Signia Expert Series: What Did They Say? Potential Solutions for Helping Patients Hear the Television

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- [Carol] Today, we're gonna be talking about, "What did they say? Potential solutions for helping patients hear the television." And at the end of this course, you will be able to summarize the importance of television and movie viewing as a leisure activity. You'll describe factors that affect the television viewing experience for people with normal hearing or hearing loss. And you will make two clinical recommendations for people with hearing loss who report difficulty listening to the television. So, with that, I would like to introduce Dr. Erin Picou. Dr. Picou is an associate professor at the Vanderbilt Bill Wilkerson Center for Otolaryngology and Communication Sciences in Vanderbilt University Medical Center. She currently directs the Hearing and Affect Perception Interest laboratory, and is funded through a variety of industry and federal funding sources.

Her research interests are primarily related to hearing aid technologies for adults and children, with a specific focus on speech recognition, listening effort, and emotional response to sound. Dr. Picou is currently serving as section editor for the American Journal of Audiology, and also, Ear and Hearing. In addition to research activities, Erin is involved with teaching and mentoring AuD and PhD students at Vanderbilt. And joining Dr. Picou today is Haiping Huang. He is a PhD student in the Department of Hearing and Speech Sciences at Vanderbilt University. He has been working in the Dan Maddox and HAPI labs since joining Vanderbilt as an AuD student. His research interests focus on listening effort and emotion perception for adults with hearing loss. So, at this point, I would like to introduce Dr. Picou.

- Thank you, Carol. Thank you for that introduction, and really, for the opportunity to be here today. I'm just so honored to be part of this Signia Expert Series, and really excited to talk about a fun area of research for us, which is, as Carol mentioned, looking at the way that people can watch TV, and what that feels like to them, and what we can do to improve that experience. Now, Haiping and I are here today, but we're just two members of a pretty big team that's looking at this and tackling this problem

of television viewing for people who have hearing loss. So, I'd like to thank and mention the co-collaborators that we have. So, Kaili McDonald, Becky Wiacek, Todd Ricketts, are all pictured here, and then also, Javier Santos.

So, this wouldn't be possible without them. And then, in the interest of full disclosure, I'd like to say that we do receive money from a variety of industry and federal sources, but we're not gonna talk about a specific product or feature today. So, Carol, has already gone over my learning objectives, but I wanna back up and talk about how we're gonna structure this talk. So, because we are gonna talk about TV and movie viewing experiences, I'm gonna kind of structure this talk around a TV show that you may or may not be familiar with. So, CBS has this series called "Crime Scene Investigation," or "CSI." And according to the "CSI," or I'm sorry, the CBS website, "CSI" is a drama about a team of forensic investigators trained to solve criminal cases who scour the crime scene, collect irrefutable evidence, and find the missing pieces to solve the mystery.

So, for us, from our perspective, the crime is that our patients can have trouble understanding television and movies. So, clinically, you might hear something like, "I can't understand the television," pretty straightforward, or, "On the television, the words are jumbled, and the music is too loud," or, "I can't hear the words, but the neighbors wake up my grand," I'm sorry, "But the explosions wake up my grandkids," or, "My wife complains that my TV is too loud," or in worst case scenario, "My neighbor complains that the TV is too loud." So, all these things are indications that our, if you hear them clinically, that our patients are struggling while they're watching TV or movies. So, if our crime is people are having difficulty, let's apply this now to "CSI: Audiology."

So, "CSI" has "New York," and "Miami," "Dark Motives," maybe, but we are the "CSI: Audiology" team, and I promise that we are well-trained forensic investigators who are

gonna solve this case. So, we're on it, so you don't have to be. So, the first thing I wanna do, after I have introduced you to our team, is now, let's look at the crime scene. So, what's the context for these clinical complaints? So, before we get into that, I'm just sort of curious. I'd like to know what you feel, or what your intuition is, about how much time the average American adult spends watching recorded media, so, TV movies, YouTube, TikTok. Do you think it's 30 minutes a day, an hour a day, two, four, eight?

Maybe I'm being conservative, maybe it's, I guess it could be up to 24 hours a day. So, Carol, I think, has, or not Carol, Melissa has put a poll question up. So, if you wanna take just a minute and tell me what you think about how much the average adult spends watching TV. Okay, great. So, nobody bought the 30-minute argument. I don't know if you can all see this, but we've got lots of responses at four hours. And a couple of people said eight hours, and then some also said two. So, you guys are right on. I can just breeze past this, apparently. It turns out that watching recorded media is a very, very common activity. So, it's the second most common listening activity, right behind conversation.

So, it's something that people do very, very often. The average adult spends about a third of their lives watching recorded media. So, if you translate this to a 16-hour waking day, that's five hours a day. So, five hours wasn't one of the options, but I think everybody, or we saw lots of people recognizing just how many hours a day people will spend watching TV. But it's not a straightforward answer, because the amount of time that people spend watching TV changes over their age. So, this figure is showing relative time watching recorded media as a function of age. And so, we see a dip here in the 35 to 50-year-old range. So, this is peak employment, family responsibilities, really active social engagement.

And then, relative time spent watching TV goes up, or increases, with age. So, if we think about our older patients who come into the clinic, maybe, or have hearing loss, we might expect them to spend even more time than five hours a day watching TV. There are some other risk factors worth mentioning, I think, about watching television. So, we spend more time watching TV if we aren't employed, maybe we have poor health, or are low income. And just as a side note, you might expect that these are also risk factors or things that are associated with hearing loss. So, our patients, who are maybe older adults, who spend, sorry, who also have hearing loss, might spend even more time watching TV.

So, this is a really common thing that people are doing, so we need to address it clinically. So, why do people watch TV? So, they're spending all of this time doing it, why do they watch TV? So, one really common reason that people watch TV is for relaxation and mood improvement. So, you come home at the end of the day, and you're tired, you turn on the TV for something fun, uplifting, or comfortable. So, I don't know what your TV shows are. Some of my comfort friends, or comfort shows, are "Friends," "The Office," and "Ted Lasso." So, these are things I can pretty reliably count on to make me feel better at the end of the day.

