Why Evidence Matters
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- [Lana] I am happy to be here this morning, or afternoon depending on which time zone you're in. I welcome you and appreciate you taking time out of your busy day to join us for this session on why evidence matters. So if you don't know anything about me, I'm an audiologist. I spent a, prior to Oticon, I spent a career as an educational audiologist and then coordinating a clinical AUD program as well as teaching courses in that program for first through fourth year AUD students. In my time with Oticon, I'm currently an education and training specialist, and I train all of you on our products and the philosophy behind our products, as well as the technicalities. So we're gonna go ahead and get started.

One of the things I wanna make sure, my hope is that when you leave this session today, you'll be able to describe the innovative research methods that Oticon has used to prove our technology and the benefits for people with hearing loss. I hope you'll be able to discuss why conventional technology doesn't support the brain's natural ability to process sound. And I want you to be able to explain how Oticon research findings can be incorporated into benefit statements that you can use during your technology discussions with your patients. So let's go ahead and get started. And I wanna start with this question. Is all hearing technology essentially the same? And it's a fair question. What you'll hear in the industry a lot is that the question is answered in this way.

You know what? Everybody is using directionality and noise reduction and compression. They may use it in a different way, but the outcomes are all the same. Patients are hearing better in noise. But are they, and to what extent? So that's really the question for today, and I want to go through answering this question by looking at how we've been innovative not only in our approach to technology, but also into, in our research methods. So I think you'll agree that by the end of this session, you'll see that Oticon technology and the benefits provided to patients are different than what you

typically see in the industry. So when we talk about the brain, everything we do at Oticon starts with the brain.

And we have been using this concept of BrainHearing since about 2014. And what that means to us is not just creating technology, but also researching how the brain processes sound and how we can improve that through hearing technology. Now on the left hand side of your screen, you'll see the key BrainHearing features that are currently on our Polaris platform. MoreSound Intelligence is where our deep neural network lives, and that is where we are analyzing and balancing sound. But the biggest key here is that noise reduction to improve signal to noise ratio. In other words, we're providing better contrast between speech and other sounds in the environment. MoreSound Amplifier utilizes our adaptive compression method, in which we deliver amplification to the individual's unique dynamic range but compression is determined based on the input of that particular device.

And it's very fast, it updates within milliseconds. MoreSound Optimizer is our feedback prevention system and very much strives to provide optimal gain throughout the patient's day. Now as you look at these BrainHearing technologies, if we transfer that over to the right hand side of your screen, you'll see the benefits that these technologies bring. And I want you to imagine this image as, as sort of a funnel, right? So at the very bottom of the funnel is the basic need to improve speech understanding among all patients, regardless of the level of technology. So that is our basic premise. But as we move into technologies that support the brain, we're able to provide more speech cues. We're able to reduce listening effort, improve memory recall, and ultimately, provide more sound to the brain, and clearer sound to the brain so that the patient can focus on the conversations that they wanna focus on at any point in time, regardless of how complex that environment is.

Now the good news about all of this is that we offer some level of BrainHearing benefits to all of our patients. And with a wide range of options in our product families, I feel confident that you can offer BrainHearing benefits to the majority of the patients that you serve every day. So if we look in terms of what that life looks like in terms of trying to create technology to change a life, we see a very typical dinner scene here where there's multiple generations at the table, there are multiple conversations, multiple interests, and if you're the individual who has hearing loss sitting at this table, it can often be difficult to focus on anything except what's directly in front of you, but you may wanna hear the little snippets of conversation at the end of the table that really helps to keep you connected to your family and what's going on in those conversations.

So when we say what does it take to change a life, we really want to keep people and this type of situation at the forefront of our thoughts, so that we can understand their needs and their challenges and develop the best hearing aids in the world. Our passion is to make life easier, not just for the people with hearing loss, but also for their loved ones who are communicating and interacting with them. You know, we're dedicated to developing and designing technology that really changes people's lives. We want them to leave behind the restrictions and the limitations that come with hearing loss. And our aim is to constantly focus on understanding the brain and helping to make better sound of it, better sense of sound.

So we believe that professional counseling and fitting that's essential for hearing aid users. They're looking to you the professional throughout their vital, throughout their journey and their hearing loss to find someone who will guarantee the best possible user experience and the highest level of user satisfaction. And you know what, really, that all begins with trust. As consumers of research, I know you value scientific evidence that supports the technology behind the hearing devices that you recommend or you wouldn't be here today. It's one thing to have an opinion on

products and technology or to provide anecdotal stories from limited patient experiences as evidence for your recommendation. But it's quite another case in which we provide level three evidence, which is considered case controlled studies that offer conclusions based on a particular research method.

