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Hearing, Cognition, and Clinical Considerations: Connecting the Dots

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Hello and Welcome. I am Dr. Andrea Hannah Dawkes, member of the Education and Training Team at Starkey, and I'm delighted you have elected to join me today. As the population ages, hearing loss and cognitive impairment become increasingly more common and often coincide. And with research demonstrating strong associations between untreated hearing loss, amplification and cognitive decline, audiologists are in a unique position to support not only better hearing, but also overall health and quality of life through timely intervention. So thank you for investing some time in this topic today.

Before we get started, I want to cover a few housekeeping notes. If you would like to ask a question during the presentation today, please click on the Q and A area, type in your question and click Send. I will address all questions at the end of the presentation, but do feel free to enter questions as they come to mind. There is a PDF handout of this talk available for you through your pending courses on Audiology Online or by clicking on the link in the Resources tab within the classroom. Today one CEU Hour is available for this session.

If you participate in the CEU program offered by Audiology Online. After completing the course, just go to your pending courses on AO and pass the short multiple choice examination. Keep in mind that you have seven days to complete the quiz when viewing live courses and 30 days when viewing recorded courses. And then finally, if you need any technical assistance, please stay logged in and request help by using the Q and A window or by calling or emailing Audiology Online.

You are welcome to review the risks and benefits that are applicable to all classes offered through Audiology Online. I'll give everyone a moment to review the information on this slide and it will also be available in the handout.

These are the learning outcomes for this course. After this course, participants will be able to explain the connection between hearing loss and cognitive function and and discuss its relevance to patient centered hearing care. After this course, you will be able to assess how cognitive factors may affect

listening, communication and successful hearing aid use. And after this class, participants will be able to integrate practical clinical communication and counseling techniques that address cognitive considerations within hearing care plans.

I would also like to point out that this course has been designed with professional and evidence based best practices in mind. In fact, throughout the course of our time together, I'm going to be highlighting quite a few research applications and giving quite a few nods to various individuals and the science that currently exists around this important topic.

And here's the agenda again this this talk will focus on the connection between hearing loss and cognition and will provide a variety of clinical or discuss a Variety of Clinical Implications I'm going to begin with some foundational information on cognition and cognitive decline before moving into the link between cognition and hearing. I will discuss the benefits of amplification for those with cognitive challenges and then share several possible clinical modifications to help better support individuals with cognitive decline. I will be touching on questionnaires, speech and noise testing, cognitive screening, and various counseling considerations. Then I will conclude the talk with a variety of features Starkey offers to support those who have challenges with cognition and memory. So, unfortunately, one hour is not enough time to go into significant detail, but everyone attending this class should walk away with important concepts and clinical considerations that they can either dive into more deeply or immediately apply to clinical practice.

All right, so let's get started. The substantial growth in public health literature over the past 15 years really underscores the importance of hearing health, revealing strong associations between hearing loss and cognitive decline, dementia, physical challenges, and increased demands on health care systems.

What exactly is Cognition? I like this definition from the Cleveland Clinic. Cognition is how our brains take in, understand, and use information. It involves mental skills used every day, like paying attention, remembering, learning, making decisions, using language, and planning. These thinking processes help us use what we already know and gain new knowledge from our experiences and senses.

From a clinical perspective, cognition includes a variety of mental processes, many of which happen without conscious awareness. Things like perception, which pertains to the recognition and interpretation of sensory signals like seeing, smelling, touch, and hearing. Attention is the ability to sustain concentration on a particular object, action or thought, along with the ability to manage competing demands in the environment. Short term memory stores information being actively used and typically holds on the order of four to seven items for approximately 15 to 30 seconds. Long term memory, on the other hand, serves as a storage system with virtually unlimited capacity, enabling information to be retained for many years or even across an individual's lifetime.

Language involves the skills to translate sounds into words and generate verbal output. And then there are several executive functions that center around planning and executing a goal, like problem solving, defining a problem, and generating effective solutions and decision making, sometimes on incomplete information and even emotions.

Aging is characterized by both sensory and cognitive changes. Age related changes in cognition include the things you see here slower processing speed, poor working memory, reduced inhibitory control, difficulty with executive functioning, poor attention, reduced fluid reasoning, slower learning, and declines in executive functioning.

