Deep Neural Network: The Cutting Edge of AI in Hearing Aids

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Welcome to today's course, Deep Neural Network, the Cutting Edge of AI in Hearing Aids, presented by Luis Camacho. This month on Audiology Online, we're celebrating innovation in the hearing industry with our fifth Industry Innovation Summit. Thank you for joining today and we hope to see you in other Summit events in the future. And all of our previous events are still located in the course library. If you would like to thank our we would like to thank our title sponsor, CareCredit, and all of the companies who are participating in the 2025 summit.

And now it's my pleasure to turn the microphone over to Luis. Thank you Anna, and welcome Everybody. I am Dr. Luis Camacho. I'm the Manager of Education and Training at Starkey and we are honored and happy to be taking part in Audiology Online's fifth annual Industry Innovation Summit.

This is our second of four events that we're participating in, so hopefully we'll see you on our other sessions later this week. Now, before we get into the content today, I do want to run through a few housekeeping items. First of all, if you have any questions, you can click on the Q and A area and type in your question and then click on send. I will be addressing any questions at the end of our session today. I've got a lot of material to get through.

I want to make sure we get through those that content, but I will address any questions that come up at the end of the session. There's also a handout for for today's session that's available as a PDF either in your pending courses or there is a link in the chat here within the classroom. Today's session is available for one CEU credit. You can earn this credit by being a paid member of the Audiology Online Unlimited CEU Access program. So after the conclusion of today's session you can just go to your pending courses.

There you'll be able to access the multiple choice quiz and upon completion of that you'll earn your CEUs. If you have any technical problems with today's session, you can contact Audiology Online Tech Support at that number 1-800-753-2160 or you can also email them at

customerexperienceontinued.com I do have a list here of risk and benefit information. I'll just leave this up on the screen for a few moments. This is part of the the PDF handout as well, so you can review these through the handout also. And then we do have three learning outcomes for today's session at the end of the session session, you should know the definition of a deep neural network.

You'll also know the benefits of Starkey's Edge Mode plus feature to your patients. And lastly, know the exercises that make up the balance assessment process for for our Edge AI devices. Just a few other reminders. All the materials in the CEU courses are based on evidence based information. Again, all of the this content is available to you in your handout if you would like to review this particular material.

So let's jump in. The topic of deep neural networks is probably the biggest topic in hearing aids right now. This truly is the cutting edge of artificial intelligence in hearing aids around a variety of factors, but specifically on signal processing and sound quality. And we're going to get into what Starkey is doing to really be the leading manufacturer when it comes to integrating deep neural networks into signal processing and hearing aids. Now I'm just going to do one kind of quick slide on the history of AI.

I know here in Audiology online, I've had the pleasure of teaching a couple of courses around the development of artificial intelligence. Not just for hearing aids, but really the whole area of computational science around artificial intelligence. And real quickly, just as a reminder, this whole concept of AI really came out of the Dartmouth Workshop back in the 1950s, where these computer scientists, mathematicians, mathematicians, came up with this concept that the features of human intelligence could in theory be so precisely described mathematically and via computer processing that a computer, that a machine, could essentially simulate human intelligence. And that's really where all of this started. And kind of the holy grail of computation is the human brain.

You know, when it comes to the brain, the brain is made up of, you know, hundreds of billions of neurons and synapses that, you know, work together kind of effortlessly, seamlessly for a particular

outcome dealing with different sensory information that's coming into a human. And this is the goal when it comes to artificial intelligence, to computer computation, is to try and mimic what's happening, you know, in the human brain and obviously with hearing aids, to essentially take auditory sensory information and really transform that into, you know, the best hearing possible as well as one of the things that Starkey's been focusing in on for the last decade or so is to provide not only the best communication but, but the best support for overall health and well being. Again, a little bit of background information. If anyone's familiar with the development of transistors, this is a photo of the very first transistor that was ever created. This is from the late 1940s.

The three people that created this transistor actually won the Nobel Prize in science. And it's hard to tell from this image, but this particular transistor is actually about the size of a softball. So, you know, a large device in terms of comparing what we're working with today. But this set up the groundwork for everything that you deal with on a day to day basis when it comes to technology. I mean, we all deal with technology and interact with technology pretty much every moment of the day.