In fact, the FDA and its European equivalent, the MDR, require at least level three evidence. And I will say that that is something that all manufacturers agree with. We want case controlled studies to show that what we're doing is effective. Many professionals have a reluctance to use manufacturer research rather than peer reviewed research because they feel the funding compromises, or the perspective compromises the efficacy of that research. And, you know, we want independent and collaborative partners, and we do collaborate globally with researchers, not just in Europe and other parts of the world, but also in the United States. In fact, some of the institutions that we have collaborated with include Arizona State University with Dr. Andrea Pittman, or Boys Town or VU Research, VU University in Amsterdam.

So we've got independent researchers, but having that independent research really presents a couple of problems in terms of researching technologies that are released by hearing manufacturers. So, the first problem is funding. Independent research requires funding. And oftentimes if you're doing technology research, NIH is not going to fund that. So, typically research is funded by manufacturers, but there's this process of finding collaborators, finding the funding, developing the research methods, collecting the data. This whole process can take 12, even 18 months to pull all of this together. Now, add to that six months of preparing an article for a peer reviewed journal that can extend that time period to 24 months after the research is completed. And by that time, there's newer technology.

So, while manufacturers do fund the research, it typically helps to speed that process, but there's still this lengthy, lengthy timeframe in which the collaborators can pull

everything together. The second problem is in finding innovative research methods aside what's from available at current sites. So, you may ask yourself, why do we need innovative methods? Why can't we just use speech and noise testing? Why can't we just use hearing handicap inventories? Why can't we just place the patient in the booth and do sound field testing, aided versus unaided? You know, there are lots of those tests that were developed 20, even 30 years ago that were looking, that were developed to look at analog technology, but they're not sensitive enough to the sophistic technologies that we're developing at Oticon today.

Our ultimate goal is to collaborate as much as possible with independent researchers, but we're sensitive that, that you need to have a compelling reason to recommend our products to your patients. Now, aside from the execution of the research and the limitation in terms of tools that you have to do independent research, you often have to rely on manufacturer research. What we would ask is that rather than asking for your blind trust and trust us, whatever we say goes, we want you to ask questions about research. We want you to look at the patient populations and the research methods that are incorporated into the research that any manufacturer sends to you. So we want you to be able to draw your own conclusions and ensure that the research conclusions are supported by the data and the evidence provided.

As a hearing healthcare company, we really strive to earn your trust by using science to develop and deliver products to your patients. And you know what, when you offer an evidence based solution to your patients, your patients in turn trust you and they'll continue to seek your knowledge and your professional guidance. So, did you know that satisfaction in hearing instruments has continued to increase since the first MarkeTrak survey back in 1989? And actually in 1989, the first MarkeTrak survey, it was mailed to about 20,000 members of a National Family Opinion mail panel. So using the US census data to target these survey recipients. And in 1989, only about 53% of individuals fit with hearing devices were satisfied with those hearing devices.

Look at how much that satisfaction has increased with the latest MarkeTrak study in 2022. 83% of hearing aid users are satisfied with their instruments, and it has continued to increase. But why has it continued to increase? Certainly with increased improved technology and increases in signal processing strategies that help with speech and noise, the biggest reason that they're choosing their instruments is because they're satisfied with the quality and the service provided by their hearing healthcare provider. Their confidence in the value of having a knowledgeable professional fit their hearing instruments continues to be strong as we move into 2022 and 2023. 9 out of 10 current hearing aid wearers report being satisfied with their hearing care provider, and that's you. So the quality of the service during the fitting and after the purchase, along with your professionalism, your efficiency and the quality of counseling that you provide influences those satisfaction rates.

So continuing to present realistic expectations while considering the needs and desires of your individual patients is really key and it influences their decision. We want our innovative technology to come alive for your patients. And when it's properly fit by a licensed hearing care professional, it does come alive and patients are very satisfied. Now at Oticon, we've conducted extensive research into the needs of people with hearing loss. And not only have we followed a different path in developing innovative technology, we took a different path in terms of our research methods as well. We felt traditional research methods really weren't making enough of a difference in showcasing the BrainHearing benefits of our technologies. Our BrainHearing technologies feed rich information to the brain, and we need to show how the nuances of our technology support the brain.

And using traditional speech and noise tests just aren't hitting that mark. So, as we use subjective and objective and traditional and innovative research methods, we continue to demonstrate the benefits of our BrainHearing technologies. Now you guys are

familiar, or I hope you're familiar with Eriksholm. This is our research center in Denmark that is completely independent from our production facility, and there's a reason for that. At this facility, we collaborate not just with engineers, but we're looking with researchers who are looking at outside research, current research on the brain, looking at the opinions and experiences of individuals with hearing loss. So it's not just a think tank for engineers to develop technology, it's really collaborating with people from all over the world to see what's the best technology to feed the brain.