Cognitive changes can be very subtle, from a small reduction in attention in a noisy environment to impairments in problem solving, planning, and memory function. In addition to age, there are several other reasons why a person may experience cognitive changes. Neurodegenerative conditions like

dementia and multiple sclerosis, cancers that originate in the brain or central nervous system, acquired brain injury from a traumatic event or stroke, and a variety of mental illnesses can also impact an adult's capacity to think clearly and make decisions. Conditions like schizophrenia, bipolar disorder, ocd, ptsd, and even anxiety disorders, to name a few.

There are three primary clinically relevant categories of cognitive impairment, mild cognitive impairment or MCI, early stage dementia, and moderate or advanced dementia with conditions like Alzheimer's disease or or vascular dementia. Mild cognitive impairment is important to understand because it represents an intermediate stage between normal cognitive aging and dementia, which provides a critical window for interventions aimed at slowing or preventing progression to dementia. It causes memory loss and trouble with language and judgment, but it doesn't affect daily activities. For comparison, cognitive decline with dementia is severe enough to impair independence. According to the literature, age is the strongest risk factor for MCI and prevalence roughly triples between ages 60 and 80.

Approximately 10 to 15% of individuals with MCI progress to dementia each year. Mild cognitive impairment is also associated with other disorders in the aging population like cardiovascular and cerebrovascular disease, diabetes, and hearing loss, with a global prevalence between 15 and 20%. We may be seeing more patients with cognitive impairment than we think.

One statistic from the literature points to approximately two out of every three Americans experiencing some level of cognitive impairment at an average age of right around 70 years. This is important for us to understand given that presbycusis is most common in people between the ages of 64 and 75, according to the National Council on Aging, and the average age of a first time hearing aid user or someone actively seeking treatment for age related hearing loss in the United States is also between 65 and 70 years of age.

Now let's turn our attention to the relationship between hearing and cognition.

As you know, hearing is much more than the ability to detect sound. It's a complex partnership between the ear and the brain that allows us to interpret, understand, and respond to the world around us. After sound enters the ear and is converted into neural signals, those signals are transmitted to the auditory cortex and integrated with brain networks responsible for memory, attention, language and emotion. This allows a person to focus on relevant speech in noisy environments, recognize voices and words by matching them to stored memories, and use auditory input to guide decision making and social interactions. So, for example, imagine a large family gathering where multiple conversations are happening at once.

To participate successfully, your brain must identify the voice of the person talking to you, suppress competing sounds, remember what was said just moments earlier, and formulate an appropriate response. This seamless coordination highlights the cognitive aspects of hearing that are often taken for granted.

Research shows that hearing loss is associated with faster decline in memory, concentration and other cognitive domains. According to the National Institute on Aging and the National Institutes of Health say that reduced auditory input can lead to social withdrawal, increased cognitive load and brain changes linked to neurodegeneration.

Based on a compilation of statistics from multiple researchers and authorities on the subject, the American Speech Language Hearing association in their piece entitled the Value of Audiology, Hearing Loss and Cognitive Decline and Dementia share some of the talking points you see here that compared to those with typical hearing, individuals with hearing loss are 1.9 times more likely to develop dementia and 2.78 times more likely to have co occurring cognitive impairment and that individuals are 1.89 times more likely to develop dementia with mild hearing loss and 3 times more likely with moderate hearing

loss and 4.49 times more likely with severe hearing loss compared to those with typical hearing. Peer reviewed studies also suggest that individuals with age related hearing loss or presbycusis are two times more likely to have co occurring cognitive impairment and 2.42 times more likely to develop dementia.

Although the phenomena underlying cognitive decline and dementia are complex, there is growing evidence suggesting that degraded sensory inputs caused by hearing loss may play a central role in cognitive decline in older individuals. Several studies have led to the conclusion that age related hearing loss may play a causal role in the development of cognitive impairments, meaning that hearing loss is not simply associated with dementia but may actually contribute to the processes that increase the likelihood of developing dementia over time.

Looking the other way Hearing loss is highly prevalent among older adults who have dementia.