People also watch TV because they wanna feel like they belong, or they want to identify a group, or they wanna know what it's going to be like in their next stage of life. So, they wanna know what it will be like, how will it feel to identify with a group next? So, very unsuccessfully, I tried to figure out what high school was gonna be like by watching "Saved by the Bell." Before I had kids, I watched "Up All Night." Neither of those really told me what life was gonna be like, but it did make me feel like I belonged. Another reason people watch TV is to get vicarious feelings of joy. So, if you're a "Big Brother" fan, or an "Amazing Race" fan, you might have your favorite contestant, and when they do well, it feels really good, and you're, you're feeling joyful and empowered because of what you're watching on the screen.

So, these are all really important and meaningful reasons to watch TV. They're all about mood, and joy, and feeling happy. Sometimes, people can get addicted to that feeling. So, there is some evidence to suggest that TV watching can be addictive, and part of that is related to the feelings of joy that come in. But all this to say, four, sorry, three out of the four top reasons that people watch TV are all about joy and happiness. We also have some evidence that adults with hearing loss do have difficulty watching television and movies. So, I presented some clinical reports just a moment ago. We know that people who have hearing loss have to watch TV at a louder volume.

It's also a really common clinical complaint. So, it's the second most common complaint behind, "I can't hear a whisper." So, people are talking about this with their clinicians. And it's not just people who are hearing aid candidates. So, more than half of people who have a mild hearing loss, or a minimal hearing loss, so hearing loss in only one ear, or a mild hearing loss, do report difficulty on the television. So, this idea of figuring out ways to enhance the TV viewing experience applies not only to maybe your traditional patient who comes in to get hearing aids, but lots and lots of people who even have maybe just a little bit of hearing loss. Well, why is the television so difficult?

I've got a couple of things, couple of reasons here. So, one is rapid dialogue. There are some cultures or shows where the speech is really fast, and it can be difficult for somebody who has hearing loss to follow along and keep up with that rapid dialogue, particularly if it's accented. So, one of the things that I hear a lot is about British detective shows, where they talk fast, and with an accent. In those sorts of shows, we might also have intermittent access to visual cues. So, in something like a TV show, or I'm sorry, a newscast, you would be looking at the talker's face all the time. But in a more dynamic or scripted show, you might not be able to see the talker, particularly if there's a narrator.

And we know that visual cues can help us understand speech, so not having access to them can be difficult. Some shows are also, or movies, are also mixed with an unfavorable or a poor dialogue to background ratio. So, we saw that a little bit in some of those clinical complaints, but you've got the dialogue, and then the other sounds can overpower. So, the music, and the explosions, and the other background noise can be loud, and that can make TV watching difficult. And the last thing is a relatively new development in our society, which is that modern television speakers can be contributing to this problem. Well, what do I mean by that? So, these are some pictures of pretty old school TVs that I found.

And what you see, they're tube TVs, kind of deep. These are relatively small versions, but there are bigger versions. And in both cases, you can see the loudspeaker on the bottom of the TV. So, the sound from the TV is coming out of the speaker that's in the front and on the bottom of that. But that's not what TVs look like anymore. TVs are much more likely to be big, flat screen, thin, maybe mounted on a wall, maybe on an entertainment center, but there's just no place for the loudspeaker anymore, when we have these really thin bevels around the TV. So, where did the speakers go? Typically, in modern TVs, you see speakers in one of two places.

The speakers could be down-firing. So, this is the TV that we use in our lab. I'm sorry for the quality of this picture, but the speakers are actually pointing down where the arrows are. So, the sound comes out of the TV and goes down, which means that the sound has to hit the floor before it bounces off and gets to our participant, or the listener, or the person in their living room. Sometimes, these TVs have speakers on the back, so we call these back-firing speakers. So, the same idea, where you've got the sound that's coming out of the back of the speaker, it hits the wall before it goes somewhere else. So, this, these down- and back-firing speakers introduce some difficulties.

So, one of them is, now, we have to deal with reverberation. So, the sound is hitting something, and bounces around before it ever gets to the listener. Also, in these down- and back-firing speakers, sometimes, they're mixed so that the dialogue and the background noise are all coming out of exactly the same place. So, we've got no spatial separation for dialogue relative to the other things that we're interested in. And what do we know about spatial release from masking and reverberation? Well, both of these things can make speech recognition more difficult, especially for older people who have hearing loss. So, I think that the modern TV setup is potentially contributing to some of the difficulties that people are having while watching TV.

So, what could be potential consequences for struggling with the television? So one of them, it could just be frustrating, right? You're struggling, you're putting in more effort to have to understand, you're maybe missing parts of the show, and that's just not fun. But if television viewing isn't fun, then it's not serving its purpose. Remember, I said that many of the reasons that people watch TV are to feel happier, to relax, and improve their mood, and feel joyful. And if you're watching TV, and you're struggling, and you can't understand, then you're not getting those benefits. So, we also know that people who have hearing loss generally struggle in their communication environments. They have to put in more effort, they might need more recovery time after work.

So, there's potential here for people who have hearing loss to be watching TV for longer to try to recover, and they're not getting those recovery benefits. So, if we take this activity that is common, and is supposed to be joyful, and make you happy, and improve your mood, and it's not working, then that can really have negative consequences on overall wellbeing and quality of life. So, we really need to figure out ways to make sure that the television watching experience can be full and joyful. So, we talked about the crime scene. So, we've got people who have, we talked about the

crime scene. So now, I'm gonna turn it over to Haiping, who's gonna talk about some of the evidence that we have to support what's going on in our crime scene.