Now I wanna take you just for a second to our website, to the Eriksholm website. So give me a second to do that. What you should see on your screen is an image of the website for Eriksholm. So if you just Google Eriksholm research or Eriksholm.com, you can find, it'll take you to this homepage. And as you scroll down, you can see some of the latest news, some of the research areas that are being focused on. But as we look at the top of the page, I also want you to look at the type of research. Sometimes this can give you a glimpse into some of the research that's going to be coming in the hearing industry in years to come.

So know that when we're doing research on our technologies, it's not just one or two years where we're saying, okay, let's try something. Sometimes that research can be 10 to 15 years paving the way for future technologies. One of the things you see here on the bottom right hand side, it's of interest to me, I think this is really cool, steering of hearing devices. Click on that and look at some of the research projects that are going on. You can see that we have a list of collaborators from all over the world. You'll see most of these collaborators are in the, in Europe, but we do have some collaborators also in North America. And then when you look at publications, all of the publications that have been released for peer reviewed journals are here on this publication site.

So as I scroll down, you can see any, choose any year that you wanna look at and you can see the number of publications that are available. So if you look at 2021, you know,

just off the top, between 2021 and 2022, I see seven articles. But if I look down here to view all 29 items, you can actually see eye movement patterns of hearing impaired listeners measure comprehension of multi-talker conversation. I think this is just fascinating. Ecological validity of speech intelligibility measures, effects of hearing aid noise reduction, and early and late cortical responses. So all of your research articles are here for the viewing. So go to this site if you're interested in what's happening in the industry and how we're supporting that BrainHearing message and that BrainHearing technology, it's all here.

So we are thrilled to allow you to have access to that site. So what I wanna do next is go back to our presentation and let me see. All right, go back to our presentation. Eriksholm, great facility, the only research facility of a hearing manufacturer, hearing aid manufacturer, to my knowledge. What we wanna look at is, you've heard me talk about research and our legacy, talking about research that started early, you know, 20, 30 years ago. And we've constantly been on a trajectory to move forward in terms of technology. We're always pushing the limit and seeing what can we do to make it better for hearing, what can we do to improve that signal processing, that sound processing for our individuals with hearing loss?

So one of the first things that we did, and a really a revolutionary technology was looking at improving speech understanding with adaptive compression, right? So the first significant change was in this particular technology. And not only was the approach to compression different, but so was the research method to prove its benefits. Speech Guard was designed to better preserve the nuances of speech by preserving the level differences, using an adaptive amplification approach. So what, our goal, of course is to have sounds be audible and within a comfortable range, but preserve the speech cues, particularly when it's loud or intrusive sound, and allow preserve those speech cues so that the brain can make sense of the sound. The goal

of Speech Guard is just to make speech less distorted and really to improve speech understanding.

And speech and noise tests really weren't addressing that. So what we did was collaborated with the university, I'm sorry, with Arizona State University with Dr. Andrea Pittman in 2014. And she actually created a very complex set of testing parameters to evaluate slow compression, fast compression, and adaptive compression. And she was looking at these compression systems in hearing devices that were fit for both children and adults. Now this was the first research method to really look at signal processing and hearing device and its effect on the cognitive load. That's really important here. Participants were actually presented with a word and when they heard the word, they were required to categorize it verbally as a person, food or an animal, but then also visually match that word to an image.

Then right before the presentation or overlapping the presentation of the word, there was some sort of extraneous sound designed to create a cognitive distraction, right? So all of this was done in the presence of background noise. Now, while completing these tasks, Dr. Pittman compared our adaptive compression system Speech Guard to both slow acting and fast acting compression. And in this complex test set, she found significant benefit with Speech Guard, especially when there was overlap between the competing sound and the target word. So she was able to measure the benefit when there was a load on a cognitive system. And this is really a good example of how we were able to show the benefit of Speech Guard and what was going on with the person's perception.

And again, traditional methodologies really couldn't capture this. So her results showed that processing speech with amplitude compression provided a significant effect on the performance of both children and adults. So listeners with hearing loss can get many benefits from hearing instruments that use adaptive amplitude compression,

especially in complex listening environments. Now, through the years as we have developed Speech Guard, it has evolved from Speech Guard to Speech Guard E, and now because of the speed and capabilities of the Polaris platform, we've added another dimension to our adaptive compression system and we improved its capabilities. So with MoreSound Amplifier, which you find on our Polaris platform, MoreSound Amplifier added the dimension of bandwidth based on input to the hearing device.