Niemann and colleagues analyzed data from Medicare beneficiaries who participated in the National Health and Aging Trends Study. In their cross sectional analysis of a little over 2,600 participants, they found that 79.4% of individuals with dementia had clinically significant hearing loss and that increased with age to 94.2% in participants 85 years or older. Researchers like Haugaard and colleagues advocate that identifying and treating hearing loss as being important for those with cognitive difficulties to improve quality of life and support independence and work done by Zhang and colleagues reference that to also be important for individuals with depression.

What may be behind the relationship between hearing loss and cognitive impairment? This is an adaptation figure from Antonella Bizzogno and colleagues from their paper that is entitled Hearing Loss and Cognitive Impairment Epidemiology, Common Pathophysiological Findings and Treatment Considerations which includes an important discussion of on the causal connections between hearing loss and cognitive impairment Several theories have been proposed to explain the association between

hearing loss and an increased risk of dementia, increased cognitive effort required for listening and reduced cognitive reserve resulting from decreased auditory stimulation psychosocial factors including loneliness, depression, and social isolation, leading to reduced social and cognitive stimulation and interactions between these factors and underlying neurodegenerative changes. Another proposed mechanism involves shared cardiovascular pathology. Vascular disease may certainly affect the cochlea and central auditory pathways contributing to hearing loss while also impacting brain regions like the medial temporal lobe that are essential for memory and cognitive functions. And these proposed mechanisms may not be mutually exclusive.

The authors do suggest that some combination is probably at work and that the relative weight of each remains uncertain.

More research is needed to understand the relationship between damages to the auditory system and cognitive decline in order to not only better understand the mechanisms underlying the association between hearing loss and increased cognitive decline, but also avenues for early and effective intervention. So it's very important for audiologists to avoid statements like those you see here. For example, we should not say that hearing loss causes dementia or that hearing aid use will prevent dementia, as there is no concrete evidence to support statements like that yet. What we do have, though, is a growing body of research and clinical evidence supporting a meaningful connection between hearing loss, hearing treatment, and cognitive health.

Hearing loss treatment is our next topic.

Hearing intervention with amplification is thought to play a meaningful role in efforts to prevent or slow cognitive decline. Cross sectional studies by several researchers have shown that hearing aid use attenuates cognitive decline. Here you see another nod to the fact that age related hearing loss may play a causal role in the development of cognitive impairments. And longitudinal studies have

demonstrated reduced cognitive decline or even cognitive gains following prolonged use of hearing aids. Some authors have even argued that hearing aids should be provided much earlier in the course of hearing loss and their use promoted more aggressively.

Let's look at some more research. Work done by Glick and Sharma found that following six months of hearing aid use, participants demonstrated improved speech perception in noisy environments along with gains in global cognitive function, processing speed, visual working memory, and executive functioning. Their findings were supported by earlier work done by Diehl and Karawani and their colleagues.

The ACHIEVE study showed that subjects with comorbidities like hypertension, diabetes, and lower cognition showed a 48% reduction in cognitive decline if they wore hearing aids compared to the cohort who didn't receive treatment with amplification.

The Lancet Commission on Dementia Prevention published its 2024 update stating that approximately 45% of dementia cases worldwide are associated with 14 modifiable risk factors that have an impact across the lifespan. Hearing loss was placed at the top of the midlife modifiable risk factors for dementia, and that ranking matters because midlife is a window when many people first notice changes in hearing and when intervention is typically straightforward with regard to testing amplification and follow up. That said, while the proposed biological and social mechanisms linking hearing impairment to cognitive decline is compelling and credible, just a reminder that we are not yet at a point where we can say that treatment actually prevents dementia, here is some additional information from the literature pointing to benefits from the use of amplification. I found these statistics in the research compilation piece by ASHA that I referenced earlier. Global cognitive function scores increased 4.8 to 6.4% among amplification users.

There is a 1.5 times improvement in long term episodic memory and individuals using amplification also demonstrated improvements in short term memory and attention.

And there's more. After cochlear implantation, 81% of adults showed improvements in cognitive performance and 32% of those with mild cognitive impairment returned to typical cognitive function.

