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**How Research into Conversational Dynamics Informs the
Development of Signia's IX Technology**
Presenter: Brian Taylor, AuD; Karolina Smeds, PhD, MSc

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- Hello and welcome to another Signia podcast. I'm Brian Taylor. Today our topic is how research on conversational behaviors informed the development of Signia's New IX Platform. And here to discuss some of that research is my guest, Dr. Karolina Smeds, a principal scientist at WS Audiology ORCA Lab in Europe. Welcome to the podcast, Karolina.

- Thank you very much. Thanks for having me.

- Well, before we dive into some of this research that helped build the IX platform, I thought it would be helpful for those audiologists out there that follow and read a lot of papers. I think they're probably familiar with your name. So maybe tell us a little bit about your background and some of your research projects.

- Yeah, I have a combined background in engineering and audiology. So I have a master's degree in engineering physics from Stockholm and a master's in audiology from the University of Southampton in the UK. And with that I started working in a school for deaf children and severely hearing impaired children. And did that for a couple of years. And then I started teaching at the bachelor course in audiology at the Karolinska Institute. I did that for a couple of years and I was teaching sort of the more technical stuff, so physics and signal systems, hearing aids, hearing aid fitting, and a couple of other topics. But then I started to work on my PhD and I did that at the Technical University in Stockholm called KTH. And my work was on loudness aspects of hearing aid fitting. So I very much stayed in the same area as where I sort of started. And one year after I finished my PhD, I was approached by the Danish Hearing Aid company, Widex, and asked if I wanted to start an external research lab, which later became the ORCA Europe lab, where I've been working since then. And, sorry?

- No, how, and can you tell us about how long have you been with ORCA lab?

- I started in 2006.

- Okay.

- So it's a fairly long time by now. And you asked also about my research interests, and I think I have a fairly broad portfolio of interest, but it started, I mean, very much sort of hearing

rehabilitation and perhaps specifically the interaction between impaired hearing, the people with impaired hearing and the hearing devices. So that's been part of what I've been doing as I said, since my PhD.

- Mhmm.

- More recently we have been very interested in understanding people's auditorial reality, sort of the acoustical environments people are in and how they experience those, the demands and things that they need to know. And related to that, we have also looked into evaluation of hearing aids in a way that is indicative of how they were actually work in real life. And last couple of years, I think my research interest has broadened a little bit more, so going more into this sort of health psychology area a little bit.

- Yeah and I want to spend most of our time talking about that, but before I do, I think of some of the work that you've done as sort of research that helps other researchers and you know, I think one example of that is a study, and I think there are a couple of studies along the same lines, but the one I'm thinking about was published in JAAA around 2015, where you talk about estimating the signal to noise ratio in everyday types of listening situations. So I think I thought that was a really interesting study. Could you tell us a little bit more about that study and what you were trying to accomplish with it?

- Yeah, I'm happy to, I think it's probably our most influential paper to date and not excluding that there might be other interesting things of course, coming out from the group. But we started off some background. We started off looking into noise reduction algorithms in hearing aids and trying to understand how we could visualize what they are doing both in this long-term perspective and short-term perspective. And what we learned was that noise reduction algorithms from different hearing aid manufacturers worked very differently. And when we later try to evaluate how noise reduction algorithms work, we didn't do it with hearing aid noise reduction, but more generic algorithms. We realized that people perform very differently because we used one of those adaptive speech testing tasks where you either adjust the speech level or the noise level to reach say 50% correct. And people perform very differently. Of course, normal hearing and hearing impact. People who participated in this research, they performed as very different SNRs, but also among the hearing impact group,

there was a big range of performances in terms of the signal to noise ratios that they needed to perform at 50%. And we started to think that this is interesting, but we also know that we from our previous research that, that the noise reduction algorithms don't work the same for say, plus five or minus 10 dB signal to noise ratio. So the people in our study where we did this evaluation, they were not really evaluating the same system you could say. And then we started to think about, okay, that is potentially a problem. But in real life, people would of course go to similar places, even if they have different hearing abilities and perhaps different cognitive abilities, they would go to the same situation and how do they perform there? So we started to think that the alternative to to doing this type of adaptive speech testing would be to test at a fixed signal to noise ratio that was realistic. But what is that? And there was some previous research, but it was all done very in very artificial ways. So we set out to decide what were the signal to noise ratios in hearing in per people's real life. And based on some recordings that were already available to us, we estimated the signal to noise ratios in real life situations.

