Hearing Health Hour: Age-Related Hearing Loss: Problems & Solutions

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>> DR. ANIL LALWANI: Hello, everyone. And welcome to Hearing Health Foundation's very first Hearing Health Hour. Hearing Health Hour webinar. My name is Anil Lalwani and if you're new to Zoom, please review the technical guide that has been shared in the chat. This event has a live captioner. You can enable closed captions by clicking the CC button in the toolbar that's at the bottom of your screen. I'm happy to see so many of you with us today. Again my name is Dr. Anil Lalwani and I'm a professor and Vice Chairman of research in the Department of Otolaryngology head and neck surgery at Columbia University College of Physicians and students but more importantly I'm also a Board Member of Hearing Health Foundation where I oversee the Emerging Research Grant program, also known as ERG.

Now, ERG awards funds to researchers studying hearing and balance conditions. In just a minute, you'll be hearing from Dr. Samira Anderson, who received an ERG grant in 2014 for her exciting research on hearing aid usage and auditory processing. ERG grants sets the stage for my leaders in our field to become successful in fact my own scientific grant many years ago was to the ERG to study genetic hearing

loss in gene therapy. I'm so thrilled that today you'll have the opportunity to learn about the results of our critical ERG funding. This work of course is only possible through the generosity of supporters like you. And if you'd like to support our work on hearing loss, tinnitus, and related conditions, you can do so today at HHF -- Hearing Health Foundation -- HHF.org/donate.

And now without further ado, I would like to turn it over to Dr. Anderson for her presentation on "Age-Related Hearing Loss: Problems and Solutions". Please do hold your questions until the Q&A portion of her presentation. And thank you again for joining us.

>> DR. SAMIRA ANDERSON: Thank you. And I'm just waiting to make sure that I can control my slides. But while that's happening, I want to thank you for the opportunity to present today. I'm excited to tell you about the research that has been made possible in part by the Hearing Health Foundation.

Let's see. I don't see seem to have control yet. Okay. Now -- no. Okay. I'd like to move to the next slide. I don't know if I'm going to be to do that myself.

So I would like to first talk about why it's so difficult to understand speech as we age. And in the past, many years ago, we really focused a lot on the ear and hearing loss and why that was causing difficulty. And we know a fair amount about hearing loss as we age. But recently there's been more emphasis on central auditory processing, and cognition.

So as I tell my participants, you can't really understand or know what you're hearing unless the sound travels all the way from your ear up to your brain.

You need your brain to be aware of the sound and to understand speech.

So that's an important part of our difficulties as we age. And then another area that's been of recent interest, maybe in the last decade or so, is the role of cognitive abilities in our ability to understand speech. Especially in background noise.

So for today's presentation, go ahead and click that. I don't seem to be able -- yeah, I'm going to focus a lot on central auditory processing because that's the main, main focus of my lab's work.

So next slide.

So this is the traditional audiogram that many are familiar with, if they have ever had a hearing test. What we do is we plot your hearing thresholds. And here you see levels of intensity or loudness going from soft to loud on the y-axis. And on the x-axis

you see frequencies going from low to high. And we develop the graph where we determine the ability to hear at these different frequencies.

And these -- this audiogram is important because it helps us determine the type and the degree of hearing loss. So without it, we wouldn't be able to determine a starting point for what we're going to recommend.

But unfortunately the traditional audiologic test does not do a good job of predicting how well we're going to perform in noisy backgrounds. And that was a frustration for me as an audiologist. I worked as a clinical audiologist for 26 years before I decided to pursue research and teaching. And one of the motivating factors for me was that I could look at an audiogram and I wouldn't be able to predict if someone was going to be successful or not with their hearing aids or with whatever other management I was going to recommend. So two people with exactly the same audiogram may report very different experiences in their own communication environments.

So next slide.

So I mentioned cognitive ability. And this has been of great interest in the last several years because research has shown that cognitive ability declines more rapidly in individuals with hearing loss than in individuals with normal hearing.

So we know that there are certain types of cognitive functions that decline with age. And that's just part of the normal aging process. But what this graph shows you or these figures show you is that the decline is accelerated in people with hearing loss. So here you see a loss in cognitive function over the course of eight years. From Year 5 to Year 11. And here we see that the loss is steeper in the individuals with hearing loss. And the same with this particular type of testing.