- Thanks Dr. Picou. So, yes indeed, our lab conducted a TV project to provide some potential empirical support for these anecdotal report we see in clinic. So, the data we're presenting today is actually a small portion of a larger project. These data are based on two groups of listeners. The first group of listeners is older with normal hearing, and the second group of listeners is older adults with bilateral sensorineural hearing loss, but with no hearing aid experience. On the audiograms you can see here on the right side, indicate their main thresholds, the solid black lines, and their individual thresholds in each group. Next, let's take a look at the stimuli and conditions involved in the study. So, we recorded ten-second clips from different sources, such as TV shows or movies.

These clips were presented at 70 dB. We changed the modality of presentation, this meaning we sometimes presented the clips with only sounds, and sometimes, we presented them with both sound and picture. We also changed TV speaker setup. So, there are some clips that we've used only the TV default speakers, sometimes, we used stereo speakers, and other times, we used surround speakers. We also included two different dialogue to background ratios so that we are covering some of the most common recorded media listening experience. Next, let's take a look at the experiment setup. As you can see from the picture here, the listener was seated at the center of the sound booth. Under this TV speaker condition, the TV is activated and placed right in front of the listener.

Under the stereo speaker condition, there are two speakers placed at the side of the listener. Under the surround speaker condition, a total of six speakers were activated. Next, let's take a look at some of the study outcomes. So, speech intelligibility and sound quality are two of the many questions we collected responses from in this study.

Both questions were scored on a basis of one to 13, with lower scores indicate less satisfactory responses. So, what do the data look like? Here, we're seeing the gray boxes, indicating normal hearing listeners, and the red boxes, indicating listeners with hearing loss. The main takeaway here is that, compared to their normal hearing peers, the listeners with hearing loss, for both easy and hard SNR, actually give us lower intelligibility ratings.

And this holds true for both the clips with sounds only and the clips with both picture and sound. Further, this is actually the empirical support that we were talking about for these very common clinical complaint that people with hearing loss have trouble understanding the television. However, there is so much more to watching TV or enjoying life other than speech intelligibility. Dr. Picou's gonna talk about emotion perception in general next.

- Yes, so, consistent with what I've been saying already, we know that TV isn't just about how many words, or how much of that speech they can understand, but it's also about how they feel while they're watching, while we're watching TV. So, in our lab, over the last couple of years, we've been studying emotion, which is why we named, well, I named the lab The Happy Lab. But so, generally, when we study emotion, what we think about is the dimensional view of emotion, which suggests that we can categorize and describe emotional responses and emotions along two dimensions, primarily. So, on one dimension is valence, which is how pleasant or unpleasant something is, or how happy or, yeah, happy or unhappy somebody is feeling.

And the other is arousal, which indicates the degree of excitement or activation. So, something that's high arousal would be really exciting, maybe annoying, something that's low arousal would be calming, or peaceful, or sleepy. So, when we think about these two dimensions of emotion, we can think about the affective space, where you've got pleasant feelings on the upper end, and they can vary from low to high

excitement, like exuberance and contentment are on different ends of that arousal continuum. On the other end of the valance continuum, you could think about misery and depression as being low in valance, but on either end of that arousal continuum. So, when we measure emotional responses to sounds, we use the self-assessment mannequin, which is this series of pictures.

So, people would listen to something, and then rate their emotional response on a scale of one to nine for valance, where one would be, they feel really unhappy, or really unpleasant, nine is consistent with feeling really pleasant, exuberant, contentment, and five would be neutral, feeling nothing, nothing much. And then, so, after a valence rating, then, they rate their arousal, so that's the degree of activation of that. So, again, nine is high on the scale, and indicates excitement, and one would indicate calming, peaceful, and five is neutral. So, before we transitioned to TV listening, we spent a lot of time looking at just emotional responses to sounds in general. So, typically, in our lab, what we're using are non-speech sounds, so laughter, crying, music, and we play these sounds, and we have people rate their valance and arousal on the scale of one to nine.

And time and time again, what we've seen is that people who have hearing loss have a muted emotional response to sound. So, they don't feel that the pleasant sounds make them feel as happy, and they don't feel that the unpleasant sounds make them feel unhappy. So, we can see that in this picture here, where you've got people who have normal, oh, sorry, yeah, normal hearing in gray box, hearing loss in the red box. And we see that the ratings of valence are lower for the pleasant sounds and higher for the unpleasant sounds. And it turns out that these group differences for hearing loss are primarily related to valence. So, it's degree of happiness and unhappiness, and arousal doesn't really, is kind of a secondary consideration.

So, what I'm gonna focus on for today is all of the valence, so the ratings of happiness versus sadness. So, what does this look like for TV listening situations? So, in that study that Haiping was describing, in addition to intelligibility and sound quality, we also asked them to rate their valence. And... So, we no longer have these pleasant and unpleasant categories. Instead, we just have these clips. And what I'm showing you here are ratings of valence for the easy SNR and the hard SNR. And in both conditions, what we see is that the people with hearing loss rated their valance as lower. So in the easy SNR, their average score is five, which is neutral, and in the hard SNR, their average score is actually less than five, which means unhappy.

And both of those are lower than their peers with normal hearing. So, what does that mean? It means that in the laboratory context, they're not reporting feeling as happy in response to these TV shows and movies that we're playing for them, as compared to their peers with normal hearing. So, this suggests that maybe in the real world, they're not feeling as happy, they might not be getting those same benefits from TV listening. But we wanted to test that, to see if this effect translates to the real world listening situation. So, rather than have people come in the lab and make ratings of valence, arousal, and intelligibility, we let people make these ratings at home. So, we started this data collection fall of 2020.

So, it was a good time to be doing an at-home research study. And we've got two groups here also, like the other study. We've got a group with normal hearing and hearing loss. And I've got the audiograms on the bottom here, looking at the group with hearing loss. They're similarly aged, so both groups are between 50 and 76 years old. As with Haiping's setting, none of them were hearing aid users, so they're all just, they have hearing loss, but they're not hearing aid users. And what we did is we had them make those same ratings of intelligibility, sound quality, valence, and arousal, while they're watching TV shows or movies at home, for at least 15 minutes, so 15 minute segments.