- And could you tell us maybe a couple of takeaways from that study that would be beneficial to a clinician in their work with patients and trying to help them fit hearing aids that optimize their ability to hear in different types of background noise?

- Yeah, I mean, the main result was that the signal to noise ratios that actually happened, you know, that people experienced in real life were higher than we previously assumed. And there were very few situations where the signal to noise ratio was below zero. And these were, I mean, the recordings were situations that people had recorded in their own life, and maybe you can say that they were avoiding these really, really noisy situations and that is the reason. But this research has been sort of confirmed by later research that people are not moving around in very low signal to noise ratios. And I think the main takeaway for a clinician is that it could be slightly misleading to do speech testing with hearing aids and use those adaptive speech tests because you might end up at signal to noise ratios where the hearing aid is not meant to work or where it doesn't do very well. And I think maybe the takeaway is to use some sort of speech testing in fixed signal to noise ratios. On the positive side, there is a speech test in Sweden where they have fixed the signal to noise ratio to +4 dB, which seems really sort of in line with our findings. And maybe we will come back to some ways where you can also do some live speech testing, not where you score percentage correct but see how people perform at different noise levels. And I think we might come back to that later in this interview.

- Yeah, no, that's interesting. I think we will, well let's get into some of the more recent work that you've done, you and your group on conversations. I'd like to first ask you if you could maybe tell our listeners about the work your group has done trying to better understand what conversational success might look like for all individuals regardless of age or hearing loss.

- Yeah, I just want to point out that when you say my group, there are lots of people in our scientific audiology group who are working with the group conversations. So we do some work in Stockholm. We have the Europe lab, and that is led by a colleague of mine called Petra Helene. And I have another colleague, Alina Peterson in Denmark, who's also done a lot of work, and we will come back to her work, I think. But we also have two PhD students that we are sponsoring in co-supervising, one in Allen and one in Glasgow. And the PhD student in Glasgow, her name is Penny Koras, and she's the one who did this conversational success study as her first study. And she used a method called group conversation mapping where she asked people to say something about what they thought was a successful conversation. It was online research, and that was very lucky because she started during the pandemic. So it was a research method that was very fitting to the time. And she asked people both with normal hearing and impaired hearing to brainstorm based on two questions. So one question was, what does a successful conversation look like? And the other one, think about a successful conversation you have taken part in what aspects of that conversation contributed to its success? So these participants brainstormed and made statements based on that. And then she and some of her co-supervisors streamed those statements. And then the test participants came in again and they sorted and named those statements. So they grouped them together in a way that made sense to them. And they also rated the importance of these statements. And then based on some statistical analysis, she came up with seven factors that contribute to a successful conversation.

- Yeah. So tell us what those seven factors are and maybe what's the difference between a successful and a not so successful conversation?

- Yeah, the first factor that she found was being able to listen easily. And that is of course bit encouraging for us as a hearing aid manufacturer because it is something that we can help with. Some of the other factors are perhaps more difficult. The second factor was being spoken

to in a helpful way, and she, as I said, she included both normal hearing and hearing impact participants. And maybe the hearing impaired participants rated this a little bit higher than the normal hearing people. And the third factor was being engaged and accepted, and the fourth was sharing information as desired. The fifth was perceiving, flowing, and balanced interaction. The six feeling positive emotions and the seventh not having to engage coping mechanisms and coping mechanism were both sort of positive coping mechanism but also somewhere I withdraw or I don't participate. And so these seven factors is what she found. And I think it's quite obvious what the opposite of of success here is. So that is not being able to listen easily and not being spoken to in a helpful way, et cetera.

