Research QuickTakes Volume 2:
After the Hearing Aid Fitting - Important Considerations

Presenter: Brian Taylor, AuD; H. Gustav Mueller, PhD

What Post-fitting Problems are Common?

- Hi everybody, and welcome back to our new series, Research Quick Takes. We're now on volume two, and in this volume, we're gonna tackle all the things you need to know after the fitting, that first 30 to 90 days or so when a person is first wearing a new set of hearing aids and the acclimation process. And with me, as usual, is a Senior Signia Consultant, Gus Mueller. Welcome back, Gus.

- Hey, thank you. Thank you. You had to add that senior part, didn't you?

- Gotta remind you. Yep.

- Yeah, I wanna know. I was the senior consultant when I was in my forties. So just for the record, just for the record.

- Your title hasn't changed.

- No, no, no.

- Well, for those of you that are new to the Quick Takes, this is our second series. The first one was devoted to hearing and background noise, and I think there's six of those that you can find on the Signia Learning Channel. And in this one, we're gonna dive into this after the fitting topic. And I think a good place to start would be to talk about some of the problems that patients experience when they wear their hearing aids. And there's really not a lot of data on this if you dig through the journals and go online and so forth, but one of the more recent studies comes from the Western Australia group, Bec Bennett is one of the audiologists there, and she published an interesting study back in 2020 on some of the problems that are reported by hearing aid users. And I'm gonna go ahead and let Gus kind of walk through some of the details.

- Yeah, thanks Brian. And as you say, it's you would think there'd be an awful lot of articles written about what problems people are having. There's not as many, but this one was nicely done, although you have to interpret it somewhat carefully, but what I liked about it is they really did some pilot work, and they came up with potential problems, and then they had users state what of those problems applied to them. So, I mean, part of it is imagine if you're given a list of things and say, is this ever a problem for you? You know, those of you listening or watching who have normal hearing, a lot of the things here would be a problem for us too.

You know, do you have a problem hearing people in a noisy situation? Well, yeah, sometimes I do. So, you know, the fact that that's the number top one by the way, it's over 80%. I think that's partly because it was laid out in that particular manner. What I think is important in interpreting this though is to look at sort of from a relative side what tends to be the most common problems today. And you see on the top there, it's people speaking in noisy situations, hearing certain voices, in windy environments, people speaking from the next room. That's of course a case of audibility for soft sounds. So it does give us sort of a hierarchy of what are the problems we maybe could expect from people walking into your office.

And in fact, in a little bit, I think we have another study here, Brian, that's gonna show how things have changed over the years. One of the things I liked about this is it's current. And so these are problems with current hearing aids. One final point here, just to put things in perspective, notice that we're saying people speaking in noisy situations, almost 90% say they have that problem. But to put things in perspective, if we take a look at the MarkeTrack 10 data, it showed that 76% of hearing aid owners, these are ones using fairly new hearing aids, actually said they were satisfied with their ability to follow conversation. So you could have the problem, but yet you're still doing well enough that you're satisfied. So there's a couple ways to look at this.

- Right.

- I, you know, Brian, I bet well, you were around Mead Killion when he was developing the QuickSIN, weren't you?

- I was. If you've been to any of Mead's lectures over the last 10 years, he shows data that was collected in my office back around 1999 or 2000 when they developed the QuickSIN. And to me, it's an indispensable tool, because as the slide says here, it really helps you determine is the problem the patient experiencing one that needs to be adjusted with programming on the hearing aids, with the hearing aid software? Or is it more a problem that really can't be fixed because the person's auditory system has got quite a bit of distortion in it? Anyway.

- Yeah, I think, you know, I've done this clinically many times myself, and you'll have a person, you know their QuickSIN score is 10 db or so, they have an SNR loss of 10 db, and yet they wanna understand 100% in a restaurant that's plus five db. And you know, that's not a programming thing. That's a let's sit down and talk about this kind of thing. So, just wanted to toss this in. I think it's a real helpful tool.

- Yeah, it's indispensable.

- And hopefully, all dispensers use this routinely. It's really great for counseling 'cause it sort of tells you where the patient is. I also want to add from a study from several years ago, but it's as relevant today as it was when it was published, Ron Levitt and Carol Flexer showed that all they simply did was take hearing aids that had been on proprietary fit, and they reprogrammed and fit them to NL two, maybe even NL one. I'm not sure when they, that study was done. The point is still the same. By simply programming them correctly, people got a six to nine dB benefit in background noise. So, you know, the comment of programming won't help. I'm saying that assuming that

you programmed it correctly to begin with. If it's not programmed correct to begin with, well then programming will help. So.

- Well, yeah. That's a really good point. It shows you the importance of audibility and then also matching a validated target. And I think that study really illustrates that so many people are under fitted.

- Yeah, yeah. It's audibility is an amazing thing. Here's another study, and this has been around for a while and has been used by a lot of people. You see it referenced a lot, relative to what problems are common. This was actually a study where there was a form sent out to working audiologists, practicing clinical audiologists, where different problems were presented, and then the audiologist reported what they believed the patient would say if that problem existed. So, you know, if they said compression set incorrectly, people might say, well, I think they'd say things were too loud or something like that. So that's what this is all about. And they had a lot of different problems. This is, I just pulled out the top 10 of them here. And so Brian, I know you're familiar with these data also.

- Yeah, I mean this is an interesting study. I think it's used a lot by manufacturers when they set up their troubleshooting algorithms. I know that it's used by audiologists that work in technical support as well, but it kind of shows you kind of clusters around some of the different, the more common problems. And you can see that list pretty plainly. I think what's interesting Gus, is that you take this list and you compare it to the previous list. This is from audiologists, and the other list was from patients. And you can start to see some similarities and some important differences in how professionals and patients view the world.

- Yeah. Yeah, exactly. The other point about this is this study is now almost getting to be 20 years old. And when I was looking at the list, I saw a couple things here that I

don't think would rank as high anymore, such as the hearing aid whistles or acoustic feedback. And another one sounds like in a barrel. First of all, you don't see a lot of people talking in barrels anymore. I'm sort of disappointed about that. God, it used to be so much fun, but the point being more that there aren't as many people with occlusion anymore. And so this was a study that coincidentally just came out a couple months ago. These two people wrote about how comments have changed over the years. And so, you and I talked a little bit, Brian, about what has changed, and we came up with four different things that really you don't see as a problem as much as we were seeing 15, 20 years ago.

- Oh yeah, that's a good, I think that you have to, so that study was published in 2003. It's a pretty good bet that that data was collected around 2000, 2001.

- Correct. Yeah.

- And what didn't we have in 2001? Well, we didn't have feedback cancellation algorithms, at least the kinds that are as sophisticated as you see in hearing aids today and have been around now for a number of years. You didn't see Open Canal instant fit ear tips, which helps with occlusion. You didn't see sophisticated wind noise reduction algorithms inside hearing aids. So this is a good, this article here that you show is a good reminder that we've made a lot of advances in technology that minimizes some of the problems that you saw, I think, on that previous slide.

- Yeah, exactly. And we were also fitting a fair amount of custom instruments back then, where I think maybe the comfort thing enters in.

- Exactly.

- Because it certainly wasn't uncommon that a custom instrument was fairly uncomfortable if it completely filled the ear. So we're making improvements, but there's still problems. Here's I think though, if when you're a person dispensing hearing aids, and somebody walks in the door, there's actually, I think, four things that you need to think about. And one is, can this be fixed through programming, or is it just a counseling issue? Will fixing the problem create a new problem? Which sometimes happens. You try to improve high frequencies, and now you have feedback. Does the patient know what's best for them, or will the problem simply solve itself? Can you coax the patient to let the acclimatization? I mean, here's a real typical example is a patient walks in and says that soft sounds are too loud.

That's pretty common if you fitted them to the NAL or DSL targets, and that's easy to fix. You know, it's really easy to turn down soft sounds. But then there's some research, Louise Hickson and her group looked at all kinds of factors that relate to satisfaction, long-term satisfaction, and of the audiology factors, the programming factors, the one that was correlated was matched to soft sounds, not to average sounds or loud sounds, matched to soft inputs. So, you know, do you really, to fix a problem, do you really want to take away one of the driving forces for satisfaction? You know, it's a dilemma that people face every day.

- Well, and it kind of makes sense when you think about it. People have, they come in to get hearing aids a lot of times because they haven't heard soft sounds in a long time.

- Yeah, exactly.

- It takes them a while to get used to it. We have to them some time. But anyway.