This slide is spotlighting research that compared the performance of non hearing aid users and hearing aid users on a memory deficit task. Non hearing aid users are shown in gray and the hearing aid users in blue. The hearing aid users did better than those with untreated hearing loss with both mild and moderate severe degrees of hearing loss, and this is promising. Additional research showed that when examining trends over time, hearing aid use was associated with better scores on the Montreal Cognitive Assessment that we will talk about in a few minutes. After six months of hearing aid use, 71% of individuals with mild hearing loss demonstrated improvements in their global cognitive score and adults with mild hearing loss showed an improvement in clock drawing performance.

We also know that amplification can provide a range of meaningful benefits that support overall health and well being. It can play an important role in promoting social engagement and connectedness, emotional well being, improved quality of life and healthy aging. And I've got a nod there on the slide to decreases in depression, anxiety and stress.

Given all of that. Work done by Niemann and colleagues also found that not only was the overall prevalence of hearing loss among those with dementia at almost 80%, only approximately 22% 21.7% of participants with hearing loss reported using hearing aids and they concluded that as our understanding of the relationship between sensory health, aging and cognition continues to evolve, ensuring access to effective hearing care is an important public health priority. And I'm sure we all couldn't agree more.

So now I would like to shift the conversation to talk about ways that audiologists can modify clinical protocols to identify and better serve individuals who have cognitive difficulties. In this section of the talk I will discuss the things you see here. Communication needs assessments, speech and noise testing, Cognitive screening and effective counseling strategies the co occurrence of peripheral hearing loss, central auditory changes and cognitive decline contributes to the complexity of caring for older adults in hearing healthcare settings and as a result a one size fits all approach to patient management really should be avoided and evaluation and intervention strategies should be tailored to meet individual needs.

Communication needs assessments are an extremely useful tool for every patient as they help identify communication needs, assess hearing loss severity and support tailored interventions. Research has shown that pure tone sensitivity and supra threshold word recognition ability are insufficient for understanding a patient's reaction to their hearing loss and as a result, self reported hearing handicap measures are valuable in older adults with cognitive decline. These tools are also helpful because they detect hearing loss and its functional impact even when cognitive impairment makes it difficult for patients to report symptoms. They certainly can also help measure the benefit of intervention. So I'm showing a few examples here, but there are others the AFAB Measures Community I'm sorry, the afab I wanted to say the full title the Abbreviated Profile of Hearing Aid Benefit measures communication ability in common situations with subscales addressing ease of communication, reverberation, background noise and negative reactions to environmental sounds.

The results will identify a patient's perceived hearing aid benefit and can identify challenges that may be occurring that warrant additional discussion or support. The Client Oriented Scale of Improvement developed by the National Acoustic Laboratories has patients identify up to five specific situations that they would like to have improved by wearing amplification. These can be listening situations or they can be emotional or social in nature. It's also administered pre and post fitting to identify changes.

The Hearing Handicap Inventory for the Elderly. This is designed for adults 65 years and older. It assesses how hearing loss affects social and situational functioning and emotional well being. The assessment includes situations that are particularly relevant to older adults and retirees. And I wanted to mention that there is a shorter 10 item screening version called the HHIS which may come in handy.

And another good to know is that a version of the Hearing Handicap Inventory is also available for use with significant others and that acronym is hhis. It measures their understanding of problems that are encountered because of their partner having a hearing loss. And then finally, the International Outcome Inventory for Hearing Aids that measures patient reported outcomes in hearing aid use including satisfaction, communication and quality of life. It can be administered alongside cognitive tools to capture the combined impact of hearing loss and cognition and can be adapted for patients with cognitive decline using simplified instructions, visual aids, or even caregiver proxy responses.

For those of you using the NOAA patient database, you can access the cosi, the afab, and the International Outcome Inventory for Hearing Aids under the Questionnaires module.