And then, we asked them to tell us what they were watching. So, it was kind of fun, but we went through in detail to categorize what they were watching into different genres. So, was it action, was it church service, comedy, et cetera? And then, once we had those genres identified, I grouped them into things that I thought should be uplifting, so things that would make you feel vicarious feelings of joy, or feel relaxed. So, action, comedy, music should be uplifting things. Then, there are some things that I thought might not be uplifting, so crime, horror, thrillers. Those are kind of scary, they don't uplift me, so I put them in the not uplifting category. And then, there were things that were really hard to tell which direction it would go.

So, drama and news, it kind of depends on the news day and what drama you're watching. So, what am I showing you here are ratings of valence for, again, listeners with normal hearing and hearing loss, the participants with hearing loss are in red, for those three categorizations, so uplifting things, not uplifting things, and then either. And what we're seeing across the board, it doesn't matter which category they're in, people with hearing loss are rating their valence lower than their peers with normal hearing. One nice thing first is that, in general, those scores are higher than they were in the lab. So, apparently, watching TV in the lab doesn't make them feel as happy as watching TV at home, which is what we might expect.

And that's the case for both groups. But... Interestingly, I guess, we've got, we still have ratings of valance at home that are neutral, or kind of close to neutral. So, they're reporting, especially in that not uplifting or the either category, the people with hearing loss are just not reporting that they're feeling as happy in response to TV shows or movies that they chose, using the speaker configuration that they chose. So, in their real lives, they're not feeling as happy watching their shows as their peers with normal hearing. Also, just as a side note, we did, as I mentioned, measure intelligibility, sound quality, and satisfaction, and we see this similar pattern at home as we saw in the lab,

which is that people with hearing loss report not understanding as much for the shows that they're watching, so that's what this figure is showing.

They also report lower sound quality and lower general satisfaction with their TV viewing experience. So, indeed, at home, using their setup, and using the shows that they choose, our listeners with hearing loss were really struggling, both, not only in their emotional response, but also, intelligibility and ratings of sound quality and satisfaction. So, just to summarize kind of where we are, what I've presented, we've presented some evidence here that adults with hearing loss rate their ability to understand speech as lower, and that includes both at home and in our lab. And they also rate their happiness as lower than do their peers with normal hearing, especially if the dialogue to background ratio is poor, and even in their own homes, using the setup of their choice.

So, the question now is, how do we fix that? How do we improve speech intelligibility, and also bring back the happy? So, this brings us to the last step in our "CSI" drama. So, we're now gonna look at the missing pieces that can solve this mystery. So, this brings me to my second and final poll question for today. For those of you who are working clinically, and when you have people who mention TV, or report that they're having difficulty, what sorts of recommendations do you make? Do you tell them to turn on the closed captions? Do you prescribe or recommend TV ears or headphones? Do you fit hearing aids, and hope that that will fix the problem?

Do you combine hearing aids with a TV streamer? Do you do something else entirely that I don't, that I'm not thinking of? If you do something else entirely that I haven't mentioned now, and I don't mention later, please let me know, because I'm always interested in thinking about and figuring out ways that we can improve this experience for our patients. Okay. So, 12% of you said "Something else," I'd love to hear what it is. Send me an email or mention it in the comment, in the chat. So, we see pretty well,

equal distribution here for closed captions, headphones, hearing aids, and TV streaming, great. So, these are all awesome options. So, I wanna go through some of these details and provide you some evidence for why what you're doing is right.

And then, I have some other tips and tricks, also. So, the list that I came up with is pretty similar to the list the came in the poll question. So, the things I'm gonna talk about for the rest of the, we're gonna talk about for the rest of the time today is closed captions, visual cues, so having, suggesting that somebody makes sure that they're actually watching the television, and not just listening with it in the background, modifications to speaker configuration, doing what we can to improve the signal to noise ratio, improving audibility, either by recommending that they turn up the volume or fitting hearing aids, and then, TV streaming is the last thing that I wanna talk about.

So, let's start with closed captions. So, what are closed captions, and are they a viable solution for improving speech understanding? So, closed captions, as you might, 69% of you are already aware that closed captions are the text display that's superimposed on the video. So, you might even have closed captions for today's talk. But in the TV, movie world, since 1993, the FTC said that every TV that's bigger than 13 inches needs to have the circuitry to put in closed captions. So, closed captions should be recorded, at least TVs, television shows and movies. On average, they display at 141 words per minute, which is just a little bit slower than average conversational speech. But that's what a closed caption is. You might also see closed captions in movie theaters, with a rear window captioning.

You might see it in video conferencing, like Zoom. That was really a nice development, I think, in the Zoom world. Do closed captions help? Short answer, yes. So, we recently did a systematic review with one of my other students, Ling, looking at the evidence that was already published in the literature, and she found six or seven really good, high-quality studies that all point to the direction that closed captions can help improve

speech intelligibility. We see the biggest benefit when the captions are, caption and speech are synchronous, so, the captions aren't too delayed relative to the talker. The captions have to be accurate, and the signal to noise ratio needs to be unfavorable to get the biggest benefit.

So, people really need to be struggling in order for the captions to help. There are some circumstances where closed captions can make performance worse. So, if the captions are really delayed relative to the speech, it can make speech intelligibility, can actually reduce speech intelligibility and increase the effort necessary for people to understand and follow what's going on. And certainly, if captions are inaccurate, that's gonna be problematic. Interestingly, in the systematic review, we noticed that the benefits of closed captions were similar for people with normal hearing and hearing loss. So, it's kind of, it's independent of age and hearing status. Closed captions are just beneficial if they're good and fast. So, one of the studies that came up in that systematic review was this one, which is looking at recorded media, so television and movies, for people who have hearing loss and who are hearing aid users.