- And I can't resist then adding this, that, you know, we're in this particular topic of after the fitting, I think we're gonna do a series of, I don't know, four or five of these, and if we stick with what we have planned, two of 'em are going to be about does the patient know what's best for them, or maybe will the problem just simply solve itself through acclimatization if you can get the patient to wait. Well, speaking of making changes, this was one of my favorite articles from a couple years ago or actually only about a year ago.

- It was last year, yeah.

- Yeah, yeah. That this was, and because it relates so much to what we do in the clinic, and that is when a person complains of something, you know, it's our nature to try to fix it. And so oftentimes, it's a problem maybe in the high frequencies, you turn up the highs because they don't have audibility, they're having trouble with background noise. You turn down the highs because they complain it's too tinny, and you do, is this better? Is this better? How about this? I mean, I'm thinking that's probably what everybody does. That's what we've been doing for, since we had trim pots, except we didn't make a lot of changes, but we take the trim pot and turn it from N to H and back to N again and to see how that would work.

So this was a really interesting study where they did paired comparisons to see when an individual actually could tell if there was a difference or not. And one of the things I liked about it is they also, one of the comparisons was when there was no difference at all, sort of as a control to see how reliable these people were when there was really no difference, did they truly say no difference. So I took their data and put it on bar charts to make it a little easier for us to talk about today. So this isn't the chart that you'll see in that journal article, but hopefully it makes sense. So what you see here, if the bar is blue, that means that particular change, they said it sounded worse.

If the bar is orange, that means that they said they didn't hear any difference when you made the change. And if the bar is gray, that means that they said it got better when you made the change. So what you see here is the patients were very reliable when there was no difference. 95% of the time they said there was no difference. Now this is for low frequencies, and you see then as you decrease low frequencies, there's a very strong trend that people say things got worse. And as you increase low frequencies, there's people say it got better, and you start to see a difference at around 40 dB. And once you get to eight dB, then there becomes a pretty big difference.

Well, when we move over to mid frequencies, it's a similar pattern except what you see now is that the orange bars got bigger, and now you see plus or minus four dB, we're still seeing more than 70% of the people hear no difference when you make a change of four dB. What I found the most interesting, however, was these, by the way, is filtered speech. That's what they're playing to these people. So it's real speech that's been filtered for low, mid, and high. And what I found was the most interesting because what we do, what we change the most is the high frequencies is look at all the big orange bars. And so what we see here is even when you get out to an eight dB change, plus or minus eight dB, over 60% of the time, people can't hear a difference.

It sounds the same. Now does that mean when they're sitting in your office or clinic and you make a change and you say, is that better? Will they say, yeah, yeah, I think that's a little better. That's probably what they'll say because they like to please you, and they're hoping it's better. But when you really look at it in a controlled scientific study, for high frequencies, you need a huge change before these people are even hearing a difference. Now granted, for some of these people, it might be inaudible, and that's why they're not hearing the difference, because they did have a variety of hearing losses. But I think it's a good teaching point for all of us to remember that sometimes, that you need pretty big differences before patients are going to.

- Yeah, no, this is a real, I think every clinician out there fitting hearing aids needs to see this because it just really, I think, underscores the point, when a person's nodding their head, yes, it sounds better, and you're only adjusting it four dB, there's a really good chance that that difference is not meaningful to them.

- Yeah.

- You gotta really, I mean, even inside the automated fine tuning of a hearing aid software, I think, there's probably some issues that they could learn from this.

- Sure, yeah, absolutely.

- Making these changes.

- And you know, all this automated fine tuning that we have, you know, tends to be pretty conservative because you don't want to make gigantic changes and really mess things up. But for something like this, it oftentimes might be too conservative, and you might have to push it a little bit to really get a difference.

- Right. So it comes down to these four points. Go ahead.

- Yeah, well this is it. Yeah. And this is what we're gonna be talking about through this whole series, and that is do you fix it or counsel it away? Is there a new problem? Does the patient know what's best for them? And maybe the problem will solve itself through acclimatization. So we're gonna be back with a few more of these as time goes on.

- I guess we'll find out next time what it is.

- I can hardly wait.

- All right, Gus.

- We'll see you then. whenever that'll be.

- We'll see you then. And yeah, we'll see you next time.

- Okay.

- Thanks. Bye.

Reliance on Patient Judgments

- Welcome back to another Research Quick Takes. We're on volume two, 2.2 to be exact. And today we're gonna be talking about issues after the fitting, and we're gonna focus on Reliance on Patient Judgments. And with me today, as always, is Senior Signia Audiology Consultant, Gus Mueller. Welcome back, Gus.

- Yeah, thank you, thank you. This is sort of a fun series we're doing. We're talking about what happened after you do what you think is the perfect fitting. And the patient goes home and they come back and have problems. Last time we were together, I know we talked about what these problems might be. And so now, we're sort of moving forward into a lot of times we want to put a smile on the patient's face, but the question then becomes, does the patient know best? So, you know, when I think about these and my many years of working with patients is, you know, you gotta think through if I fit them correctly to begin with, do I really wanna change something or is it just counseling?

But if you think, "Well, this person really should know what's best for them and I'd like them to like the hearing aids and certainly keep wearing the hearing aids," so maybe you need to make some changes or maybe you make a slight change. But a lot of it, what it boils down to is who knows best of what's best for the patient. Does the patient know best or do we know best? And that's sort of what we're gonna talk about today.

- It's not always an easy question.

- I don't know if you remember this study or not here, Brian.

- I do remember this study, this was back in 2006, 2007. This is one of the first studies that I remember that looked at trainable hearing aids. We don't really use the term trainable hearing aids anymore. We hear more and more of the term machine learning, which is another way of talking about trainable hearing aids. And I know, Gus, you were

instrumental in collecting the data and writing this up and getting it published. So maybe you could explain what you were looking at here and what you found.

- Well, yeah, you're absolutely right. This would, in fact, many would say that this was the first machine learning hearing aids that were out there from anybody. And I think down the road someplace we have plans to actually talk about machine learning and AI and deep neural networks and all that. But for right now, let's just talk about what happened here, and that is people had the ability to go out and use their hearing aids and to do training with them. And what we thought, and there had been some other studies that had looked at how well the NOW worked and they started people off by fitting them to the NOW. And so we thought what would make this interesting is to fit to over the NOW by 6 dB, under the NOW by 6 dB on two different times and then see where people ended up.

And so we had data logging to make sure people were really using the hearing aids and doing the training. And we gave them assignments for the real world of places to go. And we encouraged them to change the hearing aid as much as they can. They didn't even know they were trainable. We didn't tell 'em that, but we were keeping track of what they were doing. This is all the datapoints of the 24 people. The diamonds and triangles you see at each one of the three columns are the mean and median, which turned out to be basically the same. So you don't have to differentiate between the mean and the median. But the point here I wanna make is let's start off with, we had a wide range from in the one setting some people went as low as minus 14, in the other case, some went as high as plus 14.

One of the things to remember here is the NOW target is a range, it's not a particular point. So we would expect there to be a range from the NOW. I mean, this isn't terribly shocking, you know, which is why people shouldn't get so excited about hitting the exact target. You just want to be in the range of the target. But what I find interesting is

that in one part of the study, the mean turned out to be 5 dB below the NOW. In the other part of the study, the mean turned out to be about 3 dB above the NOW. And so there's about an 8 dB difference here in what people settled on as their preferred listening.

But the main point I want to make is these are the same people. It was a crossover trial. So if a person really, really liked minus five when they were fitted 6 dB over target, they would've tried to train all the way down to minus five. Or if they really liked plus three when they were fitted down 6 dB below, they would've trained up to plus three. But you see, they didn't. So I think from thinking about does the patient know what's best, maybe, but there can be a pretty wide range of best of what they... But this is for average speech, by the way. Maybe the range isn't as big for other factors. But it appears that, and this is we know this from MCL Testing as there's a pretty wide range of what is okay and it appears to be fairly large in this particular case.

And it also depends on where you start the person. If you start the person 6 dB over, they might just be happy at 3 dB over. And so all of this enters in to what is best. I don't know if you have anything to add, Brian?

- I think, the bottom line or one of the takeaways here is besides the individual variability that you see on the slide is that people tend to train around where you start them.

- Yes, and they tend to end up, yeah, exactly.

- And they end up there too, exactly.

- And that can be their judgment. And again, you know, this really relates directly to the fitting, is there's some people who believe that you fit the people 10 dB other under

target, and then ease them back in to target. But the problem is if you start them below, they're gonna say, "You know, that sounds pretty good, I like it here." And then, are you gonna move 'em back up or are you gonna say, "Okay, he's happy, I'll leave him there."

