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

Xiaoyin Shang
Matt Croteau, MS
Catherine Kwok
Bettina Turnbull



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Xiaoyin Shang

Xiaoyin Shang is a strategic innovation and commercialisation leader with a proven ability to translate research into impactful solutions across the Australian hearing and healthcare sectors. As Head of Strategic Innovation and Engagement at the National Acoustic Laboratories (NAL), she oversees the organisation's innovation product portfolio and leads the end-to-end product pipeline, while also directing NAL's brand and communications to drive sector influence, research translation, and innovation adoption.

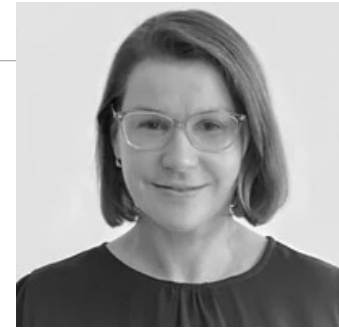
With foundational experience as a clinician and clinical manager overseeing three centres and sixteen metropolitan and rural visiting sites, Xiaoyin brings deep operational insight to her strategic leadership. Her career spans governance, entrepreneurship and systems innovation, including serving as a Board Director of Audiology Australia, Campus Director of HULT, and founder of two ventures—one commercialising nanoparticle research into consumer products and another disrupting supply chains, which won the 2020 HULT Prize regional competition.

A PhD candidate researching strategic commercialisation in public research organisations—and a graduate of the Melbourne Business School MBA and the Australian Institute of Company Directors—Xiaoyin is recognised for driving evidence-based strategy, accelerating innovation adoption, and shaping capability across complex healthcare ecosystems. She is widely regarded for her leadership in innovation, research translation, and women's leadership.



Matt Croteau, MS

Matt Croteau is a research audiologist with a science and technical background who has worked in the areas of hearing assessment, diagnosis, and rehabilitation for adult, paediatric, and complex clients. Much of the research he undertakes at NAL is in understanding individual impacts of hearing loss and the evaluation and development of new solutions and technologies.



Catherine Kwok

Catherine Kwok joined NAL as a research audiologist in 2022. She previously worked as a clinical audiologist in government, private and hospital clinics with experience in establishing, and providing direction for clinical procedures and protocols. While studying, Catherine undertook research in the Philippines for a project on objective measures of hearing aids used in a hearing aid donation programme.

At NAL, Catherine has contributed to research in perceived hearing loss, validation of hearing technology claims, enhancing vocal emotion cues for hearing impaired listeners, and clinical trials. She has an interest in the association of hearing loss, social isolation and dementia, and in community involvement in providing optimal hearing care models.



Bettina Turnbull

Bettina Turnbull is Senior Innovation Audiologist at National Acoustic Laboratories. She brings extensive experience of driving commercial success in a large hearing healthcare retail organisation, where she led initiatives to enhance clinical outcomes for clients. More recently, she has driven innovation in education for healthcare professionals, developing cutting-edge learning programs that bridge the gap between theory and real-world application. Her experience in developing markets has seen her successfully navigate complex business landscapes, identifying opportunities for expansion and sustainable growth. Bettina is passionate about translation of research into practical, market-ready innovations, ensuring that new developments are not just theoretical but create real impact.

Disclosures

- **Presenter Disclosure:** Financial: Xiaoyin Shang is employed by NAL. Non-financial: Xiaoyin Shang has no relevant non-financial relationships to disclose. Financial: Matt Croteau is employed by NAL. Non-financial: Matt Croteau has no relevant non-financial relationships to disclose. Financial: Catherine Kwok is employed by NAL. Non-financial: Catherine Kwok has no relevant non-financial relationships to disclose. Financial: Bettina Turnbull is employed by NAL. Non-financial: Bettina Turnbull has no relevant non-financial relationships to disclose.
- In lieu of honorariums, a donation has been made to the NAL student internship program.
- **Content Disclosure:** This course focuses on NAL-NL3 developed by the National Acoustics Laboratories.
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- As healthcare is rapidly evolving, new findings may change the validity of the information presented in this course. Providers should always consult the latest research and guidelines from professional associations.
- The interventions discussed in this course may be limited in generalizability, requiring practitioners to consider specific individual and population factors.
- The course may not cover all possible risk factors, diagnostic methods, or treatment options, and complex cases may require additional considerations.
- Healthcare providers should apply cultural competence and sensitivity to ensure effective and respectful care based on their patients' diverse needs.
- Providers should always evaluate the limitations of diagnostic and screening tools, considering their potential for false results as well as any ethical implications.
- It is the responsibility of course participants to critically evaluate the evidence from multiple sources to guide professional practice.

Learning Outcomes

After this course, participants will be able to:

- List three specific cases where the predecessor NAL-NL2 prescription provided suboptimal gain targets in relation to the core philosophy of the prescription.
- Describe development of NAL-NL3 prescription and explain the specific use case for each of the NAL-NL3 Modules (NAL-NL3 Comfort in Noise and NAL-NL3 Minimal Hearing Loss).
- Contrast the COSI 2.0 with other assessment tools and traditional research frameworks, and explain specific study designs and product development methodologies that support its use.

Innovations in Hearing Care

Xiaoyin Shang

Head of Strategic Innovation and Engagement

Who Is NAL?

- Government-funded hearing health research center
 - Supported by the Department of Health
 - In existence since 1942
- 50+ career scientists
 - Audiologists
 - Engineers
 - Speech pathologists
 - Neuroscientists
 - Psychologists
 - Project Managers
 - Entrepreneurs
- A part of a 185-clinic hearing healthcare service provider
- Research and Innovation programs
- Global partnerships

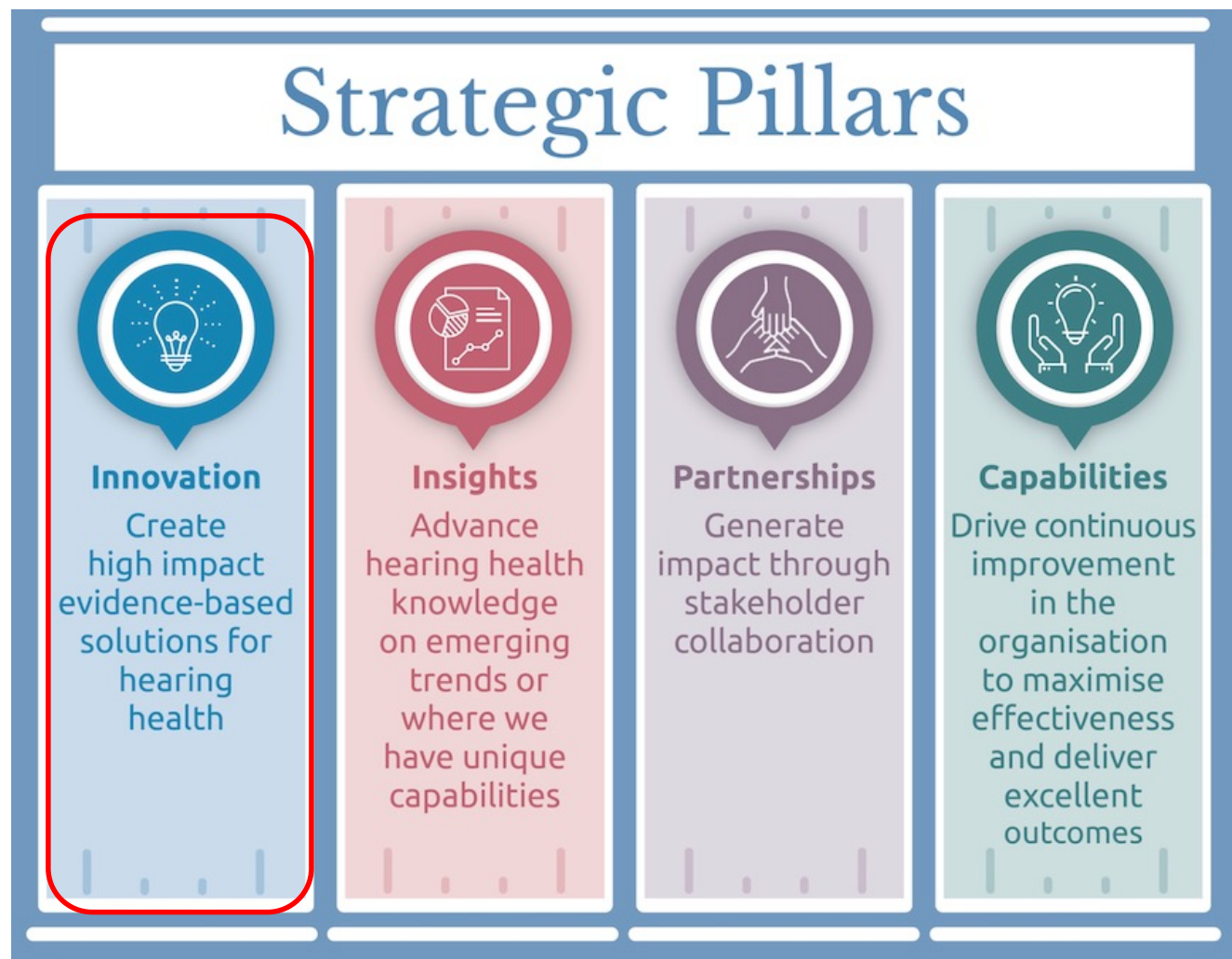


Our collaborators



Mission

- Our mission is to **lead the world in hearing research and evidence-based innovation** to improve hearing health and transform the lives of people with **hearing difficulties**





MISSION STATEMENT

Continuous leader in innovative solutions that deliver impact by applying current and emerging global innovation methodologies to NAL's world leading research program and engaging with the external innovation ecosystem.

PROCESS



A methodology to accelerate and build on an idea with Discovery Phase, Build Measure Learn and Impact Delivery process.

TOOLKIT



NAL Innovation toolkit designed to be adopted by multidisciplinary teams, internal and externally to collaborate, create and deliver.

TRAINING



Embedding innovation competency and build capabilities through an up skill program for our staff.

ENGAGEMENT



Lead the broader innovation ecosystem and be the global hearing health innovation hub.

Typical Research Process

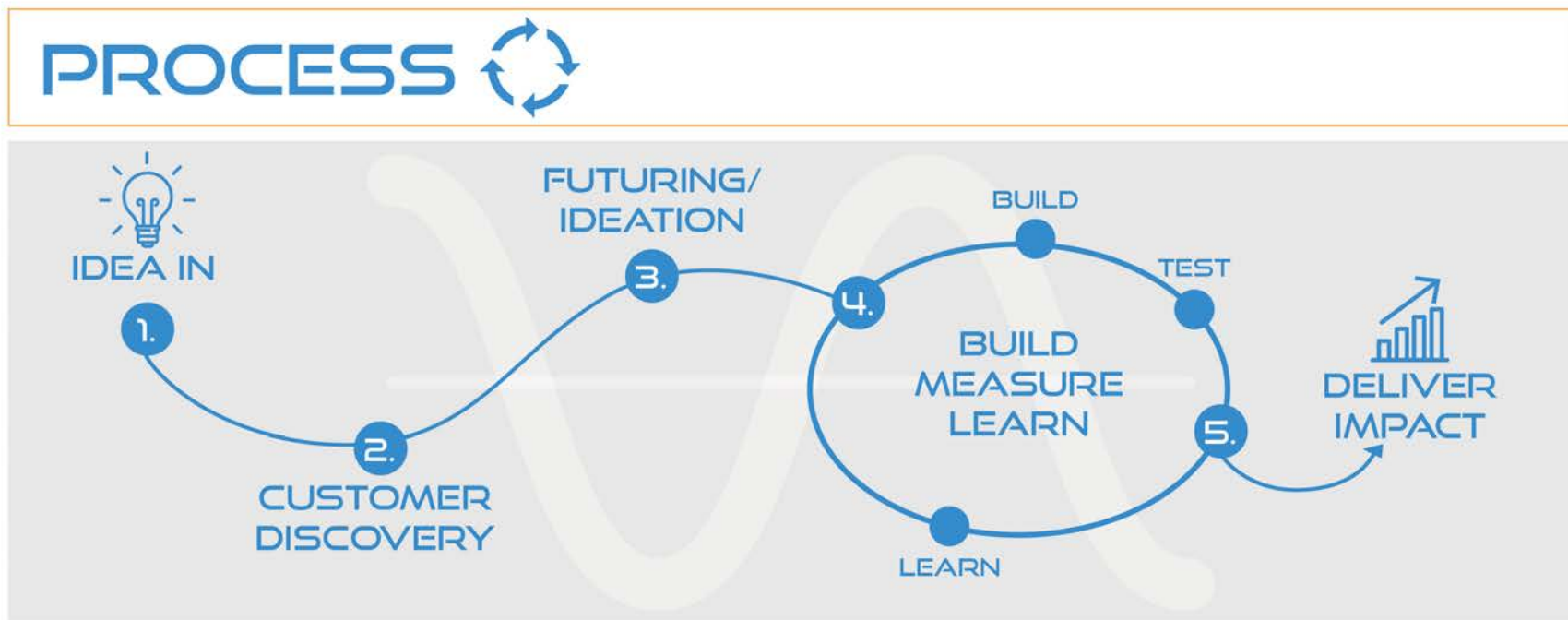


Does not lead to innovation

Innovation Process at NAL



Methodology



NAL Innovation Agenda Summary

1. Starts with Discovery Program to validate the unmet need and validate key assumptions (Biodesign)
2. Stage gate process to operationalise innovation methodologies (Lean Start up principles and Agile way of working)
3. Delivers evidence-based innovation through research design and innovative iterations with real users and decision makers

Clinical Application of the Next Generation Hearing Aid Fitting System

Matt Croteau • *Research Audiologist, NAL*

Catherine Kwok • *Research Audiologist, NAL*



Topics we will cover:



1. Philosophy of NAL Prescriptions – principles that guide our approach
2. Evolution of NAL-NL3:
 - How it builds on NAL-NL2
3. The Comfort in Noise Module:
 - Use case and best practice
4. The Minimal Hearing Loss Module
 - Use case and best practice

NAL-NL2 Rationale

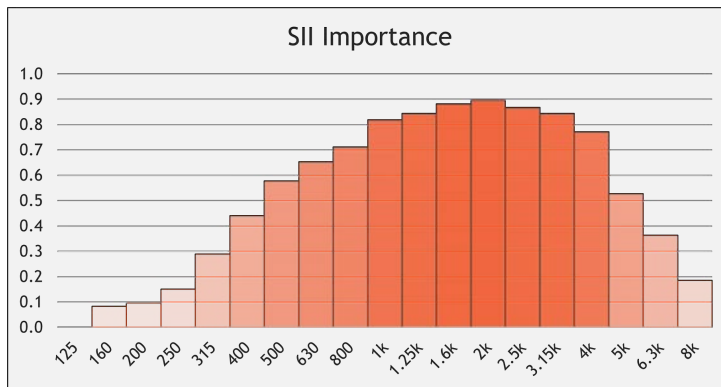
To improve **speech intelligibility** while avoiding excessive loudness.



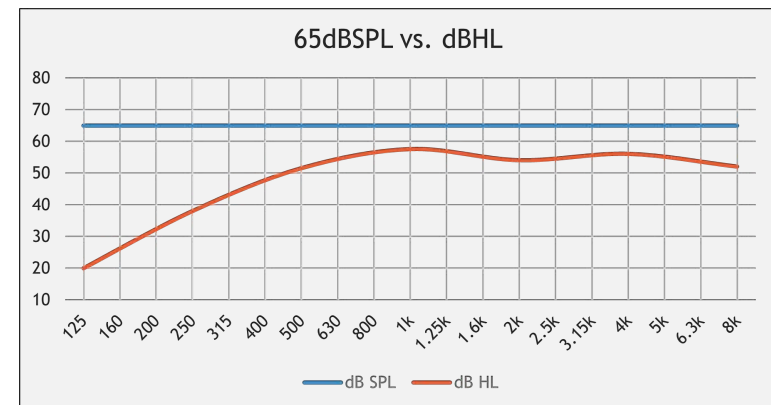
NAL-NL2 Gain

NL2 gains are guided by two key constraints:

1 Speech Intelligibility Index (SII) weightings – to prioritise clarity of speech.

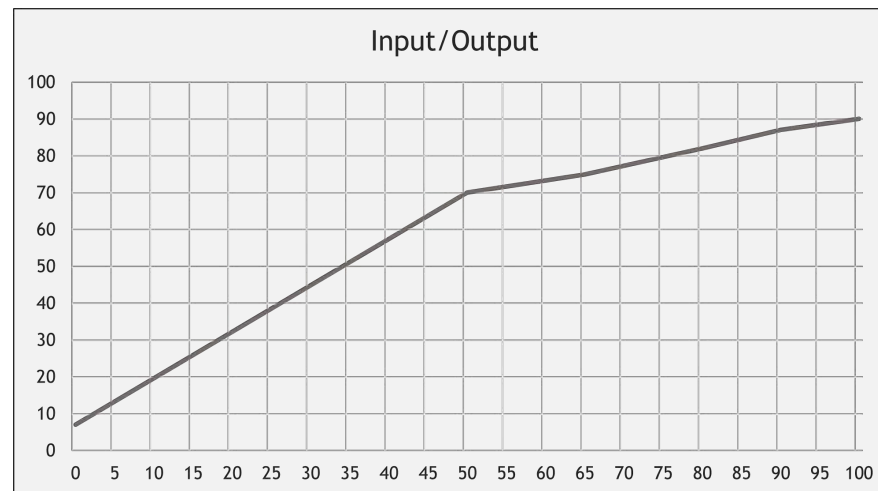


2 Maximum permissible loudness – to ensure listening comfort and safety.



NAL-NL2 - Gain

- Non-linear gain
- Dynamic range compression to maintain comfortable audibility



NAL-NL2 Empirical Adjustments

After gain optimisation is complete, the final empirical adjustments are applied for variables such as:

- Age
- Gender
- Experience
- Tonal/Non-Tonal Language
- Binaural/Monaural Fitting

The screenshot displays the NAL-NL2 software interface with the following fields and options:

- Client Name:** A text input field.
- Gender:** Radio buttons for Male, Female, and Unknown. The 'Unknown' option is selected.
- Hearing Aid Experience:** Radio buttons for Experienced and New User. The 'Experienced' option is selected.
- Language:** Radio buttons for Non-Tonal and Tonal. The 'Non-Tonal' option is selected.
- Date of Birth:** A date picker showing 'Monday, 1 January 1990' with a calendar icon.
- Number of Hearing Aids:** Radio buttons for Unilateral and Bilateral. The 'Bilateral' option is selected.