And so this isn't to say that there's a causative factor. So I'm not telling you that hearing loss causes you to lose your cognitive abilities. We really don't understand this relationship. But we do know that there is this relationship. And it's important to try to figure out what's happening. And also to determine if we restore hearing with some type of device, like a cochlear implant or a hearing aid, can we improve cognitive function? That's something that people are very interested in at this point.

Okay. So I mentioned to you that my lab is interested in brain processing. Or central auditory processing. And we know that it has an important role for understanding speech in noise.

If you're in a quiet situation, speech is redundant enough that sometimes you can fill in the parts that you miss. But if you're in a noisy background, if you don't get a precise signal, then sometimes you just can't understand what's being said. And speech has a lot of very rapidly changing components. And if your brain isn't able -- if your brain isn't able to process these rapid components, then you may be missing out.

So let's go to the flex slide.

So the way that we do that in my lab is we measure the electrical activity that naturally occurs in the brain in response to sound. So electrical activity is how the signals, the neural signals, are transmitted from the ear up to the brain. And we do that -- we can do that with just a few electrodes like you see in this picture on the left. But we can also do it with a cap full of many different electrodes. It depends exactly what we're looking for. And with our studies, at least for some of them the participants don't actually have to do anything. They just sit and relax in a recliner. They have electrodes on their head. And they watch a movie with muted subtitles while they are listening to sounds.

And so it's something that generally our participants enjoy doing because they know that it's -- for one thing, it's not hard for them to do. And for another thing, they are hoping that this might improve things for older peoples' hearing.

Go ahead and go to the next slide.

So this is an example of what we might be measuring. Here you see in the middle of the screen the word weed. This is the waveform of the word weed.

And you see these periodic peaks here. These correspond to vocal fold vibrations that correspond to the pitch of someone's voice.

So this is the stimulus. And here is the brain's response to that same stimulus. And you can see that the response actually looks pretty well like the stimulus. You see these periodic peaks here. And then you see this final spike here, which is -- corresponds to the final consonant of da. But what you notice is the younger participants in blue have much more defined larger peaks than the older participants. The older participants, their responses are smaller and they are less defined. And one thing that's really important to note about this is that all of these older participants had clinically normal hearing.

So this change was the result of aging but not as a result of hearing loss. If you add hearing loss to it, the finding is more pronounced. So this is an example of a central auditory processing that is due to aging.

Okay. We can go to the next slide.

So now I'm going to zero in on these responses and just point out a few features.

So here we see these peaks. And what these are are peaks of electrical activity. And in addition to the fact that the younger person's responses are bigger, they also occur earlier. So this peak is earlier than this peak. This peak is earlier than this peak. And so on.

And so the brain is -- the younger brain is processing the sound faster than the older brain.

This is in the initial part of the response. Here is the middle part. And mostly we just see that the older person's response is smaller.

And then towards the end of it, you can see that the older listeners' responses in red are just kind of degraded. We're no longer seeing those periodic peaks anymore. It could be that the older brain is just not able to sustain the consistent neural firing that it needs.

Okay. Let's go to the next slide.

So this is an example of how this might be relevant clinically. So let's say you have two participants. Or two patients. One of them has good speech in noise as measured by a common test that we use which is the quick speech in noise test the .5 score would be considered normal this is a male age 60 normal audiogram then another patient maybe is complaining about difficulty hearing in noise. And her quick speech in noise test is at 3.8, which would be considered a mild impairment.

She also has normal hearing on the audiogram.

Their ages are pretty similar.

So what is different between these two participants is the fact that the neural response to the sound is much more defined in the person with good speech in noise performance. You can see the peaks are more defined. And also the periodicity, the ability to follow these peaks is much better, especially in this early region. So we might think that maybe this older person has a type of central auditory processing disorder that comes with aging.

Okay. Let's go to the next slide.

This is another example of something that we look at. And I just wanted to show you what this is. Because you'll be looking at when I go over the hearing aid results. And this shows the brain's ability to lock on to the signal consistently. And so what we want the brain to be able to do is lock on to the timing characteristics. And the way this is represented is, it's over time. So you have this stimulus. This is the stimulus ditch. And we're looking at this in time and frequency.

So these are the lower frequencies. These are the higher frequencies. And the strength of phase locking or the ability to lock onto timing components of the signal is represented by color. So darker red means better. And what we can see is that the young people have good phase locking to that early portion of the word, the ditch. And then the colors are weaker in the older normal hearing and the older hearing impaired. So they basically have a weaker ability to lock on to the signal.

Let's go to the next slide.

