Innovations in Hearing Care from NAL, in partnership with the National Acoustic Laboratories

Presenters: Matt Croteau, MS, Catherine Kwok, Xiaoyin Shang, Bettina Turnbull

Welcome to tonight's webinar, Innovations in Hearing Care from NAL. We are so honored to have back with us presenters from the NatioNAL Acoustic Laboratories. We have Xiaoyin Zhang, Mattt Croteau, Katherine Kwok and Bettina Turnbull. I invite you to read more about our presenters on our course page or in your handout. And at this time I will turn the microphone over to Xiaoyan.

Awesome. Thank you so much, Kimberly. So welcome to Innovation in Hearing Health Care from NatioNAL Acoustic Laboratories. I'm Xiaoyin, Head of Innovation and Engagement and your webinar host today. AudiologyOnline and Sound Bites collaboration series has joined the Innovation Summit this year bringing two evidence based innovations.

And you will hear about now in our three feeding system and cozy 2.0 from my colleagues Matt and Catherine and Bettina. Both topics should sound both familiar and may feel new at the same time because the solutions, the new solutions bring new value to audiology practice. Throughout today's session, if you have any questions, please use the Q and A. Like Kimberly said, we will stop for questions after each of the two topics and in the event that we do not get around to everyone's question, a copy of the questions will be sent to the presenters. So you can.

You will have the option to stay anonymous when asking the question, in which case we will not be able to see your email after that. Okay, these are our disclosures. These are the limitations and risks for today's course and these are the learning outcomes for today. So for more course related details, you may find them on the event website or contact AudiologyOnline. All right, let's get to the topic.

So as a research organization, innovation to us at NAL means research that has been translated to evidence based solutions that can be deployed in clinical practice. So you may know NAL for its research. Today I'm here to talk to you about NAL's innovation. Who are we? Well, we're funded by the Australian Government Department of Health.

Since the Second World War and this has been. This was when the returning veterans presented with hearing difficulties. So the adult hearing research started. A few years later there was an outbreak of rubella and that's when the pediatric hearing research started and also back then now was asked to solve the hearing difficulties as well. So we've even made our own hearing aids at some points throughout the history.

So you could say that we've been innovating for 84 years. The team today is made up of over 50 multidisciplinary research innovators and we're also part of 185 clinic hearing healthcare provider in Australia and for innovation, we even set up our own innovation center of excellence. And on top of that we actively collaborate with clinics across the world, especially for our innovation projects. So we can touch on more about that later.

So I hope I've convinced you that innovation is baked into nel's DNA and it's also part of why we exist. So our mission is to lead the world in hearing research and evidence based innovation to positively change the lives of people with hearing difficulties. And we do that through our strategic pillars which are how we intend to achieve the mission and commit to delivering the innovation and research. And here you can see the innovation strategy is leveraging nel's insights and capabilities to create high impact solutions for hearing healthcare through and with our partners. And yes, interNALly all of the four pillars work together to embed that capability throughout process, toolkit training and engagement.

Right, so what does that actually look like in practice? So let me give you the difference. Bit too much. Okay. In a standard research organization, which is the case that now maybe six years ago we had one process, in reality when during the idea stage there's tons of paperwork, maybe wait a year until the grant gets approved with small chance of success and the project finally starts and the project is tightly planned from start to end and it's executed according to plan.

So one or two or several years later there's a project closure. Now if we intend to innovate using a waterfall approach like that, it's like assuming the solution before uncovering the real problem. So many of you know that approach does not support pivots, learning opportunities that are natural part of the innovation journey. And this also limits the rapid iterations with clinics that are in real operations. And so for innovation projects and now we have and need a different approach.

Over the past two years we've been building up a startup like approach that allows us to deliver new solutions to clinic. So we always leverage our core, our evidence based core through the research and insights we generate. We start with uncovering and discovering the unmet needs, exploring different desired solutions and converging together on the solution that will solve the unmet need in the way that leverages now's capability and actually delivers value to the clinic and the patients. So once we have that through a minimal viable product, we always co design and develop that product with working with the clinicians, clinic industry experts and clients. In this case we call clients, it's patients and all throughout.

So after that we put it into practice. So in that green box area and that Build, measure, learn, cycle. We may be doing it in the labs, we may be doing it behind closed doors still in a little bit or with a selected few people. Now in the next phase, we put it into practice in real operating clinics through trials and pilots to demonstrate that clinical value and the business value in operation. And that takes us closer to something that's actually deployable in clinics and can lead to clinical implementation.

And you can see throughout the whole process we're engaged with the hearing industry, professioNALs, experts around the world all throughout and even it's so important to us that we established our own innovation center of excellence and we have a collaboration of clinics around the world who helps us to try and test the innovation at different stages throughout the process.

So as a summary, our innovation agenda starts with the unmet need and challenging those key assumptions that it's a standard bio design process and it also has a way to operatioNALize the innovation into the real clinics in a stepwise way and working with collaborators around the world and experts in the area. And that's your typical lean startup principle. And we work with operating clinics around the world to adopt design and scale, improve the value proposition. So lastly, I want to finish on this side which is don't just adopt innovation, help create it. If you want to be part of the select group working with NOW to do so, you could be seen as leaders in hearing innovation.

You might want to help us design or test innovation out early and be the first to see the new and upcoming products at NELL or the new tools at nell. Feel free to scan the QR code and express your interest. All right, so this point I would like to now hand over to Mattt and Catherine who are research audiologists and the audiology and also they are the audiology leads on now NL3 project. Between them, they have extensive experience in clinical practice, technical expertise and clinical trials. And they also have a knack for making technical and complicated concepts feel practical.

So I'm sure you will come away with some key takeaways that you can use in the real clinic. So I'll hand over to Mattt and Katherine. Thanks Jaoyun and hello to everyone around the world. Today Mattt and I will focus on the clinical application of the Now NL3 fitting system and what it means for fitting decisions, verification and patient centered outcomes. So prescriptive targets aren't just technical settings.

They drive the clinical choices that we make about comfort, clarity, whether patients actually keep wearing their hearing devices. The NALani 3 fitting system is designed to better support those decisions. But what does it change in the appointment, I think I went too far. There we go. By the end of this session, you'll have an understanding of the philosophy and the evidence that she shape the NAL NL3 fitting ratioNALe.

You'll see how NAL NL3 has evolved from NAL NL2 and we'll look at how to apply the new comfort in noise and the minimal hearing loss modules into your clinical practice before we move on to what's new in NAL NL3. It's worth revisiting NAL NL2 because much of NAL NL3's strength comes from what it intentioNALly retains. NAL NL3 builds on the same guiding principle as NAL NL2, which is maximising speech intelligibility while avoiding excessive loudness. And this clinically validated approach still underpins the hearing aid prescription. What NAL NL3 adds is greater precision and more flexibility to better support real world clinical decisions.

So since its launch in 2011, now NL2 has become one of the most widely used prescriptions globally. You probably use it every day, but it's helpful to revisit what it's designed to do. As mentioned before, at its core is it's designed to prioritise speech understanding while keeping loudness comfortable. In NAL NL2, gain is calculated across 1/3 octave bands and it's shaped to support speech intelligibility. But intelligibility isn't the only goal.

Now, NL2 also incorporates loudness and sharpness models band by band. It wants to ensure that output remains comfortable and doesn't exceed that maximum permissible loudness. So on the left you can see the speech intelligibility index and its importance by band, noticing that emphasis around one to four kilohertz. And that's the key range for speech clarity, as we know. And on the right you can see a loudness sensitivity model with the blue showing the sound pressure level and the orange showing the hearing level.

So we can see that together. It illustrates how the gain isn't just guided by audibility, but perceived loudness as well. So The NL in NAL NL 2 and NL 3 stands for nonlinear, as we know. And this reflects the use of the dynamic range compression. It's not applied equally across inputs.

Soft sounds are increased for audibility and louder sounds are kept comfortable. And that's the key to balancing access to speech with comfort and to better approxiMatting natural hearing. In NAL NL2 and

NAL NL3, empirical adjustments are the evidence based tweaks that we apply to the baseline prescription targets. They're Refinements that are informed by how people actually respond to amplification in practice. Importantly, NAL NL3 keeps these empirical adjustments unchanged from NAL NL2.

And they're things like the age adjustments where outputs fine tuned to reflect those age related loudness preferences. The preferences and the evidence that suggests females prefer slightly less gain. So those gender adjustments and experience adjustments for first time users preferring less initial gain than experienced users. And also language considerations. So adjustments that account for the differences in speech cues and frequency importance across languages.

So for example, greater lower frequency weighting for some toNAL languages. These refinements sit on top of the core gain prescription and they improve the persoNALization without changing the underlying philosophy. So why did we see the need to evolve now? NL2 has served millions of fittings worldwide in the past 15 years and it's worked well. But with 15 years of experience, new technology and all this extra clinical data, we've identified areas where improvements are both possible and necessary.

So first of all, when NAL NL2 was designed, it was 2010 era devices. Since then, hearing devices have come a long way and people's expectations as well. They've changed draMattically. NAL NL2 optimizes for speech in quiet, but doesn't really take into account those other listening situations like noisy environments, music or a complex mix of sounds in the real world. And also neural network limitations.

When we talk about the neural network, we mean the machine learning model that's trained on thousands of audiograms that are realistic and sensible. So these are used to predict new targets. But even the best models can struggle. And sometimes the neural network doesn't find the most sensible solution. And also tricky audiograms.