- Exactly, so you mentioned that there might be some differences between the people that had normal hearing and those that had a hearing loss. Could you tell us a little bit about maybe some of the most important factors for somebody with hearing loss?

- Yeah, I think the interesting thing is that the order of the clusters in terms of importance were very similar, but the, some of the clusters were rated more important by the hearing impaired people, and it was being able to listen easily. And there they also included statements like, when my hearing aids work well, when I don't have a flat battery, when I don't experience feedback, things like that, that normal hearing people, of course did not mention. And they also rated being spoken to in a helpful way higher than the normal hearing group. And also not having to engage coping mechanisms. And it's also interesting that a statement that appeared many, many times from the group with impaired hearing was the statement that, that I feel comfortable when I have to ask someone to repeat something. So there were so many comments about, it's a successful conversation where I dare to ask and when, where people don't say things that make me feel embarrassed for asking them to repeat. And that was of course, much more prominent in the group of people with impaired hearing.

- Yeah, I mean it's really interesting sort of the emotional element of,

- Yes.

- of interaction.

- Yes. And this interaction is of course it's a complex dance that you are dancing when you, when you have a conversation.

- Right. Yeah that's really, it's just interesting to me because it's so, we don't really, when it comes to like conversations, you don't really think about it. You just kind of do it.

- Yes.

- Now you have this insight into kind of what happens. And speaking of, I know another line of research that part of that, your group you mentioned, and thank you for doing that, many people that are involved in this research, but another element of this work was trying to better understand conversational behaviors.

- Yes.

- Could you tell us a little bit more about that line of research and what you found?

- Yes. So I think that is also very, very interesting field because we have investigated group conversation using a variety of methods in the company right now. So one line of research has been related to what is called conversational dynamics. And it's a research that is done by our colleague Alina Peterson in Denmark. And then you look at the speech levels people use in conversations, how long different people are speaking, how long are the terms, and that is when you are speaking and then you hand over the floor to someone else to speak. And also looking at turn taking timing, how quickly do someone respond and get into the conversation when one person has stopped. And Alina's looked at that both for one-to-one conversations, but she has also done it for three people in a group. And she found lots of, lots of interesting things. And one of them was that the hearing impact participants, they actually, they initiated their terms with one variability so that they, some people responded quickly and some more slowly. We could also see things like that might be expected when you speak in noise then people use higher speaking levels. That is expected. And it was especially the normal hearing people in her group. She had a mixed group of one person with a hearing loss and two people with normal hearing in her triads or group of three conversing. And this was also interesting that, that when the noise level was increased, the people with impaired hearing spoke in longer

terms. So they didn't leave, give the floor as quickly to someone else. And that could also be a type of behavior so that it, because it might be difficult to get in again so that you speak a little bit longer. And also expectedly, when the people with hearing impairment did not wear hearing aids and it was a low level background noise, both groups needed to speak louder. But then when in the noisy situations where when the people with hearing impairment, when they had hearing aids with directional microphones, they didn't hear the noise as well as the normal hearing people. So they reduced their voice and sometimes to the detriment of the normal hearing group because they could still experience the noise. And what she found was that the speech level was actually the most sensitive measure when looking at differences for these different conditions. Normal hearing, hearing impaired, aided, unaided, omnidirectional and directional microphones. And the other measures that she also looked into were less sensitive to changes in noise levels and aiding.

- Yeah again, that's really interesting to to know. I mean, it takes it a step further to think about how hearing loss and the use of hearing aids impacts the behaviors in conversation of everybody in the group.

- Yes.

- And that we have better understanding about that. That's really, I think that's helpful.

- And that is, is also actually research, also previous research from other groups showing that most of the time this is in laboratory settings, but I think it happens in real life as well. Most people make it work by changing the, the speed in which they talk, by changing the level and so on. Maybe in group conversations in real life it is more difficult than that because if you have a flow in the conversation, it might be easier to forget that someone is not getting everything and is not sort of following everything that happens. So it's a really, really important area to look into as a hearing aid manufacturer, how to help in group conversation situations.