So I have this figure in here or this slide because this is a cue to let me tell you that when you first get hearing aids, one of the main complaints sometimes is that everything is too loud. Especially those high frequency sounds that people aren't used to listening. And so people wonder, why are my hearing aids so loud? And it does take a while to adjust to that.

So what is happening with that? Let's go to the next slide.

Well, what's happening is the brain likes homeostasis. So it likes to have an even amount of input. And when there's a loss of input in one of the senses, so for example, an auditory sense, when the brain isn't getting the same level of auditory input that it thinks it should have, then to compensate for that, the neurons start increasing their normal neural firing rate. So the spontaneous firing rate that just occurs all the time increases when there's a decrease in incoming sounds. So that when this person suddenly hears a louder sound they might react as though it's way too loud.

So here's an example of two groups of older people that are matched in age. But they have a difference in their hearing and this is showing frequency energy to a sound and what you can see is that the representation of the speech syllable in the frequency energy is much higher in the people with hearing loss than it is with normal hearing. And that could be that the baseline neural firing rate is just higher in these people with hearing loss.

Now, that doesn't mean that they can hear soft sounds. It just means that once the sound is moderately loud, all of a sudden it may be too loud for them. Especially when they first try hearing aids.

So let's go to the next slide.

So now I would like to tell you about this project that was funded by the Hearing Health Foundation. And this really meant a lot to me because it was my very first grant that I received after I started at the University of Maryland. And it funded a project that was very important to me because I'm a clinician scientist and I wanted to see, you know, how things changed once a person started wearing hearing aids and can we use that information to improve their ability to have success with hearing aids.

So we measured the hearing aid's ability to improve both brain and cognitive function.

So let's go ahead and go to the next slide.

So this was our study protocol. They came in for a hearing test. They were fit with hearing aids. They had the electrophysiology testing. We tested their ability to understand speech. And we tested cognitive abilities.

And then we had them come back several times over the course of six months so they came for a total of six visits. And we repeated some of the testing at each of the visits. We always repeated the EEG testing and also checked their hearing aids out. And these were participants that had never worn hearing aids before. And half of these people were assigned to the group that wore hearing aids for the duration of the study. The experimental group. And the other half were randomly assigned to a control group that didn't wear hearing aids but had the opportunity to get them after the six months.

So let's go to the next slide.

So this is what it looked like at the very first day after they received their hearing aids. They were tested both without hearing aids, the unaided condition. And with hearing aids in the aided condition.

And so this is that figure I was showing you earlier where it's looking at how consistently the brain represents timing or phased components of the signal.

So without the hearing aids, you can see that the brain is responding to the lower frequency part. But with the hearing aids, they are getting more definition or better responses in the higher frequency parts. So we can see even at the beginning the very first day that there is some improvement.

So let's go to the next slide.

So I mentioned before that older people have, you know, the responses are delayed compared to young people.

And what we found was that as they wore the hearing aids over the course of six months, the responses were actually a little earlier by the end of the six months. So here is the pregraph, which is the dashed blue. And then red is post. And you can see this peak is a little earlier than that peak.

And in the control group we didn't see that improvement. In fact, it looked like they were a little bit later after six months.

So let's go to the next slide.

So I mentioned that hearing aids seem loud because the spontaneous activity is higher probably than it should be.

And what we found was that over time, we saw actually a reduction in the amplitude of the frequency energy for this low frequency, which is the pitch.

And if that's too loud, what happens is it kind of swamps the consonants. So you don't want that to be too high. And so what we find for both unaided and aided conditions, is that this decreased after wearing hearing aids. So pre is the dashed red. Post is the solid red. This is experimental in the top panels. And the control group is in the bottom panels. And we didn't see that same change.

So this might also explain sometimes people after they have been wearing hearing aids, they actually think that their hearing has gotten worse because when they take their hearing aids out, they think, hey, I can't hear anything. Whereas before they got hearing aids, they were able to function a little bit.

And that might be just because the spontaneous neural firing rate has decreased. So it's not a bad thing. It's actually a good thing.

And here we have results of hearing aid use on working memory.

So this is a working memory test it's the National Institutes of Health cognition toolbox test. And what we see here is the two groups were matched at the pretest. So there was no difference in their working memory scores. And they were actually pretty good. Although, these are age adjusted. And 100 would be considered average. So all of these participants were a little bit above average. Then what we see is that the experimental group increased significantly after six months. And the control group did not change. And so it seems that we don't really know why this happened and it seems

to be something that needs to be further investigated but it's possible that wearing hearing aids regularly gave the person better access to what they were hearing so that their -- you know, they were free to remember -- they weren't putting so much effort into hearing. And that they could feel free to use their cognitive resources to remember what was said.