So, MoreSound Amplifier seamlessly adapts its resolution and speed to match the dynamics and or stable nature of the input sound. It works precisely and quickly to ensure the important details of the signal are made audible, while also maintaining that fine contrast between speech, the balance of the speech sounds. Now when the sound scene changes quickly, MoreSound Amplifier conveys those changes precisely so that loud sounds are comfortable and soft sounds are audible. And when the sound scene changes slowly or is more stable, then MoreSound Amplifier uses higher frequency resolution to retain the auditability of all of the relevant sounds. So MoreSound Amplifier's adaptive amplification approach still uses that linear window that, for the signal to pass through.

But now the linear window is a 12 dB linear window. And you'll see this MoreSound Amplifier technology in Oticon More 1, Oticon Own 1 and Play PX 1. Oticon, you'll also see it in Oticon More 1 and 2, and Own 1 and 2 and play PX 1 and 2. So we're looking at this 12 dB linear window, but then we're also looking at an input range of 113 dB SPL. That allows those soft sounds, the relationship between the soft, loud and moderate sounds to be natural. So soft sounds should sound soft, loud sounds should sound loud, but they shouldn't sound too loud and uncomfortable for the individual. So why does this evidence matter? And it's really important that when we start taking a step toward building a body of evidence, we want to make sure that we're capturing all of the nuances and those improvements in this technology.

So really up to this point, compression systems are either fast acting or slow acting and they both have their positive and negative impacts. But having an adaptive compression system, it does positively affect the details of the speech envelope. And really this has implications for amplification for both children and adults. We're striving to preserve more details of the speech envelope across a wide variety of listening environments and supporting the brain's natural way of processing sound so the individual doesn't have to wait for the hearing devices to catch up. These changes are done instantaneously within milliseconds. All right, so when we look at how the brain makes sense of sound, we have to look at what the individual with normal hearing experiences in their listening situations.

So external research has given us a better understanding of how the brain processes sound effectively. So I want you to look at this, this image on your screen. Imagine yourself at a restaurant or a cafe with a couple of friends. It's packed. There's, you're really engaged in this conversation despite all the noise around you. You've got people taking orders, you've got clanging and clattering, people bringing food. It's really hard to stay engaged. But as a person with typical normal hearing, you do so because the conversation really means a lot to you. But what's actually happening inside the brain as it's making sense of all the sounds in your environment? In the hearing aid industry, traditional thinking and technology have focused on narrowing or subtracting sound from the sound scene to improve speech understanding.

But in recent years, research has shown us that the brain needs the full sound scene to work optimally. So when the sound is delivered to the brain, it arrives at the auditory cortex. We all, we're familiar with the auditory cortex, but until recently we didn't know in detail what happens inside the auditory cortex. The newest research shows us that there are actually two subsystems, the orient subsystem or the primary auditory cortex and the focus system or the secondary auditory cortex. Now these two subsystems are

constantly working together. They work to optimally orient the individual to the environment. And we need to have that full and detailed view of the complete sound scene. We're constantly checking into that sound scene about four times per second.

So check in, check out, you listening, you listen to the sounds in the environment, you're making connections about what's going on around you. Having the ability to have access to the full sound scene allows the focus system to pick out anything it wants to pay attention to, right? So as the focus system is maintaining its focus, that focus becomes more and more clear. Now, back to this restaurant scene. Your orient system is creating a sound picture with a foreground and a background. The background consists of all of the noise at the restaurant and only your friends are in the foreground. In this way, the background is pushed aside and you're provided a clear focus of your friends.

It allows you to naturally focus back and forth between them as the conversation unfolds. The clear focus makes the rest of the brain work more effectively. You can store that information into long-term memory. And it's interesting through research studies using high density EEG readings to note that when the brain is listening to two or three talkers at a time with a, in the presence of background noise, the primary auditory cortex recognizes that activity as one object. Through this high density EEG, in those studies, the electrodes were lighting up, if you will, when there was just this nondescript sound going on. But once the person was instructed to focus on one particular talker, the secondary auditory cortex lit up, so to speak, with a lot of electrode activity.

So showing us that that orient system, that's just one object, but then as we start to focus, we're able to push that one environmental picture, if you will, into the background. So this is how it happens with typical normal hearing. What about the individual with hearing loss? Now, not having access to the sounds in the environment

makes it difficult for them to engage in conversation. And when it's difficult to understand, we know the person with hearing loss becomes isolated and withdrawn. You know, this can lead to social isolation, depression, even cognitive decline. I know I'm speaking to the choir here. But with conventional hearing instrument technology, I want you to think about subtracting from that sound environment, individuals often continue to struggle in complex environments.