In NAL-NL3, these empirical adjustments remain unchanged from NAL-NL2.

Why Evolve?

Room for improvement:

-  Built for another time – designed for 2010-era hearing devices
-  Optimised for speech in quiet – need for more real-world usability
-  Neural network limitations – predictions are not always accurate
-  Challenged by unusual audiograms - strain the model leading to unrealistic targets

Clinician Insights about NAL-NL2

Over 2023–2024, we reached out to clinicians across Australia and around the world to better understand how they use NAL-NL2 in practice.



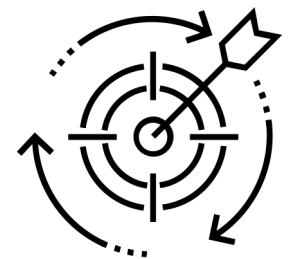
Data-driven Insights

 100,000+ sets of fitting data analysed

 1.8 million REMs reviewed

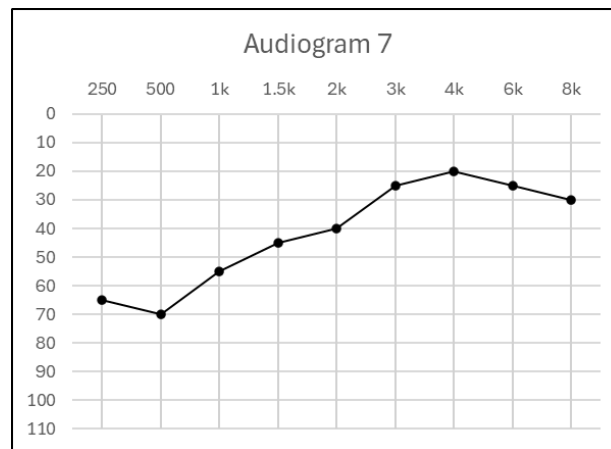
 Trends uncovered in real-world fitting approaches

 Clearer understanding of what patients *actually* need



Known Issues in NL2 Prescriptions

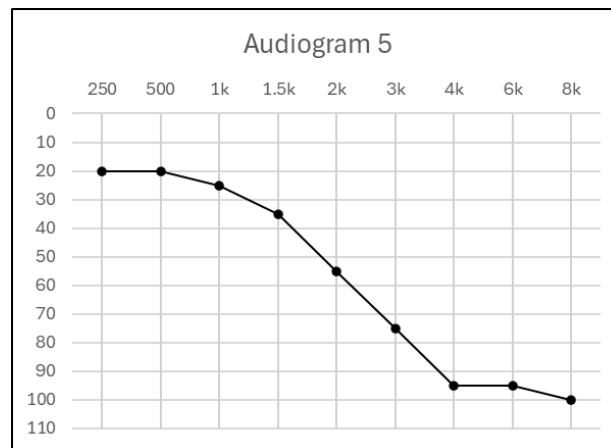
Reverse-sloping losses:



Known Issues in NL2 Prescriptions

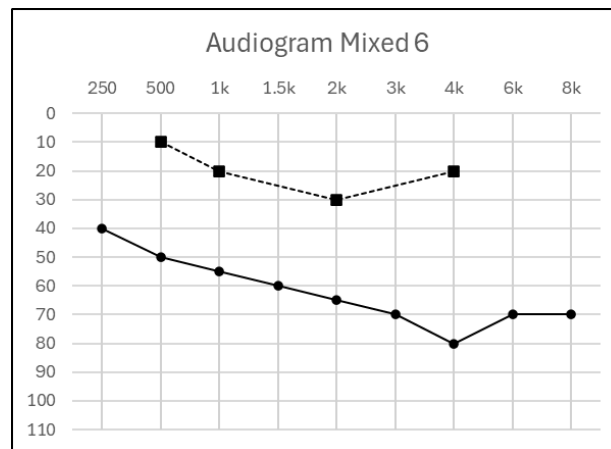
Prescribing excessive high frequency gain:

- Common in steeply sloping audiograms - pain point for severe-profound



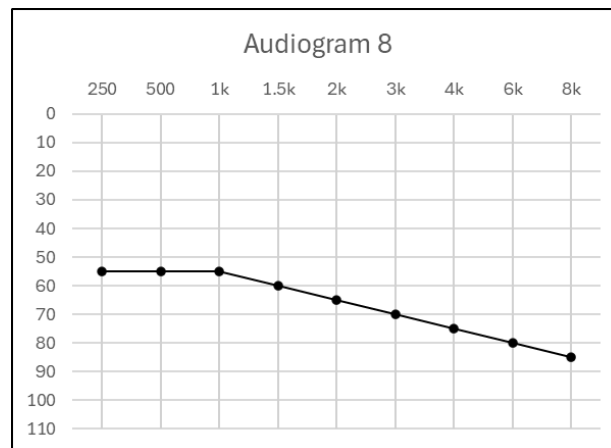
Known Issues in NL2 Prescriptions

Mixed/Conductive hearing losses:



Known Issues in NL2 Prescriptions

Some cases where output targets prescribe unrealistic or unattainable compression ratios:



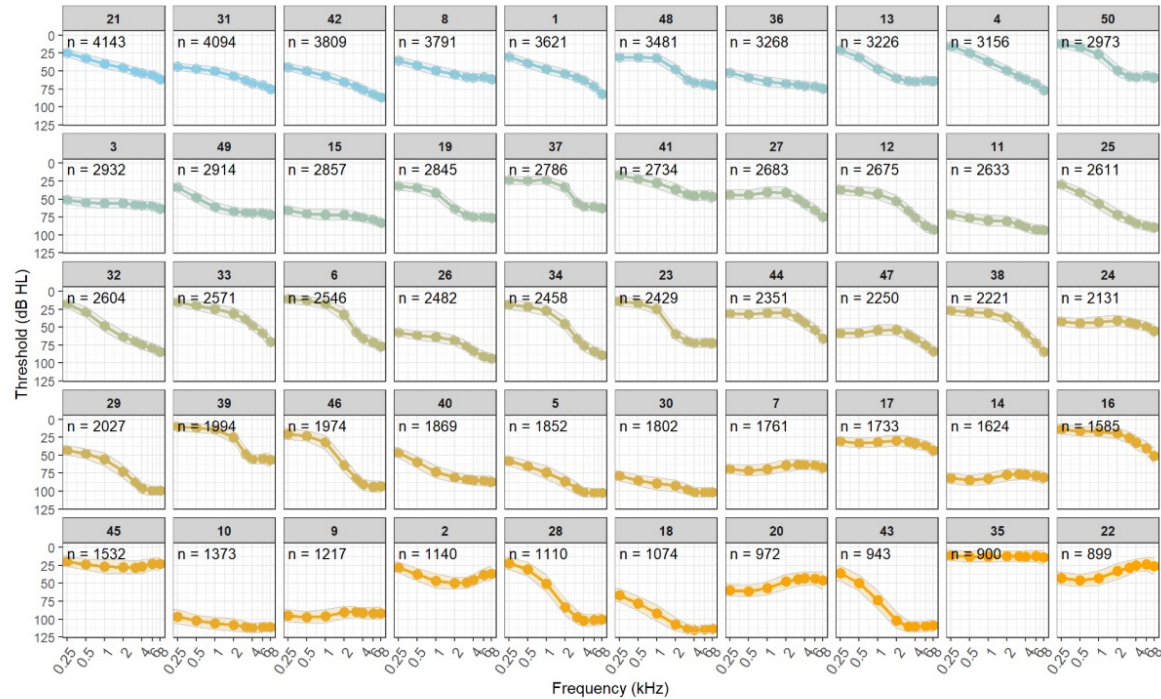
Development of NAL-NL3

Our Response:

- Undertake data- and evidence-driven approach to address known issues with NAL-NL2 and update optimisation process.
- Consider use case: NAL-NL2 is optimised for speech in quiet, but we know understanding speech in noise is a primary goal of our patients regardless of hearing levels.
- Opportunity to consider more specific cases and unmet needs

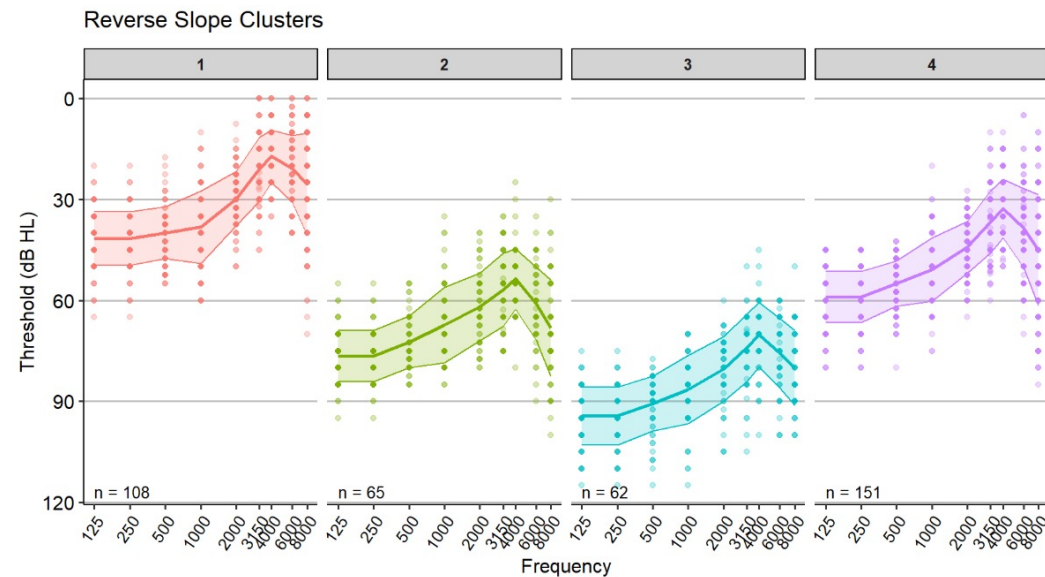
Development of NAL-NL3

Audiometric Profiles - Cluster Analysis of 116,656 Unique Audiograms (SNHL)

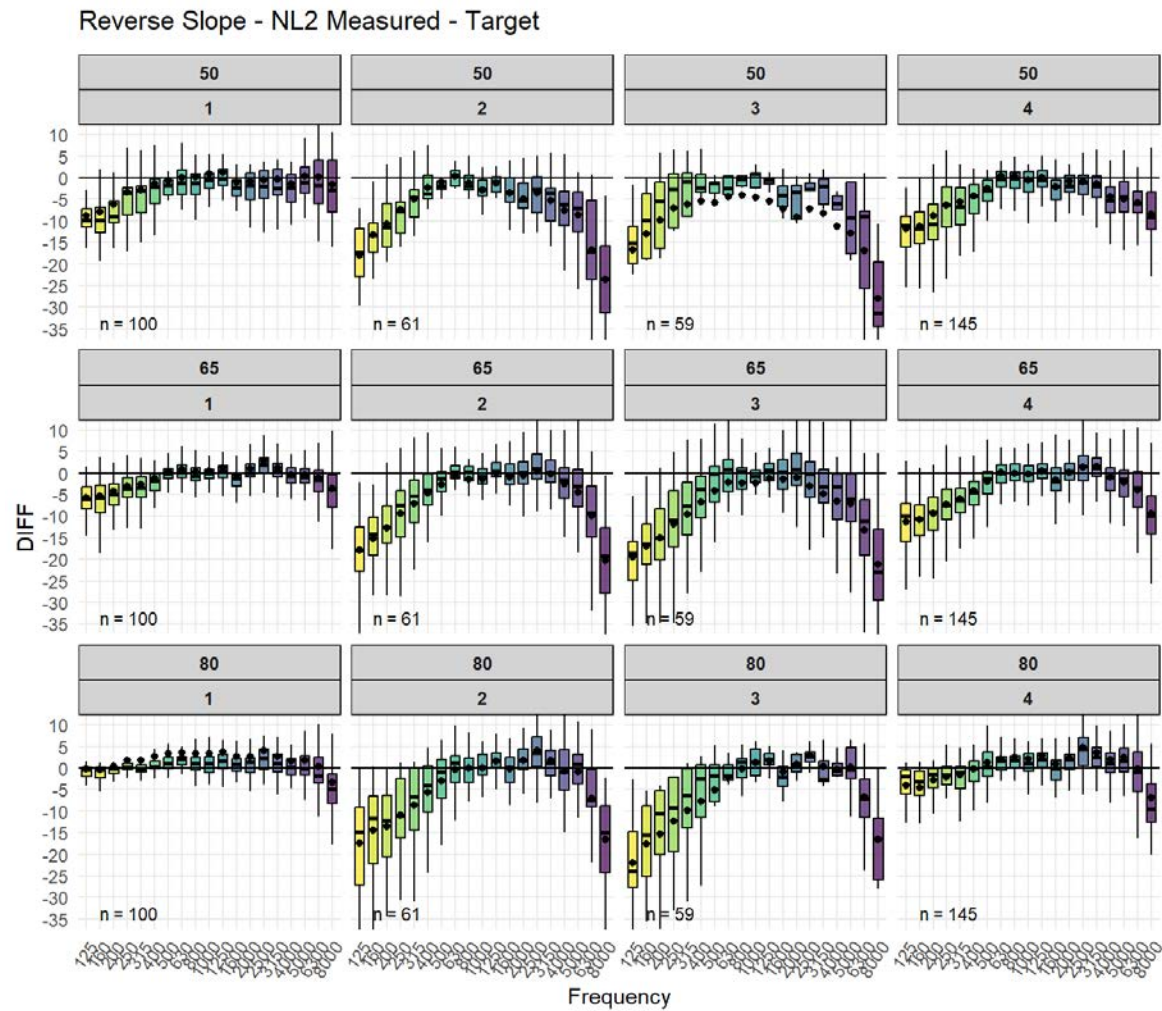


Development of NAL-NL3

A Look Into Some of the Data:



✓ Evolution of NAL-NL3



The Result

A significant update to the NAL prescription, and the introduction of **two new modules** designed for noisy situations.

- **NAL-NL3** *Prescription*
- **NAL-NL3** *Comfort in Noise*
- **NAL-NL3** *Minimal Hearing Loss*

Collectively Referred to as:

NAL-NL3
FITTING SYSTEM

Research and Iteration

Beginning in Late 2024:

- Two laboratory-based pilot studies to establish proof of concept.
- Four lab-based studies completed to help iterate prototypes of the two Modules, including two cohorts of take-home trials.
- Three in-clinic studies (with adult rehab patients) to explore the NL3 prescription: performance, patient satisfaction, clinician satisfaction and feedback, ensuring early fixes are responding as intended.

Research and Iteration

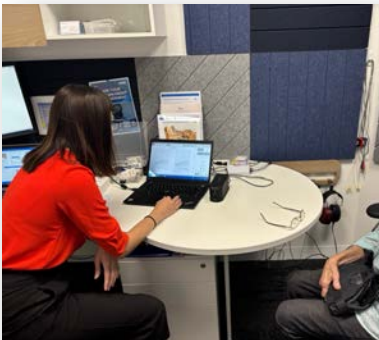
Final Studies:

- Two in-clinic studies fitting NL3 and Comfort-in-Noise modules with adult rehab patients.
- Two laboratory studies fitting NL3, Comfort-in-Noise, and Minimal Hearing Loss modules.

Research and Iteration

So Far in Our Studies:

- 6,300+ REMs and 11,800+ participant ratings (EMA) in 2025.
- Targets are closer to real-world preferences.
- Higher clinician and user satisfaction.



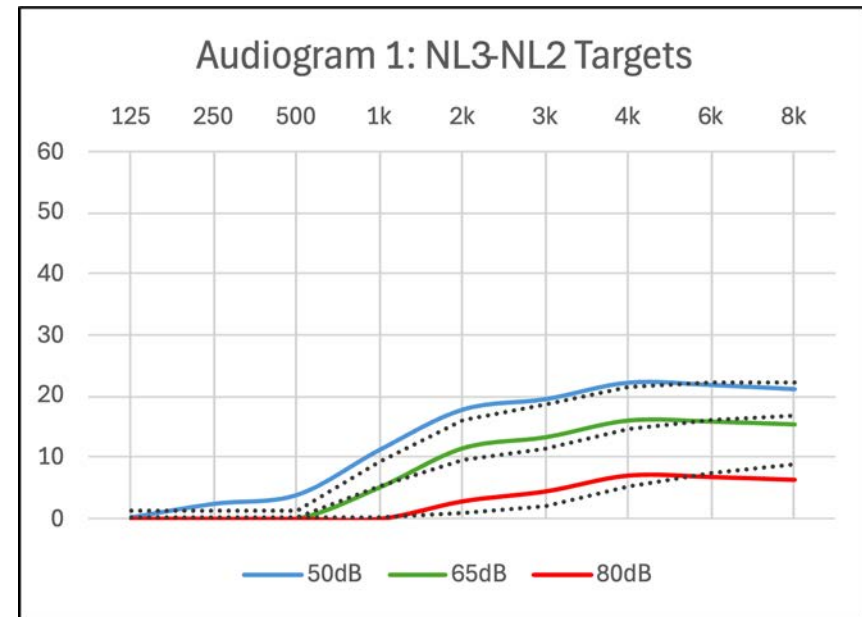
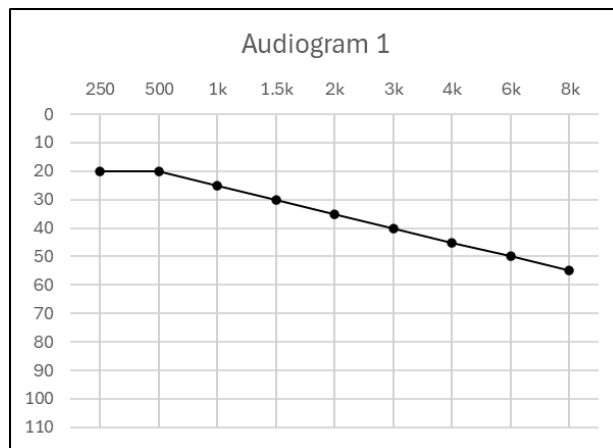
The NAL-NL3 Prescription

- Designed to improve benefit
- Designed to improve comfort
- Designed to be easier and more efficient to fit

The NAL philosophy of maximising speech intelligibility without exceeding normal loudness perception still underpins this prescription.