And what I'm showing you here are percent correct scores for the participants without any hearing aids or captions, with hearing aids, with captions, or with the hearing aid plus captions. And what we see is a small, maybe not significant, benefit of hearing aids, and this huge, robust benefit of closed captions for watching these shows. But closed captions have their limits. So, some television content is fast, over 210 words per minute. Captions aren't always accurate. So, the inaccuracy rates range from 5%, or on average, are about 5%, but they range from zero to 19%. So, if you're trying to read something that's 20% inaccurate, that can be problematic. Captions also break down in ad libbing. So, if you've got a morning TV show, morning talk show that you like, captions are probably less accurate than something that's already been scripted, or the newscasters reading from a teleprompter.

There are also some examples that are kind of fun, if you look for bad captioning on the internet. Sometimes, sounds are captured, and that can be awkward. So, there's an episode of scrubs where Turk is captioned as, "Makes 'I don't know' sound." So, that could be distracting. To circumvent some of these issues about the rapid speech, sometimes, the captioning will shorten the script. So, there's a famous movie where the phrase is, "A long time ago, in a galaxy far, far away," and that was captioned as, "Long time ago in a faraway galaxy." Same meaning, they didn't change the meaning, but it does change the feel of the show. And then, live broadcasts are really, can be really difficult.

So, I have an example from an NBC game, where the sports capture was, sportscaster was captioned as saying, "This is not a goode good decision by Eli man penguin boy." So, that can be distracting, as well. And it might be because of some of these difficulties in captioning, and the accuracy, and the speed that not a lot of people, captioning might not be as popular, at least as I thought. So, still, in this 2009 study that was published in Ear and Hearing, they asked their participants what they use, and the majority of people say they wear hearing aids. 67% of people always wear their hearing aids while they're watching TV. And only 13% of people use closed captions while they're watching TV.

And almost, and 87% of people said they never use closed captions. So, even though, in this study, they're demonstrating these huge, robust benefits of closed captions for television content, their participants just weren't using the closed captions. So, closed captions can be really helpful, but it's something that maybe people aren't doing. So, it's a really nice clinical recommendation, and it can be pretty easy for people who are willing to turn on their closed captions. So, the next thing in that list is visual cues. So, we know that seeing the talkers face can facilitate speech recognition in the lab. We've seen it lots and lots, time and time again. Visual cues improve speech recognition performance, especially in moderately difficult listening situations.

In the context of TV and movies, these visual cues are related to not only being able to see the talker's face, complementary and redundant cues, but also, the contextual cues. So, you can fill in, if you have some information from the visual world, you can fill in the missing pieces while you're watching television. One question that comes up, and it came up in that systematic review of closed captions, is something I'm gonna talk about in a minute. This, actually, is data from the study that Haiping was mentioning, looking at rated intelligibility with and without the video for people who have normal hearing and hearing loss in the easy and hard signal to noise ratio. So, we've kind of flipped the data around a little bit to show you just the really big benefits in perceived intelligibility for when the video's there.

So, we still see these group differences. So, our participants with hearing loss were having more trouble with their perceived intelligibility, but the visual cues really, really helped them. And I've got arrows to prove that to you. In terms of ratings of valence, we also see that. So, people were happier when they were watching and listening to the TV than when they were just listening to it. So, we still see these group differences, and we don't have our participants with hearing loss in the happy range for that hard signal to noise ratio, but it's much better when they can see and hear the scenes, rather than just listening to the scenes. This is the study I was alluding to.

So, the visual cues can be really, really helpful, but one question is, do the closed captions still help if you can, if you have visual cues? Couple of competing theories. If you've got visual cues, maybe you don't need the closed captions, because you're doing fine without them. Also, if you're seeing and listening to something, and now, you have to also read, is all that information kind of overwhelming, and maybe not be, not give the benefits of the closed captions? So, this student I mentioned earlier is just finishing a study looking at the benefits of closed captions for visual cues. So, we've

got listening, and listening and seeing. Yes, the bottom line is that closed captions still help.

They don't help as much. So, if you've got visual cues, the closed captions have a smaller benefit, but they still help, if the closed captions are accurate and they're not too delayed. So, just to summarize kind of this closed caption bit, closed captions help when the signal to noise ratio is unfavorable, particularly when you can't see the talker's face, or when the talker's face is coming and going, when the closed captions are simultaneous, and when the captions don't contain many mistakes. And why do I bring these things up? It's because closed captioning isn't a panacea. So, if you're on a Zoom meeting, or your patient says, "Closed captions don't help me," it could be the case that they're not helpful if they're not accurate, or they're slow, or they can already see the talker's face.b o, closed captions are great, but they do have their limits. So, the next step here is loudspeaker configuration, and Haiping is gonna return to the study that he mentioned.

- All right, thanks, Dr. Picou. So, as Dr. Picou already discussed, there are many ways that people have been using to listen to their TV shows or movies. And sometimes, they use TV speakers by default, because it's easy. Sometimes, they might be using stereo speakers. And other times, they might be using surround speakers, for multiple reasons. Maybe the quality from stereo speakers are better than the default TV speakers, or maybe they use surround speakers because they prefer this feeling of immersion in the sound. So, how do these different speaker setups affect speech intelligibility and emotion perception in general? Let's take a look at the data. So, what we're seeing here is that, for easy SNR, all the different speaker setups are giving us pretty much similar intelligibility ratings, and they're all pretty good.

However, when it comes to harder SNR, we were seeing some differences between different speaker setups. Specifically, when listeners were listening through the

surround speakers, they were giving us the lowest intelligibility ratings. What this means clinically may be that surround speakers might not be the most optimal solution. And if our patient is complaining to us that they're really struggling over understanding the television, we might wanna discuss their speaker setup at home, to see what they're using. So, what about the effect on emotion responses? What we are seeing here is that for the normal hearing listeners, their responses for valence ratings across the board were either on average or above neutral, indicated by the solid black line across the board.