- Exactly because everybody, I mean people don't communicate alone very often. You're always, almost always with a group and you forget sometimes that it has an impact on everybody. So I'm curious, oh, go ahead. You wanted to elaborate.

- I was about to say that something else. Now we talked about the conversational dynamics, but in other projects we have also looked at other types of behaviors. So the PhD student who did the conversational success work, she has an upcoming, or she's in her second study looking at head movements and body movements where you can see if people are leaning in or if they're looking really relaxed and sitting back. So that is a type of behavior. She has also analyzed lots of things, but things like when do you see shared laughter in a conversation? Is that a sign of conversation success? And she has correlated that to how people rated the conversation success of different conversations. And then we have the PhD student Pablo in London he has not really collected much data yet, but he has a very complicated setup where he's looking at EEG and EMG and pupil dilation and head movements also. So a very sort of complex looking at lots of different types of behaviors with a focus on attention, that is his task. So I think the company has really looked at various ways to investigate what is happening in group conversations.

- Yeah, that's really, we look forward to seeing those studies in print down the road somewhere.

- Yes.

- And that reminds me, I wanna mention to the listeners that the studies that are in print or that have been published that we've been talking about, we'll put those references in the show notes. So if someone wants to find those studies at their respective journal sites, they'll be able to do that.

- Yeah. Good. I also wanted to say that now we talked about looking at behavior at ORCA.com we have also focused on a method we call LEAP and that is short for live evaluation of auditory preference. And that is a method that is directly focused on evaluation of hearing aid features or hearing aid settings. So there we have also done group conversation work and, and we have looked into the ratings of how hearing aids work in group conversations and also done some direct comparison between two hearing aids settings. So we have done quite a lot.

- Yeah, exactly. Well, there's several things I wanna follow up on now that you've mentioned that. So the first is if we could go back and talk about the, some of the findings around

conversational dynamics. How could a clinician, because a lot of our listeners are people that fit hearing aids every day, how could they use that information to better counsel their patients?

- It is a very good question, and I am not sure I have a very good answer because I mean, I think this research has been really important to the development of our hearing aids and to the possibility to evaluate them. But maybe it is a little bit more difficult to find a clear application. I think the counseling of listening strategies that you do in a clinical setting could perhaps be influenced by what we have learned about group conversations. And we are actually doing a study at the University of Manchester looking into communication strategies as a collaboration with Gabby Saunders and Heinrich in Manchester. So I think when it comes to communication strategies, that could be one part and then a little bit more farfetched. I think there's also something inspiring in the work of a colleague called Dena Lillik in Denmark who is looking into how a focus on positive listening experience change your, your view on how well your hearing aids work, and actually also help you help the understanding of speech better in real life. So I don't, I think I would have liked to have a better answer on how this can be used clinically. Maybe it's not that straightforward, but I think in the counseling situation it might be something that that can be used.

- Yeah no, I think that's a good point. And I think part of it is that it enables you to kind of look more broadly at the impact hearing loss and then hearing aid use has on everybody that's part of the conversation.

- Yeah.

- And turn taking and the level that you talk and how much you talk, I think those are some things we kind of forget about. And with this research, it helps you remember at least that those are some important factors for everybody that participates in the conversation. So as a clinician myself, I appreciate this kind of research. 'Cause I think it helps you better understand some of the nuances that are happening day to day with people and what makes it so challenging.

- Yeah. Yeah.

- Okay well, let me move, we've already mentioned the IX platform, and I think this is a great segue into having you maybe give us some insights and some knowledge around how the research of your group around conversational dynamics and conversational success, how that is applied or how it was applied to the development of this new IX platform.