- [Brian] That's why it's always tricky.

- A lot of decisions to be made. So you probably know then we did a second study.

- Yeah, right. The first one you just mentioned was trainable gain. Now I know then Signia was the first to have trainable compression in hearing aids. And I think that's what the second study is about, if I'm correct.

- Exactly, exactly. This was now generation two of machine learning hearing aids I'll call it. And again, it was a somewhat similar study except now there was a lot more things going on for the person to work with. There actually was, they could also alter frequency to some degree. And so again, these people went out into the world training their hearing aids. And they had, in this particular study, they had a range of plus or minus 16 dB from where we fit them. So they had a lot of training that they could do. We also purposely, we went to a clinic where we knew that they were fitting everybody with proprietary fittings and we know the proprietary fittings under fit.

And so from that clinic we looked at satisfaction scores that people had sent in. And so we purposely looked for people who were very satisfied with their hearing aids and had used hearing aids for two years or more. So that's the group that we brought in. And so now what I'd like show you is the results that we found. So to walk you through this, the blue bar, this is for the frequencies 2000 through 400, which are, we just averaged them together 'cause that's where most of the change was going on. The blue bars are, this is output would be if they were programmed to the NOW. The yellow or orange

is what they had been using. So when they walked in the door, the first thing we did was set them down and measure what their use gain was or use output was.

And then the gray is what they were using after six weeks of out in the real world training their hearing aids. So let's look at Soft because that's where it's the most interesting. Before they started the training, remember these were people who said they were really happy with their earring aids. Before they started, they were under fit for Soft by 11 dB. When they came back, they were only 1 dB below the NOW. Overall on average, they went up by 10 dB for Soft. So I notice average for average input, that's the middle column, we saw a very similar change. Loud inputs, they were okay at loud to begin with. So we didn't expect to change and we didn't see a change.

But the point I wanna make is that these people were happy, yet they were terribly under fit. And when we gave them the opportunity to fit themselves correctly, they actually did it. And they started using more gain for Soft, which, of course, we know is critical. 55% of these people had 10 dB or more gain for Soft than they had been using in their previous instruments. I don't know if that's sad or encouraging. You'd have to-

- Well, I think it's a little bit of both. I think it's important to remember there's a difference between a patient being satisfied or happy and benefiting from their hearing aids. And it gets back to the whole point of why you can't just try to please the patient when they come into the office. You have to stick to the targets and do some things that we know the science bears out as being correct to do in the clinic.

- Yeah, you know, the analogy that's been really overused, but I'll use it again anyway, is the example of putting braces on the teeth of a 12-year-old. They're gonna be the happiest if the braces aren't very tight. But when they're 21, they're gonna be the happiest if the braces were tight; they have straight teeth. So, you know, how do you define happy? Right?

- [Brian] Right, exactly.

- Well, you know, I remember you talking about this study in one other presentation, Brian. This is the big Larry Humes study from 2017.

- Yeah, this one, I can't believe this study's already five years old. This is one of maybe the first study that looked at basically, even though they don't even today exist, but over-the-counter hearing aids, at least hearing aids that could be retrofitted as over-the-counter and compared some outcomes for that group relative to people that got their hearing aids through the traditional clinical delivery system. And then they also, I know-

- I think I have a slide, actually, summarizing-

- [Brian] Yeah.

- This, by the way, to our listeners, this article is open access and it's still worth reading even though it's a few years old. So just because it's in a journal you don't subscribe to I'm pretty sure that it's open access.

- It is open access. Yeah, you can find this and not have to-

- This is, what you're talking about, Brian, so you might want to go through this. I actually did up a slide on this for you.

- Oh yeah, thank you. So in Larry's study, there were three different groups, people fitted to the audiology best practice, so what we're supposed to do in the clinic, fitting people to the NOW target. There was a group that were fitted with OTC-like hearing

aids. We'll call that the patient or he called that the patient decides group. And then there was a third group, which was the placebo group where people were fitted basically to a hearing aid that had no gain that matched the response of the open ear canal. And the people were not able, the participants in the study were not able to change the gain. So at the end of the six week trial, I guess, maybe we'll leave our viewers in a little bit of suspension here, but the patients were told that they could get a full refund on the purchase price or they could keep the hearing aids. And I think it's kind of interesting to see what each group said.

- You know, there's of course a ton of data that comes with this study and what they did, a lot of outcome measures and there certainly were differences among these groups in some areas, particularly the placebo group on outcome. But one of the main outcome measures is your wallet. Right? And so that was, to me, was the interesting one. So I'm gonna pull back the curtains now. So under curtain number one, we have the best practice. 81% said that they were gonna keep their hearing aids. I actually would've thought it was a little higher, but again, these were people who just agreed to participate in a study. In your clinic, you'd hope you'd probably hope for more like 90, 95%.

- I'd take 80%, that's not bad.

- You don't mind 80? Okay. I'm fine with 90. All right. Well, and then we look at the patient decides, it dropped down to half of them decided. And, you know, who knows what part of that had to do with the fact they weren't really guided by an audiologist or dispenser. But here's the biggie. The placebo group with no gain, 36% said they didn't want a refund. They wanted to keep the hearing, keep using the hearing aids that had no gain. That had no gain.

- Yeah, that's an amazing statistic. Just about a third of the people that were fitted with a hearing aid that had no gain said they were happy enough that they would keep the hearing aids. And I think that's a lesson for clinicians when patients come in and they say they're really happy with things. It's probably, we need to collect a little bit more data and get a little bit more information on those patients.

- I remember the early days of pro mic measures. We'd set a person down and say, "Tell me what you want me to do." And it'd be, "Well, you know, a little more in the highs, a little more in the lows. No, this here," and they go... And you listen to 'em, you're doing all they say. And when you finish, they had matched their REUR. People love hearing aids that don't sound like hearing aids.

- Well, and I know, I think everybody has a story of the patient that comes in and they say they love their hearing aids. And then they take them out and they are plugged with wax.

- Or there's not a battery in it or, yeah, we well all know that. Here's one other thing about that study, Brian, that I thought was sort of fascinating. It's a little difficult to walk through, but I'll, hopefully I can make it meaningful. So what we have here is the audiologists looked at the audiograms and they decided that this is now the three of the pick your own. The consumer got to pick what they wanted and there were three of 'em that varied in gain. So audiologists looked at this and said, "Well, according to the NOW algorithm, this is the hearing aid that I would pick for you." They did this after it was all over. And then we have the ones that the participants picked.

So if you, the audiologist overwhelmingly, from a prescriptive standpoint would pick hearing aid Y. So read down under Y and you would see that that adds up to 62. So for 62 of the ears, the audiologist would've picked Y. The patients, however, now read horizontally and you'll see all the big numbers are under X. Overwhelmingly, the

patients wanted hearing aid X. To no one's surprise, it was the hearing aid with the least amount of gain. So when you do the math, what you find out is about 70% of the time the patient picked the wrong hearing aid. At least I'm calling it the wrong hearing aid. If you don't believe in the NOW, then you might say they picked the right hearing aid. But I happen to do believe in prescriptive methods. So I'm saying they picked the wrong hearing aid. That tells me well the.

- Overwhelmingly, they picked the wrong hearing aid that has less gain.

- Yes, exactly. Exactly, so it goes back to the same thing we were talking about before. And then we get into another area, poison ivy.

- And that's something.

- I just couldn't resist putting that picture in there. I've never had poison ivy myself.

- [Brian] I have not either.

- I hear it's nasty, I hear it's nasty. This is a classic study from the 1960s. So where I'm moving to now is the placebo effect, which interacts with all this, you know? The reason that those people kept those hearing aids with no gain, maybe it had to do with the fact that they went to the University of Indiana. And what could you get from the University of Indiana that wasn't good, really? You know? And so I don't need gain, I went to the university, man. So that this tells you how big this poison ivy study. So what they did is these were people who were very sensitive to poison ivy. And they rubbed something on their arm that they were told it was poison ivy.

So one arm was rubbed with something that wasn't poison ivy. Another was run with something that really was poison. All 13 boys broke out with the rash on the arm that

they were told had been rubbed with poison ivy. But of the ones who really were rubbed with poison ivy, only two actually broke out in poison ivy. Which led to conclusions that have been made by many. And this is really important 'cause it relates to hearing aids. Excuse me. Patient beliefs regarding treatment may have a stronger association with clinical outcome than the treatment received. In other words, if you believe something, it could be even stronger than what you received. And how does this relate to hearing aids? So here's a study. You remember this one I'm sure, Brian, that-

- Oh, yeah, this is, well we have the, just the power of labeling, right?