As valuable as communication needs assessments are, they are not a standalone solution for managing patients with hearing loss and cognition challenges. In addition, it is well documented that audiometry alone does not provide information about the status of auditory processing and cognition and we know that older adults often struggle with complex listening situations such as speech and noise perception, even if their peripheral hearing appears normal. So speech and noise testing is definitely a valuable tool. In 2017, a systematic review of the association between cognitive performance and speech and noise perception for adult listeners, Dryden and colleagues found robust associations between poorer speech and noise performance and reduced cognitive performance in adults even after controlling for hearing loss, and they stated that more work was needed certainly to tease out specific relationships. Looking at a little bit more research, a large study done at the

University of Oxford deferred in 2021 showed that people with a moderate degree of speech and noise impairment had a 61% increase in the risk of developing dementia and an 80% risk with a severe degree of deficit.

Jing and colleagues studied global and domain specific cognitive performance involving skills like language, memory, attention, executive function and visual spatial ability as well in 702 patients age 60 years and older in the Baltimore Longitudinal Study of aging that spanned 2012 to 2019. They found that participants with hearing loss showed similar baseline cognitive performance but faster cognitive decline in global cognitive function, language, executive function and attention and that participants with below median quicksin scores showed worse baseline cognitive performance in all domains and faster decline in global cognitive function, language, memory, executive function and attention. And so they concluded that audiometric testing may be valuable for intervention to help slow cognitive decline, but that speech and noise performance may be an even more sensitive marker of early memory changes.

We should all consider including speech and noise testing in our assessment protocols if not already using it within or even outside of the conversation on cognition. It is easy, fast and reliable, can help with wise technology choices for each patient and help justify the recommendations we make, can help predict hearing aid use and hearing aid benefit, and allows us to align and be compliant with best practice guidelines as well. Speech and noise testing can also help provide patients with realistic expectations and identify those who made who may need additional counseling or more handholding with regard to the clinical integration of speech and noise testing. Be sure to use test materials that are commercially available, standardized and sensitive to changes in performance, and use recorded materials to reduce presentation variables. Also consider using it as references previously to assess unaided and aided performance.

There are a variety of reputable speech and noise or hearing and noise tests available. We don't have enough time to discuss these and their clinical or research applications, but I wanted to at least provide you with names and authors, given the value they bring in a variety of ways counseling patients, choosing the most appropriate amplification, and even again validating benefit with the technology selected. So the next topic is cognitive screening and why it's a valuable clinical tool. It can help in all of the ways you see listed here. So let's just talk about each of these for a moment.

Identifying Potential Cognitive Concerns Cognitive screening can be helpful or help identify signs of mild cognitive impairment or dementia that may warrant referral for further medical evaluation. Can be particularly valuable when communication difficulties appear disproportionate to the degree of hearing loss. Understanding communication challenges, hearing loss, auditory processing difficulties, and cognitive decline can all contribute to listening challenges, often with overlapping symptoms, and cognitive screening provides additional insight into the factors affecting a patient's communication performance. **Personalizing Hearing Care** A patient's abilities can influence their success with hearing aid use, technology adoption, and rehabilitation recommendations. Understanding cognitive status helps clinicians tailor counseling, instruction and support to meet individual needs.

When it comes to clinical management, cognitive screening results can inform modifications to care such as simplifying communication, involving family members, providing additional follow up support. These insights can help create more effective and patient centered intervention plans when cognitive concerns are identified. Audiologists can facilitate referrals and collaborate with other healthcare providers and this coordinated approach really helps ensure patients receive comprehensive evaluation and support. And establishing a baseline measure of cognitive function enables us to monitor changes and recognize potential concerns sooner. So baseline screening results can also guide future management decisions and referral recommendations as well.

And so my understanding is, as I was diving into the professional landscape is that there is debate in the professional community about audiologists doing cognitive screening, but I am an advocate for it and the reason why is captured really well in this quote. Patients can expect that their hearing care or patients expect expect that their hearing care professional provide holistic care, including promoting cognitive health. Recognizing and addressing the interplay between hearing loss and cognition allows hearing care professionals to develop more effective strategies for assessment, intervention and patient support to improve overall health and quality of life for older adults.

Cognitive screening is also within the professional scope of practice for audiologists according to both ASHA and aaa. That is certainly important to know there. When it comes to cognitive screening, there are a variety of screening tools available, but today I'm going to spotlight the Montreal Cognitive Assessment, referred to as the moca, as it's known to be more sensitive to subtle cognitive changes, including executive function and memory. The MOCA is a brief, standardized cognitive screening tool designed to again identify mild cognitive impairments and early signs of dementia. It assesses multiple cognitive domains that are important for everyday functioning and it only takes on the order of 10 to 15 minutes to administer.