Remember that directionality, noise reduction, compression, those are all systems that take away from that original sound. And in some way that needs to happen. But our traditional signal processing strategies that have been used in the industries for decades, they don't take advantage of the brain's natural sound processing abilities. In order to help the listeners in background noise, we've taken a focus a front. We allow the individual to focus on the front. And this approach, again, it subtracts from the crucial sound in the environment that limits access to the user. So if we're only focusing on speech and only focusing to the front, the user loses some of those cues. And using directionality to focus on speech and providing focus to the front is great when that's all you want to do is listen to the person in the front.

And then when we look at noise reduction, we're looking at noise reduction to provide comfort for the patient. We're using compression to provide comfort for that patient. But we know that this really isn't enough to effectively help the brain. So we know that if you have normal typical hearing, you get access to all of the sounds in the environment. This goes through your intact auditory system and sends a complete neural code to the orient system enabling you to focus and then recognize those sounds in the environment. But if you have a reduced signal going to an already compromised auditory system, then both the orient system and the focus system suffer because they don't get a complete image.

Now, when we look at our studies and looking at how our technology is backed by science, we start by looking at how this brain's ability to orient and giving access to the full sound affects that listener. We want to provide access to the full sound scape and we want to make sure that the sound is more distinct. We wanna preserve information in sound. But I guess the big question here is, does orient and focus help people with hearing loss? And that's what we're going to focus on in terms of our research methods using high density EEG readings. So the journey to build evidence supporting our BrainHearing philosophy really began with the introduction of OpenSound Navigator. We had to think outside of the box, we had to reexamine those traditional ways of closing down the sound scene and approach the speech and noise problem in a different way.

So OpenSound Navigator was groundbreaking really because it utilized a new approach to, a new approach called Multi-Speaker Access Technology. This gives the listener 360 access to the listening environment, but to the important things in the listening environment. So this concept in terms of using Multi-Speaker Access Technology is preserving speech and managing noise, right? And this is actually what's happening on our Polaris platform, but we have to look at the research that was supplied using OpenSound Navigator. So OpenSound Navigator not only provided a comfortable open sound experience for patients, but it was, it supported the way the brain works to process sound. It was able to give people with hearing loss 360 access to speech that was clear and balanced.

And this is very different from the traditional approach in the industry that we've been using, again for decades. Oticon just saw that there was really an end to that and we had to do something to change that trajectory. So when we released Oticon Opn, you may remember some of these research studies providing 30% better understanding compared to our last best effort, which was Altitude Pro. We provided 20% less processing effort that was measured through pupillometry and 20% better memory

recall, not just on a speech and word test, but also a sentence word identification task where the individual listened to a sentence, repeated the last word of the sentence, and at the end of the presentation of those sentences repeated the last word of every sentence or as many of those words as they could remember.

So we had 20% better memory recall than what we had with our last best effort. So it's important to know that speech and noise testing, while that is useful information, we've also gotta start looking at objective measures to show the benefits of our evidence. Now, pupillometry was able to give an objective measure of reducing, of looking at how we're reducing cognitive load using OpenSound Navigator. Remember that the more you concentrate on a task whether it's a visual task or an auditory task, the more your pupils will dilate. So what we were able to do is we were able to measure that pupil dilation and see that improvement in reduced cognitive load by comparing OpenSound Navigator to traditional technologies.

But then we also benchmarked against conventional tests. So using the hint, using speech and noise tests, we were better able to look at how do we compare to traditional directionality, narrow directionality and OpenSound Navigator. And interestingly in this study, we found that narrow beam forming directionality and OpenSound Navigator allowed the individual to hear very well for the person in front of them. And that's great if that's all you wanna listen to. But what OpenSound Navigator offered that narrow directionality did not was access to the speech all around the individual. And then a further study looking at Opn, we were looking at what is the point in which an individual will listen in a background of noise, gather information and decide that they wanna engage in that task.

So essentially we looked at individuals who had typical normal hearing and presented them with speech stimuli in the presence of multi-talker speech babble, using pupillometry to measure their cognitive effort. And what we found was that the give up

point for individuals with normal hearing said, I will listen, but as it gets more difficult, I just shut down. And that point was at a minus eight signal to noise ratio. So a typical, a person with typical normal hearing was willing to engage and participate, but then pupillometry demonstrated they give up at a certain point, that's at minus eight. We did that same measurement with individuals using just amplification, not using OpenSound Navigator, and found that those individuals sort of gave up at a minus two signal to noise ratio.