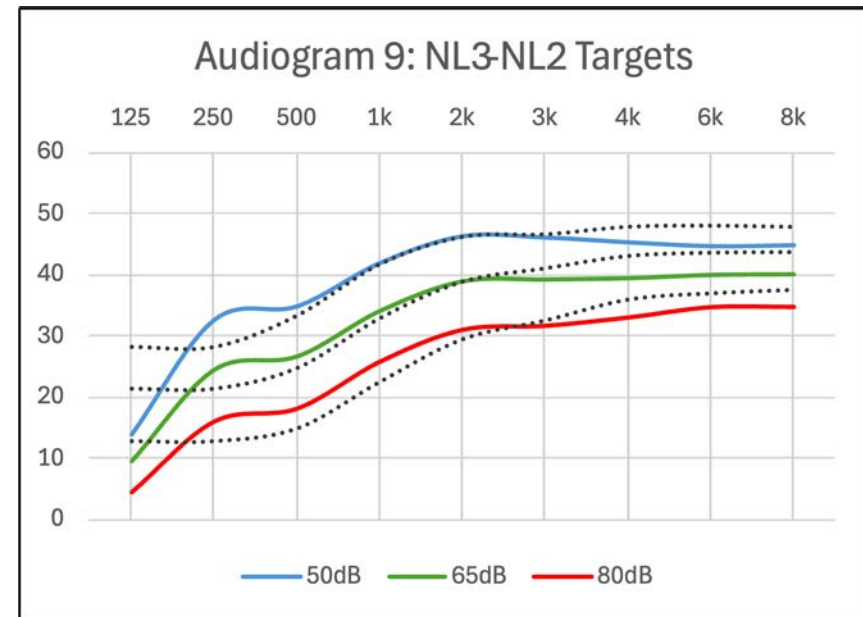
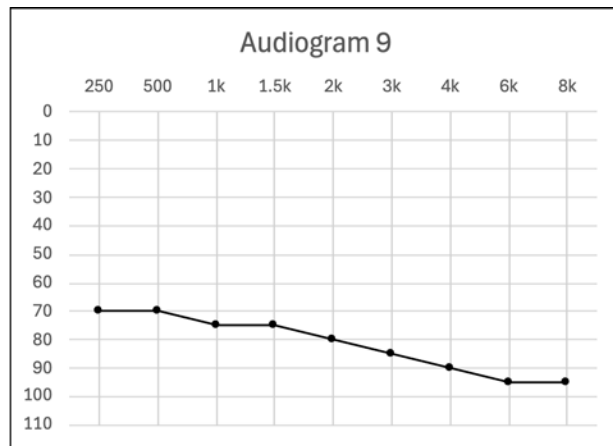
The NAL-NL3 Prescription

For many audiograms you *won't* see a dramatic difference.



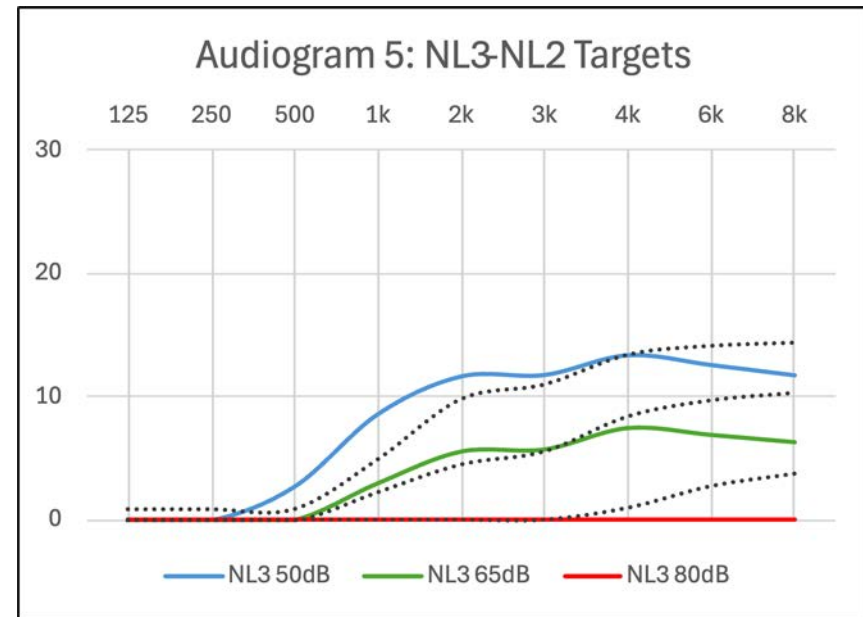
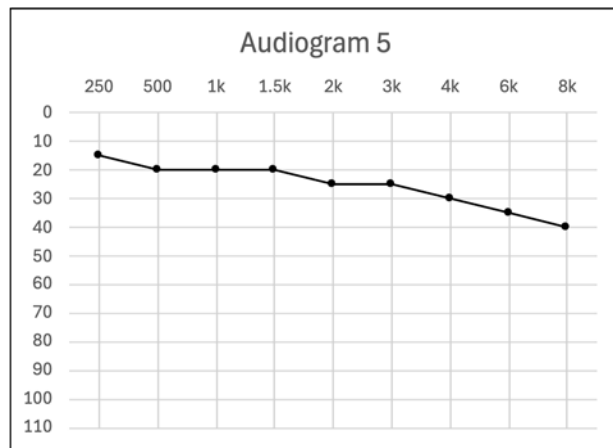
The NAL-NL3 Prescription

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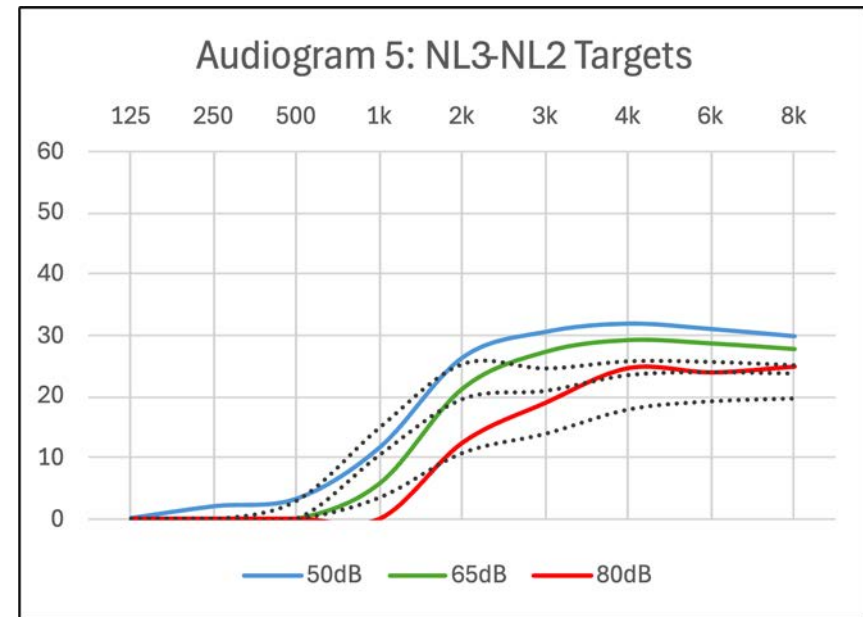
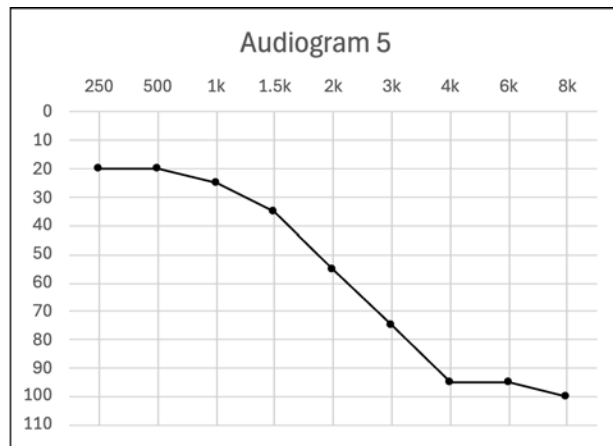
The NAL-NL3 Prescription

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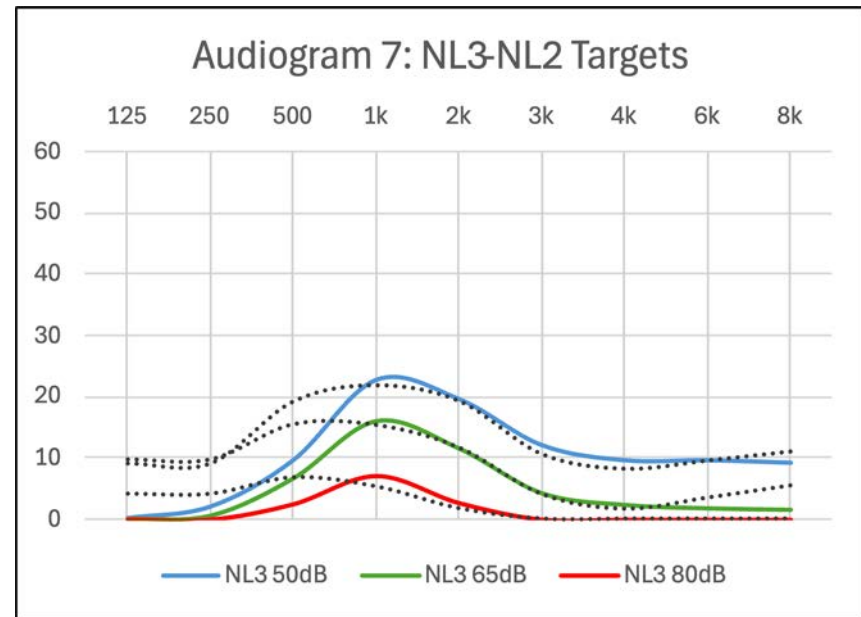
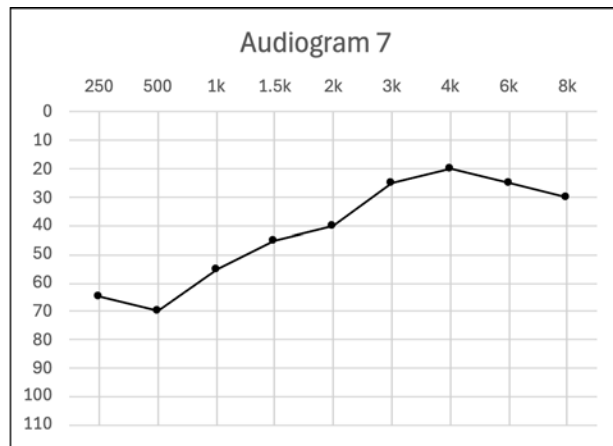
The NAL-NL3 Prescription

For some audiograms you *will* see a difference.



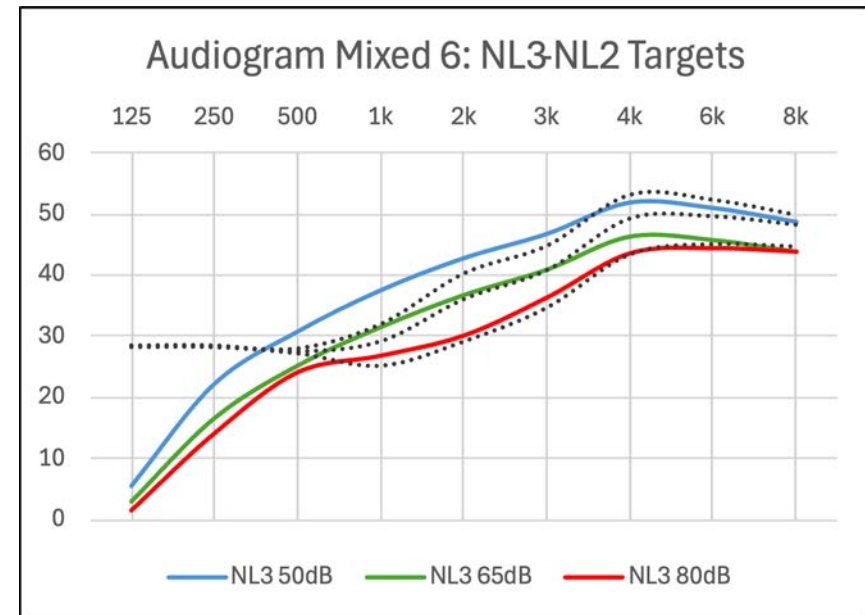
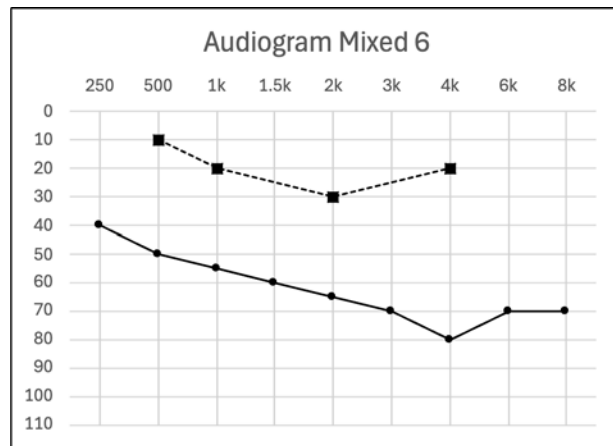
The NAL-NL3 Prescription

For some audiograms you will see nuanced, fine-tuned differences.



The NAL-NL3 Prescription

For some audiograms you *will* see a dramatic difference.



Verification

- Always run REMs as usual (50dB, 65dB, 80dB)
 - Best run in Omni or a REM/Verification mode
- MPO checks are still critical - as is fine-tuning and clinical judgement!
 - Comfort & preference
 - Acclimatisation considerations
 - Own voice misophonia and occlusion effect

NAL-NL3: Key Fixes and Changes

- Achieves better SII and lower overall loudness than NL2.
- Reduced and more clinically appropriate gain compensation for air-bone gaps.
- Detailed and re-weighted calculation of low and high frequency targets with respect to SII requirements, degree of hearing loss, and electroacoustic capabilities of hearing aids.
- More clinically appropriate handling of low and high frequency gain prescribed for reverse-sloping losses.
- More clinically appropriate handling of low and high frequency gain prescribed for steeply-sloping losses.
- Maximum permissible compression ratio reduced from NL2's 3:1 (or sometimes higher) to 2.5:1, based on updated research and ease of fitting.
- Empirical adjustments (Gender, Experience, Age, Language, Binaural/Monaural) carry-over to NL3.

Comfort in Noise **NAL-NL3**

Overview:

- Listening **effectively** and **comfortably** in noise is the top challenge for many patients.
- This gain profile provides a modification to the NL3 prescription which improves comfort in noise without compromising speech intelligibility.

Comfort in Noise Module – What is it?

- Comfort in Noise (CiN) is a **supplemental module**, not a replacement prescription.
- Designed for patients already optimally fitted with NL3 who still **struggle in noisy environments**.

Comfort in Noise Module – How is it useful?

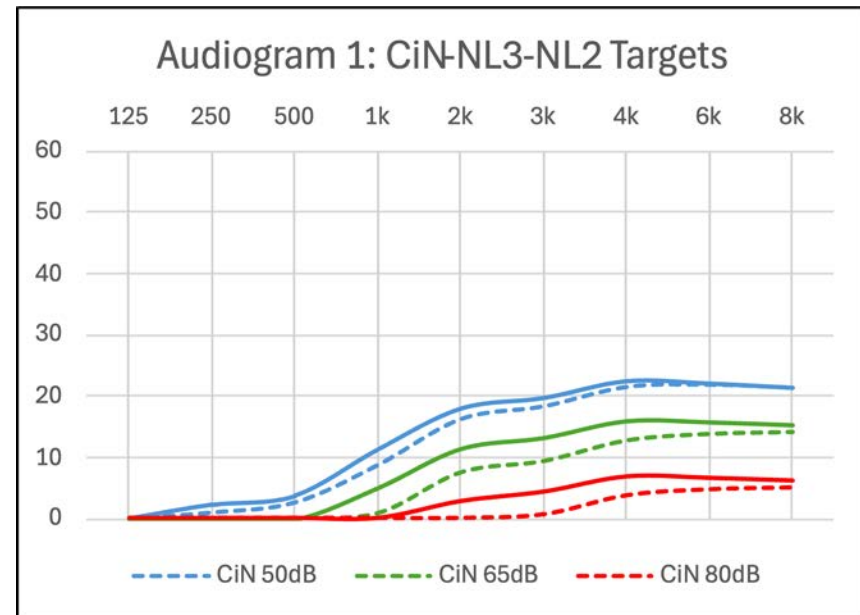
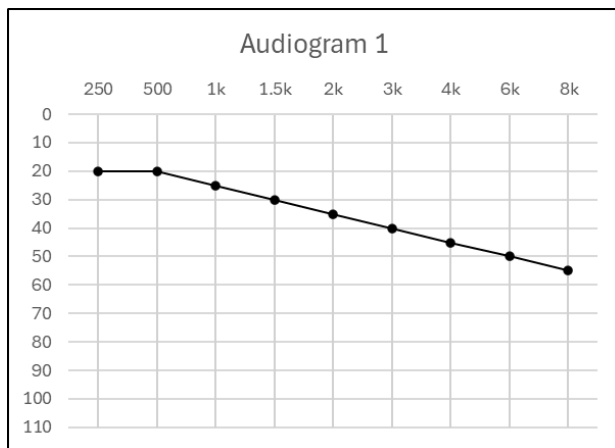
- Adds flexibility for **tailoring fittings** to patient-specific noisy listening challenges.
- Preserves clarity from base NL3 prescription while **enhancing comfort** in difficult environments.