You've seen it yourself. An audiogram that produces a target that makes you think that doesn't seem right. The target isn't sensible. So even with that solid foundation, progress means learning from what didn't always work and using that knowledge to build something better. And that's what NAL NL3 aims to do.

So how did we do this to design NAL NL3? We started by listening to clinicians, the people who use NAL NL2 every day. And we asked, where does it fall short when it doesn't quite work? What do you do instead? The responses were surprisingly consistent.

Across clinics, across countries and experience levels, across we heard many of the same stories, the same pain points, the same workarounds, and the same wish list of improvements. The feedback became the foundation for NAL NL3. Rather than simply refining an existing formula, the project involved re examining the fitting approach through the lens of real world clinical experience. So as well as clinician insights, we also had data driven insights. We aNALysed over 100,000 sets of fitting data, including NAL NL2 targets and really measurements across different input levels.

Beyond that, we looked at more than 1.8 million REMs collected across clinics around Australia. This gave us that unique opportunity to see the big picture and to uncover those real world trends. So the key questions we wanted answers were what do clinicians actually do in a fitting appointment, how do they deviate from the targets, and most importantly, what do those deviations tell us about client preferences and real world listening needs? So NAL NL2 relied heavily on simulated data, but what NAL NL3 has been trained to do is it's been trained on real clinical practice from large scale retrospective data and from thousands of fittings. So that shift means that it's more reflective of clinical practice.

So now Mattt will take a closer look at how the NAL NL3 fitting system was developed.

Thank you, Katherine. Now, as some of. Here we go. Some of the known issues in now NL2 have been addressed by this improved and more valid training approach that we had. So when we sit and ask clinicians, what are the pain points, points with NL2, what is it that the prescription doesn't seem to do well or it doesn't do well consistently?

And I've got a few examples and they may be in your heads already looking at a reverse sloping loss. So audiograms like this often go into the NL2 neural network and it comes out with a prescription target that's either unattainable or not desirable, and it ends up creating more work for the clinician to temper and adjust to make the fitting successful. And a successful fitting could be considered from different points of view. So we're looking at something that's actually comfortable, but something that actually gives benefit as well. So it's a Mattter of what's good for you, but also what's desirable and what's wearable, what's successful in the long term.

So Anyone familiar with NL2 will look at an audiogram like this and say, I'm going to have to be careful about what this gives me because it may give me way too much low or high frequencies, too much gain in certain areas where it's not useful and not desirable. So this is one of the major ones that was very hard to solve, but we had to address. And another pain point would be steeply sloping losses, but also just losses that reach down to the severe and profound range. So we found that NL2 often didn't have a very sensible approach to this. Again, providing gain in regions where it's not usable or not necessary, and maybe providing an inappropriate amount of gain where it is necessary.

With audiograms like this, you'll see that the improvements have changed, not just in gain, but also in compression ratios. So a lot of things have been adjusted to address these problems.

So another known issue is mixed and conductive hearing losses. So very consistently we got feedback from clinicians about the gain either being too high, it's being compensated for too much with the

conductive component with NL2, or again, providing gain that's in the wrong region, not optimized for intelligibility, and then again with the compression ratios when you get to a moderate sloping to severe hearing loss. So the example I have here is sort of one of those perfect cases where the Compression ratios that NL2 prescribes are inappropriate for comfort, for sound quality, for intelligibility. But also NL2 has a maximum compression ratio of 3 to 1. But the neural network's not perfect.

So if you put in an audiogram like this, this is one example. But audiograms that are in this region, it'll often give you compression ratios that exceed 3 to 1, just because of the limitations of how it was trained. And we found in real practice that's almost never attainable. So hearing devices rarely attain that. But if you do actually Mattch those compression ratios perfectly, the sound quality suffers and the clinician has to spend time with their patient, adjusting things so that the sound quality is acceptable, but the benefit is still there.

And so it's very time consuming. And we realize that having an output with those targets is not the best starting point. There's a better starting point that we could find, and that's what we've done. So for the development of this, and this reiterates a little bit of what Catherine has said, we had to sort of look at big data. We had to have an evidence based approach, looking at what's been done in the past and looking at what we're capable of now with better optimization.

And also we had to realize that optimizing for speech and quiet is really important, but there are also unmet needs. And there are special use cases that NL2 does not address. And so this is why we talk about NL3 as the, as a fitting system, because it actually has different components to it for special use cases. And that's what we'll be covering today. So here's an example of how we Found, extracted, organized, and used these big data sets that we have.

So what we're looking at here is clusters of similar audiograms. So this represents close to 120,000 audiograms from our clinics, from the clinical data that we've extracted. And what we've done is cluster

them into similar groups. In the upper left corner, we have about 4,000 audiograms that are right within that little range that you see. That's a very common audiogram.

Now, in the bottom right corner are the least common audiograms. And you can see that's a moderate or mild reverse sloping audiogram. We've clustered them by like types all the way through from most common to least common. The reason that it's important to do this is because if we want to have a neural network trained on all the audiograms that exist in the world, everything that we has happened has been tested in the clinic. It's important that we don't just take a representative sample and say, well, let's just grab 1,000 of them.

That should be enough, because the least common ones will get missed. So it's just important that we separate them out and look at, here's everything that we need, and nothing is missed. Every audiogram is represented in this table, and we can train the neural network with a representative sample of all of them so that when it gets a mild reverse loping audiogram, it doesn't have one or two examples as part of its training, training set. It has all of them.

And if we zoom in a little closer, we're going to look at the reverse slope because this was one of the more common, more commonly expressed pain points. And it's an interesting one because it's one of the rarer audiograms as well. So if we look at reverse sloping, this is a sort of zoom in on some clusters of reverse sloping. And if you cluster them into, like, audiograms, you can see they all have a similar pattern just based on averages. But these were all in different degrees.

So we were able to sort of break it up into these different clusters of, okay, here, here's a hearing test of moderate reverse sloping, severe, profound, et cetera. And here is the REM data that we extracted for the reverse sloping clusters. So all those four clusters I just showed you are represented in these four columns. And we've got REM data for 50, 65, and 80 decibel curves. And we can see the deviation.

So the black line, the, the flat in all of these graphs represents the target, what the target was for. This particular patient. And all the bars represent all the REM data that we were able to extract for those clusters and how they deviated. And you can see that we're almost never Mattching targets at low and high frequencies. There are a couple cases, the 80 decibel input, for example, for a couple of the clusters are pretty close.

But overall clinicians aren't actually Mattching the low and high frequencies very consistently with this, this type of audiogram. And there are lots of potential reasons for it. And an audiologist who does lots of fittings will have those reasons pop right up in their head. One of them is the devices are often not able to do it. You might have feedback issues or distortion issues, sound quality issues.

You may have a limitation of power, but you also might find that if you do attain those targets perfectly, you then have to go back and temper them down because of sound quality and benefit issues. So we're trying to model NL3 to better, better reflect, yes, speech intelligibility importance, which is more at the mid frequencies, but also avoiding things like upward spread of masking. So we have good models of what low frequency power affects higher frequency hearing. And so we want to make sure that we're avoiding that excessive low frequency gain. Again, the philosophy of the NAL prescriptions is for speech intelligibility overall louse.

If we were trying to just restore audibility, we would push and push and push and we could do that. But with our philosophy, we're looking at minimizing distortion and making hearing speech easier, more comfortable and clearer. Same problem with the high frequencies. Pushing high frequencies for people who have better high frequency gain has never proven to be regular clinical practice. So tempering those down to avoid excessive sharpness, again, we have good sharpness models that we base this on as well.

So looking at what clinicians actually do and looking at the types of models that we have, we're able to refine what the prescription should come out with in regards to the core philosophy, which is speech intelligibility and minimizing loudness. So making sure loudness of these prescriptions never exceeds normal loudness. And in the case of now N03, we were able to attain better speech intelligibility with even less loudness than NL2 did.

So the output of all of this retrospective research, and then of course about the studies which I'll get into, we call the NL3 fitting system, which is got three components, the prescription which is the main prescription, the Successor to now NL2, and we have two additioNAL modules as well, comfort and noise. Module and a minimal hearing loss module, which are the special use cases that we've developed developed alongside the main prescription. There it is, the now NL3 fitting system.

So as far as some of the research that went into developing this, Starting in late 2024, we started with pilot studies to establish proof of concept. We had four lab based studies early in 2025 to iterate prototypes. So as Xiaoyan had alluded to earlier, we had an approach of not just plan the project, execute the project, see what happened in the end and then decide what to do next. We actually had that constant iteration throughout so that we could improve and create new prototypes and successor prototypes to get closer and closer as quickly as possible. Even with many, many, many studies squeezed into a year, it takes a long time, but we were doing it as quickly as we could.

Through that iterative process. We also ran these Prototype prescri for NL3 in our real clinics. We were able to start fitting with real patients that we have in those particular studies. By the way, the patients themselves weren't the research participants, the clinician was. We wanted feedback from the clinician on how successful, how easy and how good the starting point was of the NL3 prescription for them.

We did finish up more studies. The comfort and noise module and the minimal hearing loss module were basically verified after several iterations in the laboratory and then tested in clinics.

So far, several thousand rems. I'm going to say this number is now over 10,000 and many participant ratings. So when we do our laboratory studies, it involves a fitting and lots of laboratory testing as a controlled baseline. But we give people a trial, we send them home with the hearing devices so they're able to try them out in their own environments, their own ecosystems, if you will, and answer real time questionnaires that we give them on an app on how they're doing. What type of environment are you in?