Now, I don't know about you, but the patients that I've dealt with in my clinical career, my indivi- my patients, even with mild to moderate hearing loss, really struggle in those speech and noise situations. And zero dB signal to noise ratio is very difficult for them. So take this a step further. We looked at the individuals wearing our open products and utilizing OpenSound Navigator. And what we saw was those individuals using pupillometry, those individuals were still participating, still actively engaged up to minus eight signal to noise ratio. Now does that mean that they have normal hearing? No, it does not. Does it mean that the individuals with normal hearing and the individuals using OpenSound Navigator got everything?

No, it does not. But it tells us that using OpenSound Navigator, those individuals were able, with hearing loss, were able to at least engage for the duration as long as those, as the normal hearing individuals did. So they were on par with the normal hearing subjects. Now, pupillometry, we've got many publications in terms of reducing load on the brain, our studies using recall from recalling more from conversations to enrich social interaction. You can see all of the references for these types of studies. And again, we're using traditional methods and we're using innovative methods with that, with pupillometry. And this evidence, it really matters because we've found new and objective ways to measure those nuances of our technology and provide objective measures of benefit.

We benchmarked against not only ourselves, but against traditional technology with what's currently in the industry and finding that patients are supported better, their brains are supported better and more naturally then individuals without using this OpenSound technology. So they come closer to performing to individuals with normal hearing. So we're continuing to develop these objective and innovative methods. And another step forward in our evidence is looking at EEG responses. So what we did was with this 64 electrode cap, we had individuals who were wearing our devices. And you know, if you have experience with ABR, you understand how we extract neural information from the EEG so that we can track a single click stimulus from the cochlea to the lower or upper brain stem, depending on what you're measuring.

Now we extract that information from the overall EEG activity because we make a correlation between the stimulus presentation and the EEG. And that's exactly what we did here with our devices using OpenSound Navigator, we were presenting speech in the presence of multi-talker background noise and creating this correlation between the presentation of that speech and the EEG reading. So let's look at the results without OpenSound Navigator. Essentially what we found was that as you look at the strength of the EEG response, you'll see here that the speaker in focus is very clear. It's represented in the activity of that EEG. But what you also find is that the secondary speaker, remember they're listening to two talkers with background babble all around, and they're really not able to pick out the secondary speaker.

And the background noise and the secondary speaker really are represented through that EEG activity equally. It's really not standing out. So that was with OpenSound Navigator turned off. Look at what happens with OpenSound Navigator turned on. Yes, we see an increase in the EEG activity with the speaker in focus, and the secondary speaker is improved by 95%. So it allows, that EEG activity is represented more distinctly for that secondary speaker. But look at what happened to the background noise. The background noise in that EEG activity was pushed to the background and

reduced by no less than 50- than less than 50%. So it tells us that the individual is able to have access to both speakers and that noise can be pushed into the background through that EEG activity.

Now this doesn't mean that we're asking the individual to listen to two conversations at one time, but it allows that person access and it's more represented in the EEG response with OpenSound Navigator turned on. So this was a huge breakthrough in looking at the objective effects and the benefits of having a really good processing strategy that can support what the brain already wants to do. And that is to orient and then to focus. So as we look at OpenSound Navigator and we look at how it helps the brain focus and switch attention when needed and do it with less effort, we really have to look at why does this matter? Well, the EEG data demonstrates that the brain really does receive good, clear information.

We're preserving that neural code. And it's proof that by focusing on helping the brain process as naturally as possible, patients can navigate conversations in challenging situations more effortlessly. But we weren't finished, we had to move forward and that's where we decided to implement or integrate a deep neural network into our Polaris platform. So with our Oticon More products, we introduce a deep neural network that was trained on 12 million sound scenes. And this highly trained deep neural network, this DNN is actually identifying the differences between speech and other sounds in the environment. So that deep neural network, if you look at our system strategies on the Polaris platform, we have MoreSound Intelligence that is looking at the environment and providing a fully analyzed and balanced full sound scene for that MoreSound Intelligence portion.

And then we send that clean signal to MoreSound Amplifier where we can provide rapid, high resolution amplification. It naturally follows the changes in the sound scene. I think it's important to note here that if you look at our sound studio in Denmark, you

will see that this is a very elaborate setup, not something that we can set up in a typical clinical setting. So we've got noise coming from all around, above and below the individual, and we're taking readings of what our hearing instruments are doing. And I love this image because you can actually go to our Oticon website and look at the sound lab and see a full video on what we're doing and the technology that we're using to show what our devices are doing in the presence of noise.

But what I wanna show you next is the spectrograms of using our technology, again, comparing ourselves to our best last effort. We're looking at noise reduction for Opn S versus the deep neural network in Oticon More. And what you see here is that the spectrogram on the left for Opn S shows that the difference in the amount of- shows a difference in the amount of red and blue areas. So the red is representing noise being reduced in the environment, and blue represents more of the speech signals being preserved. So if you look at this, you can really see that the DNN truly provides a more accurate and precise clarity, a better contrast and balance between speech and the other sounds in the environment.