Comfort in Noise Module – How does it work?

- No across-the-board gain adjustments
- Selective gain reduction in specific frequency bands
- Target frequency bands where loudness causes discomfort more than it aids speech
- Reduce noise fatigue while preserving key speech cues

Comfort in Noise Module

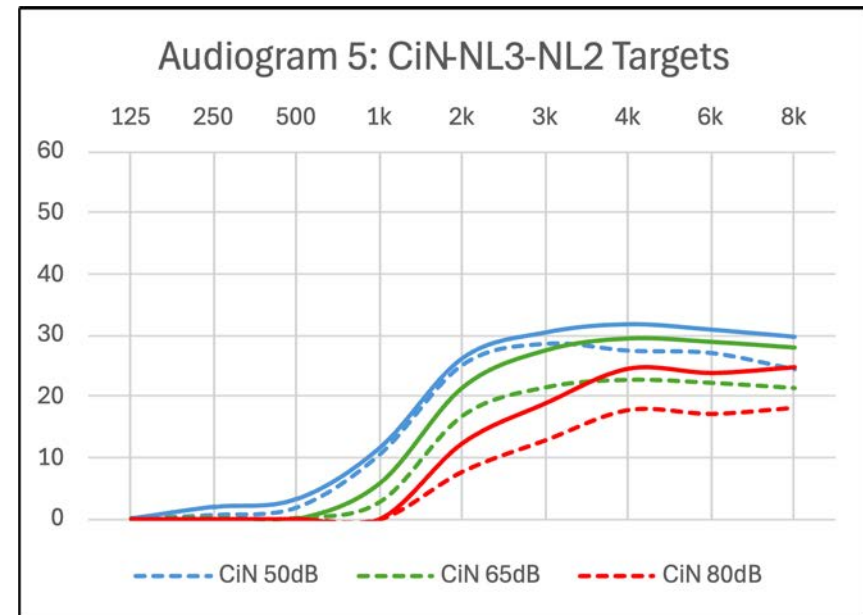
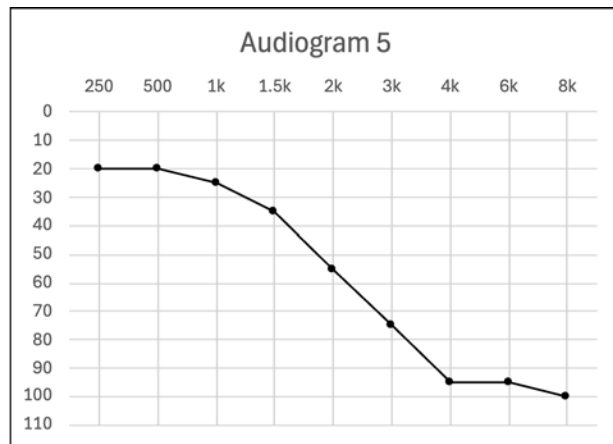
NL2 overlayed with NL3 and CiN
Targets



- ✓ The Comfort in Noise Module – Use Case & Best Practice

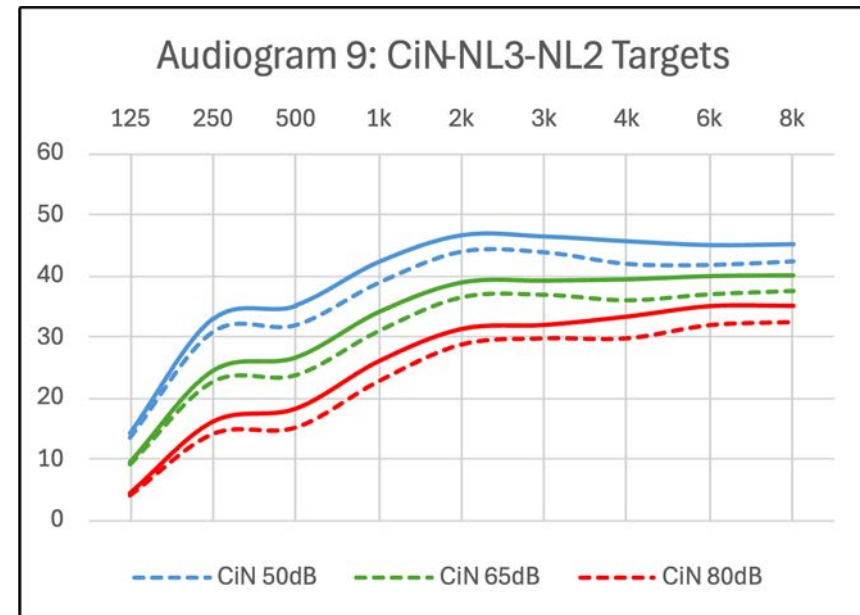
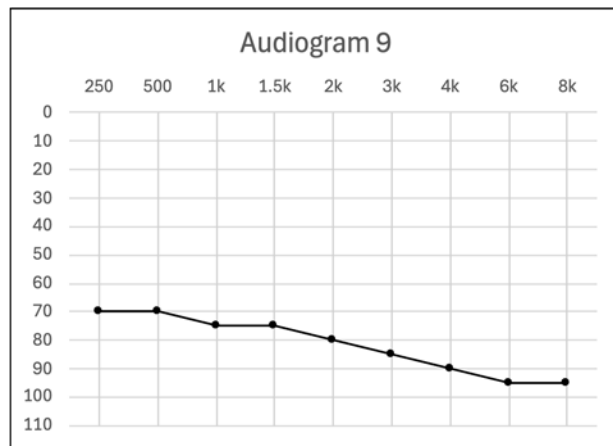
Comfort in Noise Module

NL2 overlayed with NL3 and CiN Targets



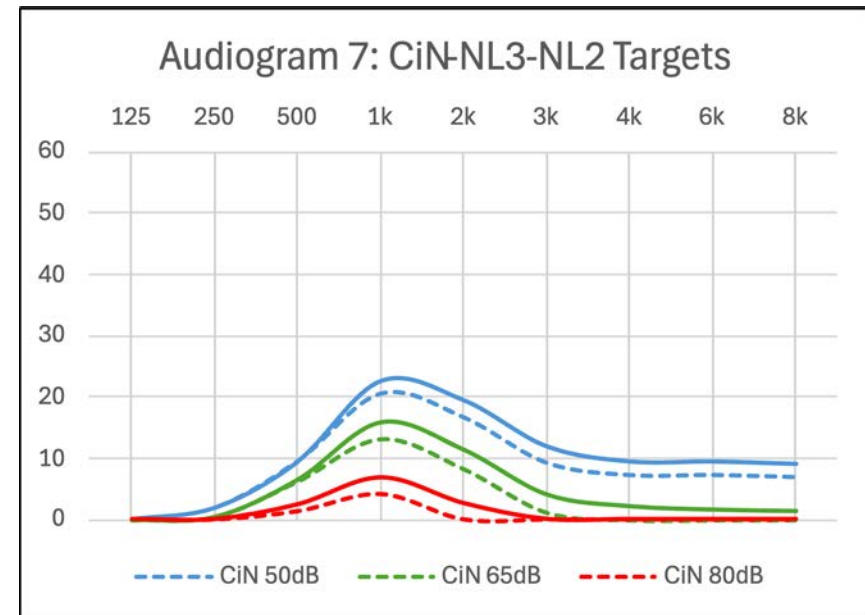
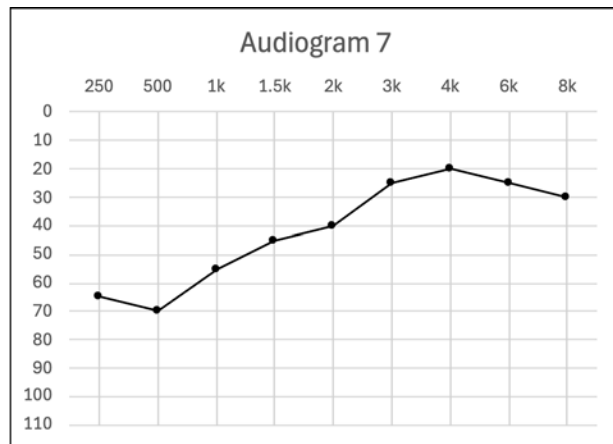
Comfort in Noise Module

NL2 overlayed with NL3 and CiN Targets



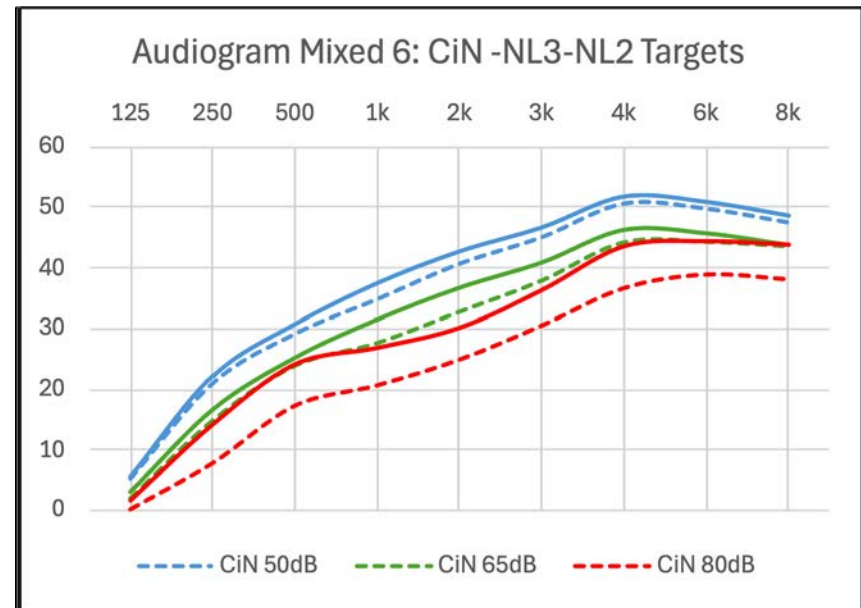
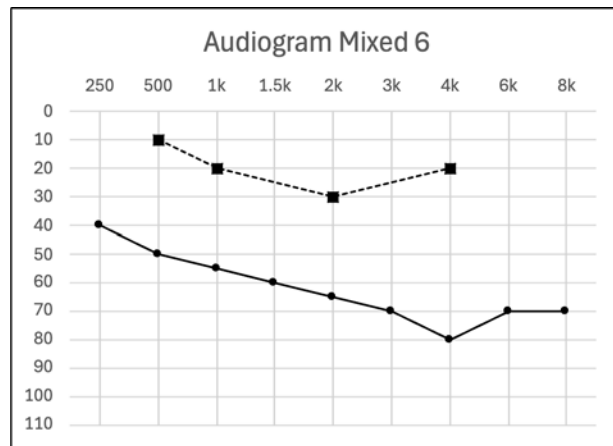
Comfort in Noise Module

NL2 overlayed with NL3 and CiN
Targets

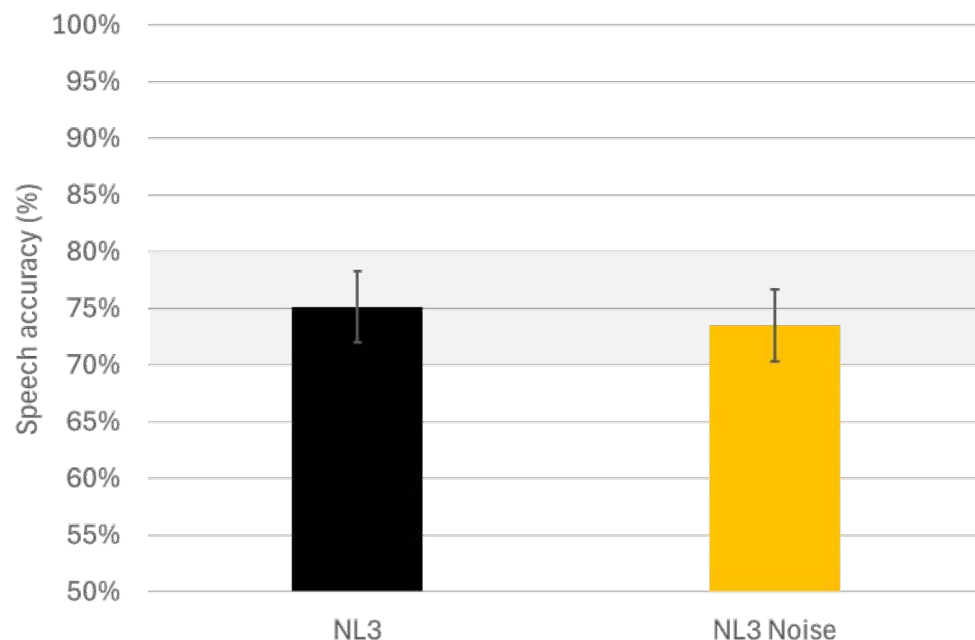


Comfort in Noise Module

NL2 overlayed with NL3 and CiN
Targets

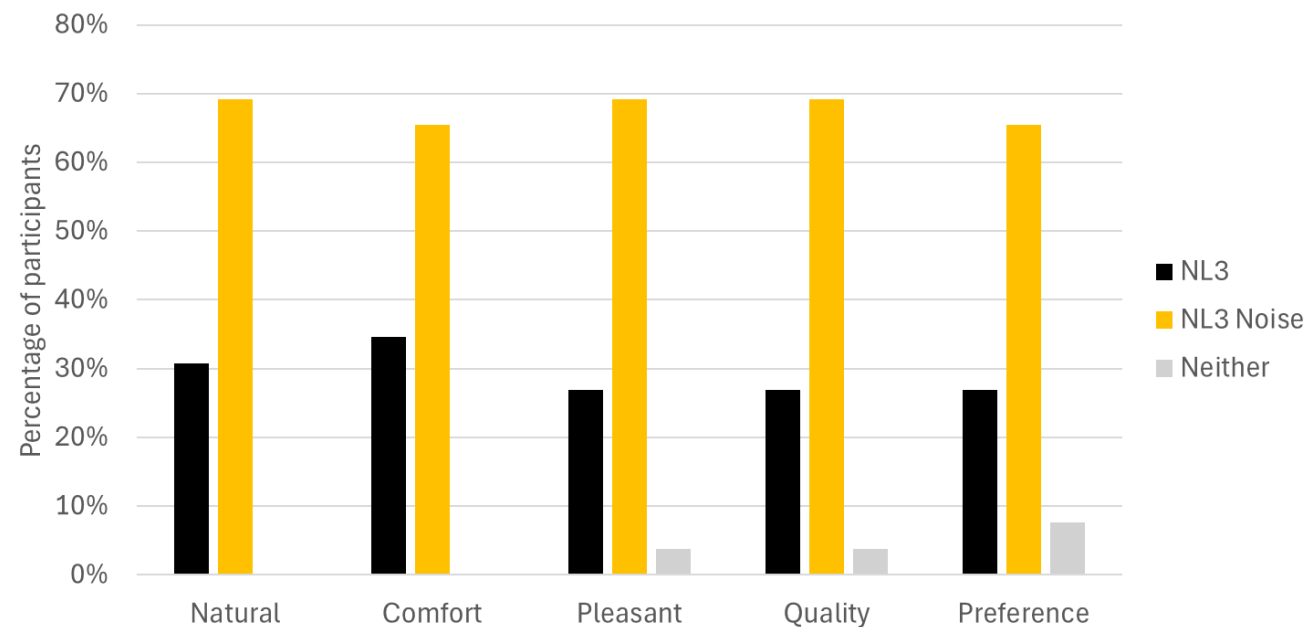


NL3 Noise: Speech Intelligibility in Noise



No significant
difference in
speech intelligibility
with **NL3 Noise**
compared to **NAL-
NL3**

NL3 Noise: Results from Field Trials



2x
participants
preferred
NL3 Noise
over
NAL-NL3 in
field trials

Graph courtesy of Dr Padraig Kitterick, Head of Audiological Science, NAL

Comfort in Noise Module – Identifying Patients

- Ongoing difficulty or discomfort in noise despite optimal NL3 fitting
- Preference for reduced loudness in noise, without sacrificing speech clarity
- Reports of high listening effort or fatigue in noisy environments

Identifying Patients

Subjective Outcome Measures

Speech, Spatial and Qualities of Hearing Scale (SSQ-12)

- Ask targeted items on *listening in noise* and *effort* subscales.

Abbreviated Profile of Hearing Aid Benefit (APHAB)

- Especially the *Background Noise* and *Ease of Communication* subscales.

Client Oriented Scale of Improvement (COSI)

- Patients nominate noisy listening situations they want improved.

Vanderbilt Fatigue Scale (VFS-A-10)

- Items on the effort required for listening in noisy environments.