What's the sound quality like? Are you benefiting? Lots of questions in that, in that area. So this gives us confidence that what we've done is appropriate in terms of amplification, but is also Mattching the philosophy of showing benefit.

So the now NL3 prescription itself, the core prescription, it's designed to not just improve the benefit of the comfort, but it's designed to be more efficient to fit, so easier for the clinician, as in it's providing a better starting point.

Here we are, I've got a few examples of the prescription itself. So the core prescription that is the successor to now NL2. And here is an audiogram from earlier. This is A case where now NL2 is quite good. So it doesn't have the same pain points that we had to fix that we identified as some other audiograms.

So if I show you this, that is the NL2 targets that you'll see for this that may be familiar to anyone who fits with NL2. And I'll just overlay the NL3 target so these targets are reweighted. There are different importance, I suppose, added to different frequencies to better Mattch the speech importance function. So you'll see a little bit of difference in terms of low frequencies and high frequencies not being as important as NL2, but overall very similar couple decibel difference.

And here is a more severe audiogram. And you'll see the NL2 targets here. That again should look familiar. You'll see a couple similarities and a couple of differences with the NL3 targets. Again, we're not trying to boost excessive gain just for audibility.

We're trying to boost gain where it improves speech Intelligibility. Low frequency 125Hz gain is not important for speech intelligibility. There isn't no gain at those frequencies. There is some power there, but we aren't trying to overload the hearing aid or provide unrealistic gain. A hearing aid at 125Hz giving 30db is quite difficult depending on the coupling.

And you'll see a difference in the high frequencies as well. One of the important differences, and this is a good example to point this out, is the NL2 targets really only calculated the gain properly up to about 4 kilohertz. And then it interpolated the high frequencies above that, but with more computatioNAL power. NL3 now considers the high frequencies individually. And so their contribution to SII speech intelligibility is fairly low.

And we actually address that. So by reducing some of the loudness and the high frequencies, it actually opens us up and gives us more wiggle room for extra loudness at more speech important frequencies. So this is starting to look a little bit like the speech importance function that we use as one of our underpinning references. Okay, here's a sort of mild to moderate audiogram. And you'll see NL2 targets.

There's a decent amount of gain not just for the 50 decibel input, but 80 decibel input as well. And the update with the Now NL3 targets, you'll see a big difference in those high frequencies. They're now being considered in terms of how important they are for this type of hearing loss. And you'll see importantly on this one that the 80 decibel input does not need any gain at all. Now, that doesn't mean the hearing aid is shutting off loud inputs.

It just means that the insertion gain is zero, meaning it's maintaining normal audibility. A person with an audiogram like this has no trouble hearing 80 decibels without a hearing aid, so the hearing aid doesn't need to contribute to that. So again, we're getting better SII with overall lower loudness, which is going in the right direction.

And here's that steeply sloping down to severe to profound audiogram. Here are the NL2 targets. And here is the NL3 targets overlaid. So again, this is using the speech importance function, but also maintaining audibility at those high frequencies. And you'll see that the highest frequencies have a very narrow compression ratio compared to the NL2 targets.

For more severe to profound and more linear gain tends to be better sound quality and more beneficial. And here is the reverse sloping audiogram. So here's what you'll get out of NL2. And with NL3, again, very little importance in the low frequencies and maintaining good speech power in the mid and high frequencies. Less gain in the high frequencies in this case than NL2 because the high frequencies are basically normal for this particular audiograph.

And now we have a mixed conductive loss. And this is what NL2 will give you, which is maybe you could consider it loud, but it's. Some of it is a little bit unattainable, particularly in the low frequencies. And Here is the NL3 targets, which again, hopefully this will be avoiding upward spurt of masking and over amplification. Better starting point.

Something that's very interesting about conductive losses in general is that what's most beneficial, beneficial and preferred by patients depends very much on the pathology itself. So we, we can't say that NL3 by itself is going to be a kind of silver bullet and know exactly what everyone is going to end up with. But we need to work toward getting a better starting point. So based on all the data that we have and based on the research and evidence that we can base it on, this is a better starting point for these people.

So for verification, yes, we always want to run rems on this and want to make sure that our MPO checks are still done as well. So clinical judgment is incredibly important for this.

So in summary, the no. 3 prescription itself, they're key fixes and changes. There's quite a list of them. I'll go through them quickly. I have already sort of mentioned them, but by all means go back and check the slide deck if you want to go through them as well.

So better SII with less overall loudness, more clinically appropriate gain for airbone gaps, RE weighted calculation of low and high frequencies in respect to sii. So a better starting point, Reverse sloping and steeply sloping losses have been specifically addressed to have a better starting point as well, because that's a very common pain point that we hear. And the compression ratio of three to one from NL2 has now been reduced to two and a half to one. So that's just based on updated research that we have. We found that the vast majority of fittings never exceed 2 and a half to 1 anyway.

And the not just fittings but NL2 targets never exceed 2 and a half to one anyway. And when they do, they're not actually fitted that way, they're not met. So to make it easier to fit and make it a better starting point, we just skip that process. We just sort of have to back away from the 3 to 1 because nobody's doing it. It's not benefiting any of the patients.

And those empirical adjustments carry over to NL3. Those have been very well used and very trusted, I suppose. And all the evidence points to these slight adjustments being beneficial and we couldn't find any evidence to actually walk back on any of those.

All right, I'll hand over now to Catherine and she will go through the Comfort in Noise module, which is one of the special use cases of the new fitting system. Thanks, Mattt. So now we will look at a module that's designed for people who want to listen more comfortably in noise without losing sound speech

clarity. So the Comfort in Noise modules, not a replacement for the NAL NL3 prescription, you don't fit it. Instead of NAL NL3 prescription, think of it rather as a specialised add on.

It's for those moments when your client or patient is fitted optimally for everyday listening, but they still struggle in noisy places. So how is it useful? In short, the Comfort in Noise module complex, the NALanil 3 prescription. And it gives you a tool to persoNALise fittings for people who need a bit more help in those environments. And it wants to protect that speech clarity that's so important.

The design of the Comfort in Noise module, it's essentially a re optimization of gain. The first principle stays the same. We still aim to maximize speech intelligibility, but we want that speech loudness below normal hearing levels to avoid over amplifying. The key mechanism is that the Comfort in Noise Module doesn't do across the board cut in gain. Instead, it uses selective gain shaping.

It targets specific frequency bands where reducing loudness can improve comfort. And it keeps those critical speech cues as intact as possible, so there's less listening effort and less noise fatigue while still preserving that speech clarity. From a fitting perspective, it stays consistent with what clinicians already know. It keeps the same empirical adjustments as the NALin L3 prescription. And it also adheres to that compression limit of 2.5 to 1 that Mattt was talking about.

And it helps to keep the prescription achievable and stable in hearing devices. Let's have a look at some examples of the comforting noise module. So these are the examples that you would have seen Mattt go through as well. So first, this mild to moderate hearing loss. So here are the NAL NL2 targets that Mattt went through.

And here's the Comfort in noise feature. Sorry, there's NL3. Here's the comfort in noise feature in the dashed lines. So what you can see, it doesn't draMattically reshape the response. It mainly reduces that gain to improve comfort, particularly as the input level rises.

So you can see that the reduction is more noticeable at the 65dB and the 80dB curve. So it selectively pulls back that loudness, particularly for the medium and loud inputs. And it wants to support that comfort without giving up those speech cues. So here's the steeply sloping loss that drops down into the profound range in the high frequencies. So this is the NAL NL2 target.

And here is the NAL NL3 targets. And now the dashed coloured line is the comfort in noise module. So you'll see a clear pattern from about 2 to 8 kilohertz. The targets pull back that high frequency gain and the reduction again is largest for the 65 and 80 dB curves. So in these steeply sloping high frequency limited cases, the comforting noise is essentially allowing gain to keep that audibility where it helps and it doesn't overdrive those high frequencies, particularly for the medium and the loud inputs.

So a severe to profound hearing loss.

Now, NL2 targets Malnl3 and here's the comfort in noise. So you can see that the reduction is more conservative with this configuration of hearing loss. And that's because audibility is really, really critical with these severe to profound losses. So the comfort in noise model module takes smaller reductions compared to what you might see with milder audiograms. And now we have the reverse sloping as Mattt showed you the targets in black NL2 targets.

Here's the NAL NL3 targets with that less low frequency gain and the comfort in noise targets are the dashed line, we can see that they decrease essentially from 1kHz onwards. The comfort in noise reduces more at the 50dB input in the high frequency. With the 65 and the 80dB, there's not much that could be reduced. And now a conductive hearing loss with a mixed component at 2 kilohertz. So, starting with a NAL NL2 target, here's the NAL NL3 target, which gives that less low frequency gain, as Mattt mentioned, and the dashed lines being the comfort in noise module.

And what stands out here is that the comfort in noise module accounts for that airborne gap slightly differently than the base NAL NL3 prescription. And the biggest change is in the loud input level. There's more gain reduction on the 80dB curve. And so that aligns with clinician feedback that we had, which called for improved comfort, particularly at the higher input levels. We wanted to be sure that improving comfort didn't just come at the expense of understanding speech and noise.

And we tested, as Mattt mentioned in lab and home trial, the results were really, really reassuring. In the lab trials, there was no significant difference in the speech intelligibility between the Malnl3 prescription and the comfort in noise module. So in other words, we're getting the comfort benefit without reducing that speech clarity. So, just to go over what you're looking at, the yellow bars indicate the comfort in noise module, the black bars represent the core NAL NL3 prescription, and this graph here summarises the participant preferences from the home trials based on the subjective ratings in noisy listening situations. Again, the yellow is the comfort in noise module, the black is the NAL NL3 prescription and the grey is neither.