And going from that softball sized first transistor from the late 1940s to today, when we're looking at an NVDIA processor that now has 208 billion transistors in it. So again, going from something the size of a softball to a microchip that has 208 billion transistors on it is an amazing feat. And just for comparison, the average human brain has 100 billion neurons. So we really are now to the point where we are surpassing the connections, the physical connections of the human brain with a computer. And then if you move from there to their latest GPU processor that now has 15 trillion transistors working together, and then as we go up the ladder, so to speak, now we're talking about cloud computing.

We deal with the cloud today on so much of the information and the data that we work with, whether it's on our phones, our computers, et cetera. And now we essentially have all of the knowledge, all communication across the entire history of the human race. Now up in the cloud, it's pretty amazing the

tools that we have at our disposal. But even with all of that in mind, again, the goal is to try and take this power of today's processing and try and get even close to what we're doing with the human brain. And again, particularly, we're talking about hearing.

The auditory system is incredibly powerful when we're talking about how we as human beings perceive and interpret and process sound. So obviously you've got, you know, information coming in to the outer ear, going through the ear canal, through the eardrum, the ossicles, and then up to the brain. And that is really, you know, where we process sound is in the human brain. And at starkey, what we've done over the course of the last five to seven years is spend hundreds of millions of dollars to create the industry's first neuroprocessor and, you know, try and tap into today's processing power to reproduce that exact process of the human brain. And we'll get into that here in just a moment, but put it to a hearing Aid that is elegantly designed, that is attractive and comfortable to wear, that has connectivity capabilities to wireless connectivity, has a small lithium ion battery that provides performance for, you know, multiple days on a single charge, and is reliable, is waterproof and can withstand all of the difficulties situations in which your patients wear their hearing aids.

Now, over the last decade or so, what we've been doing at Starkey is harnessing the power of artificial intelligence to really focus in on three key areas to really develop hearing devices that are desirable to wear for a variety of factors and job. One is always provide the best hearing possible. And we're going to get into what Starkey's been doing that's unique around the utilization of AI and deep neural networks because this is always our number one goal, because that's the number one thing that your patients want when they come into your offices. They are looking for the best communication capability, the best hearing capability possible. And that's what you're going to get from Starkey hearing devices.

But alongside that, we've been focusing in on supporting the overall patient through health and well being features that also utilize the latest artificial intelligence and then having the hearing aid be the

patient's way of connecting to the world around them from a connectivity perspective, but also allow for ease of use through virtual assistant features that have been supported by AI and deep neural network technology. But again, best hearing is the number one thing that we are focused in on and that you're focused in on with your patients. And if we look at kind of the top drivers of hearing aid performance listed by patients through market track, there's really four that stand out. You know, patients want hearing aids that sound natural, that sound like the way they remember their natural hearing being. They want comfort when it comes to loud listening environments.

They want to try and minimize the effects of background noise, both from a comfort but also a speech understanding perspective. And they want to be able to tell the direction in which sound is coming from. These are the key drivers for patients when they're looking for hearing technology that they want to use on a date to day basis. Now, what's fantastic is that hearing aid satisfaction numbers are way up. Patients overall are incredibly satisfied with the hearing devices that they're wearing when it comes to sound quality, physical fit, comfort, you know, how they're hearing and understanding speech.

But understanding speech in difficult listening environments is still one of the biggest challenges for your patients. I'm sure this doesn't come as any surprise to you as hearing professionals. This still tends to be the biggest area where we're trying to improve, you're trying to improve. Whether it's through programming, through wireless accessories, et cetera, this is an area of extreme interest for your patients. And with all of the advances in hearing aid technology over, you know, the previous years and decades, you know, why does this remain one of the biggest areas of concern?

And it really just comes down to the types of environments that we're in. You know, the real world is a diffuse listening environment. There's all kinds of sounds coming in to the patient's ears and their hearing aids. There's obviously loud sounds, soft sounds. There might be competing speech.

There might be music in the background. And again, the human brain has just an incredible ability to process all of this incoming sound and make sense of it. That is the goal of the latest hearing aid technology, is really to take this cacophony of sound that we can potentially be in and sort it and filter it and process it so that the listener can make sense of what's happening around them, can focus in on the signal of interest, which in many times is the exact same signal that they're competing with, which is other people speaking. That's the difficulty when it comes to providing the best sound in complex and difficult listening situations for your patients. Now, on top of that, how people prefer to hear, to take the information in, is very, very personal.