- Yeah. Well she called it the digital hype or the labeling of digital hearing aids. This was one that she had hearing aids, that they were all the same hearing aids, but she labeled, at one point in time they were labeled conventional. Another time they were labeled digital. This was when digital was a real.

- Exactly.

- [Gus] Really hot term, right?

- Right.

- What was the year on this study? Maybe 19...

- I think it was like 2001, maybe? Maybe '99?

- Yeah, something like that. So it's right when digital hearing aids were first coming out. What she found is their AFAB scores were higher when you told them it was digital.

And 33 of the 40 people had a preference for digital. There was a second study, I believe this was from Kevin Monroe and Oz and that group.

- Looking at new versus.

- Where they did a similar thing where they looked at what they called one pair of hearing aids new, the other pair conventional.

- One Conventional, yep.

- But they were all the same hearing aids. And they had a very similar finding. Three-fourths of those people said they wanted the new hearing aid. So again, yes, it's nice to ask patients opinion, but the question really then gets down to how good is the patient at really picking what's best for them? And how much should you change or so how much do you simply stick to your guns and say, "What I'm doing right now is, I think is best for you." My overall thought is the patient isn't very good at really picking what's best for them. I don't know, what's your concern?

- I agree with that. I think generally speaking, patients are more apt to wanna please you than they are to really have the judgment to know what is optimum, the optimum settings for benefit, that kind of thing. So, oh, I agree with you completely. I think patients are probably not the best judge of what's best for them, and that's why what we do is a science that, you know, sticking to targets and verifying and things like that are so important.

- Yeah, exactly. Exactly, so that wraps it up for this part of part number two of our little series. And we beat up the patient a little bit, but we're,

- Well, I think people, they know-

- We're still gonna, we're gonna listen to 'em, we're gonna listen to 'em.

- Well, there's a time and a place for that. But I think our viewers know where we stand on the reliance of patient judgements when it comes to setting the gain and the output of their hearing aid.

- Yeah, exactly. All right, well, I think we did it.

- Got another one in the books. See you next time for 2.3.

- 2.3. I can hardly wait. All righty.

- Okay, bye.

The Role of Acclimatization

- Welcome back everybody to another Research Quick Takes. We are on volume 2.3. We're talking about things you do after the fitting, and today we're gonna be talking about the role of acclimatization. And with me as usual is Gus Mueller. Gus, welcome back.

- Thank you, thank you, thank you, and it's always good to do these little sessions with you. And this has been a fun topic that we have here. We're talking about things after the fitting, and as you mentioned, this is the third one. So, this is all about acclimatization I guess, if that's the term.

- Yeah, I think that acclimatization can mean different things to different people, and maybe it would be a good idea for you to kind of give us some of the terminology around this term.

- Yeah, for sure. We use acclimatization in the title just because it does seem to be popular. There are some people who believe that acclimatization really is a real physical change that is happening in the system. And so, then you could argue that some things related to hearing aids aren't really acclimatization, and one might say a better term is adaptation, which is number two on the list. And actually that probably is a better term when you think of how the eyes can adapt to light and those types of things. You also could call it adjustment, but we do an awful lot of adjusting with hearing aids, so I would probably vote that term out because it would be confusing if we mean adjustment like acclimatization or adjustment like changing gain.

And then of course, some people have suggested that we call it auditory learning, that things are really changing related to perception, cognition, memory, and all of these factors enter in. We'll use acclimatization today, and by the time I think we'll finish we'll cover the areas of how acclimatization has been used differently. You know, I was sitting back when we were planning on this I was thinking about in a typical hearing aid

fitting how might acclimatization come into play and either help you or work against you as the case may be. I don't think it probably ever would work against you, but first of all, acclimatization to soft sounds is one thing that we deal with almost all the time for new users.

High frequencies, we've all heard the people who say, "Jesus, hearing aids sound so tinny," a month later, "Eh, it doesn't sound as tinny anymore." LDLs, people want to know do LDLs change? If they do, you'd really have to change the programming over time. Your own voice, you acclimatize that. Of course, fortunately now we have OVP with Signia hearing aids. And it isn't as critical, but I think we've all at one time maybe in our career when a person said their own voice sounds funny our line typically was, "Don't worry, you'll get used to it." Some did and some didn't. And then of course, the real big one is is the brain really changing when we wear hearing aids? I mean, that's the big one, right?

- Right, that's the objective measurement that something is actually happening in the cortex I guess.

- Yeah, yeah, and I think we'll get to that before this is over. If you go back to the, I think it was Gatehouse who first coined the term of acclimatization, and some of the thought then that yes, indeed, there was a brain, the brain was actually changing to these new sounds.

- Pretty wildly.

- And we'll, I think we got a slide on that later on, but before we get there I want to talk about a study that I know you're familiar with that we looked at. And the only way to explain this is to give a brief introduction to this fantastic self-assessment scale called the Profile of Aided Loudness, which was something that Catherine Palmer and I

developed. And just an interesting tidbit about when we were developing it, we had to find sounds that normal-hearing people rated the same, and a couple of interesting tidbits. We thought one of the best terms, best sounds, would be clinking of glasses. The only problem was when we did this study of over 100 normal-hearing people we found that people ranked clicking glasses, some people ranked it a two and some people ranked it a six. I guess it was what was the occasion, was it a wedding anniversary or your football team just won? I don't know.

- And much you like to socialize?

- Yeah, I don't, how would you rate your clink Brian, you've got a rating for your clink?

- Oh, I don't know. I'd probably put it somewhere in the middle.

- Middle, okay. Yeah, if you got a beer mug in your hand it could be a five or a six on the seven-point scale. The other thing that was funny, out of all the things that people rated the one that was the most consistent, we had 120 items. The one that was the most consistent was the galloping of horses. But of course these were sounds that people heard during this trial period, but really you couldn't really put that on a scale. I'm thinking the average patient isn't gonna hear galloping of horses, so.

- I don't even know how that made it on the list.

- Well, it was an open-ended thing. We sent all these normal-hearing people out with an open-ended scale and we said, "We want you to write down everything that you hear during day after day after day after day, and then when you write it down, when we write it down, then I want you to, then you rate it on this one to seven scale." Well, I don't know, there must have been a rodeo in town. I don't know what it was, but there were three people who rated galloping horses. And they all rated it a six .

- That's funny.

- But we didn't use galloping horses. Anyway, these are the norms for the PAL that you all can look up. They've been published several places, including this, I found this article Brian.

- Yeah, that rings a bell.

- I'm thinking you probably have it under your pillow. This was the award-winning one, as I recall.

- I'm not that big of a nerd here.

- I noticed in the fine print, fine print down there it says Brian Taylor and Gustav Mueller. That must be--

- I wonder who those guys are.

- Yeah.

- I vaguely remember this.

- Now, this is, now aren't you the editor of this journal?

- Yeah, I have been for about, I don't know, 11 or 12 years.

- Yeah, so was there some problem getting this through the editorial process?

- Not at all. That's the beauty of being the editor and a writer.

- Yeah, how about that. Actually, it's not a, it's not a bad article.

- Go ahead.

- No, it's pretty animated.

- You do remember it, right?

- Well, and I think the thing about this article that I remember was it was sort of when all hearing aids became wide, had wide dynamic range compression in them, which obviously means more gain for soft relative to average and loud. And I think one of the things we wanted to look at was that there's more gain for soft is how does that look on a loudness rating?

- Yeah, exactly. And because there was, and it still exists today, there was a lot of patient complaints about too much gain for soft. And so, this is a study that I was involved in, and it really makes that point very nicely. Now, using the PAL, so the PAL norms, that's based on the Cox seven-point chart. The PAL norms are two for soft, four for average, and six for loud, or very close to that. It's not exactly those numbers, but very close. So, what's interesting here is in this study we had a group of previous users and we had a group of new users, and we all fit them with, we fit them with new hearing aids programmed to the now.

And this was when the NL1 just first came out, and so we were very, we tried our best to program gain for soft correctly. And the point I want to make here is look over for soft sounds, previous users, they're supposed to rank soft as a two. That's what our norms ranked it. And we gave, these people are rating the very same sounds that

normal-hearing people ranked as a two, previous users ranked it as a three, not good, new users ranked it as a four. So, they're supposed to rank, they actually ranked soft sounds as you're supposed to rank average level sounds, which means to these new users it really sounded like average level sounds.