So it does a nice job of evaluating several areas of cognitive capabilities, including attention and concentration, executive functioning, memory and delayed recall, language, visual spatial abilities, abstract reasoning, naming, and orientation to time and place. This slide shows the MOCA cutoff scores for normal controls, those with mild cognitive impairment, and more significant, Alzheimer's disease. So the idea is to take the patient's score and compare it to the normative data. There is a range of normal, but the cutoff between normal performance and MCI is a score of 26. There are also a couple of modified versions of the assessment specifically for those with hearing loss, the MOCA HA for hearing aid users and the MOCA H for hearing impairment.

The MOCA HA was an earlier adaptation developed and validated specifically in hearing aid users, whereas the MOCA H is a newer, more broadly validated version intended for adults with hearing impairment, whether or not they wear hearing aids. And my understanding is that many clinicians and researchers now view the MOCA H as the more comprehensive and widely applicable hearing adapted MOCA version. And then importantly, the MOCA H was validated individuals with hearing impairment and shown to be a reliable tool for identifying dementia and cognitive impairment. And happy to report, is available in goodness approximately 90 languages. Now the MOCA is one example of a cognitive screening tool, as I mentioned.

Certainly screening tools can help us care for our patients. Very important to keep in mind that we should not diagnose, quantify or qualify cognitive impairment. If you consider using the moca, keep in mind that it's essential for patients to to hear the instructions. If they don't understand the instructions, their scores will be lower. And we don't want to mistakenly conclude that someone has or may have poor cognitive ability than they actually do because they didn't hear the instructions.

And that's probably straightforward for this audience. It's also important to know though that eliminating auditory dependent sections of the MOCA significantly reduces the sensitivity and specificity of the test. And if integrating this tool, certainly consider finding a cognitive psychologist or a physician in your area that specializes in geriatrics and collaborate with them on the administration of this tool. So that is something to keep in mind as well. A very good to know, I think is that the MOCA or MOCA training is free for students, faculty members, academic researchers, and publicly operated healthcare institutions.

If you fall into one of those categories, you can use this QR code to register for MOCA training. And then as we finish the topic of cognitive screening, I want to share this quote from Shen and Souza that I found impactful. As healthcare professionals who serve the aging population, audiologists are likely to

encounter cases of under diagnosed cognitive impairment in order to provide timely referral for medical assistance as well as an optimized individual outcome of Audiological Interventions Audiologists should be trained to recognize an abnormality in older clients cognitive status.

So I will leave you with that on the topic of cognitive screening. And now let's jump into some important clinical considerations. Effective hearing care for individuals with cognitive impairment often requires adapting assessment, counseling and rehabilitation strategies to meet specific needs. I know I mentioned that earlier. So using clear communication, visual aids and structured guidance can improve engagement and outcomes while involving family members and caregivers helps support adherence and maximize the communication, social and emotional benefits of treatment.

As referenced earlier a couple of times, close collaboration with geriatricians and neuropsychologists, for example, further supports a whole person approach to care by providing information that can be used to customize hearing care plans in order to optimize patient outcomes.

So here are some specific counseling strategies known to be helpful with patients who have cognitive impairment. The amount of new information presented during any one appointment or interaction should be limited to approximately somewhere between three and five novel points. Each point or topic should be presented as a small manageable chunk of information. Allow time after each point to repeat and paraphrase, and do keep in mind that longer appointment times may be needed.

Additional counseling Considerations Schedule appointments in mid morning or whenever energy levels are high. Have important conversations in a setting without distractions like noise or other people nearby. Speak slowly, clearly and enunciate your words and certainly keep hands away from your face when having a conversation as well. We don't want to obstruct any visual cues that may be helpful to the individual.

A good communicator will show their listening by nodding, using eye contact and friendly facial expressions. Keep in mind that communication is a combination of words, body language and tone of voice. Talk with the patient, not about them or at them or over them. If the person is sitting in a wheelchair for example. Well, whether they're sitting in a chair or in a wheelchair, go ahead and sit down and converse with them at eye level.