Every patient has a preference for sound quality. Every patient has a difference, a different ability to handle loud versus soft, to be able to filter through background noise and focus in on the signal or the speech or whatever they want to hear the best. That varies from person to person. And that is a challenge that we as hearing professionals deal with every day. And the reality is, we don't only hear with our ears.

You know, when we're talking to patients, we tend to talk about hearing, and we focus in on, you know, the outer ear, the ear canal. How does something physically fit on the ear? But the reality is, is that is just kind of the sensory component of our auditory system. The real magic of auditory processing happens in the brain. So, again, we're funneling sound in through the outer ear, through the ear canal, the eardrum, the ossicles, and then up to the brain.

And that's where the magic happens. That's where, based upon the information that's being sent on through the cochlea, things are broken down and are translated to in a manner that we as humans can perceive. And again, we can filter through what we want to hear, what we don't want to focus in on. And this is Done through, really a computational approach. This is how the auditory system makes sense of the information that's coming into the brain through the outer ear, et cetera.

So we're looking at things like frequency, intensity, the envelope of the sound, the spectral components, the modulation. All of this is broken down, fed to the cortex. And the cortex has that hundred billion neurons, that processing power, that computational power, if you will, to then translate that to usable information to us as a human listening to someone talking to us across the dinner table, or listening to music, or sitting and reading a newspaper in a coffee shop and not paying attention to the background noise, but being able to then hear your name called when your espresso is ready to be picked up at the counter. That's the power of the human brain and the human auditory system. And this is what we're then trying to mimic when it comes to signal processing in a hearing aid, and particularly with deep neural network processing.

So with a deep neural network, I think the best way to kind of think about it is literally hundreds of different or AI algorithms that have been trained on millions of different points of data than all working together, crossing different pathways for one particular outcome. That is how a deep neural network works. And it is within the Starkey neuroprocessor. This DNN is based upon this computational approach of the human auditory system. Now, there's a lot of different ways to approach DNN processing from a chip perspective, from a computer processor perspective.

And I want to break down the differences of the different types of approaches to DNN processing and really why Starkey's made the decision to do it the way we are approaching dnn. Now, the one way of creating a DNN processor, it's what's known as an embedded DNN approach. So this is essentially where you have a computer chip, but nothing within that particular processor is specifically designed for deep neural network processing. Essentially, a different amount of resources from different areas on the chip are pulled together to create a DNN processor. You kind of cobble together different components of the processor to say, well, we want some of this to do a deep neural network processing.

Now, the downside to this, number one, nothing specific about this processor has been designed for dnn. It's also very resource heavy, and it's very power inefficient. So essentially, within that chip, you're now sapping resources from certain areas to try and create a DNN processor, and then you're draining the battery quite significantly very quickly when you are taking this approach. Another approach is to create a dedicated AI chip But it's essentially separate from the core signal processor. So when we're thinking about a hearing aid, you know the sound is coming in, it's being sent to that main processor.

That processor then makes the decision to send certain amounts of information, of auditory information off to the dedicated AI chip. The dedicated AI chip does its processing, sends the signal back to the main processor and then on down through the auditory pathway. Now, you do have obviously dedicated AIDNN processing in this particular approach, but because it's not integrated within the main processor, you're looking at a little bit of a time factor in sending the information back and forth. And again, it is very resource heavy from a battery perspective. So you are now adding in a strain on the battery, draining the battery quite significantly with this particular approach.

And because of these kind of drawbacks to these approaches to DNN processing, what we've done at Starkey has literally taken the last five to seven years to create the industry's only, first and only integrated neural processing unit. Now, a little history on npus. The first company, the first tech company to create and utilize an integrated NPU was Apple. You know, Apple spent a lot of time to come up with this particular approach. And again, it's a very expensive to do, it takes time to do, but the benefits are well worth it.

I mean, if you're using the latest iPhone, you always are getting more and more features, but you're maintaining the battery life, you're maybe probably increasing speed of processing. Today's top of the line phones all use integrated npus. If you go to look at any computer today, most of them are actually marketing the fact that they're using integrated NPUs because again, it means maximum speed,

maximum processing power, minimal effect on battery life. And that's what we've done with the neural processor in our Edge AI devices. We've integrated the neural processing unit into the main core.