In fact, if you go to average notice that where they ranked average-level sounds was not much different than where they ranked soft sounds. Yeah, so that's the problem, that's the problem we're dealing with. What does this have to do with acclimatization you might ask? Well, this is a second study, and in this study we only looked at soft. And so, what we did in this study is patients had hearing aids where they could not change the gain, and they had to agree to wear the hearing aids for eight weeks without the gain being changed. We only had one person out of 30-something who dropped out who said, "I just can't wear it at this level," dropped out of the study.

The rest of the people went through the study and at intervals they completed the PAL. And so, I think there's a good teaching point here if you look at what happened at day one, week one, week four and week eight. So, first of all, when we look at the orange bars these are the experienced hearing aid users. They were rating soft correctly after only one week, after one week they were rating soft as right around a number two. That's where they're supposed to be rating soft. But look what happened to the new users. The new users did not rate soft correctly until eight weeks of hearing aid use.

After eight weeks they filled out the PAL and they go, "Yeah, my own breathing sounds like a two." Where back on day one and week one their own breathing sounded like a four. And so, these are the kinds of things that are a, that's a type of acclimatization. And it's really something that I think as we're fitting hearing aids we have to take into consideration. It also relates to self-fitting. I mean if a patient, is a patient gonna say, "You know, I think I'm just gonna wait eight weeks until I get used to this," or are they gonna take out the app and turn down gain for soft?

- Yeah, that's a really good point. I mean, if you go back, you don't have to go back to that one, the slide previously you showed, I would say kind of expected with WDRC hearing aids people rate soft sounds much louder than average when they first--

- Well, they rate 'em as if it was an average sound.

- Yeah, like an average sound. But over time, to your point about self-fitting hearing aids, that's really an important one I think is they never get there if it's too loud right out of the box. But if they work with an audiologist that counsels them properly, within eight weeks it should start to sound the way it's supposed to.

- Yeah, it's a, you can't acclimatize to anything unless you experience it. That's the whole definition of acclimatization.

- Exactly.

- I mean, if you go to Florida in the middle of the summer you're never gonna get used to the humidity if you never leave your hotel room. You have to go out in it before you acclimatize to it. And well, soft sounds are like a hot, humid day in Florida to some people. Well, a question, here's an easy one to answer. Some people wonder if LDLs change over time. In other words, the more you listen to louder sounds in hearing aids do they go up and up and up? There's been two really good studies done on that, one by the VA and one by Ruth Bentler. And in both times their conclusion was no, they don't go up, they stay the same.

Now, maybe if you fit somebody 10 to 20 dB above their LDL I don't know if that would change, I don't know if that would change it or not, but I don't know if you're familiar with any of that research Brian. But that's not a study you would normally do, right?

- No, I mean I don't think--

- Why would we purposely fit somebody above their LDL?

- You really probably couldn't get that through an IRB, the same way we wouldn't

- I agree, exactly.

- really fitting somebody above their loudness. Although, I'd have to say in the world that we're, in the new OTC world it would be nice to have some data that looked at that.

- Yeah, yeah, it certainly would. I mean if it only raises your LDL that's one thing. If it's noise hazardous that's a whole different issue, which indirectly relates to this. Although, things can be noise hazardous without infringing on your LDL, and we see this with people with severe profound hearing loss. A lot of times they want an output of 135, and they're not complaining that it's too loud. Well, the one good news then is, as a clinician, you don't, if the LDL doesn't change it means you don't have to keep measuring it every year 'cause it's probably gonna stay the same, so there's some good news here.

- Do it once and be done.

- Exactly. Here's some data, I know you're familiar with this Brian. This is from Herman,

- Yeah, this is really interesting around, yeah.

- and some of her colleagues.

- Mm-hmm, go ahead.

- Oh, okay, this is, I know you're interested in the brain so I didn't wanna make sure you had a chance to talk about it. But this is, I need to walk through this just a little bit, but this was a group of people who came in and then were fitted with amplification. They all had hearing loss, and what you see on the left there is, this is the visual, this is the cortical visual potentials that they're recording. It's called density source reconstruction, and it shows where these visual signals are being processed. Now, most of you, I think, are well aware that where the temporal lobe is, and what you see here is that a lot of this processing is taking place in the temporal lobe because these people have hearing loss and the vision people are saying, "Hey man, there's some empty real estate over there, I think I'm gonna go move in," right?

Well, the beauty of this particular research is they then looked at these people six months after they had been fitted with hearing aids, and now you see, same people, now you see where the reconstruction lies. It's back in the occipital lobe where it's supposed to be, and the temporal lobe is not lighting up at all, which tells you after six months that the signals came back in, reclaimed the real estate in the temporal lobe and told the visual hey, go back where you belong, back a little behind us there.

- The visual person, they were squatting in the wrong spot.

- Exactly.

- Right.

- Yeah, really amazing stuff. And to go along with that, which isn't really surprising, but these authors also found then after six months there was improvement in the QuickSIN

and also improvement in cognitive function. And one more thing is this group is also now looking at people comparing a poorly fitted, people who are under fit, versus people who are fitted correctly to prescriptive methods to see if they see different changes in brain behavior, which is going to be really, really interesting.

- Mm-hm, yeah, no, this is, again, kind of speaks to the importance of fitting to a target.

- Yeah, it does seem to come back to that now and then, so again, one other point relative to acclimatization, and these are hearing aid studies now, some of you might be familiar with these. I wanna point out, first of all, that way back when there was a couple studies done that showed how hearing aids improved processing and how speech scores would improve over time, a lot of people selling hearing aids really jumped on that. So, when a patient came in and said, "These aren't working very well," it was like hey, just wait three to six months and things are gonna really get better. One of the problems with some of these studies is they didn't control very well for gain.

And so, over time people tended to use more gain, and if they use more gain their speech scores went up. So, it wasn't that the brain changed it was that audibility changed. So, my point here is you wanna make sure that when you're reading about this that there are well-controlled studies that control for gain and also have control groups, which is why I picked the two that you see there. They both sort of have the same kind of findings. The one of 'em by Dawes and Kevin Munro showed that over time, and this was a subset of their people in the study. These were the people who had a little, moderate hearing loss and used hearing aids for at least six hours a day. They found that the signal noise ratio over time improved three dB compared to their control group. Three dB SNR is pretty significant.

- That's a huge improvement, yep.

- Yeah, exactly. A second study that was similar, this study had a 10-month field trial, but again, they showed the same thing, very close to the same. They showed a two dB SNR, and although they followed these people for several months, this two dB improvement ended up after only one month of hearing aid use. And they again had a control group, and showed that indeed this had to be some type of acclimatization. In the Dawes study they also mentioned that one of the things that they believed helped, call it acclimatization or adjustment, is that the people who had the improvement they had a self-report that background sounds were less distracting over time. But again, that is sort of a brain thing, that the brain is able to filter out. My favorite saying back when I was fitting hearing aids was, "You have to hear what you don't want to hear to know what you don't want to hear." And indeed, that's sort of this, that's exactly it,

- I think that's what they're saying there.

- relative to background sounds.

- Right, you can't be distracted by something that you don't hear.

- Yeah, exactly, exactly.

- Right.

- So, the final word I think is acclimatization is real, and if you can get the patient to stick with you it can be your best friend, which goes back to what to do after the fitting. There are times that counseling and acclimatization can work together and I don't know that it'll solve the problem, but it might make things better.

- Well, I think you have some words to live by there, understand and trust the process, both the patient and the provider I think need to keep that in mind with each fitting.

- Yeah, I used to use strategies. I was only in private practice for five years, but when I was, if it was a guy who I could sort of, and I say indeed a guy who I could relate with, and he wanted to meet and make some changes I would usually throw out the line, "I tell you what, if those soft sounds are still bothering you a month from now I'll buy you a steak dinner." And people can identify with that. They go, "Okay, well I'll try it a month for a steak dinner." But yeah, I don't know, did it always work? Probably not, but I don't think I ever bought a steak dinner, so.

- Well, you got a little skin in the game when you say that to a patient, that's for sure.

- Exactly. It looks like, I think we need to be done because I'm seeing I'm losing my power.

- Yep, I think now--

- At least my computer is. I'm probably losing mine too. I am a senior consultant you know, I lose my power after 10 minutes.

- Yeah, that's why we can only do a few of these at a time. All right, well Gus, it's good to see you. We still have a couple more of these for volume two, so.

- Yeah, well, we'll be back before too long I guess.

- Sounds good, take care.

- All right, talk to you later.

- Bye.

How Machine Learning Can Help

- Welcome back to another Research Quick Takes. I'm Brian Taylor, and with me today as usual is Gus Mueller. Welcome back, Gus.

- Hey, thank you, thank you. Nice to be back talking about what happens after the fitting, something everybody wants to know.