Identifying Patients

Assessments

Speech-in-noise tests

- BKB, SPIN, QuickSIN, LiSN-S, or HINT

Loudness scaling tests

- MCL, UCL, *Contour Test of Loudness Perception/Categorical Loudness Scale*

Identifying Patients

- Quick screen 
 - COSI goals
 - Include relevant case history
- Further assessment 
 - 2–3 targeted SSQ or APHAB items
 - Speech-in-noise testing
- Ideal CiN candidate 
 - Low comfort / high difficulty in noise
 - Normal speech-in-quiet performance

Comfort in Noise Module – Programming

◆ Step 1: Begin with a validated NAL-NL3 prescription

- Ensures everyday listening needs are met before adding CiN.

◆ Step 2: Apply the CiN module via fitting software

- Integration details depend on manufacturer (not yet disclosed).
- Undefined if applied automatically (adaptive settings) or manually via a speech-in-noise program.

Comfort in Noise Module – Validation

✓ No need to re-run REM

- Already completed for the base NAL-NL3 prescription.

👂 Shift to subjective validation

- Ask patients to rate comfort in noise.
- Gather self-reported feedback on speech understanding.

🔄 Confirm preference

- Use an A/B comparison

Comfort in Noise Module – Counselling Patients

When to Use CiN

- 🎯 Best for challenging noise
- 🚫 Not intended for quiet listening /everyday one-on-one conversations

Set Realistic Expectations

- ✓ Improves listening ease in noise but won't deliver perfect clarity.
- ✓ Reduces fatigue - helps manage discomfort, though some background noise remains.

NAL-NL3 Minimal Hearing Loss

Use Case:

- Adults with **subjective hearing difficulty** in noise;
in overall *poor* SNR situations.

Generally, NAL-MHL is recommended for adults with a 4FAHL of $\leq 25\text{dBHL}$, but further refinement of this advice is ongoing.

NAL-NL3 Minimal Hearing Loss

Candidacy:

- Questionnaires like HHIE/RHHI, VFS
- Communication Goals – COSI/COSI 2.0
- We are still exploring which clinical tools are most sensitive and appropriate to identify these patients

The audiogram is an important input to this prescription, but self-reported impairment and establishing clear communication goals are *essential*.

The Minimal Hearing Loss Module

What it's designed to do:

- The NAL-MHL module provides a minimum gain for *all* audiometric profiles.
- Amplification provided >1kHz.
- Takes a semi-nonlinear approach:
 - Linear gain from 0dB-65dB.
 - Compression will be introduced at inputs above 65dB as hearing loss worsens.

The Minimal Hearing Loss Module

The technology is going to matter!

- Better SNR-improving technology (**directional microphones** and **beamforming**) = better performance.

The coupling is going to matter too!

- The most **occluding coupling** the patient can accept = better performance.

Remember, this for *situational use*; not an all-day amplification profile.

The Minimal Hearing Loss Module

An example patient:

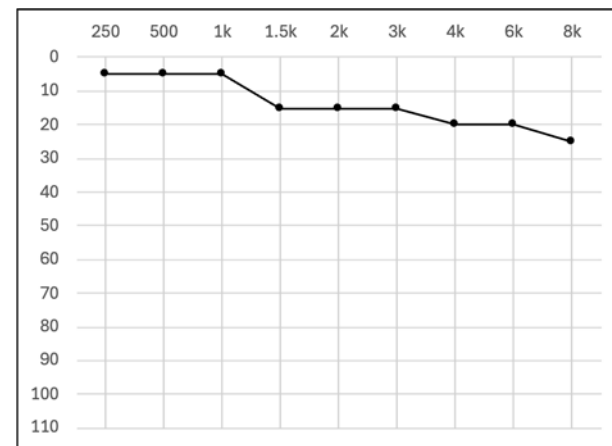
- Patient has decent hearing – 4FAHL of 11dBHL
- Reports significant difficulty hearing in noise, impact on QoL
- Poor self-report/questionnaire scores in noisy situations
- Clear communication goals
- Motivated

The Minimal Hearing Loss Module

An example patient:

- Reports significant difficulty hearing in noise, impact on QoL
- Poor self-report/questionnaire scores in noisy situations
- Clear communication goals
- Motivated

Hz	dBHL
250	5
500	5
1k	5
1.5k	15
2k	15
3k	15
4k	20
6k	20
8k	25
3FAHL:	8
4FAHL:	11
HFA:	17



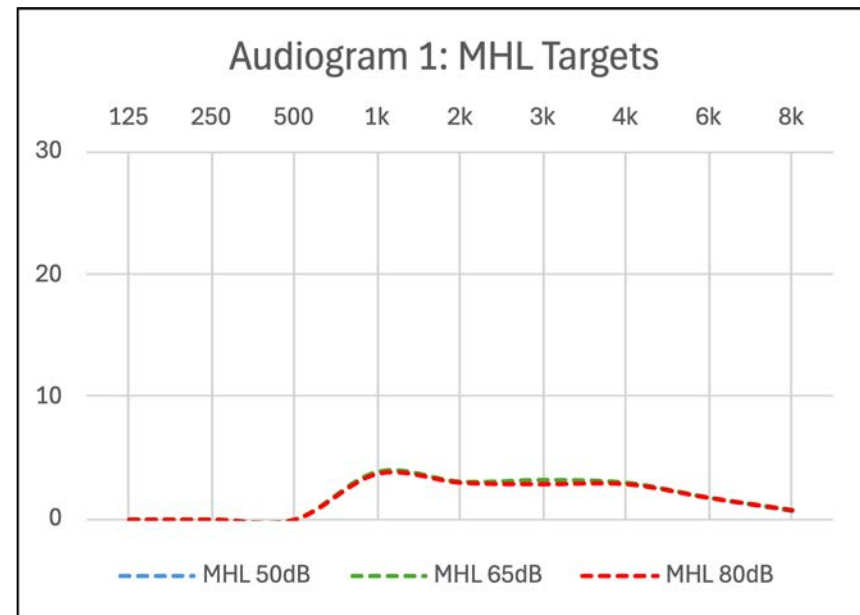
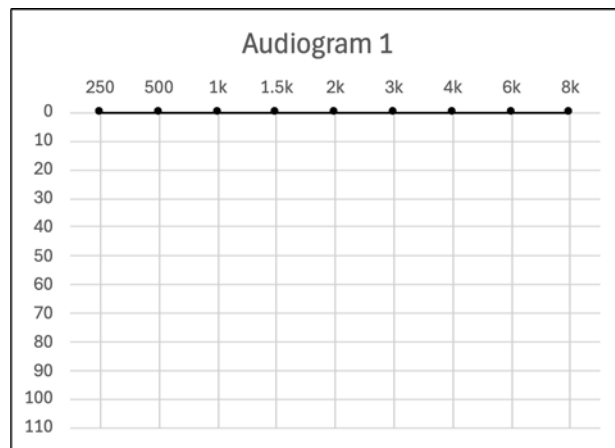
The Minimal Hearing Loss Module

A typical strategy for this patient:

- Plan for situational use; define these situations.
- Aids programmed with SNR-recovering features (directional mics, noise management, etc.).
- Occluding domes – this is a key difference with this module.
 - Good clinical judgment is critical here to balance patients' expectations between **benefit** and **acceptability**.

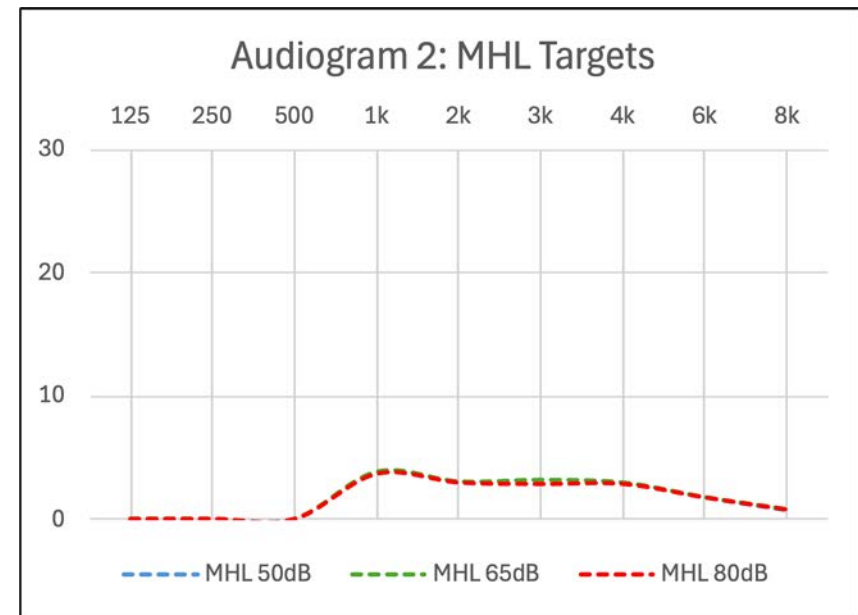
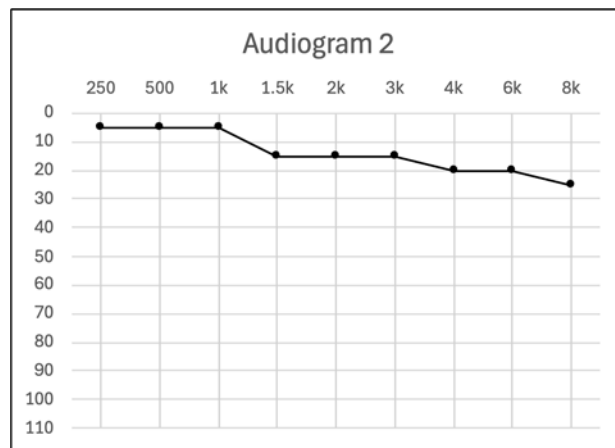
The Minimal Hearing Loss Module

NAL-MHL Targets by Audiometric
Input



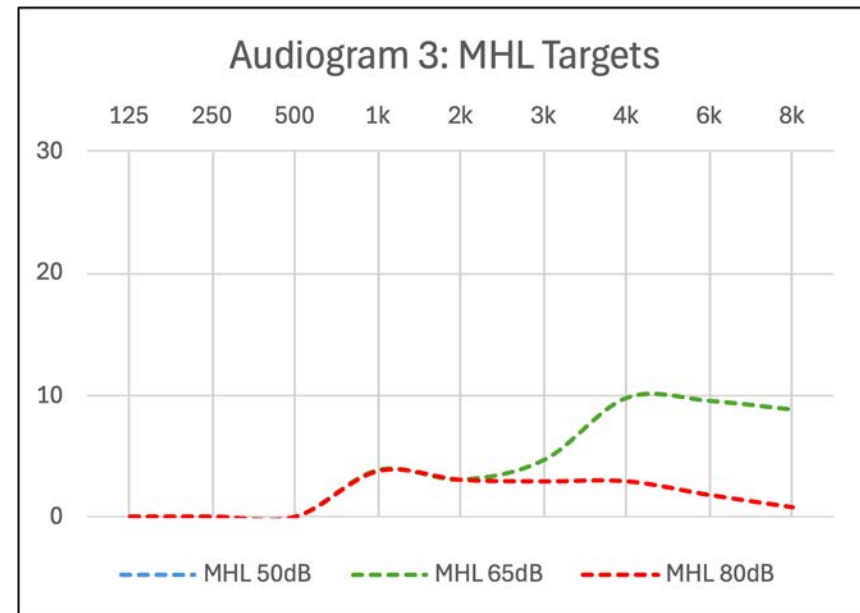
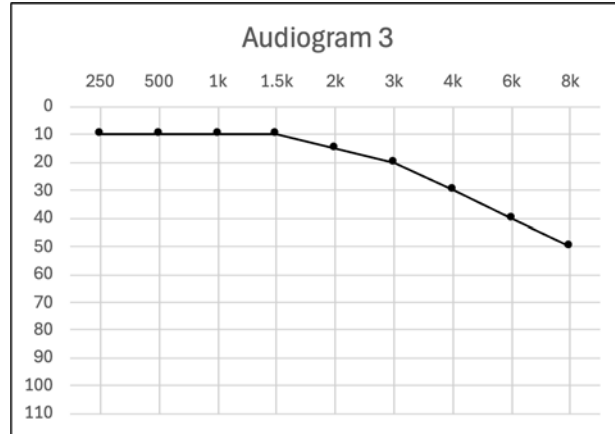
The Minimal Hearing Loss Module

NAL-MHL Targets by Audiometric
Input



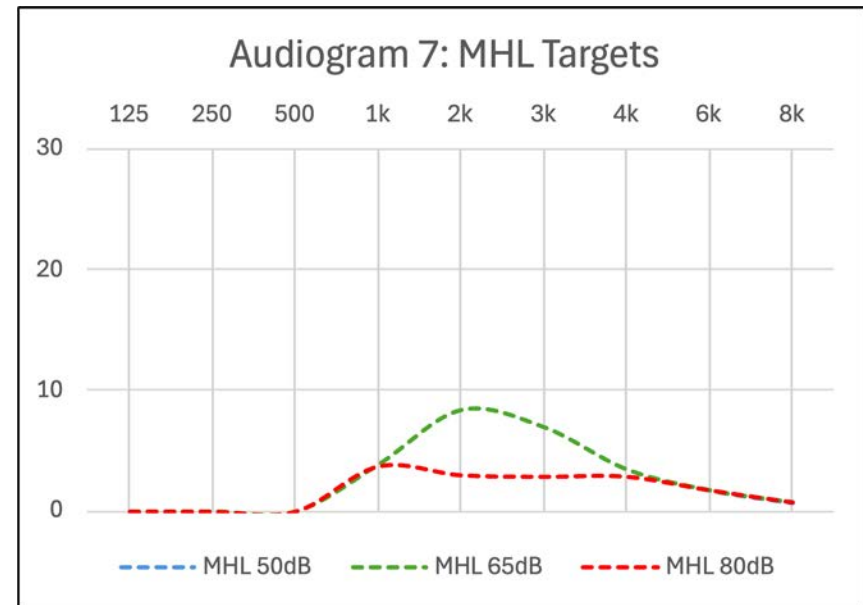
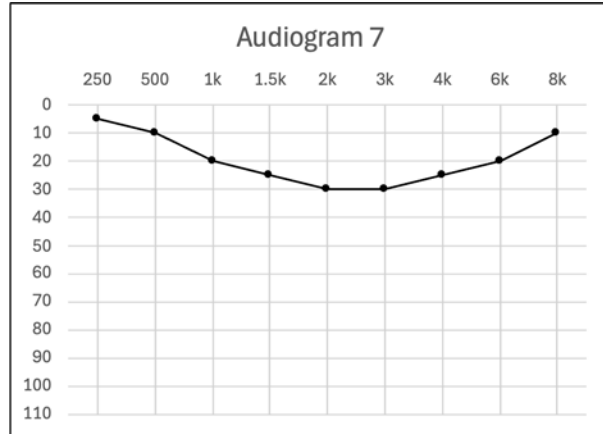
The Minimal Hearing Loss Module

NAL-MHL Targets by Audiometric
Input



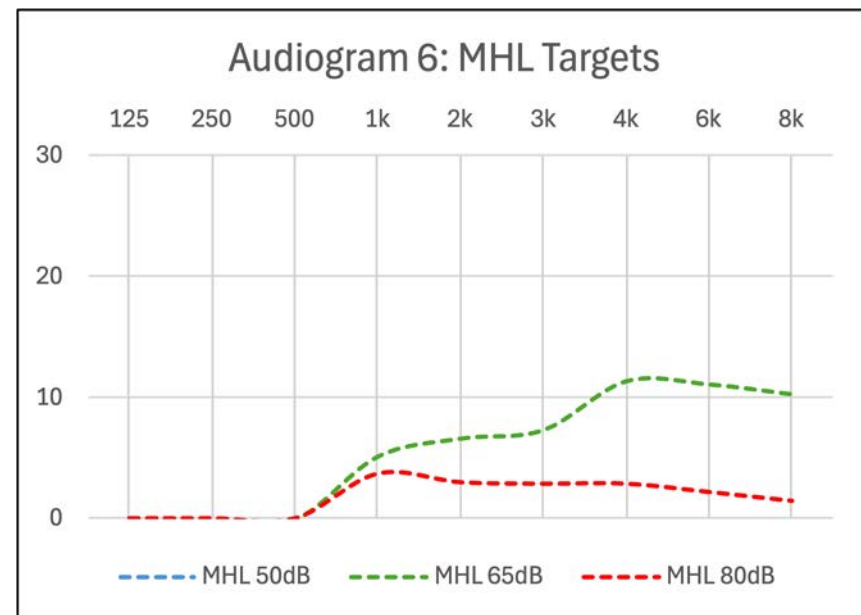
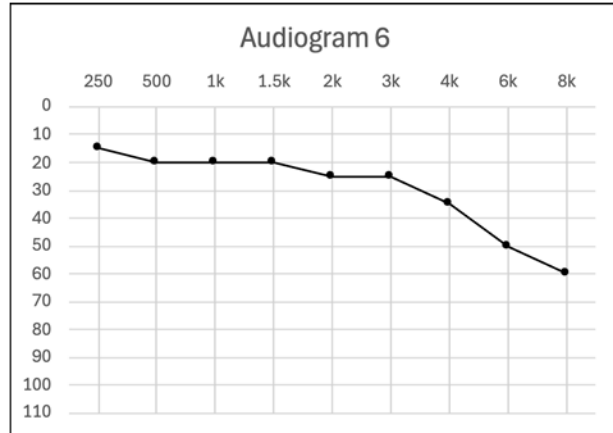
The Minimal Hearing Loss Module