Neither choice. So, across the board, participants consistently favoured the comforting noise module over the now NL3 presence prescription when they were in noisy situations. So this is for comfort, naturalness, pleasantness and sound quality. They were. About 2/3 of responses went to the comfort in noise module and the NAL NL3 prescription sits closer to about quarter to a third.

And the same pattern holds for the overall preference comfort in noise module selected more often than the NAL NL3 prescription and only a small proportion choosing neither. So, key message is that in noisy situations, participants consistently prefer the comfort in noise module. So how do we identify the clients or patients that are likely to benefit from comfort in noise? In practice, it's anyone who's fitted with the NAL NL3 prescription who has a communication goal that involves noisy environments, and especially those clients who, despite an otherwise optimal everyday fitting still report high difficulty or

fatigue in noise. And the way we want to get those reports from the clients, we would use subjective outcome measures.

So it's a great way to start with finding out and identifying their preferences, their perceived difficulty and their listening goals. So here's a menu of choices for you. Some tools the SSQ12 has some targeted items on listening in noise and effort, which is, you know, very great and targeted. The AFAB has subscale specifically on background noise and ease of communication. And of course the COSI or COSI 2.0 is always a great place to start.

So clients who nominate that noisy listening situation that they want to be improved would be good candidates. Candidates and also the Vanderbilt Fatigue Scale is another good measure looking at the effort required in listening in those noisy environments. So you may have your own preferred tools. These are just suggestions, you wouldn't use all of them in a single appointment. Choose what fits the client, the goal and the time that you have, and to assess the comfort in noise candidate, you can use any of your speech in noise measures that you usually would use, like vkb, sbin, Quicksand, also some loudness scaling tests.

They can get a bit of understanding about whether loudness discomfort in noise is reached too quickly, and these give us some performance data and insights into whether it would be a good idea to fit them with the Comfort in Noise module. So here's just a quick screening pathway, cosy goals, relevant case history, some targeted questions so you can pick just a few questions and use them in your clinic from those outcome measures, the speech and noise testing and then looking for that ideal candidate who's somebody with low comfort, high difficulty in noise and normal speech and quiet performance when they wear their hearing aids. So fitting the Comfort in Noise module, here's a way to do it that's very consistent so you would only ever fit it after you have fitted the NAL NL3 prescription and that has been fully verified with RELIA measurements. And that's to make sure that the patient's everyday listening

needs are already met before we introduce any noise specific changes. Once that's done, you can activate the Comfort in Noise module in the manufacturer's fitting software following whatever NAL LL3 implementation that platform provides.

So different manufacturers may label or package it differently. It might sit inside an adaptive noise program, it might appear as a dedicated option, but the function's the same, which is to apply that validated gain profile designed to improve comfort in those challenging environments and a reminder that this always operates as an extension of the underlying NAL NL3 prescription. So validating that this module is working, there's no need to do an additioNAL relay verification with the Comfort in Noise. It's not necessary because you've done it with your now NL3 prescription and when it's integrated into the fitting software, you shouldn't have to repeat it. That said, if you prefer, you can verify it in your REM system if required, and that's your clinical decision.

And then you'd look at the subjective validation. So use noise simulations, do a simple ab comparison between the NAL NL3 procedures prescription and the Comfort in Noise option, making sure the noise is presented at 75 db spl or higher. And most clients should be able to tell the difference and quickly indicate which setting gives them better comfort in noise. So it's very important to do counseling as well. Once you've set up the Comfort in Noise module, make sure they know when to use it and how to use it, what to expect.

So explaining that it's intended for challenging listening environments. So busy restaurants, social gatherings, cafes, situations where that background noise makes listening tiring or uncomfortable. It's not designed for quiet settings or everyday one to one conversations. And this is where they would use their standard NAL NL3 prescription. And that should work really well.

Setting expectations that it's comfort in noise, it doesn't mean that it reduces noise. Part of your normal clinical practice, I'm sure. And that wraps up our Comfort in noise module. And now I'll hand back to

Mattt to take you through the minimal hearing loss module. Thank you, Katherine.

Okay, so the minimal hearing loss module is probably the more outside the box and newer approach that we're taking. So this is a specific use case for people who have a subjective hearing difficulty in noise. So they don't do well when they're surround by challenging situations or intrusive noise. But they don't have a particularly, I guess, severe or significant hearing loss. So they may have normal hearing or a very mild or minimal hearing loss.

And so what we're looking at is how can hearing aid technology that's so good at preserving snr so speech reception and noise and sound quality, how can that be used for people whose hearing difficulty doesn't require restoring audibility, but they just need better SNR improvement. They just need better speech reception and noise. So we're looking at adults who have a 4 frequency average of less than or equal to 25 dB HL. So this is a range where traditioNAL prescriptions provide very little or in some cases no gain whatsoever.

So the way that we look at identifying patients for this module would be similar to some of the tools that Kathryn just went through. For example, in our studies, we used the hhi, RHHI and Vanderbilt Fatigue Scale just to screen people coming in, finding out how much listening difficulty they have. Of course, having clear communication goals is important. Cosi Cosi 2.0, which we'll hear about later. Those are really important because if the person is struggling but can't identify any situations where they need help, it's a little bit murky on exactly what we're trying to accomplish for them.

Now, we are still looking at additioNAL clinical tools to identify candidacy for this module because it doesn't mean everyone who has normal hearing, who struggles in noise, should go ahead and try hearing aids with these particular settings that I'll discuss. But we want to know exactly who it's likely to be successful for and who it's not. So counseling and understanding that challenging situations are challenging is fine, but also understanding that some people may go beyond that and benefit from this

great technology that's in hearing aids. So the audiogram itself, as you'll see, is an important input to this prescription, but it's not the only thing. So self report, we find, is the most motivating factor that we can garner from our patients on how successful they might be with hearing devices.

So basically what this module is designed to do is that it does provide gain for all audiometric profiles, even normal hearing, even the ones that are down to a to the 4 frequency average of 25. Amplification is generally provided above 1 kilohertz. And when I say amplification, I really mean insertion gain. So depending on what sort of coupling you put on it, in terms of domes or molds or whatever, you could be reducing gain at lower frequencies. And we have to make sure that that's going to be insertion gain of zero and not less than zero.

So we want to maintain normal audibility. And then up at the frequencies where speech importance is Most important, above 1kHz, this will provide additioNAL insertion gain for the extra audibility. Because these people don't have cochlear damage or sensory neural loss, we're looking at a semi nonlinear approach. So gain from 0 to 65 will be linear gain. You won't see separate curves for 50 and 65, for example, like a traditioNAL prescription.

However, depending on the hearing loss, you'll see less gain at loud inputs. So loud inputs, we really don't want to provide any extra gain for it, just for safety and for sound quality. So there is some compression at louder inputs.

This is a case where technology really Mattters. So directioNAL microphones, beam forming, noise reduction systems. The better the hearing aid is at improving SNR and noise, the more beneficial this is for this group. So we're not looking at people, again, who need to have audibility restored. We're looking at people who need to have noise managed and need to be able to control what they're listening to in challenging situations.

This is an interesting conundrum, of course, because for that hearing aid to pump sound in with an SNR with a sigNAL to noise ratio that's better than the intruding noise, it's only effective if you have a fairly occluding coupling. Now, this is a little bit of a loose clinical judgment, but we have to say that using open domes, which you would go for for people that have good hearing thresholds, are not beneficial for this group. So you have to sort of counsel them to understand that having a closed or power dome or even a mold, if you're going to go that far, will be much, much more beneficial. And we found in our studies, by fitting people with heavy domes, power domes, they were very acceptable to it. Nobody rejected this, but it's because they're not wearing them all day long.

So this is for situatioNAL use only. People that situation that's important in their life, whether it's a job, whether it's family or meetings, regular gatherings that they have that they're struggling to hear in, they find that the occluding coupling is fine for that. So getting a balance of what is the need that this patient has, what features do they need for this to be beneficial? How long do they need to wear the hearing aids? How much of an occluding coupling can they accept?

They're all important parts to how you decide to set up the hearing aid for them.

All right, I've got an example patient and we'll just sort of talk about some of the attributes here. A patient who has a 4 frequency average of 11, so very normal, or at least near normal, they do report significant difficulty in noise. So they're motivated. They have a quality of life issue with this poor report on questionnaires. So whichever tools that you use, we've mentioned quite a few of them today, but there are many out there.

They're motivated, they have clear communication goals, they come into the clinic and they do the hearing test and you get something that looks like this. So very good thresholds, very difficult for a clinician. An audiologist to recommend, oh, hearing aids is going to help you. You'd certainly start with counseling and you start with understanding their problems a little more. But now that we've sort of

validated and developed an amplification profile that can help them with the right.

It's another option that you have that you can offer someone like this. So situatioNAL use again, we want to sort of define these situations. We want to make sure that they have a particular need and that you're setting it up for the need. Is it 30 minutes, a couple times a day, or is it six hours a day because they have a noisy workplace? These are going to help inform your decisions and how to counsel them about things like occlusion, for example.

Familiarity with the technology is important. So the SNR recovering features, again are the most important part of this. And the clinical, sorry, the occluding domes are going to be a part of your counseling and judgment. And by all means, you may have to try a couple different ones as part of your hearing aid trial with your patient.