That will be helpful if the patient is confused. Reassure them and instill confidence with phrases like we're going to figure this out together. Always speak to the individual as an adult, have patience and compassion and stay focused on the present moment. And also know that open ended questions can be difficult for someone with cognitive decline to answer. So keep that in mind as well.

All reading material should be at the sixth grade level. Large font is always advantageous or almost always advantageous. Checklists can be very helpful. Maybe a checklist centered around hearing aid use and care, for example videos, visual tools to supplement what was communicated verbally can go a long way and there are quite a few of those available. And I mentioned the potential for the need for longer appointments just a moment ago.

But keep in mind that more frequent visits are likely going to be a good idea as well. So if your typical, let's say hearing aid fitting follow up is, you know, two to four weeks out, we want to translate that into a matter of days for an individual with cognitive challenges. And then another clinical recommendation is to promote oral rehabilitation. Research suggests that early auditory rehabilitation offers great benefits that reach beyond audibility, really helping to support brain health, cognitive function, emotional well being and overall quality of life. So by improving access to sound rehab, auditory rehab may promote healthy neural functioning, enhance cognitive engagement, and foster greater confidence and social participation as well.

To conclude this discussion on hearing and cognition, I want to take a few minutes to highlight some of the features in the brand new Omega AI technology family that can be used to support individuals with memory or cognitive difficulties.

Research tells us that hearing aid features that reduce cognitive load may be particularly beneficial for patients with cognitive impairment because they make hearing aids easier to use and eliminate challenges or even additional things that someone needs to understand or consider. Features like digital noise reduction, automatic directionality, automatic program or signal processing changes, automatic streaming as well. When we talk about automatic features, verbal prompts for things like program names and low battery and rechargeability, all of these are things that Starkey offers with unique capabilities. Complex listening environments increase the cognitive demands of communication. When auditory information is degraded by hearing loss or masked by competing sounds, the brain must devote additional resources to processing speech, resulting in greater listening effort.

And evidence suggests that cognitive factors like working memory and processing speed are critical contributors to speech recognition performance, particularly in challenging noise conditions. So I'm going to take a moment here to discuss four Starkey features designed to support patients in complex environments. The DNN enhanced digital noise reduction feature DNN 360 automatic directionality edge mode. And I'm going to give a nod to our remote microphones as well. So DNN enhanced speech and noise.

A few years back we integrated the use of DNN into the main audio pathway. As we sounds are coming into the hearing aids being analyzed, features extracted and then patterns classified. That process of classification then driving the noise management algorithms to apply what is needed when it's needed for the individual. A couple years ago we introduced again DNN right into this pathway to make the identification of speech and then the ability to reduce noise better for individuals. In fact, the use of

DNN enhanced speech and noise makes the hearing aids 30% more accurate at identifying speech compared to legacy technology, which is wonderful the more accurately we can identify what truly is speech versus not like.

Take for example a difficult difficult for a hearing aid signal like multi talker babble. So if we can be more accurate and identify in the identification of speech, then we can have the noise management engage more effectively and precisely for the individual. DNN360 is automatic directionality. So the hearing aids will automatically move into different directional or different microphone modes based on what is happening in the environment. If the environment's quiet, the hearing aids will go into an omnidirectional microphone mode.

If there is some noise present but no speech, the DNN spatial awareness configuration will engage using split band directionality. If there is speech and noise, the DNN directionality will automatically apply. That's the independent adaptive null steering. And then we even have a motion based optimization tool. So when the patient is in motion, the ability to engage that spatial awareness or split band directionality application to enhance awareness of the environment and keep the SNR the signal to noise ratio advantageous for speech onsets.

Some wonderful data around this feature when we compare to our legacy technology. 28% improvement in speech intelligibility and up to an 8dB improvement in signal to noise ratio for better spatial awareness. Edge mode is another wonderful tool for promoting greater comfort or clarity anytime the patient thinks they need additional support. When it's activated, an environmental analysis is done and hearing aid parameters are changed to support the listener. The response of the hearing aid and microphone mode may be changed and a greater degree of noise management can be applied than is available even through the software to address the acoustics in the moment if needed.