NAL-MHL Targets by Audiometric
Input



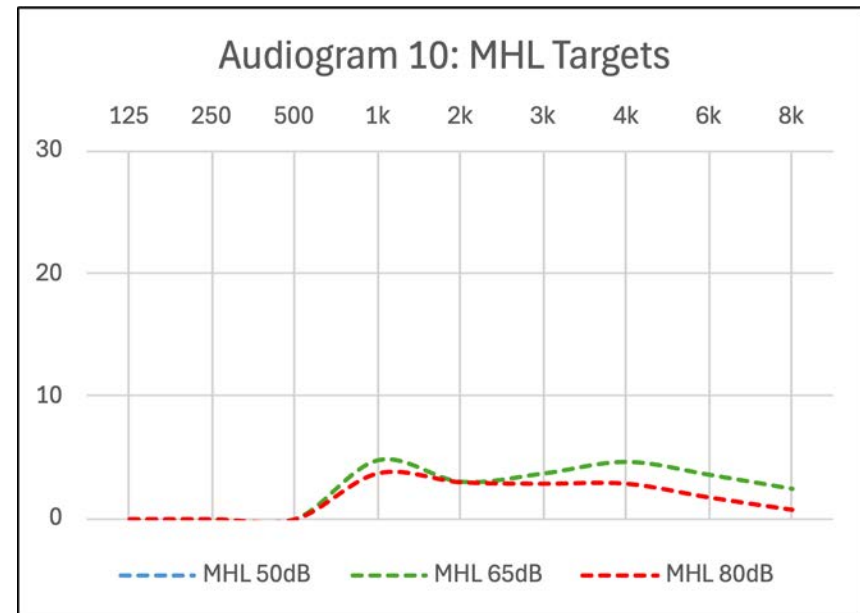
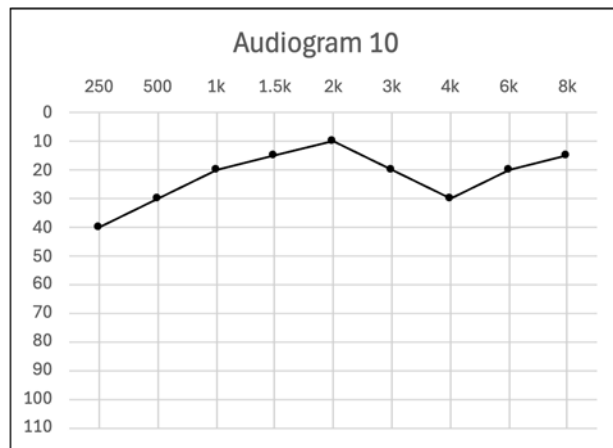
The Minimal Hearing Loss Module

NAL-MHL Targets by Audiometric
Input

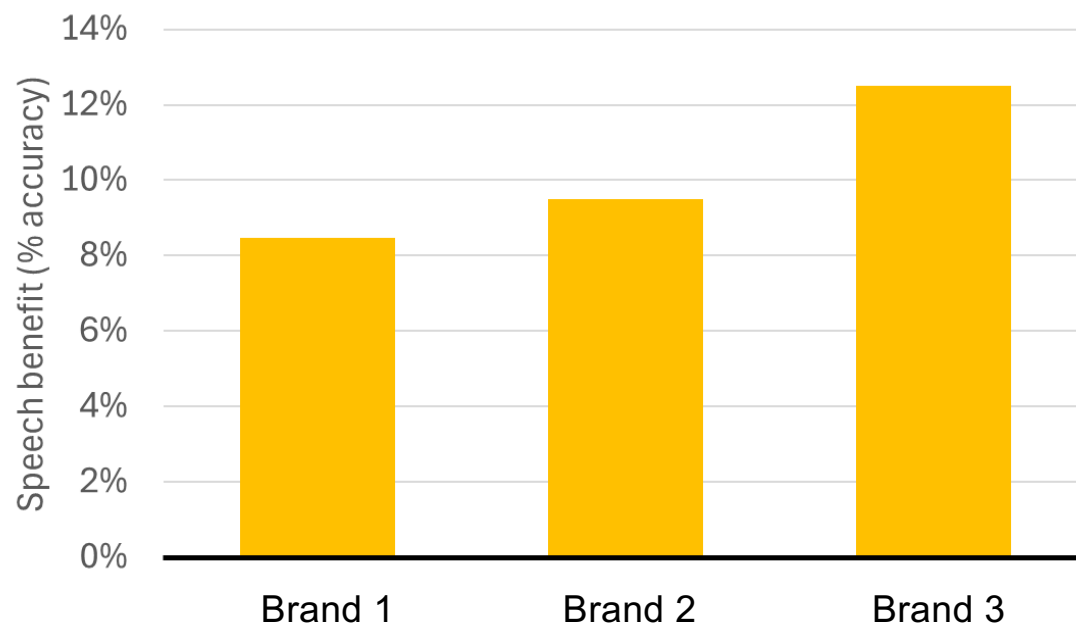


The Minimal Hearing Loss Module

NAL-MHL Targets by Audiometric
Input

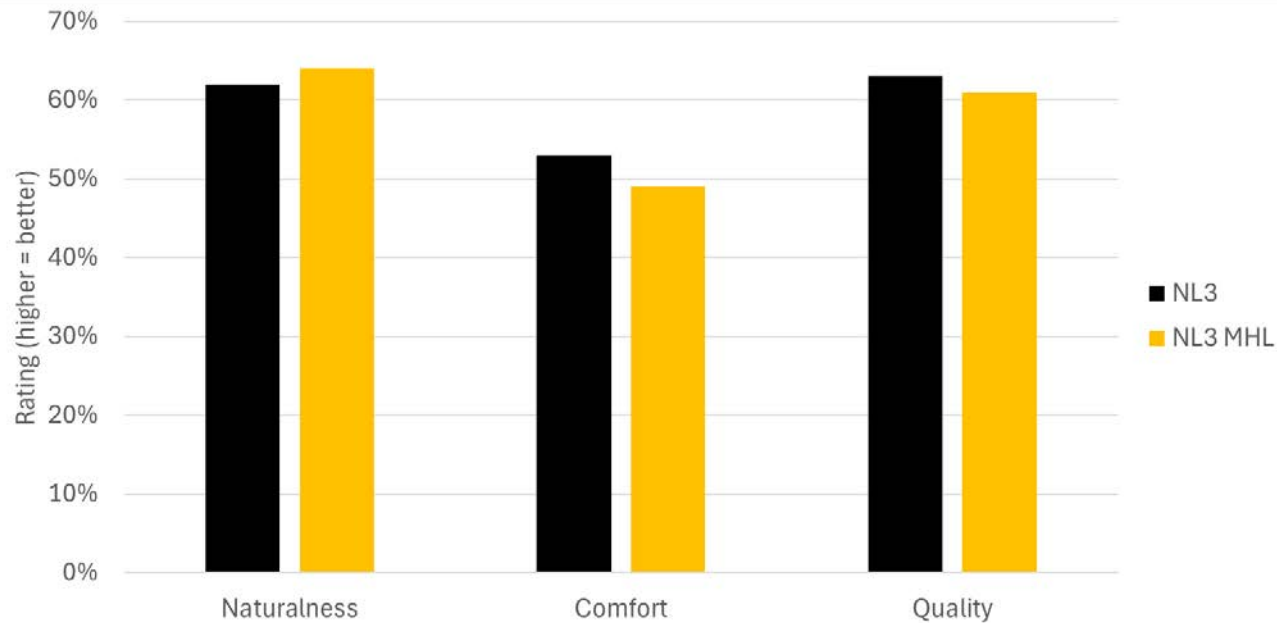


NL3 MHL: Speech Intelligibility in Noise

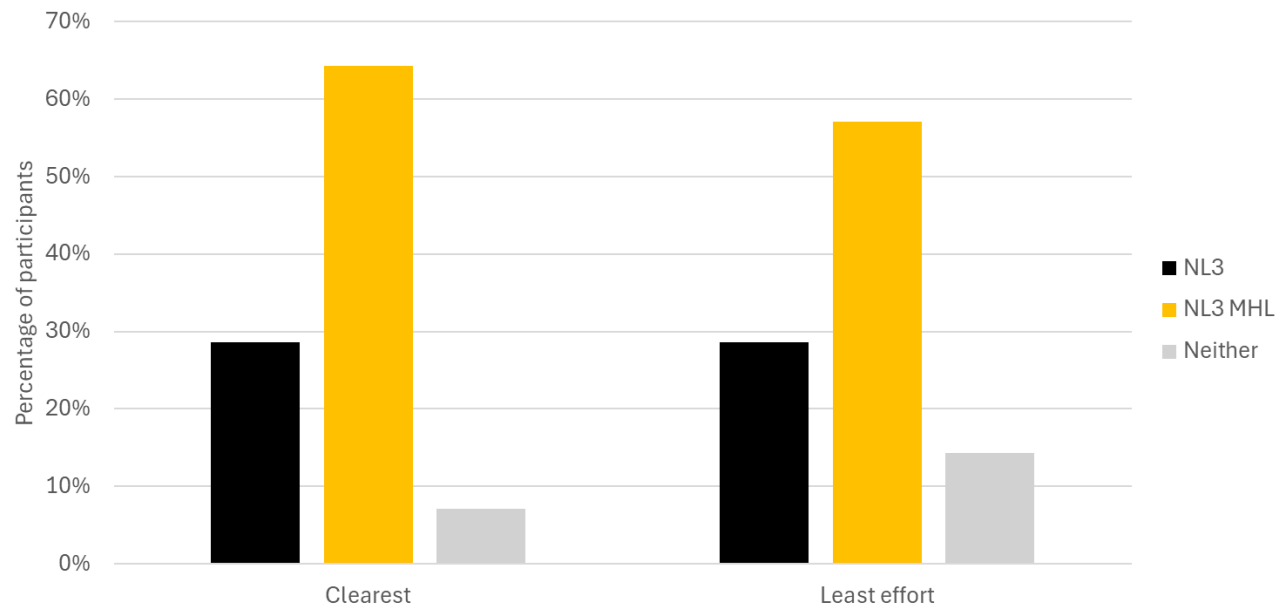


Significant improvement
in speech intelligibility in
noise with **NL3-MHL**
module compared to
NL3

NL3 MHL: Acceptability



NL3 MHL: Measured in the Real World



Key Takeaways

- NAL-NL3 is designed to reduce need for fine-tuning, providing a *starting point* that is closer to benefit and preference for most patients.
- Use clinical judgment to select modules:
 - **Comfort in Noise** → everyday hearing aid users who want comfort in noise
 - **Minimal Hearing Loss** → patients with functional difficulties despite normal or near-normal audiograms

The NAL-NL3 Team



<https://nal-nl3.com.au>



NAL-NL3 Cheat Sheet for Clinicians

	NAL-NL3 Prescription	Minimal Hearing Loss Module	Comfort in Noise Module
Rationale	To maximize speech intelligibility without exceeding normal loudness.	To maximize speech intelligibility without exceeding or subjective hearing impairment by providing the minimum gain required to access the listening domain of hearing devices.	To improve loudness comfort in noisy environments. Features a linear speech compression with 20dB HL NAL-NL3 prescription.
Primary Use Case	Adults or children with measured bilateral hearing loss, or clinically advised. For general hearing aid use.	Adults with measured bilateral hearing loss, or with a degree of "borderline" hearing loss. This gain profile is intended for individual use in noisy or quiet conditions.	Adults or children using the NAL-NL3 Prescription who are clinically advised to their primary program.
Hearing Device Requirements	Any hearing device capable of matched mid-frequency compression can be programmed with NAL-NL3.	Any hearing device with dynamic range compression that can be programmed with NAL-NL3.	Any hearing device with dynamic range compression that can be programmed with NAL-NL3.
Age	Any age.	Adults (15 years) only.	Any age.
Coupling Considerations	Whichever coupling is clinically appropriate for the hearing loss, device fit, and client needs.	The most suitable coupling the client will accept will enter the most benefit, most comfort, and low noise.	Whichever coupling is clinically appropriate for the hearing loss, device fit, and client needs.
Programming Considerations	Program following standard protocols, including NAL-NL3 checks, and noise counseling, and low noise.	Keep the default gain for maximum benefit in loud noise and only reduce if discomfort is experienced.	Ensure any personal preferences (e.g. speech enhancement) are applied to the NAL-NL3 on the device to the Comfort in Noise Module.
Verification	REIN matched to target at 50dB, 65dB, 80dB.	REIN matched to target at 65dB, 80dB.	REIN matched to target at 65dB, 80dB.

20/11/2022 - Version 1.02

- Full of NL3 news, information, and publications.
- Resources such as our FAQ and Clinical Cheat Sheet

Feedback and Future Work?



Fit for the Future: Evolving COSI

Bettina Turnbull, AuD

Senior Innovation Audiologist

National Acoustic Laboratories



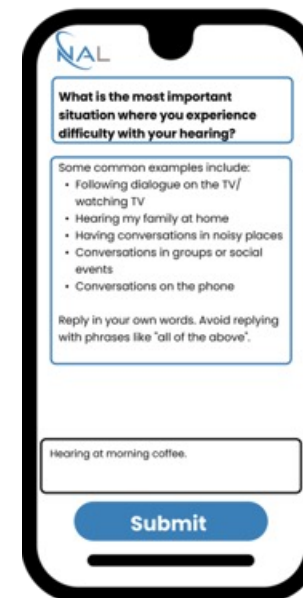
✓ From COSI to COSI 2.0

Foundations, Challenges and the need for Evolution

COSI 2.0

Needs Assessment

Outcomes Measurement



The image shows a mobile app interface for the 'Needs Assessment' phase of COSI 2.0. At the top is the NAL logo. The main question is 'What is the most important situation where you experience difficulty with your hearing?'. Below this, a list of common examples is provided: 'Following dialogue on the TV/ watching TV', 'Hearing my family at home', 'Having conversations in noisy places', 'Conversations in groups or social events', and 'Conversations on the phone'. A note instructs the user to 'Reply in your own words. Avoid replying with phrases like "all of the above".' A text input field contains the example 'Hearing at morning coffee.' and a blue 'Submit' button is at the bottom.

NAL

What is the most important situation where you experience difficulty with your hearing?

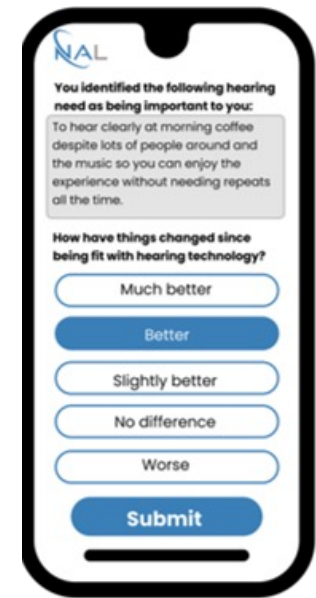
Some common examples include:

- Following dialogue on the TV/ watching TV
- Hearing my family at home
- Having conversations in noisy places
- Conversations in groups or social events
- Conversations on the phone

Reply in your own words. Avoid replying with phrases like "all of the above".

Hearing at morning coffee.

Submit



The image shows a mobile app interface for the 'Outcomes Measurement' phase of COSI 2.0. At the top is the NAL logo. The main question is 'You identified the following hearing need as being important to you:'. Below this, a text box contains the example: 'To hear clearly at morning coffee despite lots of people around and the music so you can enjoy the experience without needing repeats all the time.' The next question is 'How have things changed since being fit with hearing technology?'. Below this, there are five radio button options: 'Much better', 'Better', 'Slightly better', 'No difference', and 'Worse'. A blue 'Submit' button is at the bottom.

NAL

You identified the following hearing need as being important to you:

To hear clearly at morning coffee despite lots of people around and the music so you can enjoy the experience without needing repeats all the time.

How have things changed since being fit with hearing technology?

Much better

Better

Slightly better

No difference

Worse

Submit

What is COSI?

Client Oriented Scale of Improvement (COSI)

- Individualised outcome measure in audiology
- Focuses on *client-nominated* listening and communication goals
- Measures perceived improvement and final ability
- Widely used in hearing aid fitting and rehabilitation

“A radical alternative is to let each client make up his or her own questionnaire.”
– Dillon et al., 1997

History of COSI

- Developed by Dillon et al. (1997)
- Introduced to address limitations of standardised outcome measures
- Adopted globally as gold standard in adult hearing aid practice

[illegible]

How is COSI different to other needs assessments?

- Individualised vs fixed question sets
- Client-defined goals vs clinician-defined scenarios
- Flexible application across diverse lifestyles
- Not norm-referenced

Examples of comparison tools:

- HHIE / HHIA
- APHAB
- IOI-HA (outcomes only)



Intended use of COSI

- Actively engaging in patient-centred care
- Shared goal-setting at the evaluation appointment
- Measuring outcomes post-intervention
- Supporting counselling and expectation management

Evidence that there is a problem

In the clinic...

Client **not involved** in setting goals
(particularly if comm. barriers)

Client **not told** why goals are important
and what their role is

Client **doesn't know** their goals (even if
clinician documented them)

Clients **don't attempt** their goals

Clinicians report...