And what this means is we can now have DNN processing on all the time. It's part of the main signal pathway without affecting battery life at all. So you've got speed, you've got the most powerful DNN processing, but you're not affecting the resource of the battery. You're maintaining those incredible battery lives, even though you've got DNN happening 100% of the time. Now, part of the way we're taking advantage of that integrated NPU is continuing to try and mimic how the human brain and the human sensory system deals with incoming information.

And obviously here we're focusing it on hearing. So the NPU is looking at you know, the information that's coming in, the sensing, what's happening around around them from an auditory perspective. You know, what kind of sounds are coming in, are in motion, what's the physical position of the human body and taking that information and having that processing happen behind the scenes and then moving down the signal processing pathway and then adapting to information automatically. And this is going to be things like, you know, your compression algorithm, it's going to be things like all of the noise management features, it's going to be things like directional microphones adapting automatically, feedback cancellation happening automatically, and then lastly adding in some features for your patient to input their intent in the environment. And this might be something as simple as user controls or as sophisticated as our DNN based Edge Mode plus feature, which we'll talk about here in a moment.

But I mentioned that we have always on dnn. So you know, the DNN processing is on at all times. And if we look at kind of a schematic of traditional DSP processing, you've got the sound coming in, going through all of the, you know, the processing, being converted from analog to digital, trying to clean up the signal and then converting it back to analog out to the ear. With Edge AI, we have now integrated in parallel our DNN and what's known as our speech probability predictor. So this is on all the time, but

again, it's not affecting your battery life and it's happening incredibly quickly without any type of delay in the signal processing.

And I want to play a couple of a little audio clips for you that'll give you an idea of the benefits of this always on a DNN processing. So you're going to hear an audio clip of just typical DSP processing and then you're going to hear that same clip running through the always on dnn.

Look, we all suffer from range anxiety. Our goal at Starcase. Look, we all suffer from range anxiety with rechargeable batteries. Our goal at Starkey was to remove the fear from hearing aid users that they'll. So that gives you an idea of the benefits of having DNN running all the time in the main audio pathway in terms of clarity of sound comfort.

All of the things that those patients in the market track study said. This is what's important to me when I purchase a hearing aid and when it comes to that benefits. You can see here we've got some clinical data showing that our latest DNN algorithm provides for a 30% improvement in speech detection. You know, detecting the signal of interest compared to previous approaches. And this is particularly in environments where the competing signal is multi speaker babble.

So again, the signal of interest is essentially the same as the background noise. And We've got over 30% improvement in detecting the signal of interest, the speech of interest. The other area where we've got some incredible benefits is when we're looking at that same multi talker babble. With our Edge AI devices, we're able to provide up to a 13dB signal to noise ratio improvement. Really incredible improvements in speech understanding and then improvement of snr.

Now I've mentioned Edge Mode plus. This is our on demand DNN algorithm. This was our first utilization of DNN with our Genesys product line and this continues with Edge AI. And essentially this is a feature that allows your patient, if they're in any environment like they wish they could hear a little

differently, a little bit improved, whether it's in speech and noise. Maybe it's just clarity of speech on the tv, the granddaughter's voice is a little too soft for them in a particular environment.

They can engage Edge Mode plus and get the advantages of another layer of advanced DNN processing on demand anytime they need it. And again, this has been a highly researched algorithm showing very significant benefits to your patients. You can see the first graph on the left is showing an 11% increase in word recognition scores when engaging Edge Mode Plus. And then again we're seeing a reduction of listening effort, a reduction in the signal to noise ratio required to provide that enhanced speech understanding. And that listening effort component is really important.

You know, this is something that Starkey's been focusing in on for really over 10 years. We were the first to have a noise management feature that showed clinical reduction of listening effort to show that we're taking some of that cognitive load off of the patient in those complex listening environments. And we continue to show that benefit now with our DNN driven Edge Mode plus feature. And I do have to kind of circle back and talk about how having all of this power of deep neural network processing with Edge Mode plus and the always on DNN with our speech probability predictor does not affect our battery life at all. We have the industry's longest lasting battery lives.