- Yeah, I think there are two main areas where we have contributed. And I think one is the understanding of group conversations, as we have talked about already in this conversation. I mean, both the literature reviews that we have done previous auditory reality work and the current group conversation work has taught us lots of things about what is a common group conversation size, what happens when the group conversation is by too many people? Then it will sort of separate into two groups. What are the locations where people are having group conversations, et cetera. I think that has been influential for the development. But also what are the challenges in a group conversation situation for the people who participate in the situation. But of course also for the developers of hearing aids that are supposed to help in these situations. And they are what you sort of, I mean, when you have identified a talker, and especially if you are in a situation where it's noisy, then you want to be able to focus on that speaker as well as you can. But you can't have something like an extreme directional microphone that may gives you the opportunity to focus on that person because suddenly there is another speaker and you must be able to identify the next speaker. And the focus is on listening, but the focus is also on preparing to say something. And in order to sort of be able to keep what is considered a natural flow of a conversation, you need to be able to listen easily because it is a complicated interaction. And what people do in order to keep the very short turn taking timing that is usual, 200 millisecond is a very standard turn taking timing. So when someone's ends his or her sort of phrase or something, then it usually takes 200 millisecond for the next person to chip in. And that is too short to listen to the end of that statement and then think of your response. So what people do is that they predict when someone will stop speaking and they prepare their own, their own contribution. And that is a very sort of cognitively demanding task and it calls for a good hearing aid so that the listening is not taking up your cognitive, all of your cognitive ability. So I think the role of listening versus speaking and that intricate sort of interaction that you have in a conversation, I think that has been, that we have investigated that has been important for the development.

- Right and the fact that, you know, what's unique about IX I think is the three frontal facing acoustic snapshots where there's independent processing happening in all three of those and then one's in the rear hemisphere. I think that that's a really novel approach to trying to improve somebody's ability to have a conversation with multiple talkers around them.

- Yeah, and sort of helping with many of these tasks that I just described are happening in a group conversation.

- Exactly.

- I think the general understanding of group conversation is one thing that we have been able to contribute to, and the other is more straightforward and that is the development of test methods that can be used to during development and for evaluation of different features.

- Tell us more about that. Yeah. This is where, where the LEAP comes in, right? So please tell us more about that.

- Yeah, so I mean, we were actually very early in our research group to have studies where we had real conversations with people and not recorded speech centers. And it is our first step was not with groups, but it was with one test leader and one test participant. And just being able to really contribute to a conversation and also use your own voice. So that, I mean, for some hearing aid features, it's really quite central that you also speak and not just listen. So we were quite early with that part. And then what I think we have done is that we have found some suitable scenarios to use for group conversations based on, what we have learned previously. Also in the auditory reality studies we have, we have also come up with sort of lab setups that can be used. And those have been used for various types of research. It's been used for the conversational dynamics for looking into other types of behavior. And maybe the most straightforward one is the LEAP test, the LEAP test where we directly can compare how, what people think about two or more options for signal processing. And one thing that that is, yeah, so I think that is the most, perhaps most straightforward way to analyze what people prefer. But one important thing that we have worked quite a lot of with, and that is also something that our colleague Alina in Denmark has looked into is how on earth do you start a conversation among people who don't know each other beforehand? How do you create a natural

conversation that is not scripted or too sort of yeah, stiff. How do you create a natural conversation? And we have used different ways to do that. So in our, it was different in our, when we had the one-to-one conversations in LEAP because then the test leader could encourage the conversation. But then we have done things with fixed tasks. So one-to-one conversations using a so-called dia-pics task when two people have two drawings that differ in some aspects, and then they come converse and decide where the differences are. So it's a dual spot the difference test. And then we have had three people conversing freely, both in Stockholm and in Denmark. We have had four people conversing freely in Glasgow with a PhD student. And then we have come up with a set of conversation sparkers that we can use. So we have had some photos which turned out to work very well in the one-to-one conversations in the original LEAP test, but less well in the group conversations. So what we have used there is what we call consensus questions. So the group is supposed to, to agree on something and the questions could be of the type, let's make a dinner plan with dishes that no one in the group likes. And the good thing with that is of course, that everyone needs to chip in and contribute because it's needs to be something that no one likes. And it's a bit funny and people sort of enjoy solving that task.

