues with feedback?

Does this restrict the power output of the receiver? Originally, we had some questions about this in the beginning. We've got some excellent quick guides to kind of show you what you should be coupling with. For real mild losses, mild moderate, you could probably get away with a tulip, but if you are doing things more in severe thresholds, then you may want to go with a power dome. But we've got some quick guides for that

and would be happy to get those out to you. Is M&RIE receivers for all hearing losses, all hearing loss configurations? It would not be for severe to profound. It would also not be for very precipitous sloping hearing loss configurations. Next question.

How about any feedback risks? We already kinda answered that so if you have any other questions, please let me know. And then last question I see here, is receiver in the canal percent fit previously? Stacy, I'm not exactly sure what the full question is. I don't have the receiver and the canal percent that was fit previously, but if you would like to email me and have a bigger conversation, I could definitely look up some numbers and find out some statistics for you, so I'd be happy to take care of that. All right, well this was a really fast 30 minutes with some great questions. If you have any further questions, please feel free to email me, and I would be happy to answer those. Thanks.