You can see here with our RIC rt up to 51 hours, our CROs system in the RIC RT up to 29 hours a day, the microric 41 hours, our custom rechargeable devices 42 hours. And these are numbers with again the DNN on all the time with the speech probability predictor. And even if a patient were to engage Edge Mode plus, the Whole day, the whole time they're wearing their hearing aid, if they needed it, you would not see a decrease in the battery life that the patient would notice in any way, shape or form. That is the benefit of having the integrated npu. We can provide the best signal processing possible, the best utilization of dnn, but not have it affect battery life in any way, shape or form.

So that's job one, best hearing possible. And that's where we've been the leaders in AI and DNN in the hearing industry. And those two examples really stand out, the always on DNN in the audio pathway and edge mode plus. But of course, Starkey has focused in on the overall health and well being of the patient and really harnessing the power of our AI in the hearing aids for a number of years now. Because we really truly believe that hearing healthcare, hearing is healthcare.

It's just part of what a patient needs to be focusing in on to provide their best life possible to take advantage of the latest technology to support their health and well being. And this is something that's really been in the news for quite a while now. Wearable technology is now a common term. Many times we like to use also the term a healthable device. Something that provides multiple benefits, that really provides a desirable technology.

Obviously, hearing aids, unfortunately, as you all know, are something that many, many people resist wanting to use. You know, it's kind of, they have to be pushed, you know, into your office by a loved one, a family member, a spouse, you know, because the person is having hearing problems. And we all know the research around the health benefits of simply getting better hearing through hearing aids. But if we can offer other health benefits through hearing aids, you know, that's just icing on the cake. And again, we are really proud of the fact at Starkey that we were the first manufacturer to integrate what's known as an IMU or inertial measurement unit into a hearing aid.

You know, taking advantage of gyroscopic technology, accelerometer technology in a hearing aid that can then expand the features, expand what the hearing aid can do for your patients. And again, we were the first company to do this. And you're going to see utilizing the imu. Starkey is still doing things that no other hearing aid company is doing to provide additional health support to your patients. Now of course, you know, you can use these IMUs for things like activity tracking.

You know, obviously this approach became very popular through things like Fitbits and Apple Watch. But why not integrate this into a device that your patient ideally is Wearing all day long, the minute they get up to, the minute they go to bed and on a position on their body that actually tracks this information the most accurately. So being able to track how much walking they're doing, how much running, aerobics, biking, all of these types of physical activities that, again, we know support overall health and well being, help people achieve those physical activity goals while hearing the best they possibly can. Another element of this is the introduction of still the industry's only fall detection and alert system. And I'd say this is something that is incredibly important.

I always tell a personal story around fall detection. My mother wears our latest products and she took a fall a couple of years ago. And the only reason anybody knew it was me was because her hearing aids detected the fall and sent me a text message. And I was able to go over to her house and discover that she had fallen and she had broken a hip. I could call the ambulance, get someone there, and, you know, to get her to the hospital.

That would not have happened without her wearing her starkey hearing aids. And again, this is all driven through our AI engine to be able to have that technology there to take advantage of what those sensors are doing. We've trained the AI engine to know what a fall looks like, what does it look like in those sensors when a patient takes a fall? We're very, very accurate around this. So you've got that ability when your patient's wearing their hearing aid.

If they take a fall, those hearing aids know they can compare the information that's happening on one side versus the other to make sure a fall really did happen versus, oh, I dropped my right hearing aid when I was putting it in, and then send that information through wireless connectivity to the patient's smartphone. The smartphone then takes that information and if a fall truly has occurred, can send that alert to the loved one, to the connection to that patient via a text message. So we introduced fall

detection a number of years ago, and again, it's very, very accurate and has been very helpful for patients all around the world when a fall has occurred. But we want to move beyond just detecting a fall to potentially helping your patients prevent a fall. And we all know through some of the research out of Johns Hopkins that there is definitely a comorbidity between hearing loss and falls.

And so we've worked very closely with Stanford University to come up with a system that can potentially help predict if a patient is susceptible to a fall. And then the patient can maybe can take steps to try and prevent that fall. So we've Worked with Stanford and we've based this particular feature around the Steady program out of the cdc. And essentially using again the artificial intelligence connected to those sensors in the hearing aids, your patients can now do a self guided balance assessment at home that is based on the CDC protocols. And we've done research to show that the results of these tests within the hearing aids and the mobile app are equal to an actual in person assessment by a balance professional.