When they were listening through the TV default speakers, they actually gave us the highest valence ratings. When it comes to hearing loss group, their overall ratings were pretty much neutral. And when they were listening through the surround speakers, they actually gave us the lowest valence readings. So, taking a step further, actually, none of these speaker configurations brought back the happy. And we might conclude that surround speaker might not be the best option. Aside from the effect of different speaker setups, we also wanna discuss signal to noise ratio. And let's take a look at some data again. We've already presented these two data in today's talk, but we wanna here stress on the effect of better SNR.

As indicated by the arrows here, we can see that better SNR can actually facilitate improved intelligibility ratings, as well as higher ratings of valence. And next. So, as audiologists and clinicians, what can we suggest to our patients to improve the SNR? Of course, removing noises in the environment is always helpful. If you have a chatty friend in the background, or a barking puppy in the background, that's not super helpful for you understanding the television. For some tech-savvy patients, you might wanna encourage them to play around with the settings on their TV to potentially maximize their dialogue to background ratio. As for those very tech-savvy patients who actually have stereo speakers or surround speakers paired with an equalizer, you might

wanna encourage them to reduce the level coming from the back speakers. And next, I'm gonna hand it over to Dr. Picou to talk about effect of hearing aids.

- Thanks, Haiping. Yep, so we were actually really hoping, when we started that study looking at different TV speaker configurations, that we'd find something that we could recommend. And some of us in the lab really thought it would be surround sound, but it turns out that the surround sound is maybe the least good option. So, if you can't, so if you've done everything you can to recommend that your patient improve the signal to noise ratio by changing their TV settings and minimizing background noises, we don't have a great loudspeaker configuration recommendation, and they've got closed captions on, but they're still having trouble, other things we could do are just make it more audible. So, we know that if people have hearing loss, we need to overcome that hearing loss in some way, by improving audibility.

So how do we improve audibility? Well, one way that we do, presumably, is fit hearing aids. And I've already shown you these data, but I just wanna comment again that this study has some kind of limited evidence to support hearing aid fitting. So, it's not a very big improvement. It was at 12 percentage points. And I think, in the study, it wasn't statistically significant. So, we've got a little bit of evidence that hearing aids might help improve speech intelligibility anyway, of the TV. In a different, very different kind of study, published in 2019, in PLoS One, these authors were looking at, it was a survey, it was a large scale survey, lots of respondents and lots of questions, and we're looking at hearing aid owners versus hearing aid non-owners.

So, everybody has hearing loss, and some of them are wearing hearing aids while they watch TV, and some of them aren't. And the hearing aid owners in the study reported fewer problems in a variety of domains. So, they didn't report that the commercials were as loud, they reported being less annoyed when somebody else was talking in the room, they had fewer problems understanding the newscasters. So, I think that this is

evidence to suggest that the hearing aids are doing something in the real world, in people's real lives. They also found that hearing aid owners are more likely to be satisfied than non-owners with their television listening experience, particularly when somebody else sets the volume control.

So, the people who have hearing aids were fine watching TV with their hearing aids on if their spouse was the one who's in control of the volume. So, this, I think, is benefit, and evidence to suggest that hearing aids really can help improve television viewing experience, and especially preserving that, maybe helping in the marital or spousal relationship there. So, hearing aids do a great job. They increase the overall level in a prescribed manner. So, we do a hearing test, and we fit and verify the hearing aids based on the individual's hearing thresholds. We might, it increases the overall level. It does require technology, hearing tests, and some kind of adjustments, either fitting or remote control, some kind of adjustments for personalization.

Another option would be just to tell people to increase the overall level on their TV, use their remote control and increase the volume. So, it's just a straight, overall increase in level. So, it's a uniform gain increase, it's not frequency-specific. Well, there's lots and lots of speech intelligibility data to suggest that the hearing aid is gonna do a better job than increasing the overall level. That's why we're fitting hearing aids. So, that's speech intelligibility. For emotion, I think it also makes a difference. So, this isn't specific to TV listening, but this is emotional responses to non-speech sounds. And what we did is, we tested people who have hearing loss, unaided in the red, and then aided, so we turned everything up 20 dB, and then we turned it back down 20 dB and tested them aided.

And what we see, so this is, the black is increasing overall level, so that's like turning up the volume control, and the blue is hearing aid fitting. So, again, this is ratings of valence, so five is neutral. And we see that when we turn up the overall level by 20 dB,

their ratings drop. So, rather than increasing the happy we were making them more unhappy. But we don't see the same thing in the aided condition. So, the hearing aid is doing a better job of at least preserving the emotional responses to non-speech sounds, and turning everything up by a flat 20 dB was unfavorable. So, if we look at this dichotomy here between hearing aid fitting and just overall level increase, I strongly encourage a hearing aid fitting, rather than just a change on the remote control.

So, we know hearing aids, if somebody's wearing their hearing aids, it improves satisfaction. It's also better for emotion perception, which is one of the reasons that people watch TV, so that's really getting to the heart of the matter. Then, the overall level increase is gonna disrupt that emotion perception. And then, one of the other things that came out in that large scale study I mentioned is that the more times during a show that somebody has to change the volume, the less happy they are with their experience. So, if they have to turn it up to hear the dialogue and then turn it down for the explosions, they're less satisfied with their viewing experience altogether. So, in this way, I think hearing aid fitting is a much better choice than just overall level changes.

So then, the last thing I wanna talk about is TV streaming. And I don't have a lot of, well actually, I don't have any data, but I do wanna mention it, that I think this is a really good and viable option that's really increasing in popularity. So, back in 2019, the Market Track 2019 survey, there were only 11% of hearing aid owners that used TV streaming, and in 2022, that number's up to 27%. So, it's something, I'm sure, that you're aware of, that's increasing in popularity. And the advantages, I think, to me, are pretty clear. So, we've got personalized amplification, based on a person's hearing loss, that's coming from the TV. So, we're improving the signal to noise ratio, we're improving audibility, sorry, we're improving the signal to noise ratio for things, for noise that's in the room.