The next step was to use Oticon More, and we use those in our studies. And the research really for our More products was focused on three blocks of evidence. Orient, focus and recognize. You know, recognize is that cognitive aspect. So once the brains been able to orient and focus, the final step is really to recognize it's the ability to understand and remember speech. Now these systems, again, they're constantly interacting and if there's a compromise to one system, there's a compromise to all of them. So here we used EEG recordings again and we investigated the orient and focus subsystems and how clearly the sounds are represented in the brain. What we found was that when we had MoreSound Intelligence turned on compared to when it was turned off, we found that the EEG represented 60% clearer sound from sounds in the environment.

Then we compared to our last best effort with Opn S using these EEG recordings, and we found that actually Oticon More provided 30% more of those detailed sounds in the environment than even Opn S. We took it one step further and compared the speech understanding of Oticon Opn S versus Oticon More and found 15% improved speech understanding in noise with Oticon More. But we didn't just stop there. While we were taking these EEG readings, we were also looking at pupillometry. So we're looking at that pupil dilation as the brain is introduced to the, to speech and noise in the environments. And what we found with MoreSound Intelligence turned on versus off, we found 30% reduced listening effort compared to what we had with MoreSound intelligence turned off.

So with MoreSound intelligence turned on, 30% less effort. You're getting more information, but your effort is going down. And here's the data to show that. If you look at this graph, you're gonna see on the Y-axis, the amount of pupil dilation. Zero doesn't refer to zero dilation, it's just the onset of that stimulus. But as that number gets smaller, you're going to see that the smaller number represents smaller pupil, so lower effort. And so in the blue here, blue line here, you see that MoreSound Intelligence is turned off. So you see the onset of the stimulus acclimating to that sound and you see that pupil dilation start to reduce. So this in and of itself doesn't tell a story, but if you look over time on that X-axis in terms of up to 25 seconds, you'll see that as time goes on, with MoreSound Intelligence turned on, how much that effort is reduced by 30%.

This is a huge, a huge piece of data that supports that the more information you have, the better your brain is able to make sense of sound. So it's really counterintuitive to what we've been saying for decades to say the brain can't handle all of that sound in the environment, so let's shut it down. But essentially what we need to be thinking about is that the more information we provide, provided in the right way and at the right time and the right information, the brain actually exerts less effort in those difficult listening situations. So for us, Oticon More, more means more information, but less

effort, more recall and better speech understanding. So in real world listening environments, what does this mean?

Well we all know that real life noisy listening environments don't last a minute or two. Just think about the last time you were able to go out to a busy restaurant or a large family gathering. How long were you there? Imagine if you were the hearing impaired person in that group. You're gonna struggle if you're not able to sustain that attention. And the way to sustain that attention is to ensure that you get a clear signal. So Oticon More provides the brain a clear sound and better access to the full sound scene and reducing listening effort. And again, why does this matter? Well, it underscores the importance of understanding how the brain processes sound by clearly identifying those two subsystems, that orient and that focus subsystem, and pulling those together so that they can perform optimally.

And by using a fundamentally different signal processing strategy, we're able to show that we can provide the brain access to the full, and this is important, precisely balanced sound scene. Now the deep neural network was shown to be able to more precisely and accurately provide contrast between speech and noise, allowing for more clarity, contrast and balance, allowing for a better signal to noise ratio. Now, we have done research over the years for our premium products and particular, particularly those premium advanced and mid-level products, but we also have special populations and we've done research. We can't just assume that the research that we have transcends to those difficult populations. So we've got research that supports the BrainHearing benefits, using that open sound scene for people with severe to profound hearing loss, using that strategy of analysis, balance and noise removal with documenting the benefits for single-sided deafness with our cross system.

And then also looking at the BrainHearing benefits for children. Having that open sound scene that allows children to learn and listen incidentally, so that they can be engaged

in what's going on in the environment and not have to rely on an omni setting or have to give up sound through traditional directionality systems. Now how does this evidence have any bearing in how you counsel your patients? Can you think of how you could use this evidence when you're counseling those patients that are looking to you for support? Well, we believe that evidence can really play a role. And regardless of how much information your patient wants, you have to understand our research into the mindset of people with hearing loss, no matter what age, is showing that these people are interested in the concept of brain health and aging well.