And essentially it's made up of a number of tests. You've got four static balance tests that the patient does. There's what's known as the chair stand test and then the timed up and go test where they get up and walk 10ft, turn around and sit back down. And again, this can all be done on their own via the mobile app wearing their Edge AI devices. It's a simple process.

They do an initial screening through the mobile app. Essentially it's a questionnaire based upon again the Steady program questionnaire. And then they conduct this self assessment that's looking at their gait, their strength, their balance with those exercises, the standing exercises and the chair exercises.

Now a lot of people would say again, similar to why would we offer fall detection? Is that within our scope of practice as hearing professionals? Why would we offer a balance assessment? And the reality is that, you know, we know that connection between hearing loss and potential falls. But maybe you've got a patient who, who already has some concerns about falls, but maybe they're not quite ready to go

to a physical therapist or someone, but they want to get an idea, you know, am I susceptible to a fall?

This is an easy way for them to take this assessment at home and get either reassurance or maybe get prompted. Yeah, maybe I do need to go and get some support for this to prevent a fall. Or maybe one of your patients is already seeing a physical therapist, is working on strengthening their balance and their ability, ability to function throughout the day and they just want to reassess and see are the things they're doing in their therapy actually providing the benefit, are they moving forward in their therapy? So a couple of really good reasons to integrate this into many of your patients. Utilization of their hearing aids.

And again, it's very easy. This is just a quick screenshot from the My Starkey app. There's an area where they can just learn information about it. They can get information about what is the process, what would they do to complete this and then they can start the assessment to begin those different stages, those different exercises. A couple of quick things to know they can quit it at any time.

They don't have to continue if they're not comfortable doing it. They can attempt every exercise if they so desire. They can repeat them if they desire. They could skip something that they think, well, maybe I don't really feel comfortable doing this. So again, it's kind of personalized to their comfort level at home.

And all of this information is saved really, regardless of how far they go into the process. Again, it's very easy to set up. They get the instructions streamed through their hearing aids so that they hear what they're supposed to do. They're prompted to put their phone down at different times. They're told how to set up the chair and the space that they need.

They can adjust the volume for the stream so that they know that they can understand and hear the instructions before they begin the process. And then they simply click on start the assessment. And of course the imu, the inertial measurements units are monitoring all of the information during the process.

And at the end they get a quick and easy to understand result. You know, if there's a concern, they'll see the little yellow exclamation mark and they can click on that and get further information.

If they've done and completed something without any concerns, they'll get a green check mark and they'll be able to click on that as well to see deeper dive information and it'll let them know if they didn't complete a particular step. And again, they can do this as many times as they want. It's saved in the history. They can go back and compare the results over time. So those are just a couple of things with the health and well being area that we focused in on Starkey with our AI driven technology.

The third component, and the last that I want to talk about is what we refer to as our virtual assistant. And again, being the first to integrate an inertial measurement unit, we've been able to add in a simple way to communicate or to utilize features in the hearing aid with our tap control. Sometimes refer to this as the double tap training the hearing aids to know when a patient does a quick double tap on their hearing aid or their pinna to assign certain functionalities to that. Also utilizing the My Starkey app to really kind of be a one stop shop, if you will, when it comes to a mobile app for your patient to do things like translation of languages, transcription of a conversation, set up reminders to do important things or something as simple as you've got a haircut appointment today, run a Check on the hearing aids to make sure that the hearing aids are actually performing up to the level they were when they got them brand new. And then our smart assistant with things like voice commands to be able to double tap the hearing aid and simply tell the hearing aid to turn the volume up or down to go into my music program.

There are so many devices today where our patients are talking their requests, whether it's Siri or Alexa, why not have that capability in their hearing aid as well? And I'm going to focus in on just a few of these. The intelligent reminders I think is one of the kind of unsung features in these devices when it comes to things again around overall health and well being. One of the key areas is taking medications and actually following the medication routine. Many, many people do not adhere to their medications

when they're supposed to.