So I've got a few examples. You're probably curious to see what the amplification looks like. Here's a very unrealistic flat 0dB loss if you put this into the software. The targets that you get for MHL look like this. So this is basically what you get for n normal hearing audiogram.

You can see the gain rises up 3 or 4 decibels above 1 kilohertz and it has a speech importance shape to it. This is completely linear because it's very mild, mild gain that is. And if we start to reduce and this is going to be essentially normal, but slightly different thresholds, you'll not see any difference. So this is pretty much the go to now. You could imagine this little bit of gain and again it's insertion gain.

So whatever occlusion, whatever pathways blocked, acoustic pathways blocked by your domes or your mold, you have to overcome that plus three or four decibels. And with SNR improving features on that's going to make the SNR much better, much sharper and still maintain comfort. Of course, here's another audiogram. This is starting to sort of push the limits of where this MHL module stops. And you would start to consider switching over to NL3, for example.

And you can see the 50 and 65 inputs are now pushed as far as about 10 just to maintain the clarity and the audibility in the high frequencies. And you can see that the 80 decibel doesn't move. So for this module, the 80 decibel is never going to move. It's always going to stay low, meaning that there's always going to be compression when necessary.

And here is a cookiebyte example Again, the 80 still looks the same. And as far as compensating for that loss of clarity, the 50 and 65 are providing gain in the middle.

And all right, there's another example again, you can see that it's just responding to the thresholds in the regions where there is a hearing loss.

And here's a tricky reverse slope sort of hearing loss. This is, is right at the boundary of where the minimal hearing loss module will stop providing anything. And you would consider moving over. This is a very interesting example of understanding the needs and the use case of the patient. Because somebody with a hearing profile like this might go down the path of a traditioNAL prescription.

NL2. NL3 will provide gain for a person with this hearing profile. And if they're going to wear them all day, every day, and want to accliMattize and be hearing aid users in the traditioNAL sense, that would be appropriate for them if they don't want to, if they have situatioNAL use and you're counseling with them, has decided, okay, your first step into hearing aids will be hearing minimal hearing loss module. You could set it up for them and you'll see that again, it's not going to provide gain, insertion gain below 1 kilohertz, but it's also going to make sure that there is that normal audibility. And then for the rest of the hearing profile, it just reinforces that clarity.

So as part of our laboratory studies and trials, we did find that across different hearing aid brands that we tried, there was a significant improvement in speech intelligibility compared to NL3. So we had

people with a variety of different hearing profiles, all of them within the range, as in better than 26dB HL, but that varied. And so we were able to program them with the traditioNAL prescription and the MHL module and get some benefit in terms of acceptability. There was no difference. So they could hear both the NL3 and the MHL amplification.

They didn't find one or the other any more or less acceptable, at least in a significant way. And then finally, clarity and listening effort had a big difference with the MHL module over using Nothing or the NL3 prescription as well. NL3 prescription generally was providing less gain, but it was still providing gain, so still very audible and was still beneficial, but it wasn't designed with the same purpose.

So overall, the key takeaways about NL3 fitting system in general is that it should be more beneficial and require less fine tuning. So providing clinicians the best starting point for the benefit and comfort of their patients is the whole point. We fixed a lot of the pain points, we think so that the targets are more appropriate. And then finally the two special use case modules which are kind of the thing that people are most excited about are that good clinical judgment should be used for both of them. But there's very little risk in trying either one for your patients.

So just remember that the comfort and noise module is, is a very well guided and validated way to adjust gain for people who experience discomfort or lack of clarity and noise. So as an audiologist myself I used to always sort of try to temper it and work on it myself. But this now gives you a great starting point on how to adjust for noisy situations and loud situations. And then minimal hearing loss module is something that hasn't really existed before from a perspective of a prescription. So this special use case is very exciting and we're still doing lots of work on it to find out how to best program the aids, which couplings are going to work and what the best candidacy is for that.

There's a very large team, basically the entire organization that worked on N03. So we're all very happy and thankful for their hard work. We do have a website, malnl3.com that has clinical resources. It also

has publications. It also has a lot of our public communications available as well.

We have peer reviewed papers under review at the moment that will be coming out shortly and lots of different trade jourNALs and magazine articles. And finally we are looking at future modules and more opinions about prescriptions. NL2NL3 what would you like to see from us? What modules do you think should come next? By all means, access that QR code and give us some feedback and ideas.

We love to hear from people as far and wide as possible. So hearing from people around the world is very insightful and we really appreciate it if you can.

Thank you very much. I will hand over to Bettina to talk about COSI 2.0.

All right, thanks Mattt. I can see Bettina's jumping on very, very soon. With the interest of time we are going over and I would just want to make sure that Bettina has the opportunity to share cosy 2.0. So we will reserve the Q and A until the very end if there is time and in the interim if Mattt and Catherine want to have a look at some of the open questions that we have and perhaps type your answer or engage. Feel free to do so.

So I would now hand over to Bettina, who's the Senior Innovation Audiology at nel. So many of you may already know her as she's had extensive experience in large hearing organizations and led education for hearing professioNALs. Through my interaction with Bettina, I can tell you that she's always focused on what will make the biggest difference for patients and clinics. So I'm sure you'll enjoy her journey as the lead on the cozy 2.0 project. Bettina, over to you.

You. Thank you. Shin hi everybody. Thank you very much for having me here today. And I also want to say special shout out to Kimberly and Carolyn in the AudiologyOnline team for the amazing support that they've given us to make this a really smooth process.

So evolving our beloved Client Oriented Scale of Improvement, or KZ for the short.

So in the first section of this talk we'll be exploring the origins of cosi, how it's traditioNALly been used, where its limitations lie, and why changes in clinical practice, patient expectations and advancements in technology provided the perfect time to evolve CO COSY to fit with current and future audiological practice. In the second section of this talk, we're going to look at the process and the science that we use to develop our product. We're going to be talking about the different approaches used in traditioNAL research versus those for product design and development and why this distinction is important. We're going to do a deep dive into the different types of studies that we that are typically used for product development and how they help us to make certain decisions. In the fiNAL section, I'm going to show you exactly how we applied that methodology to the COSI 2 development and what that meant for the decisions that we made along the way.

We'll also see what Cozy two looks like today and how it might fit into your workflow. So let's get into it.

So what is the Client Oriented Scale of Improvement, or COSI for short? COSI is a persoNALised outcome measure that asks clients to identify their own priority listening situations. Harvey Dillon, who was part of the team who developed this in, said a radical alternative would be to let each client make up his or her own questionnaire. So rather than measuring performance only in a test booth or with really measures, the COSI really focuses on real world communication needs and the perceived benefit after any intervention, such as hearing aids that come in. So why was this so groundbreaking?

COSI was introduced as a client generated outcomes measure and this was a radical shift at that time from the fixed Questionnaires that have been used to that point and some of which are still in use today, and we're not saying that one is better than the other, both are still applicable. I'm just kind of pointing out that it was a radical kind of shift at the time time and in doing so, COSI came within really

strong alignment with person centered care and counseling theory. It is also a really validated, a well validated and widely adopted tool internatioNALly.

The COSI emerged in the late 1990s when audiology began that shift from a purely audiometric outcomes to much more patient centered measures. Back in those days, it was all about audibility and getting the hearing aids amplification correct and the frequency response correct. The authors were looking for a tool that reflected what actually Matttered to the client while remaining really practical for clinical clinicians. COSI is the most commonly used tool for setting goals in audiology, especially in countries where goal setting is required for reimbursement. COSI is often the goal setting tool of choice and as you can see, it's really a basic paper form where the clinician just writes down the patient's goals and then reviews them at a later appointment.

And at that point we would be measuring the patient's progress against the degree of change change and then the fiNAL ability after they've been fitted with hearing aids. But apart from some minor digitizations, such as making it into a PDF or putting it within an online system, there have been no major updates to COSI since it was origiNALly developed.

Unlike the fixed surveys I mentioned earlier, COSI doesn't assume what situations are important. So if you think about questionnaires like the afab, IOIHA and hhi, there are some assumptions that are made about what clients want to hear or where they're likely to be having issues hearing. The upside of this is that that it's very standardized and there is little variability. But you might miss situations that are really important for the patient that could really help motivate them towards taking action. If they're sitting on the fence about taking up hearing aid use, for example, two clients with identical audiograms, they could have completely different crazy goals.

They might live with a different, different number of people, they might live in different circumstances, they might have wildly different lifestyles or communication needs. And this is both cosi's greatest

strength. But it can also be a source of variability in how that is recorded.

COSI was always intended to support a shared decision making. It helps align audiological intervention with what the patient wants to achieve rather than focusing solely on audiometric change. So the important part to remember is that COSI was always intended to be driven by the client. From a counselling perspective, COSI provides the platform to counsel on specific issues that really Mattter to that patient, making the whole process really individual, individualized and persoNAL.

So we heard a lot of what is good. So why would we look at this tool again and look to update it? Well, while COSI is really well supported in the literature, it's well used in real world. It does vary in the real world and in some cases clinics it is deeply integrated into care while in others it becomes a compliance driven task. These challenges can reduce the clinical value of cosi.

Vague goals and inconsistent outcomes measures make it difficult to clearly demonstrate benefit or guide future care. When we looked at how COSI was being used, we sent out a survey to to clinicians around 15 countries. We got just under 100 responses. We saw a massive range of variability. Some clinicians had really in depth discussions while others would write down some items that occurred naturally in the case history without being explicitly developed together with the patient as goals.