- Hmm.

- So I think we have contributed with some insights into how we could test and evaluate signal processing. So I think both are the two main things.

- No, that's right. I just wanted a couple circle back on a couple of things we talked about. One around the LEAP, so you can take this approach and you can evaluate differences across hearing aid platforms, sounds like?

- Yeah so you could either rate how well a hearing aid works and then you can compare across platforms sort of quite easily. We have also worked with direct pair comparisons, sort of AB comparisons where you switch between two settings that is more difficult to do across platforms. But for instance, during development, if you have suggestions for what the signal processing should be, you can evaluate is this better than that?

- Is there a clinical, is this something that could be used clinically or is this more designed for the research lab?

- So far it's been designed for development and research, but I said at the beginning that maybe we would come back to having some live speech testing and I think now is the time. So one way to actually evaluate how it's going in the clinic would be to have a loudspeaker set up and then actually speak to a person and let them rate how well they hear. And the problem is that it's not standardized. Not everyone is testing it the same as as in ours but it's realistic because as we said previously, people usually help each other to succeed in conversations. So if the clinician needs to increase his or her voice in order to make this work, I mean that will be increase the signal to noise ratio that is realistic and it could actually be a way of finding out how, how well a person is doing in some preset situations.

- No, that's a, that's great information because I think in my travels and talking to clinicians all around, I think that we do lack standardization when it comes to trying to evaluate someone in noise. It seems like everybody does it differently. And of course when everybody's doing it differently, it really doesn't, it doesn't really tell you a lot. And you mentioned, you mentioned early on you were finding in your research that a good place maybe if I think I understood you correctly, +4 dB signal to noise ratio.

- Yeah. That, for in the realistic SNR work that we did, then we found that speech in bubble noise that was around between four and five dB SNR,

- Yeah +4. That's important to remember.

- Yeah. That's important.

- Anyway, my last question, Karolina, any other studies that you or your group is presently working on that you might wanna share with us?

- Yeah, I have shared a little bit about the Manchester work with the communication strategies. We are also just conducting a new auditory reality study where we are looking into different groups of participants because we have been challenged, you could say in our previous work.

When we say that it's not so noisy and people are not in very noisy situations, then the standard comment is, but these are hearing impaired people. Maybe they have adjusted their lifestyle to avoid those situations. So we have, we are just writing up a paper on normal hearing and hearing impaired older people and normal hearing younger people to see if there are differences in auditory reality between those groups. And we are also just starting an investigation related to where in the world you live. So we are starting an auditory reality project in Singapore right now.

- Oh wow. That's interesting. That's lots of important work. Go ahead.

- Yeah and then I just wanted to mention the empowerment work, which I actually think that you have already done a podcast on. That was early on in our empowerment work. But my colleague Larson is leading the current empowerment work together with colleagues both in Sweden and in Australia, where they have now developed a questionnaire for end users, hearing aid users about empowerment during the hearing aid journey and validated that. And there is now a translation to Sweden and there is also a study upcoming empowerment for clinicians, when do they feel empowered? So that is another big research topic for the group in Stockholm.

- Yes that's important research also. And yeah, thank you for reminding me about that. We did have a podcast maybe a little over a year ago on that topic. Is the empowerment questionnaire now available? Could people use that if they wanted to?

- I think it is. Yes, I think it is available. I don't know exactly where they are with the publication of that work, but it's available in a longer version and in a shorter version.

- Well, that's good to know. That's something I'll follow up on. Anyway, for those listening, a reminder, we will put in the notes, the references that are available that you can find online at the various journals. For those that don't know much about the IX platform, I will put a white paper in there that kind of summarizes some of the unique features of the IX platform. And with that, my guest, Dr. Karolina Smeds, a principal scientist at WS audiology ORCA Lab in Europe. Thank you so much for taking some time outta your busy schedule to be with us.

- No, thank you so much for having me. It was good fun to talk about our research.
- Exactly. I look forward to doing it again sometime.
- Good. Thank you.