And we also know that people who are using TV streamers are just generally more satisfied with their hearing aids. So, we've got streamers being good for TV listening, and also, streamers being good for general hearing aid satisfaction. Of course, if you are gonna fit a streamer, well, it's gonna be for the right patient. So, we need a tech-savvy clinician, and we need a tech-savvy patient, to be able to set that up and get that all connected. And then also, we have to be careful and mindful of what kind of gain changes we make for open fit hearing aids, because the open fit lets the noise in, and lets the streaming out, so we would have to make some adjustments there.

But overall, I think TV streaming is probably a really great option, because it's getting to a lot of those different things and challenges that people could have while they're watching television. So, just to put some appraisal on these potential strategies that I mentioned, I think we have some really good options. Subtitles, visual cues, improving the signal to noise ratio, hearing aid fittings, streaming, these are all things that should help improve the television viewing experience for our patients. We don't have solid evidence yet on the loudspeaker configuration, and I'm, so that's a yellow question mark, and I'm pretty convinced that just straight remote control changes are the least good option. So, let's return to our "CSI." So remember, I said that we were gonna scour the crime scene, and we did.

So, I showed you some anecdotal reports that television viewing is problematic. I mentioned that difficulties with media viewing is related to rapid dialogue, accented speech, intermittent visual cues, modern TV loudspeakers, poor dialogue to background ratios. And that's, all of these things are bad news, because we also know that adults spend a lot of time watching recorded media, recorded shows, especially if they're older, and particularly if they have hearing loss. And the reason that they're doing this is to feel good. We're looking for vicarious feelings of joy, and mood improvement, and relaxation. So, by not addressing television viewing clinically, we

really risk not addressing something that's really important to people, and that has implications for overall quality of life and wellbeing.

So, if people are spending their time doing something that's supposed to bring them happiness and it doesn't, that's no good. So, what can we do? Oh, well I showed you some empirical support to back up that anecdotal evidence that I mentioned. So, we saw in the laboratory and at home, adults with hearing loss are having difficulty understanding, and are less satisfied with their TV viewing listening experience, and they also feel less happy than do their peers with normal hearing. So... And just to reemphasize that, that happened in the lab and at home. So, at home, they're in control. They get to pick what they're watching, they get to pick what the speakers are, if they're using surround sound or whatever, they get to pick, and they're still struggling.

So our patients might be struggling with TV, and both intelligibility and in terms of emotion. Fortunately, we have some solutions, but our team is still investigating all of these solutions. So, we have some pretty good evidence to support some solutions with robust benefits. So, if you've got a patient who is struggling, make sure that they know to look at the TV. Facing the TV is gonna make things easier. Closed captions can be really helpful, especially if they're accurate and timely, or if they can't see the talker, for some reason, like there's a narrator. Anything we can do to improve the dialogue to background ratio or improve the signal to noise ratio are very helpful for watching, for TV viewing experience.

We have some solutions that we think will be beneficial, based on what we know, but we need to investigate them a little bit further. So, one recommendation we have is, if somebody is struggling and they are using surround sound, maybe suggest that they don't use surround sound, or that they change the ratio of the front to the back loudspeakers. We're still looking, really, at hearing aids, and under what conditions

hearing aids can improve television listening experience. And I really think that hearing aids with a streamer is probably a really nice option, based on everything that we know, but we don't have any data to support that yet. And then, I did present some evidence that we have one solution that has pretty limited benefit, which is just, overall remote control changes is not great.

So, it's gonna limit the potential of happy, and then also reduce the satisfaction with the television experience. So, if you are going to see your patient, your Wednesday afternoon, Wednesday after lunch patient, or your Monday morning patient, and this is Bob, and Bob says, "I have trouble on the television," what do you do? The first thing is, right, to know he's probably right, not that you wouldn't have believed him in the first place, but I've shown you lots of evidence now, I think, to suggest that if somebody thinks they're having trouble on the television, they probably are. We see our people with hearing loss have trouble with intelligibility, reduced sound quality, and reduced emotional response, so they're not feeling as happy while they're watching the show.

Some really concrete recommendations that you could make would be to discuss the room configuration. So, as Haiping mentioned, there are TV settings in many TVs where you can change the, you can really enhance the dialogue or reduce the background noise. It might be some trial and error. I don't have any recommendations for particular brands that do this really well, but there are different settings. So, encourage them to try to get into the menu and play around with the settings a little bit. You could also talk about speaker configuration with them. Find out what they're doing. If they are using a surround sound and the surround sound isn't, maybe, set up right for them, or it's really causing them to struggle, consider suggesting that they try something else, even the default TV speakers.

And I know that I spent some time at the top of this talk, talking about how modern TV speakers are contributing to the problem, but the other solutions that we tested weren't any better. So, maybe the modern TV speakers are fine, particularly if somebody's using surround sound and they are struggling. One thing I haven't mentioned yet, but I wanna be sure to mention, is, in that large scale study that I talked about, the survey study, they found that people who have carpeted living rooms report fewer difficulties watching TV. Now, I don't know if you wanna get into room decorating with your patients, but I do think that, particularly because of these down-firing and back-firing loudspeaker, TV speakers, where sound has to hit the wall and then hit the floor before it gets to your patient, the carpet might help reduce that reverberation, and might make it easier to understand.

So, if you're feeling brave, you could talk about carpets. So, those are some room configuration, TV, loudspeaker setup things you could do. I mean, I think closed caption is really a great option if people are willing to do it, and if you're convinced that the captioning is gonna be pretty good, and for TV and movies, it probably is, it is good. So, closed captioning can really help. TV ears, which I haven't really talked about, TV ears or headphones, both of those solutions would be really good for improving audibility and getting rid of the external noise in the background. So, anything we can do to improve the signal to noise ratio will improve the TV viewing experience.