- Yeah, we're already at 2.4. And for those that, just as a reminder, if it's been a while between viewings of these recordings, the first three, we talked about some things that you can do after the fitting, during that so-called trial period around acclimation, adjustment, what can the patient do, what should you do, so on, and so forth. So now we're gonna get into a little bit more detail around machine learning, and how that might be able to help. I think probably a good place to start, Gus, is to, there's a lot of terminology that kind of maybe confuses people a little bit. I mean, every manufacturer now in their marketing uses terms like artificial intelligence, and neural networks, and some of those, even though those terms are overlapping, I think there's some important differences we probably wanna get out of the way.

- Yeah, and you could go on and on with this as to all, breaking it down and making it as complicated as you want. I thought I'd take the opposite approach and just try to make it as simple as possible. So let's take the most general term, which is artificial intelligence, and that means that you're having a machine do some task that a human would normally do, okay? A common thing would be a machine could actually translate a language. So this would be you program a machine and, or at least that's the earliest approach would be to program a machine, and then that machine would do something that a human would do. Brian, you're probably... Well, back in 1952, I'm thinking you don't remember that too well.

- No, I don't remember that, no.

- But I'm betting you remember those events on the bottom there, huh?

- I do, yes. I think those are great examples of artificial intelligence. The way I think of artificial, and I'll let you share these examples in a second, Gus, but I think of artificial intelligence as sort of anything that involves simulation of how the human brain works. So everything from motion detection, robotics, artificial language processing, like Siri or Alexa, those are all examples of artificial intelligence, and I think inside of that bucket is machine learning. But anyway, I do have a couple of really good...

- Yeah, well, these are just a couple examples that, of course, sort of fun to talk about, and I won't spend much time on them, because you mentioned machine learning, and that's sort of our next level. This I guess probably was indeed machine learning. But this is just a progression of teaching a computer to play checkers. 45 years later, many of you probably do remember this, when the IBM beat the national champion in chess. And then finally, only 10 years ago or so, Watson was the winner on Jeopardy. Even heard he beat Aaron Rodgers on Jeopardy. I don't know if that's true, but it could be, so we'll... But he beat, I recognize those two guys there. The guy on the left I thought, at one time, was the all-time Jeopardy champion, I don't remember.

- I think he's the host now of Jeopardy.

- Yeah, I think that's right. Yeah, exactly. Well, that takes us to machine learning, which is, so this means that not only is there artificial intelligence, but the artificial intelligence, as it's going along and performing tasks, it actually collects historical data and will change what it does without actually programming. It will more or less program itself from what it learns, and makes a mistake. And you've probably seen a lot of examples of this is, and you mentioned robotics. You can see these robots, that they have them walking on a plank, and then they do it over, and over, and over, and over. And

eventually, with no human programming, the robot actually learns what they did wrong, and will then be able to walk on a plank.

- Yeah, I mean, that would be a...

- [Gustav] What's that?

- No, there's, I think there's some... Machine learning is all around us. If you subscribe to Netflix or Spotify, and you get a favorite playlist, I think that's a really good example of machine learning.

- Oh, it is, yep. And in fact, one might even consider that deep learning depending how far down it goes into what what you looked at on Facebook, or whatever the case may be. So this now is a more extended machine learning, where it actually has different layers of learning, and it's putting these layers together. And so that's why it's, so deep simply means that it's going deep into the learning process, into these different layers, or what they call neural networks to find things out. So again, if you're looking at things on the Internet and how it relates to, how it relates to Facebook and other webpages, it's a lot of deep learning there, knowing where you live, and what you like, and all of these different kinds of things.

- Well, and another, just as a little bit of a side note, there's this whole field in audiology now that we're starting to see more about, to learn more about computational audiology, which is nothing really more than deep learning, pattern recognition around the audiogram, and other test results. Instead of the audiologist interpreting the results, you can train the machine using deep learning to interpret the results.

- Yeah, exactly.

- Pretty interesting how that works.

- Yeah, that is. I just saw an article on that somewhere. Well, I'm gonna take it back to hearing aids.

- [Brian] That's a good idea.

- This is, and these, surprise, surprise, are all Siemens or Signia hearing aids. And there's a reason for that, is that Siemens was actually the first hearing aid company that used machine learning. And this was the first study that was conducted with that product back in 2006. And what this product did is you would adjust gain, the patient would adjust gain for varied listening environments, and the hearing aid would then remember what gain you liked. And when you would turn the hearing aid on then in the morning, it would start to train to your desired gain settings. It's a simplified form compared to what we do today, but it actually worked pretty well, and my point here is this, the circle in the middle.

The NAL targets are the zero line, but it just showed all the different gains that people trained to to show that indeed, the NAL is not a specific spot. It's a range. The whole way the NAL was designed was to put speech at patients' preferred listening levels, their MCLs at various frequency bands. And so people don't have the same MCL. And so what you see here, people ended up at different preferred levels, which we assume is a good thing, as long as, if they're 14 dB below NAL, maybe that isn't so good, but we certainly would expect the plus or minus 6 dB range would be very common, I think.

- Yeah, and I think what's interesting about that is machine learning, the application there is it's learning the wearer's preference for gain. And like Gus said, how it deviates from the NAL starting point. But I know there's more, that was generation one.

- That was generation one. I have a photo here of Catherine Palmer, who was the main researcher when generation two came out. Generation two, now, didn't just train gain, it trained gain for various input levels. So typically it was called compression learning. So an example of that would be that let's say that I used this hearing aid for two weeks, and I like to listen to, I listened to soft music, and I listened to loud music, but I never listened to average music. The hearing aid would actually know that if I like soft music at 80 dB, and I like loud music at 100 dB, it would learn, or learn that I probably like average music at 90 dB, and it would automatically go to 90 dB when average level music was on.

So it was like a big template, and it filled in little squares on that template, but it didn't have to fill in all the squares because it trained itself for the missing squares, for soft, average, and loud sounds. Catherine did a really nice study with that product. 36 subjects who were... That's interesting, 36, I have something wrong here, 'cause 16 and 16 is 32. She must've had two groups of 18, I'm gonna say. Anyway, close enough.

- So they were all new hearing aid users. That's what made it interesting. And they trained for two months. And one group only trained for one month, and the other group actually trained for two months. What she found was after this training, they basically were, average gain was almost exactly the same as the NAL for both groups, as the original, for both groups that trained either one month or two months. And what she did is she did pre and post speech and noise testing. And the speech and noise testing was essentially identical for before and after. Meaning that the people weren't messing up their speech understanding. But what I thought was the most interesting finding was she then did blinded comparative ratings of the two different programs, the original NAL and the trained program.

And two thirds of the patient favored the learned setting. Somehow it had learned to mimic their loudness growth function, which sounded more natural to them, and that's why they preferred it, we're assuming. But fortunately, it had no negative impact on anything else. So just yet another benefit of machine learning. This study also was done with generation two. These were people who'd been fitted for at least two years. They were all said that they were happy with their hearing aids, but in this study, we sent them out, and had them again do compression training. I want you to note under soft, that's on the left of the bar chart, the orange bar. Compare the orange bar to the gray bar right next to it.

And what you see is after they did the machine learning, they were using on average 10 dB more gain for soft inputs. They had been under-fit, as you can see, originally. The blue would be had they been fitted to the NAL. Not uncommon if anybody's using proprietary fittings. These people had been walking around for two years being under-fit. But when we gave them the chance to use machine learning, they actually learned up to the NAL fitting, which isn't terribly surprising. Really important point.

- I thought, well I know you've worked with the world famous count the dots, Brian, so...

- Well, you're one of the coauthors.

- [Gustav] I'll let you talk about this.

- Well, I think that, first of all, I wanna remind all of our viewers that if they want the exact paper or article where we've referenced here, there's a written quick guide that you can, that accompanies what we're talking about here. And you can find that specific article that we referenced, for those of you that wanna get into the details. But what Gus was just talking about was that 10 dB increase for soft sounds when people

are allowed to train gain for soft. And you can see that illustrated here on the count the dots audiogram. Remember, each of the red dots, there's 100 of them, each dot contributes equally to intelligibility. That's why it's important to get gain for highs right, because you can see how they cluster around that two to 4K range so much.

But anyway, you can see here the lower Xs, the lower aided audiogram where they were originally fit with the proprietary target, that equates to a speech intelligibility index score of 45%. But when they're able to train for soft sounds and get that 10 dB increase, that's the higher, the top Xs there, you can see that their speech intelligibility index goes up to 80%. So that 10 dB increase in gain for soft sounds equates to a an SII score, a difference of... Well really, it doubles it, essentially. And I think you have some additional...