So let's go to the next slide.

And of course, you know, if you wear hearing aids, you want to see an improvement in your communication ability. And these are the results of the abbreviated profile of hearing aid benefit. And on this particular test, if you go up, that means it's better. And never means you're having less difficulty before than you were with hearing aids. We see improvement with communication ease, reverberation and background noise the only thing that got worse is aversive sounds because of course if you're wearing hearing aids you're going to notice aversive sounds in your environment more frequently. I didn't mention this before but all of our participants that wore the hearing aids throughout the six months were advised to wear them for at least eight hours a day. That was a condition that they had. And we also told them that they would get used to the hearing aids but we could not make any changes. So we did not adjust the hearing aids until the end of the six months. And actually most of these participants adjusted to the way the hearing aids were set right from the beginning as long as we counseled them about what to expect.

Okay. Let's go to the next slide. We're wrapping up here.

So in summary, hearing, cognitive ability and brain processing change with age. And we know that central auditory processing has an important role for speech understanding, especially in noise.

And performance improves over time through the use of hearing aids or cochlear implants.

And that's -- oh, and then note that we don't expect that hearing aids or cochlear implants will solve all problems, especially if somebody has more difficulty with age-related changes in auditory processing. And so the use of supplemental auditory training may also enhance brain processing and perception. And I just want to thank my lab members. And especially again the Hearing Health Foundation for making this possible. And now, we can open it up to questions. Okay. So should I just answer the questions from the chat that I see? Or how is that going to happen. Okay. So there's a

question, did you test for recruitment and its influence? And no, we did not. Although that would have been a good thing to do.

So recruitment is something that people with sensory hearing loss have and it is responsible -- it's part of the reason that loudness may seem -- it -- sounds may be louder to -- as loud or louder to somebody with hearing loss than they are with somebody with normal hearing but we did not test for that. And that would be something that would be interesting to look at in the future.

What is auditory training? That would be -- actually I'm part of a big grant called neuroplasticity and auditory aging right now that's funded by the National Institutes of Health that is looking at whether we can train people to hear better.

For example, if we combine practice with listening to sentences in noise with a memory task, will that help the older person to hear better.

Use it or lose it? Yes. I would say that using hearing aids could possibly help reduce some of the consequences of age-related hearing loss. What is adversity noise -- aversive noise what I mean is sounds like car honking, environmental noise, those are the kinds of things that bother people.

Do you know what hearing aid participants were fitted with and for how many hours in a day they wore them? Yes, so for the purpose of this study, we wanted to have everything controlled. So we only used Widex hearing aids. And they were the Dream 440 back then. This was in 2014. And they wore them at least eight hours a day.

So the signal processing settings were -- they were set with just the -- they were set with an automatic program that automatically adjusted for quiet in noise. And we didn't want the participants to interact with the hearing aids. So they were set that way and then left.

Did you have patients with tinnitus? And did hearing aids help? No, we did not have -- we had some patients with tinnitus but we didn't have any patients that significantly bothered by tinnitus so I wouldn't be able to answer that question.

Let's see.

Two-part question. You talked about Dr. Lin's claims that loss of cognitive function can be induced or accelerated by untreated hearing loss. From what I've read many younger people who experience hearing loss do not experience cognitive decline, at least on the scale we see in those with prebycusis. How might you account for this?

Well, like I said before, I'm not saying that hearing loss causes cognitive decline and it could be that younger people have already learned how to interact with their environment with reduced hearing whereas that's something that maybe an older person hasn't learned how to do and it may affect them more.

Cognitive decline seems to affect more than memory. People with memory decline often experience declines in balance, sights test, smelling and hearing perhaps a slow decline in our senses is actually a manifestation of cognitive decline not the other way around. Is it more likely that sensorial decline is an early warning sign of declining function? That could very well be. There's actually a number of different ideas about why these things seem to be connected. And so it may be that there is some kind of overall process that is causing declines in the senses. Let's see what is the age difference in younger versus older in the study presented the younger people were 30 or younger and the older people were actually not that old. Some of them were younger than me as a matter of fact. We used ages 55 to 70 in that particular study. Because we wanted to maximize the chances of seeing people with normal hearing. In the hearing aid study, however, people were aged 60 to 85.