So we're also seeing edge mode replace the need for the use of multiple programs in a starkey hearing aid. So A great tool there as well. And then the My Starkey app provides some additional flexibility with edge mode where the patient can tap into, literally tap into their intent to enhance speed speech or reduce noise. A little bit of data around this feature. So again, it's a feature designed to provide additional support whenever the patient needs it, whether that be in quiet or noisy conditions.

Here you're looking at some data that came from a study designed to evaluate both speech intelligibility and listening effort with edge mode. And the results showed an improvement in both in a very complicated test environment. So this feature can be accessed in a number of different ways through the hearing aid user controls if programmed that way by the professional, through the My Starkey app or through the favorite button on the Starlink remote control and then remote microphones. So let's talk a little bit. We know that remote microphones can do an amazing job of improving the signal to noise ratio for an individual.

And so I wanted to show a little bit of data here on the Starlink remote microphone in a study. This study or the data you're seeing here came from a study that was created to look at the benefits of the remote microphone. And the results showed that subjects received on average over 12dB of additional signal to noise ratio benefit on top of what they were already getting with the hearing aids. Using the remote mic, some participants were able to get 50% of the hint sentences correct at a greater than minus 10 decibels signal to noise ratio which is a very difficult listening environment. So accessories can be a wonderful tool.

And then I did definitely want to point out a number of helpful features for those with memory and cognitive difficulties that can also be found in the My Starkey app. Intelligent reminders can be a wonderful tool. Hearing aid maintenance to remind patients to perform the self check feature that will analyze the device integrity. A reminder to insert their hearing aids if they have forgotten and then

brand new with the Omega AI plus family is the hearing aid left behind notification. So to help individuals not lose their devices that might be a great tool.

Self check I described just a moment ago but the patient can have the hearing aids out of their ears and tap the button and have an analysis done of the receiver, microphone and circuit. If there is a problem that will be indicated by a red badge and then they can tap details to get to be led with very simple straightforward strategies for correcting the difficulty. Really empowering and helps them be hearing well again as soon as possible. Basic reminders Love this feature. Banner notifications or audible alerts throughout through the Hearing aids.

Maybe it's about around taking medication or eating hydration the various appointments. Lots of possibilities there. Smart assistant is a great tool. Voice commands can be used to manage the hearing aids. Perhaps volume muting the devices, changing programs but also easy access to the hearing aid user guide, setting a reminder find finding their phone even if the ringer is off and it's hiding under a couch cushion.

And if there's wi fi or cellular connectivity, even accessing the Internet. Maybe it's having the weather play through their hearing aids. Maybe it's the need to be reminded of what the weather is. One example of many and then transcribe that should be up next here. Yeah, this is a great tool.

Voice to text transcription of information maybe when going to a doctor's visit can be really great for someone with memory issues or maybe simply transcribing and keeping a list of the shopping list or you know, other important information that they may want to keep track of. And there's even an opportunity to share that transcription with others. So that can certainly be very helpful. As I mentioned earlier, patients with cognitive decline may need longer appointments and more of them. Keep in mind remote programming.

Starkey's TeleHere feature has three versions. The synchronous appointment based tool, an asynchronous strategy through a help request that provides some provider and patient convenience and even telehere AI where the patient can interact with a generative AI tool that was taught or trained using information from our research team team, our clinical product research group, our product management and customer service audiologists. So that can also be a great tool and then hear share. Do keep this in mind. This is a free app to use with Starkey hearing aids for the caregiver or family member.

The patient can invite someone to to view data that is collected through their My Starkey app. And I mean whether they are, you know, their hearing aid use, their battery life if they're home or away and their variety of health and wellness metrics too that allow that caregiver or loved one to come along and support the patient journey. Okay, well that brings us to the close of our time together. I've got a variety of slides here that should be in your handout that cover the resources that we have or that I used, I should say to prepare this talk for you. Please do dive in more, learn more.

Stay on top of the research on this or as it pertains to this important area of hearing and cognition. And with that I want to thank everyone for joining me today.