- And one might ask how, how does that impact on speech understanding, one might ask.

- Exactly, and I think you can kind of go through that on these.

- Yeah, well, this is a chart that's commonly used. In fact, the Verifit actually uses this chart in their software these days, or at least a portion of this chart. So you can take their SII, and get an estimate of speech understanding. So what I'm going to do here is take what these people had in the beginning, which we would predict they'd be understanding about 60% of speech. This would be single words. And we then see where they ended up. That they ended up at 80, we would predict that at 80, they're at about 93% of single words. So does that 10 dB make a difference? Absolutely. And machine learning helps. Part of it, of course, is they weren't fit correctly to begin with. Probably, the better you fit the person to begin with, the less they need machine learning would be my thought.

- Right, but I think this is a great example of what happens in the real world.

- Sure. This is now generation three, and I won't spend much time with this. This was done at the NAL, that's Gitte Keidser that you see there. And again, Brian, you mentioned the article. All of these articles are referenced in the Quick Takes 2.4 document that accompanies our little chat here today. Basically what this was, we've now gone into generation three, where it's using signal classification and compression learning all together. And what you see here, this is for high frequency gain, 'cause they also could train gain. And what you're seeing is deviation for the NAL. And I guess for those of you who are using the NL2, the good news is that when people go out and pick what they want, it doesn't vary much from the NL2, and you see for the different listening conditions.

So these are just examples of how, in the past, we're going all the way back to 2006, how machine learning has been used in hearing aids. And then about, what, four or five years ago, Brian, we came up with one of the better applications, I think. Certainly the most unique, and that's Own Voice Processing.

- Yeah, well, I think if you go back to the Quick Take we did, maybe 2.1, or maybe 2.2, I can't remember which one. We talked about some of the common problems associated with wearing hearing aids, and it should be not unsurprising to anyone that own voice, sound of your own voice, so-called talking in a barrel, which is a term probably from the 1950s. But that own voice problem has been persistent for a number of years, and you cited a study, Gus, from about 20 years ago that underscored that point. Yeah, about five years ago, Signia came up with this algorithm, this feature called OVP, Own Voice Processing. And even though we don't really talk about it this way, I think it's a really interesting application of machine learning.

It really is machine learning baked into a hearing aid. And the whole idea here is you can train the hearing aid to recognize the wearer's own voice. And when the hearing aid algorithm has been trained to recognize the wearer's voice, it'll essentially turn the gain down for the sound that it thinks, or is trained to recognize as the person's voice. And it works so quickly that as soon as the person stops talking, it adapts, and gain goes back up to the typical setting for other inputs. So it's a very seamless change. It happens almost instantaneously. And it's a really simple process. For those of you that are unfamiliar with OVP, there's a really simple application in the fitting software where the person has to make a few vocalizations to essentially train the algorithm while the wearer is in your office, so that it knows when it walks out the door what sound is the person's own voice, and therefore, can turn it down. And I think that on the next slide, you maybe talk about that.

- Yeah, yeah.

- Well, I know you have some data here that shows how effective it is.

- Yeah. And the results are pretty amazing. There's a ton of research on this, probably four or five papers I think have been written. And I think we're just gonna talk about a couple key findings today. What was interesting in this particular, in the data shown here is these were two competitor products, and all of these products were fitted to the NL2. So they all started out the same, so that we knew the frequency response, the starting point was the same for all products. In this particular chart that you're showing, the Signia product was fit with a closed ear coupling, the competitor products were fitted with open fittings, and then the patients rated their satisfaction of their own voice.

The thing that actually was surprising, I initially were thinking if it's even as good as an open product, that's pretty good. It turned out that for both competitor products using

OVP, the Signia product was better than the two competitor products, which is a pretty strong sign that it works.

- And I think the big takeaway there is that the Signia product is closed, and the other two are open.

- Yeah, exactly, exactly. And we know the importance for having a closed fitting for the benefit of noise reduction, directional, and all of these special fit. Not to mention, in some cases, sound quality. This is a different study. And this was done at University of Arkansas Medical Center back when...

- Amyn Amlani.

- Yeah, Amyn Amlani was there. He was the lead investigator on this. So this is three, four years ago. And what we did is we were wondering if people, if when they were fitted with OVP, if when they were fitted with OVP, would they actually talk more, because their own voice is gonna sound more natural. So they did a COSI, and all of their COSI items had something to do with more communication, talking more. And what you see here is the initial findings that showed 20% or so, their COSI results were the same. But in 80% of the patients, their COSI score was actually, and they had their number one, number two, and number three item. About 80% of the people, their COSI scores increased when they were using these hearing aids with OVP.

What really then I thought was the most significant finding is at the same time, they rated their quality of life, that's on the X-axis, and whether it improved or not. I think number one was it got worse, two, it was it stayed the same, and then three, four, five were levels of improvement. On the Y-axis was the increase that was the change in their COSI score. So what you see here is the relationship between changing COSI score and overall quality of life. And you see a very strong correlation. And that is if

their COSI score went up, their quality of life also went up. And we're gonna give OVP credit for that. I'm putting a star by OVP for helping quality of life. And that's probably a good ending point.

- Yeah, what's really interesting about that study, I think, is it's a great example of how manufacturers bring a new feature to market every year or so, and it's relatively easy to show that those features work well in the lab, or in the sound booth, but you don't always see that translate into when people wear them in real world situations. And I think that's a great example of how this feature, OVP, really works effectively, helps people socialize more effectively. They talk more. That's a great benefit.

- Exactly. Exactly. Well, I think we did it.

- Yeah, thanks again, Gus. It's another Quick Takes in the books. So we'll see you again for 2.5 soon.

The Signia Assistant

- Welcome back to another Research Quick Takes. I'm Brian Taylor, and with me as usual is our senior Signia consultant, Gus Mueller. You got to get that senior part in, Gus.

- Get to get that senior part in there, I tell you. I earned this white hair one way or another. So yeah, this has been a good series we've been doing all about happening After the Fitting, and we sort of started out with what problems might be, and what you can do right after the fitting, and how acclimatization might work or not work, and can the patient really hear a difference? And now we're moving into machine learning which we did couple weeks ago and now this is sort of the finale. We're going the ultimate in machine learning and that's the Signia Assistant so, which has been out now, what? For a couple years, Brian?

- I think at least two. It's one of those, we talked about artificial intelligence, machine learning, deep learning, and I think Signia Assistant's a great example of deep learning and the use of neural networks. What's really cool about it is a person can take their fitting and they can customize it to where they want the preferred settings to be. They can base those settings using thousands of other data points from similar fittings around the globe and it's a system that's continually fine tuning and upgrading, which again, is one of the kind of the hallmarks of deep learning is that it's continually improving based on more data entering into the system.

- Yeah, I mean, it could be the solution that it chooses for a problem today might not be the solution it chooses six months from now 'cause it may have collected another 2,000 data points and says wait a minute, I think this other solution seems to work a little better.

- That's why we call it a live neural network.

- Live, yeah, the interesting thing is around the world which would also be interesting if a solution in Denmark is different than a solution in Wisconsin. But I don't know, Denmark, they're sort of similar. They're probably gonna be the same so.

- I think there's a lot of Danes that live in Wisconsin so.

- Yeah, probably so, yeah.

- Heritage-wise, the interesting thing about Signia Assistant when you think about deep learning, it could get incredibly complicated in a hurry just because there's so many data points. So I think one of the things that R&D and product development has done a really good job with around Signia Assistant is they made it user-friendly, and here's an example of that. They've kind of narrowed down the choices. You can see here, it's an app that you would download onto your smartphone and you can see when it comes to fine tuning an adjustment, there's really only four areas that you can use Signia Assistant with, but those are four of probably the most common problems that people have with their earing aids.

Their own voice, other voices, sound quality, and handling and of course, here's an example. Even though we have OVP and that tends to minimize problems with own voice, on our screenshot here we have an example of how Signia Assistant might tackle the problem of own voice. And I have those controlled choices. You can compare it to your current setting. If you don't like it, you can go back to the old setting. You can keep the new setting. You can continue to try to refine the setting. So you can kind of see here on the screenshot just how user-friendly Signia Assistant is.

- Yeah, looking at this, I see the term nasal. I'd sort of forgotten that was out there. I was picturing Willie Nelson who probably needs hearing aids by now. He's hitting

nasal, it still sounds nasal. Nasal, that still sounds nasal, darn it. No, what's going on here?

- Well, I wonder if, he's in his 90s, so he may be wearing ear aids.