At the worst end of the scale, it was simply an item, you know, a list of items in the case history where the clinician just ticked them. So in those cases there was just no involvement at all from the clients. On the clinician side, we saw them cutting corners and emitting cosy all together due to time pressure. So we all know how much time we pressure clinicians are under in getting everything done. Some clinicians also reported finding that it was difficult to elicit goals from some clients.

They struggled to set achievable goals and in some cases they were also afraid to delve deeper into more emotioNAL topics. So they were unsure if they were straying how of scope of practice or just

simply feeling a little intrusive cozy. Goals that we've seen can range from simply wife to uber Specific smart goals like to be able to hear 90% of conversation when the local when at the local cafe with six friends every Tuesday afternoon during book club, the bag will ones tell us little about the actual problem. So they can be really difficult for clients to rate. While the very specific goals can end up feeling like they're really difficult to meet, let alone at the rate them at the outcome stage.

So you know, if there were only four people and it wasn't book club, do I still, you know, rate that? So it can be quite tricky when you get that specific.

So over the last 30 years, audiological practice has also evolved with that shift from a more medical model where the doctor or clinician had kind of the power and patients just did as they were told to. A much more patient centered, more model where the patient has sort of a 5050 role in making decisions. With the evolution of hearing aids and their expanded features and functioNALity, an audiologist's job has moved away from just simply providing the right amplification to a more broader communication functioNALity support. We know a lot more these days about behavior change and motivation of our patients and we want to focus on these to better support patients in coping with those changes.

Another facet that we looked at is sort of that growing patient empowerment and these are all spokes of the similar of the same wheel I guess. Patients have become a lot more engaged and informed. The baby boomer generation is much more used to googling what they need and the older generation who might not be doing that themselves have children and grandchildren who are definitely doing that on their behalf. The Internet and the access to smartphones has fundamentally changed how people approach. So together with a push towards person centered care, patients understanding their role as experts of their lived experience, they can feel more empowered when it comes to taking advice from healthcare professioNALs.

And they're much more likely to go for second opinions. They're more likely to ask questions and ponder their next move than what previous generations did. We've also had this tech revolution where smart have transformed how patients interact with healthcare. They provide opportunities for engagement outside of the clinic that a paper based tool like COSI just can't support. We've also seen a plethora of health apps appear.

People are used to receiving and answering surveys. Phone literacy and computer use are getting much stronger in this generation. At the same time as that our patients are also getting younger.

finally, we've also seen the emergence of AI artificial intelligence. This has completely exploded all around us, especially I want to say in the last sort of 12 to 24 months. And the use of AI has the potential to help reduce administrative burden in clinics, to help improve consistency and but while also still preserving the patient's voice in audiology and specifically for our project, this opened up really a lot of possibilities for communication assessments and outcome measurements. The principles behind COSI really remain highly relevant. But the traditioNAL forMatt no longer fits well with the modern workflow.

One more aspect is that it was it's difficult for businesses, whether they are large or small, to track business outcomes when using a traditioNAL cosy. Often if they are on paper that's really hard. But if they're on in on the computer, they're often captured in free Text fields which are really difficult to produce reports from. And consequently it's not possible to make any business decisions about efficacy or benefit, which might then determine whether extra educatioNAL training could help, or looking at compliance for regulatory purposes, for example. So all of these are the topics and issues that we looked at when deciding whether COSI needed to be updated.

And the answer was a resounding yes. So in the next section we're going to look at how we went about doing that.

So in this section we're going to look at two different ways of creating change. There's traditioNAL research and there's product development. Understanding how these differ or how they can be used, used in harmony is really critical to understanding how tools like COSI can evolve responsibly and effectively, and especially as a healthcare product.

So what exactly is research? Research aims to answer, and I'm talking about traditioNAL research here, research aims to answer the question or a question and reduce uncertainty through really rigorous methods. In healthcare, this often means running controlled studies which have long timelines and there's a strong focus on minimising bias. Typically the research question requires a really narrow lens which looks deeply at one problem, so there's little scope to change halfway through because that could kind of derail answering that particular question.

When it comes to product development, the methodology is also a type of research, but it typically has a very wide lens. And this means that you may not be answering a question with in a lot of depth, but if it is enough to reduce risk or uncertainty, then it's a kind of sigNAL that we use to move forward with that inforMattion to keep that product rolling on and keep developing towards making maybe decision, design decisions or how that product might be used. And we can do that very quickly with this type of research. So in order to, so that the lens is not completely wide, because at the start of product development you sort of, you know, you could go in a lot of different directions in order to focus it some more. There are three major lenses that we use, and these are desirability, feasibility and viability.

So desirability is about what people actually want and do they actually want this product better even do they need it at this early stage? So very early on in product development, it is the most critical sigNAL that we look for because if nobody cares about it, then nothing else really Mattters. We, we could build and fund that product perfectly, but if there's no demand, then it's just not going to succeed. So desirability focuses on a real user needs and problems and motivations. It's about understanding who

the product is for what pain point it solves.

So what is the unmet need and why that solution is compared to compelling? So why, why do people want that? And this usually involves user research. We can do interviews, we can observe in the real world and we can test early concepts to see what resonates with people early on. Desirability helps us to avoid building the wrong thing.

It guides how we prioritize what kind of prototype we might build and what assumptions that we want want to test first before we invest heavily in technology or putting something out there that doesn't meet the need. So I just want to give sort of some real world examples about this. So Google Glass was a technology that was very impressive. It's a set of glasses with a camera in the front where people can take pictures and videos. But most people didn't actually want to wear a camera on their, their face and they felt a bit awkward wearing it.

Bystanders were kind of uncomfortable about being filmed. And so it basically this product solved a problem that people didn't feel they had. Most of us carry a phone around in our pockets and it has a camera and that's what everybody's using, so why wear one on your face? There were also social and privacy concerns and that value proposition just really wasn't clear for people to use. So even if you have a breakthrough technology, if that doesn't align with real user needs, then it's just not going to work.

What did work was Airbnb. So they started by solving a real human problem, and that was that people wanted a 4 affordable accommodation and other people had spare space that they weren't using and that they could potentially earn money from. So there was a clear pain point for both the guests and the hosts. There was a strong emotioNAL appeal because rather than staying in a, you know, sterile type of hotel environment, they could really get a very local suburban type type of experience. And they used feedback from people always to shape that product very early on.

So the lesson here is really that you really need to deeply understand your user needs to potentially unlock entirely new markets. So let's move on to feasibility. So feasibility asks whether we can actually build and deliver that product with the resources, the skills, technology, and any constraints that we have. Even a highly desirable idea can fail if it's too complicated or if it's too risky or just unrealistic. What we do with feasibility, it looks at technical complexity, it looks at data availability, integration with existing systems, timelines is it, is our team capable of actually building it and at this early stage, it's about, it's not about creating a perfect solution, it's more about identifying major risks and what constraints we know that we have.

And is there anything unknown before we move on to investing more that could become really expensive problems down the line. So by testing feasibility early, we can shape the ideas into something that's really achievable. So small steps, baby steps, rather than taking those massive leaps, it helps us extend, explore simple approaches, maybe a phase delivery or alternate solutions if the first one was just way too complicated. So we don't want to over engineer at an early place. So again, some examples would be Theranos.

So those of you might have seen there's a, there's a Netflix series, I think on this, this they promised hundreds of blood tests from a single drop of blood. And this claim wasn't actually technically feasible with the science. So the core technology just didn't work. The technical risks were ignored by the company or they were even hidden away. And the delivery just, just didn't fit with the scientific reality.

So if something isn't feasible, it doesn't Mattter what vision you have. You can be super enthusiastic about it, you can tell great stories about it, but that doesn't make it real. A success story was with Slack. It didn't invent new technology. It combined proven tools like chats and notifications into a smart, usable way.

It was built on reliable, scalable infrastructure. They made incremental improvements instead of trying to shoot for the moon. And they iterated rapidly based on what was technically possible. So feasibility can stem from really simple ideas that are used in a really smart way. So they don't necessarily have to be, you know, technically a technical breakthrough.

So the last lens we look at is viability. Viability ensures that the product makes sense from a business perspective, from an organizatioNAL perspective, does it fit into the workflow? Does it, it fit with policy? It asks whether the product is sustainable and is it worth continuing to invest our time and money into it. So this includes costs, funding, models, is there operatioNAL impact, Are there any constraints around regulatory or policy?

Is it in alignment with organizatioNAL goals? So it's very much a real world, practical kind of lens to look at. So it's, yeah, it's looking at what success might look like, how we create value and what needs to be true for that product to continue over time. It helps us to prevent sort of a really cool product, but that's just not sustainable and really grounded in real world. So a couple of examples here.

A failure was Movie Pass MoviePass was a service that offered unlimited cinema tickets for a flat monthly fee. So if you were an avid moviegoer, this was awesome. The price was fantastic. But unfortunately that price lost money on all, almost every active user. So the business model just didn't cover the cost.

So growth was prioritized over sustainability and there was no clear path to profitability and they basically just ran out of money. So if the economics doesn't work and you get more and more customers so you're scaling, that just makes that problem even bigger. Amazon Web Services, on the other hand were as a success story where viability was concerned. It started as an interNAL solution and then became a paid service with a clear scalable revenue model. They had strong alignment with Amazon's long term strategy.

It was kind of a pay as you go pricing which Mattched what customers expected and they found it valuable. It provided high margins and a recurring revenue stream for Amazon. And so this was a really viable product that provides ongoing value and is really sustainable.