Time pressure

Difficulty identifying relevant goals

Difficulty setting achievable goals

Communication barriers

Interviews with clinicians from Australia and survey data from 91 clinicians from 15 countries



Evolution of Audiological Practice

- Shift from device-focused to person-centred care
- Emphasis on functional communication outcomes
- Greater focus on counselling and behavior change
- Broader rehabilitation models



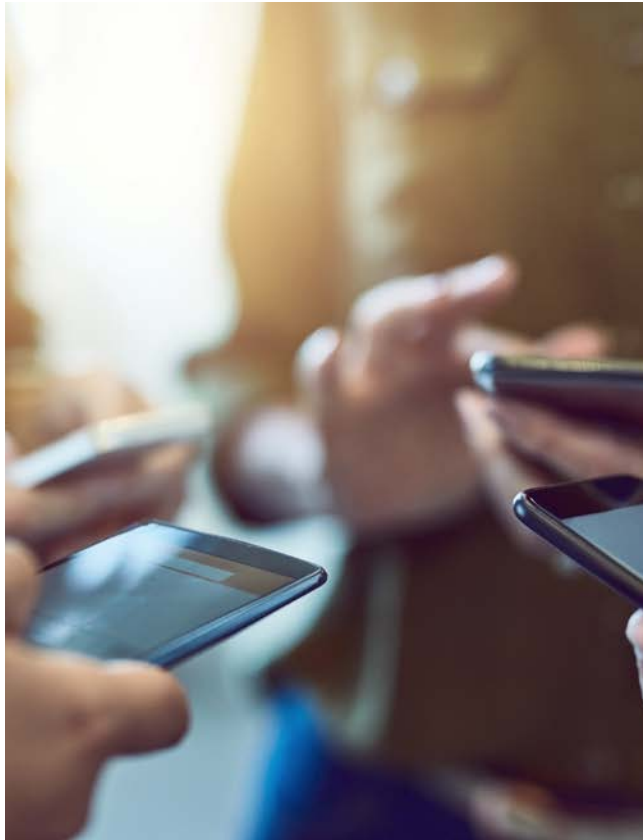
Patient Empowerment

Then:

- Clinician-led decision making
- Limited patient access to information

Now:

- Shared decision-making
- More informed, proactive patients
- Value placed on personal goals



Tech Revolution

- High rates of smartphone ownership
- Use of health and wellbeing apps
- Real-time data entry and feedback
- Increased patient capability
- Younger patients

The Emergence of AI in Healthcare – Evolving COSI

- Natural language processing
- Pattern recognition and summarisation
- Personalised insights
- Clinical decision support tools
- Reduce time pressure in clinics
- Expectations of digital healthcare
- Need for consistent, high-quality data
- Opportunity to enhance patient engagement

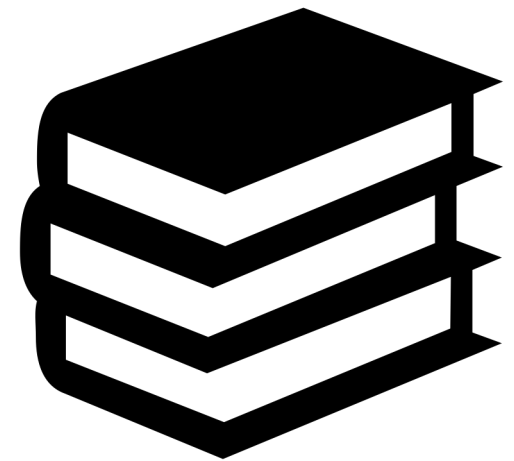


Research and Product Development - Different Mindsets, Shared Goals

What Do We Mean by Research?

Traditional clinical and academic research:

- Seeks to generate new knowledge
- Focuses on validity, reliability, and control
- Hypothesis-driven
- Often slow, linear, and cautious and risk averse
- Success measured by evidence quality

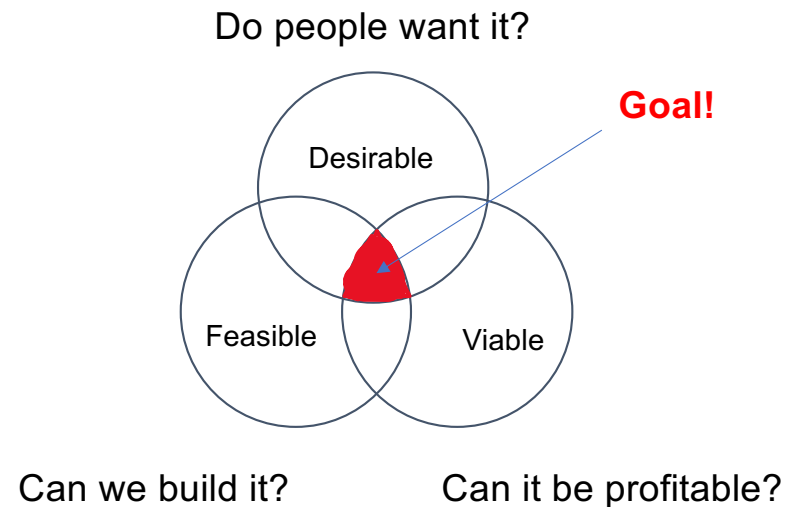


What Do We Mean by Product Development?

Product & Service Development

- Seeks to solve practical problems
- Focuses on usability, adoption, and impact
- Iterative and adaptive
- Often fast-moving and user-driven
- Success measured by outcomes and uptake

Three lenses of Design Thinking



Key Differences: Research and Product Development

Research

- Knowledge generation
- Controlled environments
- Linear process
- Risk-averse
- Publication-focused

Product Development

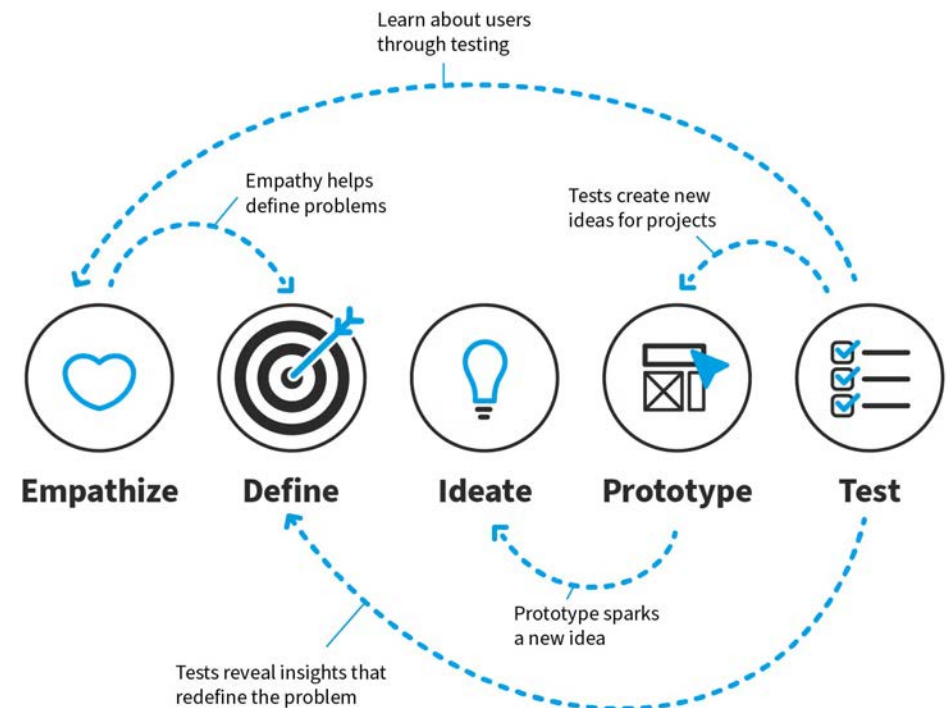
- Problem solving
- Real-world contexts
- Iterative cycles
- Risk-managed
- User- and outcome-focused

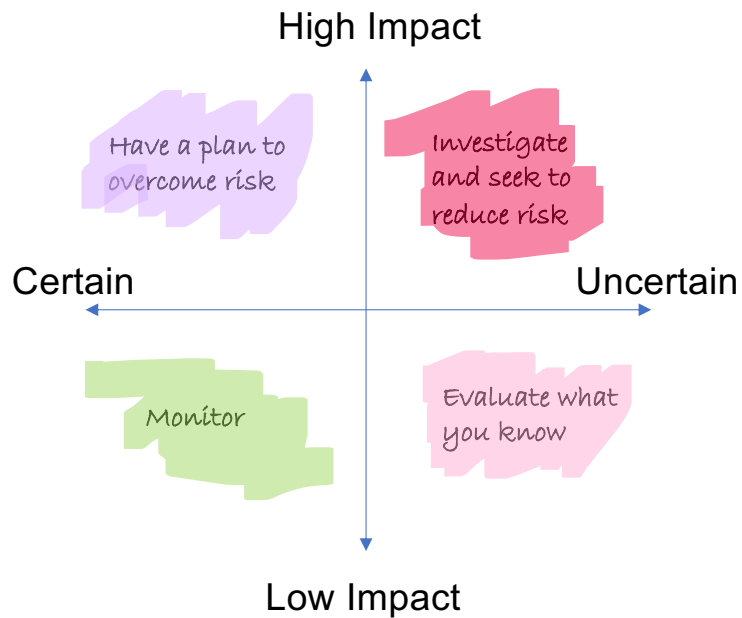
Innovation Tools: Design Thinking

What is Design Thinking?

- Human-centred problem solving
- Emphasises empathy and user needs
- Iterative testing and refinement
- Accepts early failure as learning
- **Typical stages:** Empathise → Define → Ideate → Prototype → Test

Design Thinking: a Non-Linear Process





Reducing Risk Through Design Thinking

- Small-scale testing before large rollout
- Early identification of usability issues
- Continuous user feedback
- Evidence generated alongside development

Research Thinking and Design Thinking

Research Thinking

- “Is this true?”
- Control variables
- Delay implementation

Design Thinking

- “Does this work for users?”
- Embrace complexity
- Improve through iteration

Challenges in Shifting Mindsets and Cultural Barriers in Healthcare

- Discomfort with uncertainty
- Fear of 'getting it wrong'
- Perception that iteration equals poor rigor
- Regulatory and ethical concerns
- Strong traditions of evidence hierarchy
- Funding and KPI structures
- Training emphasises certainty
- Limited tolerance for failure



Traditional Research Pathway

- Identify research question
- Design controlled study
- Recruit participants
- Collect and analyse data
- Publish findings
- Translate to practice (often delayed)

Design-Led Product Development

- Identify user problem
- Co-design with users
- Build low-risk prototype
- Test in real contexts
- Iterate rapidly
- Scale once value is demonstrated



Why This Tension Matters in Healthcare

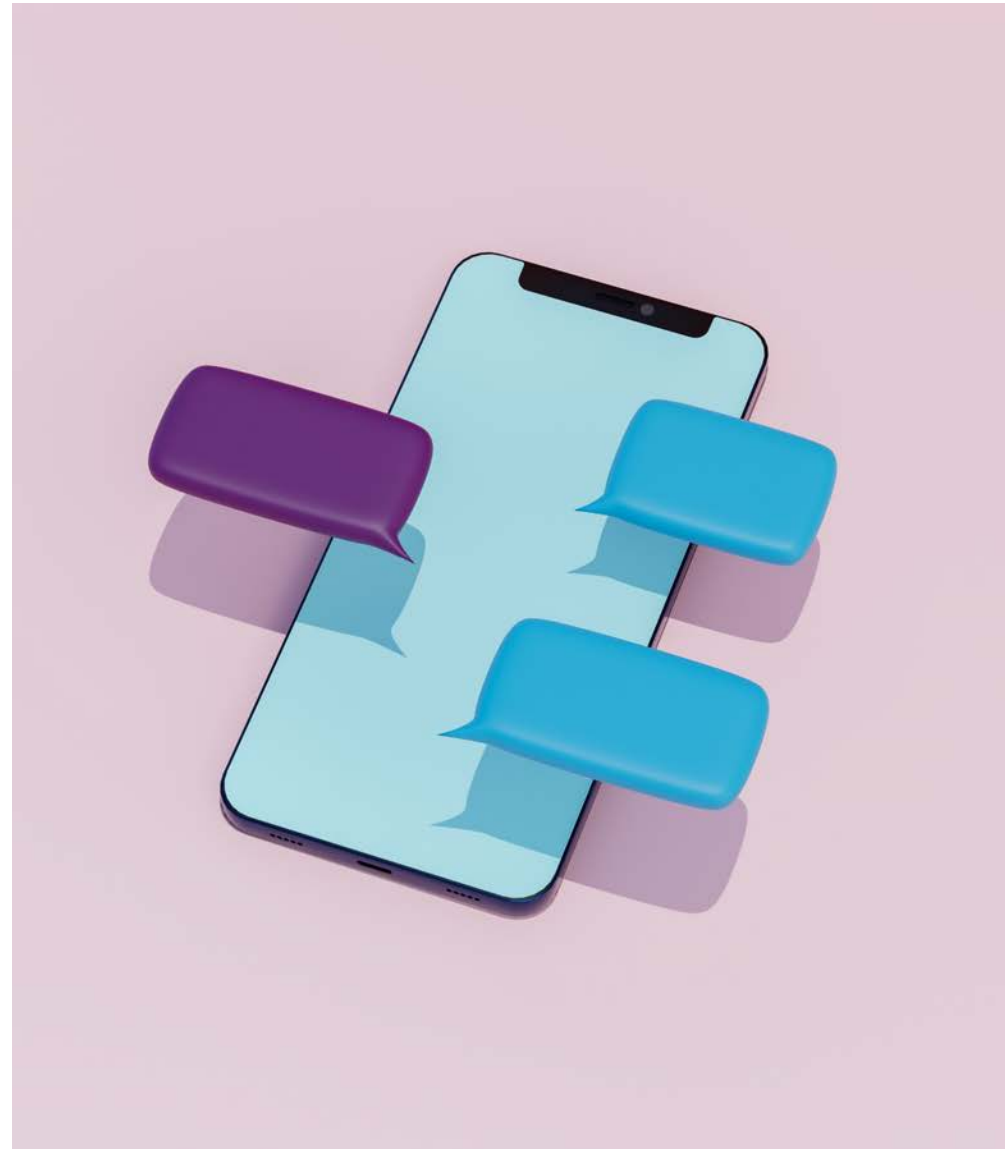
- Patients expect safe, evidence-based care
- Clinicians need tools that fit workflow
- Technology evolves faster than research cycles
- Innovation stalls if risk is avoided entirely



Applying This to COSI 2.0

Testing riskiest assumptions:

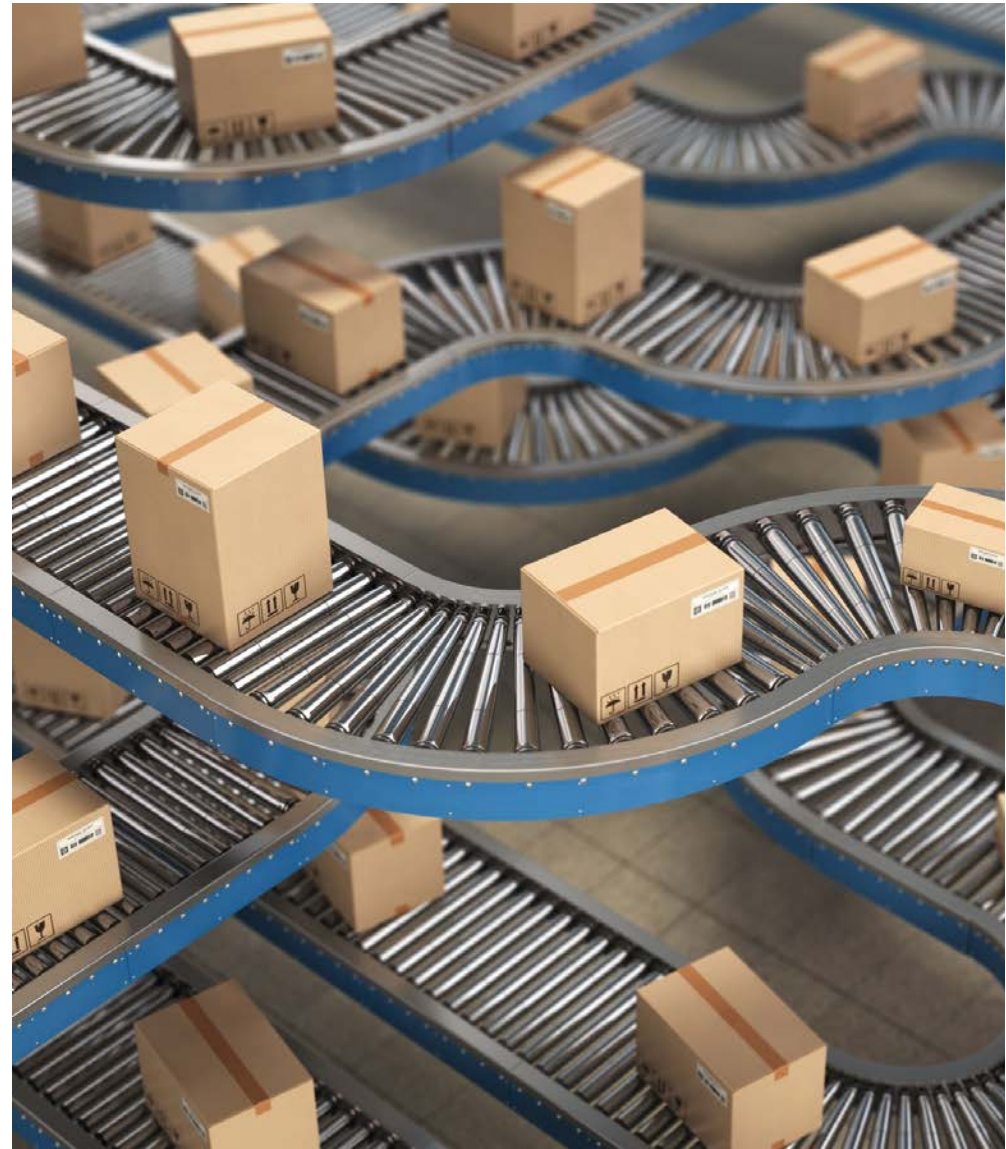
- Would typical hearing aid patients open a link on their smartphone?
- Would they want to engage with an AI chatbot about their hearing needs?
- Would clinicians trust a chat bot to elicit valid hearing needs?



✓ Research and Product Development

Types of Studies

- Feasibility
- Clinical validation
- Usability
- Small pilot
- Large-scale pilot



Purpose of a feasibility study

A feasibility study is a structured assessment that looks at whether a proposed project, idea, or solution is realistically doable and worth pursuing.

It's basically a "can we do this and should we?" check before committing serious time, money, or resources.