How specific is the EEG signal that you're recording to auditory areas? What does the signal really represent? My understanding is EEG is an average over thousands of neurons. Yes, that's correct. So you'll notice that it's -- in other words, its populations of neurons that this -- we're measuring at the surface of the skin. So we're not able to say, hey, this part of the brain did this. And I was careful not to really label any particular brain area. It dependencies the frequency. Sometimes -- it depends on the frequency. Sometimes you can narrow it down. But we're looking at populations of neurons. So some of the testing that we did was probably more in the midbrain and some of it was more in the cortex. Let's see. Do you want me to respond to the Q&A questions rather than the chat? I've been looking at the chat. But I can go to the Q&A.

>> DR. ANIL LALWANI: You might do both.

>> DR. SAMIRA ANDERSON: Well, I haven't looked at this Q&A. So let me look at the Q&A and then I'll come back.

So the -- how does a hearing aid help with my tinnitus? Well, that's kind of a different topic area. But with tinnitus, if you increase the contrast between the tinnitus and the outside sound, it makes the tinnitus seem more noticeable so if you're in a really quiet environment suddenly you're really aware of the tinnitus but if you use hearing

aids, you're sort of decreasing that contrast so the tinnitus blends in. At least that's one idea.

So oftentimes hearing aids are very helpful.

What was the degree of hearing loss in the study? They were in the mild to moderate range.

These are people that had never worn hearing aids before. So you're unlikely to get somebody walking around with a -- much of a severe loss.

Any comment on reverse hope hearing loss? I don't know if that would change the outcomes as long as the person was appropriately fit. Which test did I use for measuring working memory? I used the NIH cognition toolbox that lists the working memory test. Hearing aids and tinnitus. I mentioned that. What role does cochlear in -- what role does it play in memory in older listeners. That's a good question. That's something up for debate. But at least in animal models, we have seen that mice that have been raised in a quiet environment have developed this -- what it is, it's an imprecise connection between the inner hair cells and the auditory nerve fibers. So we think that maybe what happens is that leads to an imprecise representation of the speech signal so maybe everything isn't clear. Especially in background noise. But that's something that more work needs to be done to actually totally understand what's happening with older humans.

What causes ringing in the ears? Actually that has a little bit to do with what I talked about with the brain liking homeostasis. And so if you have a little bit of hearing loss, even a little bit, sometimes you'll get ringing in your ears because there's a number of different things that might happen but if you have an increase in spontaneous neural firing the brain might interpret that as sound.

Typically tinnitus doesn't cause hearing loss, it is caused by hearing loss. And sometimes it is helped with hearing aids. My hearing aids are not providing enough help, will cochlear implants be the next step? Well, there's a lot of factors with that, but that's definitely something that should be considered because cochlear implants are becoming more and more effective with people.

Can you have problems understanding simply because of auditory processing difficulties and still have good hearing on an audiogram? Yes, especially if you're in a background noise. And so I didn't mention this. Sometimes I'll show a young person's response. And then I'll show an older person's response of somebody with normal

hearing. And you'll see that the older person's response is really degraded. And then I'll everybody that that's my response. And I do know that I have a terrible time understanding speech in background noise, even though I have totally normal hearing.

So a conclusion is that brain function plays a big role in hearing loss than hair cell loss. I wouldn't say a bigger loss. But you know, it's really important.

So it's just something to consider. And it could be a limitation in someone's success with a hearing aid.

Let's see, what about tinnitus? Was that considered to inhibit processing and with hearing aids provide -- well, if you have incoming sound, that can -- like I said, that can reduce that spontaneous neural rate of firing and maybe that will improve the tinnitus. I don't really have an opinion about lipreading training versus auditory training, that's not really in my -- that's not my area of expertise.

Do I have any thoughts on recent studies claiming people with hearing loss are more prone to develop Alzheimer's disease? That is not something that I have expertise in, either. I need to look at more of the literature.

I will say, though, that one thing about some of these studies that you have to be real careful about is not everybody presents the cognitive tests at levels that are adequate for hearing. So of course someone is going to do worse on a verbal cognitive test if they can't hear or if it's not audible.

On the speech ABR responses it appears that there's delayed as well as reduced amplitudes yet later on in the presentation you indicated the spontaneous amplitude responses was greater. Okay. That is a little bit confusing. But keep in mind that the reduced amplitudes were in older normal hearing people.

So you're going to see the exaggerated amplitudes in people with hearing loss.

Anyway, that's something that needs further work on, too, to really totally understand. Let's see.