- I would think maybe so. Maybe his life habits gave him some preventive medicine. Who know, who knows?

- Yeah, well, I know that there's been a couple of studies.

- Yeah, this one was the first one. This was right out of the gate. This was sort of the initial evidence to make sure that certainly that it didn't do no harm. That was the starting point with all of these, with these new things, and so in this case, people were fitted bilaterally with prescriptive targets and they also in the lab had speech and noise testing for the very reason that I just mentioned. We wanted to make sure that this assistant didn't make things worse. They went out for a two-week trial. They were given a sort of a notebook that told them what they should try to experience. We didn't want people just sitting around the house all the time.

We wanted them out in background noise, difficult listening situations. After that, they came back and they had the repeat speech testing to see what had changed or not changed, and then they also completed a survey of benefit. Actually in this particular study, there was a group of people whose specialty was this type of study and they were interviewed extensively, the participants were in person relative to what their thoughts were on the assistant. And we are today, just gonna show you just a real glimpse of some of the findings. Particularly from the interview, there was a lot of findings. One thing, I guess this shouldn't really surprise us, is what was the listening situation when they used the Assistant?

Half the time they were in quiet simply because people spend most of their life in quiet. Most people do anyway. Where it says noisy here, this was actually a combination of background noise and speech and noise, so it was anytime noise was present. And then we have 14% was from music and 3% of the time they were in the car. Anything jump out at you, Brian, on this?

- No, I think the only thing that's, I don't think it's surprising, but it's interesting that the majority of time people spend in quiet situations, but in the clinic we have a tendency to really focus on all the problems and challenges associated with noise, even though that's a minimum amount of time typically.

- Yeah, well, if you go back to the very first, well, first paper and talk we did in this series of After the Fitting, we looked at what was the number one post-fitting complaint and the number one post-fitting complaint was listening in background noise, yet they only used the Assistant 1/3 of the time. Well, that's not the right way to word it. Of the time they used the Assistant, 1/3 of the time was background noise. But again, that's because people aren't, a lot of people aren't in background noise a lot so. In fact, this makes that point very clearly because what this shows is we also recorded what was the overall SPL at the time the Assistant was being used, and you see that only about 10% of the time was it used when the overall SPL was greater than 75.

So these people weren't spending a lot of time sitting out in noisy restaurants or if they were, they weren't using the Assistant. And again, as you might expect, most of the time, in fact, about 70% of the time when it was used, the overall SPL was 65 dD or softer. So which is good to know and I can imagine people are just tweaking it when they're around their house trying to do better, and that's when they're using their hearing aids.

- Yeah, that's an interesting point. Maybe they tend to use it when they're in a more relaxed situation, when they're comfortable.

- Yep, exactly, well, here's one of the questions that we had and I mentioned this, that it was before they were sent out, and so initially they were fitted to NL2. So we did speech and noise testing and what you see there is the SNR, SNR for 80% correct. The absolute values really aren't meaningful for our discussion right now. What we wanna look at is to see what happened over time. So you notice they started out, that would be on your far left, they started out at around minus 13. They came back and we retested them on their now program and it was around minus 13. And we then looked at what they had adjusted to and it was around minus 13.

Again, the point here is we wanted to make sure that people wouldn't go out and make things worse and destroy their speech and noise recognition ability that we'd worked so hard to achieve in the first place. Then these people, as I mentioned at the end, had a survey of what their feelings were about using the Assistant. I guess the main point of this is the results were very positive. Everything was 80% or better which had more control, made them more confident. They think they're getting more benefit from the hearing aids. There's nothing negative really to say. All the findings were very good, happy people. Which I guess takes us to survey number two. You were part of this survey I think, Brian, so I know your name's on the paper. This is a "Hearing Review" paper of about a year ago I'm thinking.

- No, it was just a couple months ago.

- Oh, no, it was just this year.

- November of 2021, so just a few months back, but the second study was published in "Hearing Review," just like the first one. And probably I should mentioned that Eric

Hoytle who is part of our audiology team over in the global group over in Denmark was the lead author in both of these and the second one was a survey that was conducted in Germany, German audiologists and German hearing aid wearers or patients. And I think in this study, there were around maybe 58 hearing aid wearers and about 40 hearing care professional surveys. That doesn't mean there were 40 hearing care professionals that were doing the survey, but I think there was a handful of hearing care professionals, maybe around 10, that completed 40 surveys that corresponded with those 58 patients.

And I think the reason why you wanna do a survey like this with a new feature like Signia Assistant is I think you wanna get some data. Do people like it? If they do like it, what part of the feature is beneficial to them? And it's good not only get it from the wearer because obviously they're the ones that are using it after they buy it, but I think it's also good when you first launch a feature that's kind of new like Signia Assistant, you wanna get the perspective of the professional too to see what they may like or not like about the feature because Signia Assistant's not going away. Because it's a live neural network, it continually improves.

Anyway in this survey, there were three rounds of surveying. They surveyed the patients and the hearing care professionals I think at the time of the fitting, and then when they came in for their first follow up, and then more or less at the end of the trial period. So three different surveys and here are the results following the trial, and you can see some pretty high bars here again. It increased their interest in using hearing aids. I think over 80% of the wearers are showing that which kind of makes sense because you give somebody more control, more ability to make meaningful adjustments, they might be more interested in wearing the hearing aids and wearing them more consistently.

And I think the same holds true with confidence. When somebody has the ability to make meaningful adjustments in real time without having to come into a clinic for an adjustment, that might add to the person feeling more confident about wearing their hearing aids. And then I think the other one that's good there is the top bar, improvement in difficult situations. If you have the ability to make some adjustments using Signia Assistant in situations that are, maybe there's some background noise where it's difficult, I think that bodes well for the hearing aid wearer as well. So I don't know, Gus, did you have any other insights that you wanna?

- No, I think just the one thing that sort of, that struck me was the, well, they're all, it's all, it's nice to see findings that positive. But the achieve the best hearing aid setting. I mean, we're all familiar with and you'll remember them, these patients who are going geez, if you could just maybe turn this a little bit more. Could you turn this down a little bit? But if a person really believes that they have the best hearing aid setting, then they're not gonna come into the clinic asking you to make changes 'cause they already believe they have the best setting. So it shows that, which probably goes hand in hand with being more confident using the hearing aid.

So yeah, I'll mention that we saw the slide before and everything was over 80%, and I think probably it had to do with the methodology that was used. This was a paper and pencil thing that people completed I believe, where the other one was actually a personal interview and maybe that's why you might see a little bit different. Anyway we're seeing results of 70% or better so. And then you mentioned, Brian, that the people who did the dispensing also were surveyed and I think we have those results right here.

- Right, so I think again, it shows that the feature, for the most part, clinicians like it. They reported over 80% of them that it's easy for the patient to use, that it improved the relationship with the patient which is kind of interesting because how can a

smartphone app and a new feature actually do that? But maybe because the person has to interact with their hearing aids more, they had a better relationship with their patient. They felt that it provided them a better fitting and maybe it made them look better. That's that competency bar there at the bottom. So I think it's kind of interesting, it just kind of shows you from the clinician's perspective how Signia Assistant makes things better. Did you have any other insights you wanted to share on this, Gus?

- Well, I think it's good news. I think both you and I have run into some people who are saying I don't wanna mess with that. But certainly it appears looking at this that at least for this group, they have very strong feelings that it is helpful and to the fact that it actually strengthened their fitting competency which is a pretty positive statement.

- Yeah, no, I think Signia Assistant is a really, I think from a clinician's point of view regardless of what the survey might say, I think it's a way to just cut down on the number of follow-up visits. Everybody's getting busier and busier and if you can put some of those tools in the hand of a patient and they can make the adjustments in a more precise way than coming into your office, I think everybody wins in a situation like that. And to boot, the patient feels more confident, more empowered that they're able to kind of take a good fitting and make it even better with a simple little app so.

- Yeah, and you link that with telecare which all can fit together because you can talk to the person, and give them ideas, and the person has a tool to implement them themselves or you implement them for them. So there's a lot of advantages of what can be done.

- Yeah, so anyway I think we're pretty much wrapped up here with our second volume of Research Quick Takes. This is the fifth and final, 2.5. All the things you need to know After the Fitting.

- After the Fitting, and who knows where we may go next. We could talk about what to do before the fitting. There's a long series right there.

- You have to wait with bated breath to find out what we do.

- Oh, my god, I'm pretty excited to see what's gonna happen.

- All right, well, Gus, until that time, it's good to see you and.

- All right, yeah, again, next time.

- Take care, bye.