The purpose is to help decision-makers understand if the project is viable by evaluating key factors such as:

- **Practicality:** Can it be delivered with the available skills, technology, time, and resources?
- **Cost and value:** Will the benefits outweigh the costs (financially or strategically)?
- **Risks and constraints:** What could go wrong, and what limitations exist (legal, operational, environmental, etc.)?
- **Options and recommendations:** What approach is best, and are there better alternatives?

Feasibility

Lab simulated
Inclusion criteria
In-Person
Online Unassisted
Research participants

Accuracy



Ease-of-use



Trustworthiness



Purpose of Clinical Validation

A Clinical Validation study is a structured research study designed to confirm that a medical device, diagnostic test, digital health tool, or clinical method works accurately and reliably in real-world clinical use, and that its results are clinically meaningful for the intended patient population.

The main purpose is to demonstrate that the product or approach:

- **Performance:** performs as intended in a clinical setting (not just in a lab or controlled environment)
- **Results:** are accurate, consistent, and reproducible
- **Relevance:** Is relevant to clinical decision-making (i.e., it supports diagnosis, monitoring, treatment, or risk prediction)
- **Appropriate:** for the intended population and use case, including specific patient groups, conditions, and settings

Clinical validation - Participants

Inclusion criteria

Test group

Control group

Clinicians

Patients

Engagement



Trustworthiness



Effectiveness



Outcomes

Clinical Validation – Results

Control

To hear TV clearly

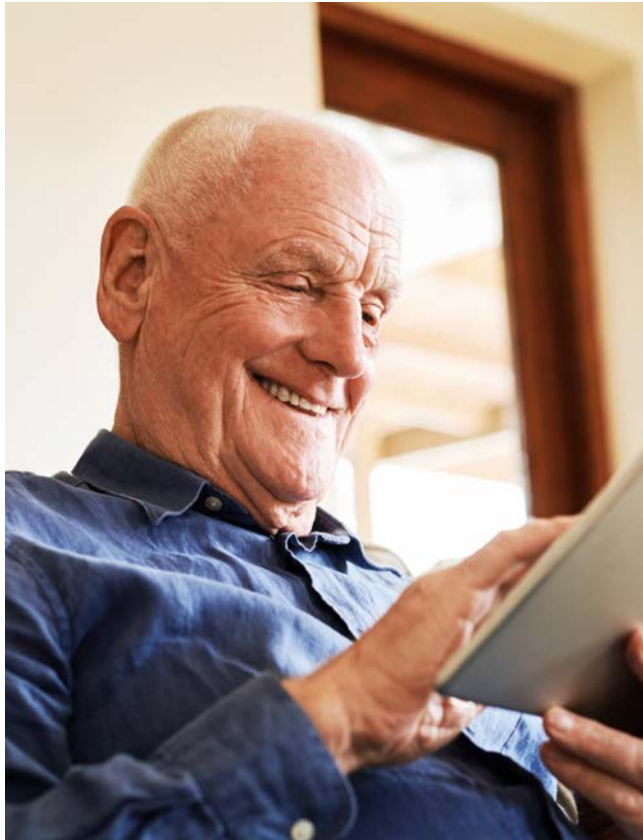
COSI 2.0

To enjoy watching TV without having to turn up the volume, so you can relax and unwind without straining to hear when watching with your family.

Purpose of a usability study

A **usability study** is a structured evaluation that examines how easily and effectively people can use a product, system, or service to complete specific tasks. It focuses on the user experience in practice, identifying where users succeed, struggle, get confused, or make errors.

- The purpose is to assess and improve key aspects of the user experience, including:
- **Ease of use:** Can users figure it out without extra help?
- **Efficiency:** How quickly and smoothly can they complete tasks?
- **Effectiveness:** Can they achieve the intended outcomes accurately?
- **User satisfaction:** Do they feel confident, comfortable, and supported while using it?
- **Error detection and prevention:** Where do mistakes happen, and how can the design reduce them?



Usability

- Are the needs summaries helpful?
- Did COSI 2.0 fit into the clinical workflow?
- What was the clinical impact?
- Was there any friction when using COSI 2.0?

Purpose of a Pilot study

A **pilot study** is a small-scale, preliminary version of a larger study or project that is run to test whether the planned approach will work in practice. It's essentially a "trial run" used to identify issues, refine methods, and confirm that the study design is workable before committing to a full rollout.

- The purpose of a pilot study is to:
- **Test feasibility** of the study procedures, tools, and workflow
- Check whether **recruitment and participation** processes work as expected
- Identify practical problems (e.g., timing, resources, data collection gaps)
- Provide actionable feedback on product value and operational readiness

✓ **Research and Product Development**

User Insights - the Road Ahead

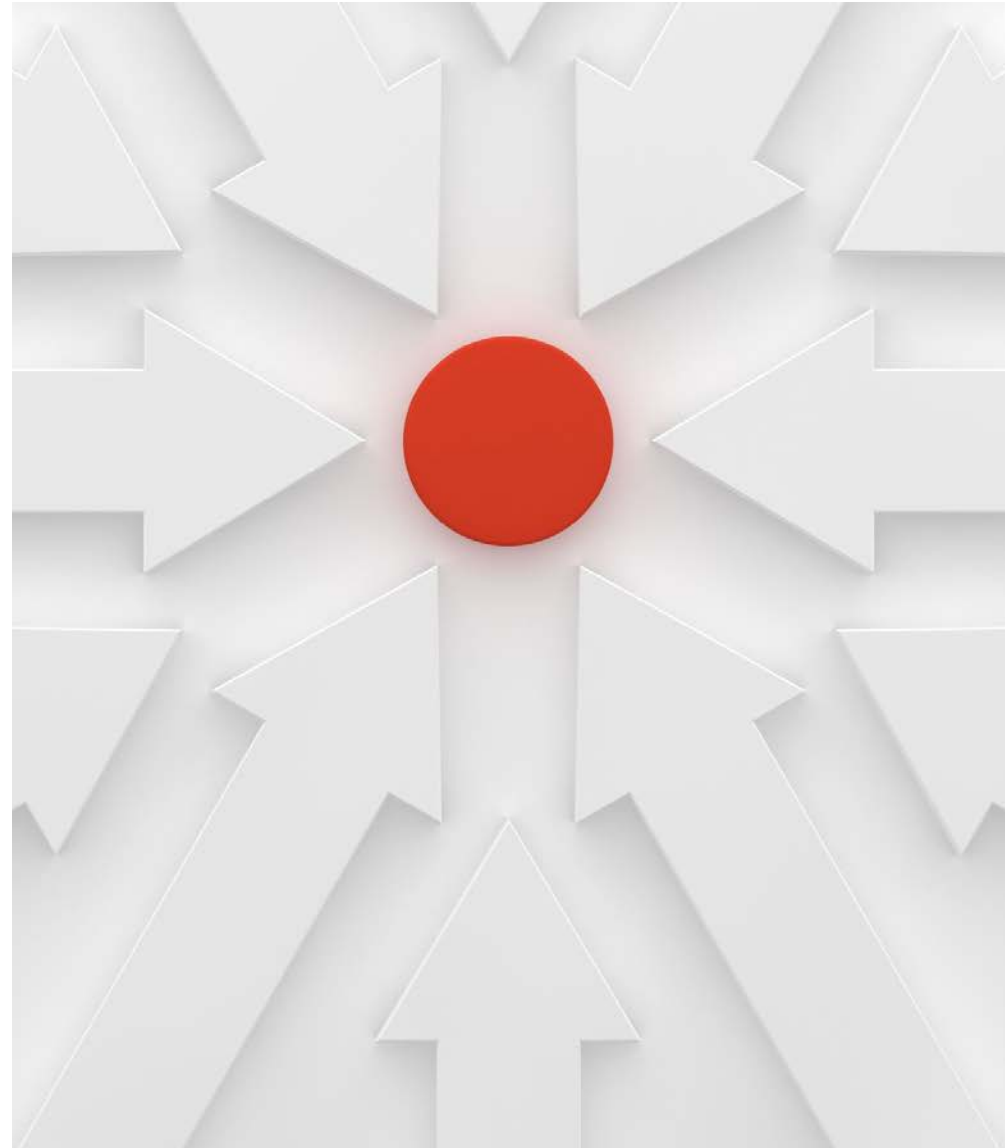
- We can enhance the conversation with patients by leveraging AI
- People like engaging with the COSI 2.0 prototype
- Patients used emotive language providing a richer ground for discussion
- Clinicians broached sensitive topics, allowing for a deeper dive
- There was a trend for increased hearing device uptake





Why User Insights Matter

- Validate design decisions
- Reveal real-world impact
- Highlight unintended consequences
- Guide iteration and refinement



✓ COSI Evolved

COSI Evolved

- Pilot studies
- Pathway to commercialization
- Applicability in different domains



✓ COSI Evolved

COSI 2.0

- Digitally enabled
- Patient input captured before appointments
- Structured yet personalised
- Supported by AI-driven insights

COSI 2.0

The image displays two smartphone screens side-by-side, representing the COSI 2.0 app interface. Both screens feature the NAL logo at the top.

Left Screen:

- Question: "What is the most important situation where you experience difficulty with your hearing?"
- Examples: "Some common examples include:"
 - Following dialogue on the TV/ watching TV
 - Hearing my family at home
 - Having conversations in noisy places
 - Conversations in groups or social events
 - Conversations on the phone
- Instruction: "Reply in your own words. Avoid replying with phrases like 'all of the above'."
- Text input field: "Hearing at morning coffee."
- Submit button.

Right Screen:

- Question: "You identified the following hearing need as being important to you:"
- Example: "To hear clearly at morning coffee despite lots of people around and the music so you can enjoy the experience without needing repeats all the time."
- Question: "How have things changed since being fit with hearing technology?"
- Response options: "Much better", "Better", "Slightly better", "No difference", "Worse".
- Text input field: "Hearing at morning coffee."
- Submit button.

Product Vision

Clients better understand their needs and are more receptive to thinking about how hearing aids could 'make things better'.



Client is more likely to recognise when/how they are experiencing positive effects.



Assessment

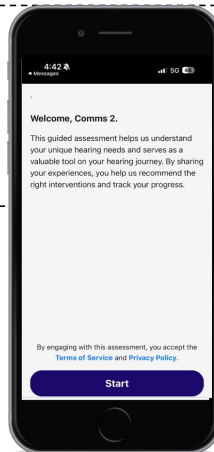
Fitting

Follow-up

COSI 2.0

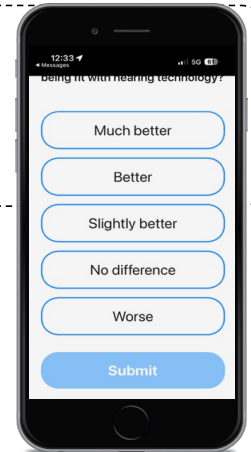
Self-guided
needs
assessment

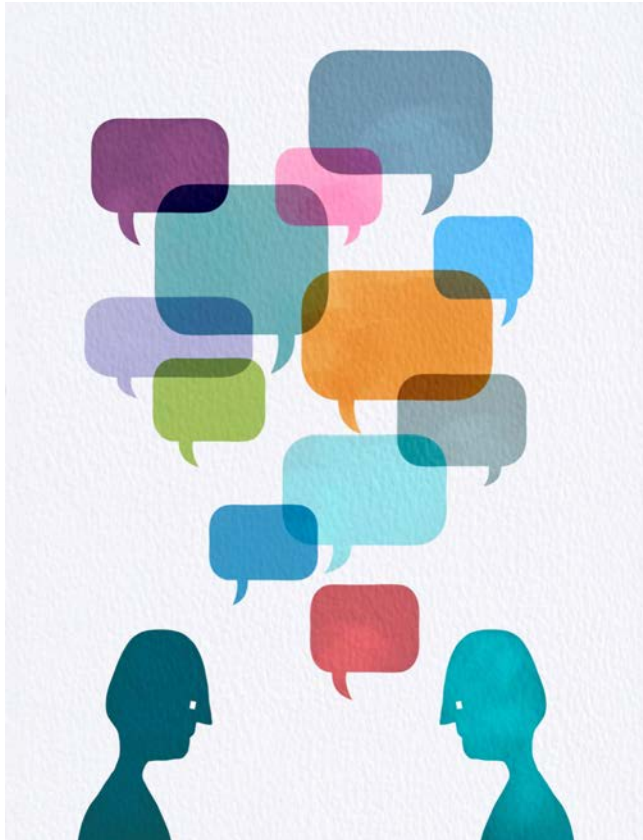
*Gives **client** opportunity to consider what their hearing needs are prior to purchasing device. Increases readiness to consider/accept solutions. AI is used to help the client articulate their listening needs and formulate this for the clinician to see prior to the appointment.*



Self-guided
reflection on
positive impact on
hearing needs

*Helps the **client** recognise positive impacts, and increases satisfaction with hearing aids. The clinician receives outcome ratings prior to follow-up.*





Not just a Chatbot

- Multi-agentic
- Validated by 1.5M goals
- Objective evaluation
- Elements of motivational interviewing
- Based on needs identified by current clinicians in different settings
- Consistent and evidence-based

Examples of the change in language

Example COSI 1.0 Goal	Example COSI 2.0 Goal
"Wife"	To hear your wife clearly at home, even when she is walking away, reducing frustration for both of you and improving communication.
"Background noise"	To hear conversations clearly while eating lunch out, minimizing distractions from background noise and loud music, so you don't need to ask people to repeat themselves.
"Asking for less repetition"	To clearly understand the takeaways from speakers at work networking conferences, minimizing the missed educational moments and enhancing your professional development without needing clarification or repetition.
"Being able to participate"	To hear your grandchildren clearly as they learn to speak, ensuring you can fully engage in their development and cherish those precious moments without missing out on their early words.

Next Steps for COSI 2.0

- Expanded pilot studies
- Ongoing usability refinement
- Formal outcome evaluation
- Ethical and governance review



It's the Journey that matters

- Writing a goal in itself is not the target
- Patients benefit from **reflection**
- Clinicians **remain as integral part** of the needs assessment
- COSI 2.0 helps to **focus** the conversation on things that matter





Bringing It All Together

- COSI's philosophy remains relevant
- Practice and technology have evolved
- Design thinking enables safe innovation
- User insights guide meaningful change
- COSI 2.0 modernises delivery, not intent
- AI supports personalisation and consistency
- Clinicians and patients remain central

Thank you!



Bettina Turnbull
AuD



Taegan Young
MClinaud



Lindsay Prusick
AuD



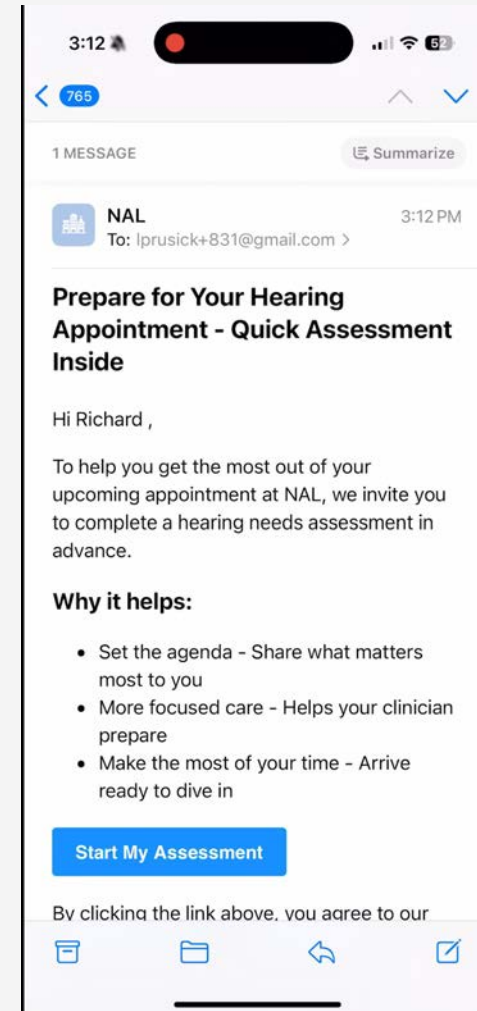
Padraig Kitterick
PhD



Daniela Dixon
MClinaud

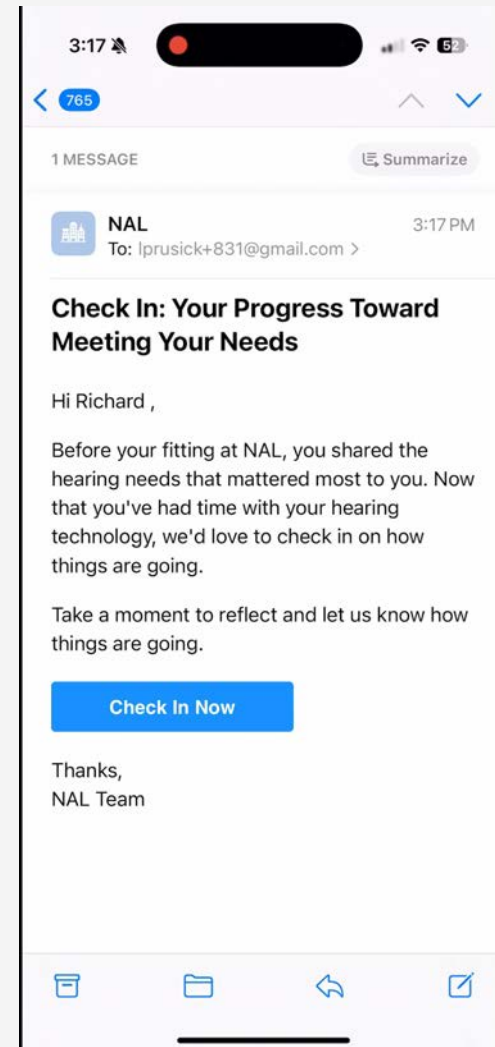


Demo Assessment





Demo Outcomes



Thank You!

Xiaoyin Shang
Matt Croteau, MS
Catherine Kwok
Bettina Turnbull





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