Is there a real difference between in noise tuning challenges versus for muse significances, restaurant noise is of course uncomfortable however as a musician hearing my colleagues' music accurately is also a big challenge. Well, I think what you're talking about, too, is when you say accurately, you want to hear the specific frequencies correctly, the timbre in the instruments. So if you have hearing loss, that is going to affect timbre, although lifelong musicians tend to have some profound effects against some of these aging things that I've talked about.

Unless I missed it, is it somewhat known if a person who has lost cognitive ability and later was aided with a device were they able to regain cognitive ability in any way? Well, this is something that is too early to tell.

I know that the hearing aid -- some of the hearing aid companies at least, are advertising use of hearing aids as a way to prevent -- to restore cognitive ability I found this result in my study but keep in mind this study was relatively small. So it needs to be carried out in a bigger way across sites and in fact that is being done right now. Not by me but by other researchers.

Should hearing aid wearers be concerned about more hearing loss from the amplification of hearing aids? Given that aversive noise was worse. No because the aversive noise, it wasn't enough to cause damage to their hearing, it was just enough to be annoying. And I believe these people had had hearing aids for six months. But after a couple more years, they probably were fine. Why did I choose Widex? Because I had a good relationship with Francis Cook, the hearing aid representative -- no, he's the director of audiology research there. And also because I had used Widex a lot as a clinician and I had had good experiences with them. But other hearing aid companies are also really great. So it's not like Widex is the only thing that I would want to work with. It was mostly because of this relationship that I had.

Okay. Sorry about this, I have difficulty hearing rapid speech? Can you slow down. I know that that is a problem. And I feel bad that I'm talking so fast. I'm just trying to get through all of these questions but I'll slow down.

I work as a museum docent how can I best explain my hearing deficiency to visitors? I would just ask the visitors to do what this previous person asked me and that is to say, I have trouble speaking -- when people speak rapidly. Can you just slow it down a bit?

Let's see. How many people participated in the study? We had 32 people completed the study.

Are you seeking study participants? We are not seeking study participants currently because of COVID. We do not have permission to see human subjects. But stay tuned. And if you want to follow -- I'll just type in my lab address. That would have something about it once we start.

Do hearing aids work with a failed stapedectomy which is failed surgery on the stapes bone and surgery was done in 1977 and I wouldn't be able to tell without further

information but oftentimes hearing aids are an effective treatment for problems with the stapes bone.

>> DR. ANIL LALWANI: Dr. Anderson I wanted to give you a heads-up you have 3 minutes until 5:45 at which time you're ending the webinar. But I just wanted to give everybody a heads-up.

>> DR. SAMIRA ANDERSON: Okay. Okay. Now that we know all of this, what can I as an 85-year-old bilateral cochlear implant user do to help what is going on with my aging brain? I would say that you should try to practice listening as much as you can. You know, with maybe something -- audio books or audio books that -- for example, if you could have an audio book where you could actually read at the same time, that might be effective. Or some type of auditory training.

Did you interview your treatment group at the end of the study? How well did they adapt to the hearing aids? Did this affect their results? So we did talk to the treatment group. And they had the choice of keeping their hearing aids or returning them. And they did not pay for the hearing aids during the six months of use. So if they chose to keep them, they had to pay them at a greatly reduced rate. Probably about 50% of what they would have paid at a clinic. And most of them -- almost all of them kept their hearing aids. Which I thought was pretty remarkable because we recruited these people not from a clinic but just from the community. And so these were people that were not thinking, oh, I want to get hearing aids.

They came because they wanted to participate in a study. And some of them weren't even aware of how much hearing loss had affected them.

What is the status of hair cell regeneration that is not my area of expertise. So I'll pass on that.

>> DR. ANIL LALWANI: Actually that's a wonderful place I think, Dr. Anderson, to stop. What an amazing talk. As I get older I'm just thinking maybe I should go get my hearing aids now while I'm still young and can get used to them as opposed to waiting until I'm older.

But thank you for everyone who has attended the webinar. Our first webinar at Hearing Health Foundation. And Dr. Anderson, that was a phenomenal lecture. And thank you for taking so many of those questions. I noticed a lot more.

Now, again, remember that presentations like these and research projects like Dr. Anderson's are only made possible by supporters like you as Dr. Anderson pointed

out her work was in fact supported by Hearing Health Foundation. Please help us. You can donate at HHF or Hearing Health Foundation -- HHF.org/donate. And again, thank you for attending and Dr. Anderson, an amazing, amazing presentation. We look forward to many more.

>> DR. SAMIRA ANDERSON: Thank you very much. Thank you for the opportunity.