And we don't have a lot of control over the dialogue to background ratio, so what's coming out of the TV, the explosions, and the music, and all that stuff, or if you can't control those things, then TV ears or headphones can get rid of the other noises, like appliances, and barking dogs, and stuff. And then finally, of course, you'll probably do what you do well, which is fit hearing aids, and you could do that with or without a TV streamer, depending on your patient and their listening needs. But I do think that

hearing aids should probably help, particularly if it's in combination with these other things, so, also closed captions, also thinking about reducing the background noise.

So, I wanna make sure that I address my learner outcomes. So, I think that I have given you evidence to support the importance of television and viewing as a leisure activity. It's, people do it to relax and feel good. Reasons that television viewing could be tough, no visual cues, or if you have no captions, or poor signal to noise ratio, accented speech. And then, I just gave you a list of clinical recommendations, but in case you weren't paying attention and you wanna come back right now, change the loudspeaker configuration, fit hearing aids, suggest they turn on closed captions, suggest streaming, and maybe suggest they get into the menu of their TV and monkey around with those different settings, and see if anything there helps. So, that brings me to the end of my lecture on TV listening. And I would be happy to answer any questions. I think we have-

- [Carol] Yep, Dr. Picou, we do have one question, and I have a question, as well. So, thank you for sharing all of this research with us. I mean, we really need the research to help us make the best decisions for our patients, rather than making assumptions. And I don't know about others in this room, but I've always been focused on audibility, and now, I realize the importance of the emotional quality, or the emotional aspect of watching TV, as well. So, what I would do is invite our participants, if you have any suggestions on how you work with your patients for TV listening, type that in the Q&A so it can be shared with all. But there is a question that's coming forward. "Are there hearing aids that are now compatible with the Fire Stick?"

- Ooh. I don't know the answer to that. I don't know.

- [Carol] So if any of our viewers can type into the Q&A, that would be great. And while you're doing that, I did want ask a question. It's my understanding that when you use a

surround sound system, that typically, speech is coming from the front speakers, and these other environmental sounds are coming from the surrounding speakers. So, given that information, if somebody is using a surround sound system, I'm wondering if what we need to do is take a look at the hearing aid settings, specifically, the directional microphone technology. So, I know that at Signia, when we set up a TV program, we have the option of surround sound, or more of a directional focus. And so, that might be something to consider, as well as the fact that we know that reverberations are much more difficult for patients with hearing loss than they are for normal hearing. So, I think looking maybe at those two things for your patients that are fit with hearing aids might help in this situation of listening to TV and having that enjoyment.

- Yeah, I think you're 100% right. And that's something we've talked about on our team, too, is directionality with the surround sound. I mean, it's great. The only thing I'll say is, not all of the... Where the speech comes from will depend on how the audio mixers mixed it. So, for our study, we worked really hard to make sure we got things where the speech was in the center channel, and noise was somewhere else. But sometimes, there can be speech in those other places. But it's probably not very common. You're not gonna miss out on a lot if you put in a directionality, 'cause you're not gonna have a lot of speech coming from the back, that would be a strange TV show, I don't, I don't know.

- [Carol] Somebody is asking, "Where can we find equalizers for the TV?" I know that can be specific to different TVs, but usually, it's under audio settings. And I remember one patient who managed to find the audio settings and change those, and they had the TV set up for hearing loss. And if you set up the TV audio settings for hearing loss, it is automatically going to increase the high frequencies.

- Oh, interesting.

- [Carol] So now, not only do you have the hearing aids increasing high frequencies, but you also have the TV, and that can create some enjoyment issues, I would say.

- Yeah, that's a lot of highs.

- [Carol] I don't know if you can see, there's a great comment here from Greg. "How TV shows and movies are mastered has changed over the past 40 years with the advent of 5.1 and 7.1 surround sound. Media used to be mastered in mono, then stereo, and now in 7.1. From what I understand, speech comes from the center speaker. Is there any thought into doing studies on effect of how sound is mastered for modern audiences on those with hearing loss, i.e. '60s TV shows versus 2022 TV shows? Could a study enact change in how sound is mastered in the future to be geared to those with hearing loss?" Great question, and observation! Do you wanna take a shot at answering that?

- Yeah, that is a very great question. We have talked about it. We haven't done it, so I don't have any data, but I think it would be really interesting to do that study. And I'll say, there's something else that's happening with the way that Dolby is mastering sound. So, we now have, instead of channel-specific audio, we now have object-based audio. So, Dolby, I think it's Atmos 10 or something, is mixing, the channels are now auditory objects. So, the stream of dialogue would be in one object, and the music would be in another object, and the explosions are in another object. And then, they can change the relative ratio of the objects, rather than the relative ratio of the channels.

And so, that's something that I'm really excited about, because it has the potential to interact really well with the kinds of hearing technologies we have. But it's also so new that the movie has to be recorded in Dolby Atmos, and you have to have a TV show or a technology that can handle those object-based mixes. But I think that monitoring and

studying how these mixings change over time and how that affects our patients is really, could be, potentially, really useful. I think it's Dolby Atmos, A-T-M-O-S, A-T-O-M-S?

- [Carol] Okay, thank you for answering that question. I think you saw, it came in from Charles. And Greg is very thankful for all the information you gave, as well. So, definitely, audio settings are changing, and it's a lot to keep track of, especially when you're doing a research study.

- Yeah. I mean, it, it's above my pay grade, the audio mixing, but it's really fun to think about and watch, and I hope to study it in more detail, 'cause I think it's really important for our patients, and, well, it's important in my life, which is how I got involved in the TV stuff in the first place.

- [Carol] Well, Dr. Picou, we are actually a little bit past the hour. It has been great discussion, great information. I wanna thank all of our attendees for participating today. And I'd also like to thank both of you for sharing your research and knowledge with us. So, at this point, I'm gonna end the CEU presentation, and wish you all a great day. Thank you.

- Thank you so much.