And that really even starts in our early fifties looking at brain health and aging well. So by starting the discussion and looking at the implications of untreated hearing loss and brain health first, you're really cutting through all of the noise that your patients are hearing on a daily basis with OTCs and cost of hearing devices and connectivity and whatever they're hearing through the internet or through their friends. You're cutting through all of that because you're changing that conversation to a hearing healthcare conversation. So if you can educate them on what benefits a hearing solution will provide, it makes it easier for them to understand why you're making the recommendation that you are. And then you can support that recommendation with benefit statements that are backed by evidence.

Now does that mean that you need to talk about the details of the evidence? Not necessarily. But what you really wanna do is focus on the effects of untreated hearing loss and brain health first, providing education and then your strong recommendation. Now, you can use some of these benefit statements. If somebody asks you, why are you recommending this particular product? You can assure your patient that Oticon's approach is to help them understand all of the listening environments that are important to them. We're using innovative research techniques to show and prove that the benefits that our technology provides are actually what we say it's providing, right?

We're validating what we're doing. Your brain needs a complete picture of the sounds around you to make sense of sound.

And Oticon BrainHearing technologies have been proven to support how your brain naturally processes sound. And then our hearing instruments, they're easy to use. The instruments function across listening environments without you having to adjust your hearing aids throughout the day. And I will say that if a patient has to use an app or has to push buttons to get into this program or that program, then maybe those hearing devices aren't doing what they need to do and be as automatic as possible and let the hearing devices provide the information to the brain. When you're talking about benefits, regardless of the product family or the performance level that you fit, you can share the BrainHearing benefit statements with your patients to help them understand how our technology meets the expectations of a modern hearing instrument and what that should provide.

So, you know, designed to give your brain more of the relevant information. And that's important here. The relevant information to make sense of sound. I love these benefit statements. They're just so helpful and you don't have to go into the details of the research, but it's backed by research and you can be assured that you can trust us and know that we're presenting valid information. Now, if you have a patient who's replacing their devices or perhaps they're upgrading to another technology, they're gonna probably come to you from somewhere else because rather than go from, I'm sorry. They are gonna come to you rather than go somewhere else because you've been taking care of them for a long time, you've been honest with them and professional with them and based your selection on the sound research that's provided.

And you know, when you're looking at newer technology, patients wanna know that what they're investing in is actually going to be better for them. So when you get new

technology from Oticon, again, we're comparing to our last best effort and ensuring that we're taking this technology to the next level. And then finally, if you've got somebody coming from questions about OTCs or perhaps they took advantage of a basic insurance benefit then maybe they're, that patient is ready to upgrade to a higher technology. And in some of those situations, you know, the plan may allow the patient to purchase higher levels of technology if they want to. Or it could be a situation where an experienced user purchased a lower performance level of hearing instruments for their first devices and now they're thinking, you know what?

I wanna know, is there something better? Let me try that. So as you go up in technology, you can tell your patients, your brain doesn't have to work as hard, it makes it easier for you to engage in social activities and remember more. You have more options. I have more options to customize your hearing solution or your individual needs. And with our BrainHearing technologies, as you go up in performance, you're better able to reduce that background noise. Remember, we don't wanna totally get rid of that background noise, it's necessary for that orient system. But it's gotta be presented in the right way. So by preserve- by having that reduced background noise, we can preserve speech and allow you to engage in conversations more effortlessly.

So we're sort of back to where we started and looking at that trajectory of the research and the development of products over the years. Remember we're not done yet. We are still looking at ways to improve that speech and noise performance. That is always going to be our holy grail. So we're always trying to find the best technology to support the brain. And so keep your eyes peeled for new technologies. And I will say that, you know, as you hear a lot of noise out there, your patients are coming in with questions and thinking that your services aren't valued. You have a history of providing excellent counseling, excellent services, excellent support for your patients. That's why they're satisfied with their instruments, not by buying something off of the shelf.

We have a vision and our BrainHearing journey isn't over. We're gonna continue to work hard on your behalf and for your patients. And adding to our body of evidence so that you can offer your patients the very best hearing instruments that are backed by science. We wanna ensure that new BrainHearing technologies and new benefits that we develop support the way the brain makes sense of sound. And on that note, I'd like to stop this presentation and see if we have any questions. Well, I hope you've had a wonderful morning. I hope you enjoyed this presentation. Certainly if you have questions, let me know. My email is l.ward@oticon.com. Well, I see that we're about a minute past the time.

My computer and my phone don't seem to be coordinating. We're a couple of minutes off. If you want CEU credit, there is a a course, a test at the end of this course and an evaluation and then you can get CEU credit. Well folks, thanks so much for your time. Have your, have a wonderful weekend. Your CEU credit, this is considered a live presentation, yes. So you will get a CEU credit for a live presentation. Sorry, that was one last question. Have a wonderful weekend. Again, Lana Ward, l.ward@oticon.com. Thanks so much for your time.