And you know, you can see in the image here kind of the classic, you know, weekly pillbox. And this is a great way to organize your medications. But why not have the device that your patients obviously or hopefully are wearing hearing all day long, remind them to take their medication and they can set these up utilizing the AI, utilizing kind of the voice recognition and the. They can either do it manually in the hearing in the mobile app or do a quick double tap. They can literally just double tap on their hearing aid and say, remind me to take my blood pressure medication every day at 10am and that now becomes part of the hearing aid routine.

They're wearing their hearing aids every day at 10am they get a notification that says, take your blood pressure medication. And of course there's other intelligent reminders that can be set up reminding them to maintain their hearing aids, meaning reminding them to clean their devices, you know, on a regular basis to run a self check to make sure the wax has been cleaned out of the hearing aids, et cetera. They can actually have a reminder pop up on their phone if they haven't put their hearing aids in when they normally do. So they can really utilize a variety of reminders to make using their hearing aids as easy as possible, but also to remind them of important things like taking medication, doctor's appointments, etc. Now, before we kind of wrap up, one of the things that we're very proud of at Starkey is partnership with other technology companies.

We are incredibly, you know, fortunate to have Dr. Achin Bomick as our chief technical officer. If you're not familiar with Dr. Bomick, he came from Starkey, from Intel. He was the head of Human Computer Interface there One of the leading developers and technologists in artificial intelligence and dnn.

And we were lucky to have him come over to Starkey about seven years ago. And really a lot of this was his vision to create the integrated npu because he knew if we wanted to do what we want to do with hearing healthable smart assistant, we couldn't do that with existing chip technology. And that's

again, we're really fortunate to have that vision there. And with his connections in the tech industry, we have very close partnerships with tech companies that probably most of you deal with every single day. Apple, Google, Amazon, but also connections with Microsoft, Intel, Stanford University, where Dr.

Bomak is a professor there. So a variety of different technologies and one of the other areas where we're hearing more and more and more about not just in the hearing aid industry, but in the world as a whole is OpenAI. You know, I'm sure many of you out there have used Chat GPT for something. You're seeing more and more about these generative AI models out in the world. Things that can help you plan a trip.

I mean, I, I've heard many people recently say, yeah, I use Chat GPT to plan a trip to, to England. You know, I simply put in prompts and the chatgpt gave me, me a full itinerary of things that would meet, you know, my goals as a visitor to England or to another country. People are using ChatGPT to help write emails to, you know, look up information, you know, on a particular topic. This generative AI feature is now common part of again, everything that we do today. If you do a Google search, the first things that come up at the top of your Google search are AI derived results to what you're searching.

If you're an Apple user, the generative AI, or what they refer to as Apple Intelligence, is integrated within their operating system now. So this is becoming more and more common. And at starkey with our connection to the tech world, we're wanting to integrate generative AI into our features as well. And really this comes down to the idea that that kind of virtual assistant that your patients are talking to, people want that to be more natural today. I noticed this the other day when I was using Apple Maps to navigate somewhere and the most recent update to iOS and Apple Maps, you can pick the voice that you want as your navigation voice and it's much more conversational than it ever used to be.

Growing up with the old Garmins and that type of navigational tool and then moving into things like Google Maps and Apple Maps now, we're all kind of used to hearing that kind of synthetic, almost robot

voice that was telling us to. To turn right in two miles or take the next left or whatever it might be. I noticed with Apple Maps now, it's a very conversational style. You get more naturalistic inflection in the voice, more natural pauses in the conversation, etc. And that's what patients want today.

That's what people want today when they're interacting with these voice assistants. So with. With our latest updates to our virtual assistant within. Oh, I'm going to pause that for a second. Within our My Starkey app, we are also using generative AI to make the interactions for things like reminders, searching the Internet, et cetera, to be more natural, to adapt to, again, the things that your patients want when talking to a virtual assistant.

So I'm going to back up one slide and let's take a listen to the virtual assistant now in action.

Oh, turn on my restaurant program.

Turn the volume up, please.

And before I forget, what do you want to be reminded?

Remind me to take my Levitar. When should I remind you?

10 o'clock tonight. Reminder created.

What's the weather going to be like in Eden Prairie today?

On Thursday, September 19, 2024, Eden Prairie will have morning and late afternoon rain, clear skies in between, with temps from 64 to 88 degrees Fahrenheit and winds at 5 to 13 miles per hour. So I'm thinking of going to Minneapolis next week. What should I do if I go there?