So what is the some of the key differences between research and product development? Neither approach is better or worse, they just serve different purposes. So with the research, traditioNAL research, we are looking at knowledge generation. It's done in very controlled environments, it's very risk averse. Whereas on the product development side, we're really looking to solve a problem.

It's seen in the real world context and the risk is managed and we'll talk a little bit more about how we manage that risk later on.

There we go. So some of the tools that we use at NAL, this is I guess more of a philosophy is design thinking. And design thinking really starts with understanding users. So that's the empathize part that you see there. It's really about understanding patients and clinicians before jumping to any solution.

It got. Oops, something's happening with my slides again. Kimberly, can you help out please? Getting us back to the right slide. We're on 98.

Thanks.

It instead of jumping sort of towards answers, we want to encourage to deeply understand the people that we're designing. We want to understand their needs, we want to understand their friction points, what's frustrating them, we want to understand what motivates them and then kind of clearly design along that problem from their perspective. From there we create a range of ideas that are generated and then be building sort of prototypes and testing. So you're testing early and often and iterating really

fast. And this means that you're learning as you go rather than kind of having to wait all the way to the end till the study is finished to get to that decision.

And ultiMattely, design thinking sort of blends creativity and logic to create a solution that's innovative but genuinely useful and really grounded in the human experience.

So I talked about risk earlier, and so while traditioNAL research is quite risk averse and we design our studies to reduce risk in design, in product design, where less, well, not less, not less concerned about risk, but we manage it a little differently. So what we do is we make some assumptions. So when you're developing a product, there are a whole bunch of assumptions that you're making. And what we do then is we write those assumptions down and we map them so that you don't end up with a product that people don't want. So one that you can't sell, that you can't build, or that's just not sustainable commercially.

So we write down all of these assumptions and we might ask questions like, is this something people will be interested in? So, for example, for Airbnb, an assumption they might have had at the beginning would be, would people feel comfortable renting spare room in someone's house? And this would be in the highest, in fact, very uncertain category, because if, if it falls up there, the whole concept just wouldn't work if people weren't prepared to stay in someone else's house or if the host weren't prepared to host people that are complete strangers. So identifying and then mapping your assumptions allows you to identify the riskiest assumptions. So those would be the ones with the red splodge up in that high impact, highly uncertain type of area, which allows you to focus your efforts when you're testing on those assumptions, those riskiest assumptions, these are the really critical ones.

So because you don't want to be testing and spending effort on proving things that are kind of, you know, in the other zones, especially that green zone, is kind of a waste of time because you're feeling fairly certain or there's a smaller amount of impact if they go pear shaped. So it's the riskiest

assumptions that we're really focusing on.

So when it comes to research versus design thinking, the questions here really highlight how they're different. So with research thinking, we're asking, is this true? We're focused on generating knowledge. In design thinking, we're asking, does this work for our users? It aims to test, you know, what is, what is really happening in the real world.

So we're wanting to understand people's lived experience and then quickly move on to prototyping and testing. It's iterative, it's Flexible, flexible. And you might redefine a problem halfway through because new insights come and tell you that whatever you, the pathway you're going down isn't, isn't great. So the goal isn't just to understand the world, but how to change it by creating solutions that work.

So while, yeah, all right, so what are some of the challenges? Challenges in the shifting mindsets and the cultural barriers that are particular to health care. So for clinicians and researchers, design thinking can feel really risky and unscientific. And letting control can often be really hard. In this shift, that was probably one of the hardest parts of my job, I'll admit, is getting the team of traditioNAL research to be comfortable with uncertainty.

So throughout the Cozy2 project, communication within the team was absolute key in addressing uncertainty. Getting back on the same page, multiple stages, different people had different ideas about certain things. Moving from one question quickly to the next, deciding what to do next, what to tell, test next. So in a place where it's not unheard of to recruit like one or two people a week or even a month, if you're thinking about a cochlear implant study, for example, we were testing cozy on literally hundreds of people in a few weeks. And then we were expected to make decisions and move that product on, you know, very, very quickly.

So that, that was challenging, but it was kind of also fun because it's a bit of a roller coaster coaster and it was really cool. So just to wrap up this sort of difference where kind of traditioNAL research pathway is essentially about safety and efficacy and especially, you know, it can be take years before we see any benefits from traditioNAL research because it's kind of quite long winded. But we're looking for real certainty. While the design led approach kind of prioritizes early value and usability and we're accumulating evidence over time. So why is there this hurry with product design?

The reason design led product development has to move rapidly is that typical quickly you need investors to even start. So investors might only provide enough funding to get you to that next stage. And if you take too long, their money might go to another project. You might, you want to make sure that your money gets you the answers that you need as quickly as possible so that that next round of investment is secured. And the investors also want to see a return on their investment and they just don't want to see that be years.

So one of the things that particularly in healthcare happens is that you can get tension between these two approaches because in healthcare, obviously we are looking for certainty where if you're designing a shoe tie or a different shaped hockey stick, it kind of doesn't Mattter so much. But. But in healthcare, patients expect safe and evidence based care. We need to develop tools that work within the clinician's workflow. So we can't just abandon all rigour of research and in that process that we're using.

So if we were only to apply traditioNAL research, we might find that by the time we get the answer answers, technology has already moved on and our answers are now outdated at, you know, at best and obsolete at worst. Fine. But if we take out, and if we take out all risks, then we're also unlikely to be nimble enough to innovate and come up with really new ideas. So how to find that balance? So that is why we use a balanced approach at NAL and we're going to take a look at some of the studies that we did to develop COSI 2.

So the first thing was to define the problem. And earlier on in the presentation I outlined how Cosmic is currently working and what some of those pain points were. And they were essentially that clinicians don't have enough time. There's that time pressure to administer it at all or correctly. The patients typically weren't involved.

And that there was that missing consistency in application of how it was administered. And then we also obviously had that sort of evolution of audiological care as well. So ultiMattely that kind of landed, you know, these things were all discussed and there were quite a number of different ways looked at and how we could tackle this by leveraging the technology that has also emerged in that time. And so ultiMattely we landed on one direction to pursue and learn from. And once we chose to that that particular direction, we then identified the key assumptions that we needed to test and whether this idea had legs at all.

And so what, what that did was it set us on a sequence of studies not to prove anything upfront, but to kind of systeMattically reduce the risk and to decide what to do next.

So before I walk you through the studies, I just want to pause on why we use the different types at different stages. So these weren't traditioNAL categories of research. They were learning tools and they were chosen specifically to answer different questions that we needed to know about at any point in time. So rather than starting with large definitive studies, we tested the riskiest assumptions first using the smallest method that we could get away with just to give us a sigNAL about a yes or no. So when you see terms like feasibility, usability, validation, think less about the label and what you, you might be used to with those and more about the questions that we were trying to answer at that point.

I'll show how these, the sequence of studies that we did helped us to understand whether COSI was going to be solving those problems that we set out to solve. So the overall validation was done in an approach that kind of blends that patient centered research with product development strategy.

So the first thing we did was we wanted to test feasibility.

Feasibility meant that, and I want to maybe just take one step back. We looked at desirability as well. We did that through a survey and we had like 97% of clinicians tell us, yep, they use it all the time and they wanted to use it. And so we knew it was desirable. I didn't want to skip that step, but we didn't do a study as such for that, but we did still look at that lens as well.

So here feasibility meant reducing early uncertainty, not about proving anything or any outcomes, anything like that. It really just helped us decide whether this idea was viable enough to pursue at all and what we needed to learn next. It's basically, can we do this and should we do this type of check before we were prepared to commit serious time, money and resources to that project? It helped us reduce uncertainty and costly mistakes and support clear go or no go decision before we were moving on. So the feasibility study was done at NAL and the types of questions that we asked ourselves were, could we elicit input from users and then generate coherent need summaries using artificial intelligence?

Did the participants find it easy to, to use? Did they trust this process and did the setting Mattter? So to answer the questions, we built a really simple prototype AI chatbot. It just had four distinct questions that it asked and we had participants. So these were research participants.

They came into NOW and engaged with this, with this chatbot. And then we had a second cohort that did it in a self directed, online only kind of model. So we tested out different settings and we looked at, you know, could we do any of these things? And all of the questions came back with a resounding yes, it was possible. People did it, they liked it.

We received positive feedback from both participants in, in both groups, not both. We had several participants in two groups that gave us the confidence to then move on to a real clinical environment, but still at a small scale.

I've been remiss and moving on my slides. So that was our feasibility study. And the, the next questions was then again not about improving outcomes. The next question was, can we add value in real clinical practices? And in this context, clinical validation didn't mean proving efficacy or making any clinical claims.

It meant validation stating that the tool performs as intended. In real clinics, does it produce outputs that clinicians find meaningful? Does it fit into their day to day workflow? And at this stage we're looking for sigNAL about was it relevant, was it consistent and was it useful for both patients and clinicians? Again, just enough to justify continuing development.

So in the validation study, this phase took place in Australian hearing clinics which are a government run, it's a large network, natioNAL network of hearing clinics across the country. We do that with real patients and clinicians using COSI2 prototypes type as part of their routine assessment. And for four weeks the COSI 2 was sent to all adult patients who were booked for an assessment appointment at the participating clinics. And we had five, I think at that stage, five or six clinics. We were looking for sigNALs about clinical value and the context and patient engagement.

So what we saw was strong engagement from both the patients and the clinicians. And the clinicians reported that they were having more focused patient centered discussions, which was really awesome to hear. We also saw an increase in the hearing needs that were recorded in the case notes compared to a control group that were just following their notes. Normal practice and the kinds of differences that we saw.