Minneapolis has many great attractions. You can visit the Minneapolis Institute of Art, explore the Chain of Lakes, or check out the Mall of America. Enjoy your trip. Are there any foods they're famous for? Minneapolis is famous for its juicy Lucy burgers, wild rice soup, and Scandinavian pastries.

Enjoy trying these local favorites.

So there you can kind of see that example of a much more conversational approach to the virtual assistant within the My Starkey app. And in particular with setting up the reminders, it knew that the thought process wasn't complete yet. Remind me to take something. Oh, well, when do you want it to be reminded of. Or, oh, before I forget, I need to do this.

Oh, what do you want to be reminded of? A much more naturalistic interaction between the technology and the patient and the listener. And again, this is really what people are desiring when it comes to interacting with these voice types of assistants. And adding this generative AI approach to the virtual assistant is making people more comfortable to work with this type of technology. Just like Apple Maps or Alexa or any of the other systems that are out there, there.

And this will just continue to improve over time. And that's another one of the advantages of having the power of the neuroprocessor. The neuroprocessing unit in the hearing aid is we are now just starting to grow out the features, the capability because that particular chip has really been future proofed to look at all of the things we want to do, as you know, in our roadmap improvements both in hearing, the health and wellbeing features and the virtual assistant component. So today really this is what a hearing aid should be made up of. Again your patient's number one goal is the best hearing possible.

And that is always what we are going to be looking at at Starkey. Primarily that's the first thing we look at with any new technology is is it improving the patient's hearing? How is it improving the patient's hearing? And then we can upon that with the health and well being features, with the virtual assistant

features. So your patients have a device that ideally they're wearing the minute they get up to the minute they go to bed and they're taking full advantage of all of this AI driven technology and having a hearing aid that does everything they want, but again is comfortable, is durable and has a battery that they never really have to worry about it, about it, you know, dying at any point when they're using it.

So that wraps up the session today I do see a couple of questions. Let me just quickly glance at these. So one question. How does Edge mode plus ascertain the speech signal of interest from the competing speech stimuli in the environment, such as when being engaged in a conversation with two talkers? Well, there's a number of different things.

The core answer I'm going to have to say is proprietary. We're not going to actually give you the full details, but just know that we have trained Edge mode plus on millions of different inputs in different environments. The other component of it is having a user intent element of this. So if I'm wearing my hearing aids and I'm out at a restaurant and I've got two people sitting across from me and you know, maybe there's a lot of people talking around me, number one, the direction and that I'm looking is my listened, my intent, that's the area that I want to listen to. So when I gauge edge mode plus the focus is on, well, where am I looking?

Where are those microphones pointed, for instance, what sound is coming from what's in front of me? The Other would be within the mobile app for the two highest technology tiers. I can actually tell Edge Mode plus speech is my main primary signal of interest. You know, I want to really have that signal, that speech signal that's coming in from the front be the primary area that I want to have the processor focus in on and take the other elements and attenuate them as much as possible. The other thing with Edge Mode plus is that the patient can always disengage and re engage at any time.

So, you know, maybe I'm sitting alone waiting for my friends to come meet me at the restaurant and I engage Edge Mode plus just because it's too loud and I'm, you know, reading the news on my phone or

whatnot. And then my friend friends come and sit down in front of me. Maybe I want to re engage when their voices are present because I know that's what I want to focus in on. Another question. I work for Miracle Ear and will our Starkey products worth the Starkey app?

That is a question in which I cannot answer. I do know at this point that is not the case. You utilize the Miracle Ear apparently app. I don't have an answer to that unfortunately, so I can't really answer that. But again, I want to thank everyone for joining me today and it's been, it's always our pleasure to work with Audiology Online for their industry innovation summits.

We've been a part of them from day one. Again, this is our, our second of four sessions here during the summit. So take a look at those particularly Dr. Dave Fabry is going to be part of the industry roundtable this week and also Dr. Keely Layfield will be doing a 30 minute session this Friday.

I'm sorry, that's Dr. Michelle Hicks is doing it this Friday. Dr. Keely Layfield did one for us last Friday and that should be available as a recording for you. So take a look at all the stuff we have on here and we look forward to continuing to support Audiology Online and being a part of Audiology Online Innovation Summit.

So thank you for joining me. Have a great rest of your day.