In the goals you can see here, the post trial clinician interviews told us that Cosi 2 also brought up social and emotioNAL factors that don't normally get brought up up in early appointments, helping them to have those deeper conversations. And I mentioned earlier that some clinicians were kind of hesitant to go to those more emotioNAL topics because they weren't sure if they were treading on people's toes if they asked about it. And they kind of felt that the emotioNAL content that came out in the, in these cozy goals, these AI generated cozy goals, kind of gave them the permission to go there and they were really enjoying these conversations.

They not only just captured the people and patients that want to participate, but it offered us insight into sort of current experience. So in this particular example, straining to hear can captures, you know, that, that pain point right now and they want to achieve the enjoyment and relaxation in a normal family activity. So it, it really helped put that patient at the center, at the center. And because the patient engaged with the AI kind of separately from, from the clinician, they were very aware of those goals now because they were given a copy of, of that. So all of these insights then gave us the confidence that the tool was in fact surfacing inforMattion that really genuinely Matttered in Clinical practice.

And that sigNAL was strong enough for us to then move beyond that sort of manual wizard of Oz kind of set up. So one of my team members was sort of being the system that sits behind and emailing things out and that kind of thing and placing those goals into the clinician workflow. So she was doing that manually. And all of this gave us the confidence to set up and invest in a minimum viable product that would help us to actually test it out in a larger scale.

So that took us to developing that minimum viable product or an mvp. And the first study we did with that was a usability study. And the usability study then is about whether this product could be used successfully for a pilot study. So during usability you want to find out how easily and effectively people can use a product, product, system or service to complete that specific task. And it focuses the user

experience in practice, in real life.

So that will identify whether you're succeeding, whether they're struggling, or whether they're getting confused or making mistakes. So this really helps us ensure that the product is intuitive, it's accessible and fit for use in the real world. And any feedback that you get can go into guiding design improvements before you're launching sort of a wider rollout or the fiNAL product.

The tool can theoretically be found, but it can still fail if it's hard to use. Useability test testing ensures that the COSI 2 fits into the real workflow and supports that rather than disrupting the care Delivery. So for Cosi2, usability testing showed that both the clients and the admin users could complete those tasks without help using that minimum viable product, and that the system was reliable in practice. So we had, we did have some minor friction points that were brought up as well. Well, like the goal length was a little bit long sometimes and we identified some issues with the instructions so we could kind of polish and hone the instructions a little bit better.

We also surfaced some workflow questions that needed deeper exploration before we went to a larger scale. And that was particularly around admin use. But overall the MVP was usable enough to support a larger scale policy study which with then clear guidance on what to refine in the next stage. So once the usability was done, we moved on to the pilot.

So the product pilot is intended to generate actionable feedback and whether that solution delivers real value and can be run reliably in an operating in real world operating conditions. So for COSI 2, we expanded from those early sort of 5 or 6 clinics out to 19 clinics again within Hearing Australia and We did that over a three month collection window to determine values. So we were collecting really a vastly larger amount amount of data at this point. And the sorts of questions we wanted to look at was did COSI2 save clinical time? Were patients who did COSI2 more likely to accept recommendations that the clinicians made?

Did the clinicians offer different types of solutions based on COSI 2 compared to what they would previous? Were patients who did COSI 2 more likely to keep their hearing aids than those who went through the normal workflow with the traditioNAL cosi? So we are still aNALyzing those because we haven't quite finished our data collection, which means you will have to wait to another presentation for those results.

So, user insights and what is currently coming up. So pulling all of these stages together, a few consistent user insights emerged for us. First was that the patients were willing to engage with COSI2 and they often used a more emotive and reflective language when given that time and space outside of the clinic. The second big insight we got was that clinicians reported that these richer input made it easier for them to to broach more sensitive topics and have those deeper, more meaningful conversations during appointments. Or they were able to move on to that problem solving and recommendation, talking about technology earlier than they might have if they'd had to talk about those basic needs first.

So together these insights suggested that an AI support pre appointment reflection can really enhance the quality of the clinical conversation, but not to replace it. And Cosi 2 was never intended to replace that clinical conversation. We also saw early sigNALs that this approach might support greater readiness to consider hearing solutions, which is something we plan to explore more.

So these user insights are really important because they stop you from building the wrong thing really well. When you don't deeply understand your user, their goals and their frustrations, their habits, then you're basically designing based on these assumptions. And assumptions can be really sneaky. They can feel logical, but they're often wrong. So user insights really replaced they guesswork when with real understanding, they also help you uncover needs that people might not articulate directly.

So sometimes users are not going to say I need X. They describe a workaround or they describe a complaint or a moment where things just aren't working, which we refer to as friction. And this is where the gold is. So the insights is really, really important in turning surface level feedback into deeper patterns that you can then design around. And practically they save time and money because fixing a product after launch is really a lot harder than adjusting as you're going early with the early Prototypes based on what people are telling.

So here we go. COZY evolved. So when we set out, we addressed, we set out to address these problems and I think we've shown that we've kind of addressed all of those problems. So what does COSY look like now?

So cozy is now an 8ai powered digital tool that makes it easier for patients to identify their hearing aids and track their hearing aid benefit. COSI 2 aims to modernize the way patient goals are captured and used without losing that persoNALized focus that made COSI so valuable in that in the first place. So the workflow looks a little bit like this, this. Oops, we've gone too. There we go.

All right, so the idea is that any patient who is coming in for an evaluation appointment is sent a link to the COSI before they arrive. Typically we were sending it out around two days before. And the client then has the opportunity to think about their hearing needs before they're coming in and to develop those. And they're send a copy of what is generated from their chat with, with the online cosy and the clinician is also sent a copy of that before that client arrives. So the clinician can review that before they see the client.

Hence we can. They have sort of a springboard to get straight into it. They then have a really cool and in depth conversation. Hopefully they can talk about any interventions that would be suitable for their client. Then they would go to fitting.

And then a couple of days before their follow up appointment, the patient is then sent another link, this time for the outcome. So this time they're rating how well they're doing compared to before they were wearing their hearing aids or any intervention that happened. And their fiNAL overall kind of ability, again that is also available. The outcome of that outcomes assessment is available to the clinician before that patient arrives in their clinic. So they can be forewarned if the patient isn't doing so well on a certain goal.

And then the clinician can kind of have a think beforehand go, okay, what, what is the best next pathway for this client to resolve those issues as quickly as possible? So having all of this recorded digitally also means that businesses can look at reports that would help them to think about regulatory, so compliance in doing it and also what actual benefit is happening.

So COSI ultiMattely is not just a chatbot, it's multi agentic, which means there are several agents all working together. We found out in our prototype and later MVP that a single agent wasn't able to handle the vastly different answers that we got from different patients. So Some will write an entire essay, others just use single, single words and others, again, just simply don't answer the question. And so we wanted to be, we wanted Cosy to be smart. We also found that we needed to validate that a goal was relevant and somewhat realistic.

The true realistic things should probably be done in the clinic with the, with the clinician. But we didn't want COSI to be producing needs that were potentially completely unreal realistic. So we're validating each goal first against a database of goals that we have here through our Hearing Australia network. And we've got like over a million goals to do that. We also embedded elements of motivatioNAL interviewing which helps patients to better understand their own motivations towards taking action, especially if they're ambivalent or kind of sitting on the fence around, you know, looking at intervention.

And we tested in traditioNAL brick and mortar clinic settings as well as in online models of care. So at every stage ensuring there was consistency and decisions made on the evidence that we were seeing.

Here are just some examples. So you can see these are straight from clinical practice. So out of real files where we've got things like wife or background noise and we're getting way more emotive, longer and quite sort of consistently worded goals that really help with that consistency and providing a much richer ground for then meeting those outcomes just a little. So next steps for COSI is that we're going to continue to study cosi. However, it is now a product and has been handed over to our commercialization partner who will be helping you and your clinics to integrate Cozy 2 into your workflows.

What I just want to point out quickly is that with cosi, what we found during all of the studies that we did, it's not so much the goals themselves that Mattter. So just writing down the goal isn't going to help. It's really the journey that Mattters. We found that even people who sort of partially did Cosy might have got interrupted, were still really benefiting from, from that. So it's really the journey and that reflection that's really, really important.

And finally bringing it all together, we, we found that cosi's philosophy still remains relevant, that, you know, we've addressed how practice and technology have evolved in involving a new, a new product. Our user insights really helped us guide meaningful change. And really clinicians and patients remain central to cosi. I want to say thank you very much for listening today. This is the amazing COSI team.

Every single one of these people have contributed an enormous amount of their expertise and time to this project and I'll hand back over to Xiaoyan. Thank you so much Bettina. That was really interesting. And also thank you to Mattt and Catherine for answering all the open questions around now NL3 because we knew that we were going over time just a little and so we do not have time for open live Q and A right now. What I would say is a big thank you to AudiologyOnline once again for being such a

wonderful partner on the AudiologyOnline and now Sound Bites Webinar partnership and if there are any more questions coming up again, if you leave your email we can get back to you post post webinar so with that I'll hand over back to Carolyn who will wrap up well.

Thank you all. It is always amazing to see a peek behind the curtain at NAL and learn about the latest innovations from the people who are making it happen. We very much appreciate your time and expertise and value this partnership with NAL. Thank you. Thank you to all of our participants who logged in and we hope to do this again in the future.

So we'll see you all soon. Have a great rest of your day or evening wherever you're located. Take care. Bye bye.