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Deep-Diving into the Next Era of Hearing: The Research Behind ReSound Nexia



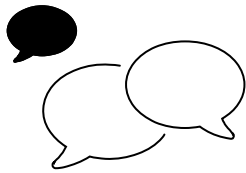
Today's Learning Outcomes

- 1) After this course, participants will be able to discuss how ReSound directional technology empowers hearing aid users for better hearing in real-world environments.
- 2) After this course, participants will be able to detail how the new and improved First Time User – Onboarding setting was derived and validated to suit the needs of users who are sensitive to amplified sound.
- 3) After this course, participants will be able to explain how Bluetooth Low Energy Audio and Auracast technology can promote more inclusive listening experiences in some of the most difficult listening situations.

Let's Dive Into Directionality!



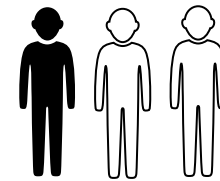
Hearing well in noise is still the biggest challenge we face



Hearing conversations in noise is the main reason for purchasing hearing aids¹



Hearing in noise is the #1 driver of hearing aid satisfaction and the biggest unmet need for current users²



Nearly 1 in 3 Hearing aid users are unsatisfied with their ability to hear conversations in noise³

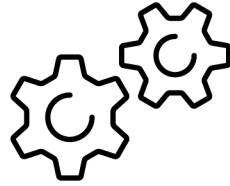
1. Manchaiah and colleagues, 2021

2. Picou, 2020

3. MarkeTrak, 2022

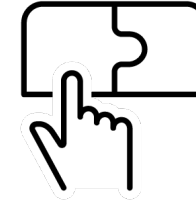
ENVIRONMENTAL CLASSIFICATION

Provides key input for
decision-making on how and
when to apply sound
processing features



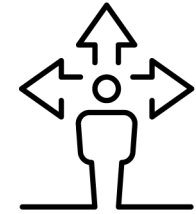
ACOUSTIC FEATURE EXTRACTION

Overall Level
Spectral Shape
Signal-to-Noise Ratio
Amplitude Modulation
Temporal Patterns
Spectro-temporal Profile



CLASSIFICATION

Estimation of the Feature Space Using
Proportions to form environments

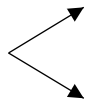
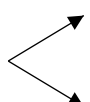
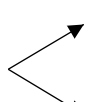


DECISION RULES

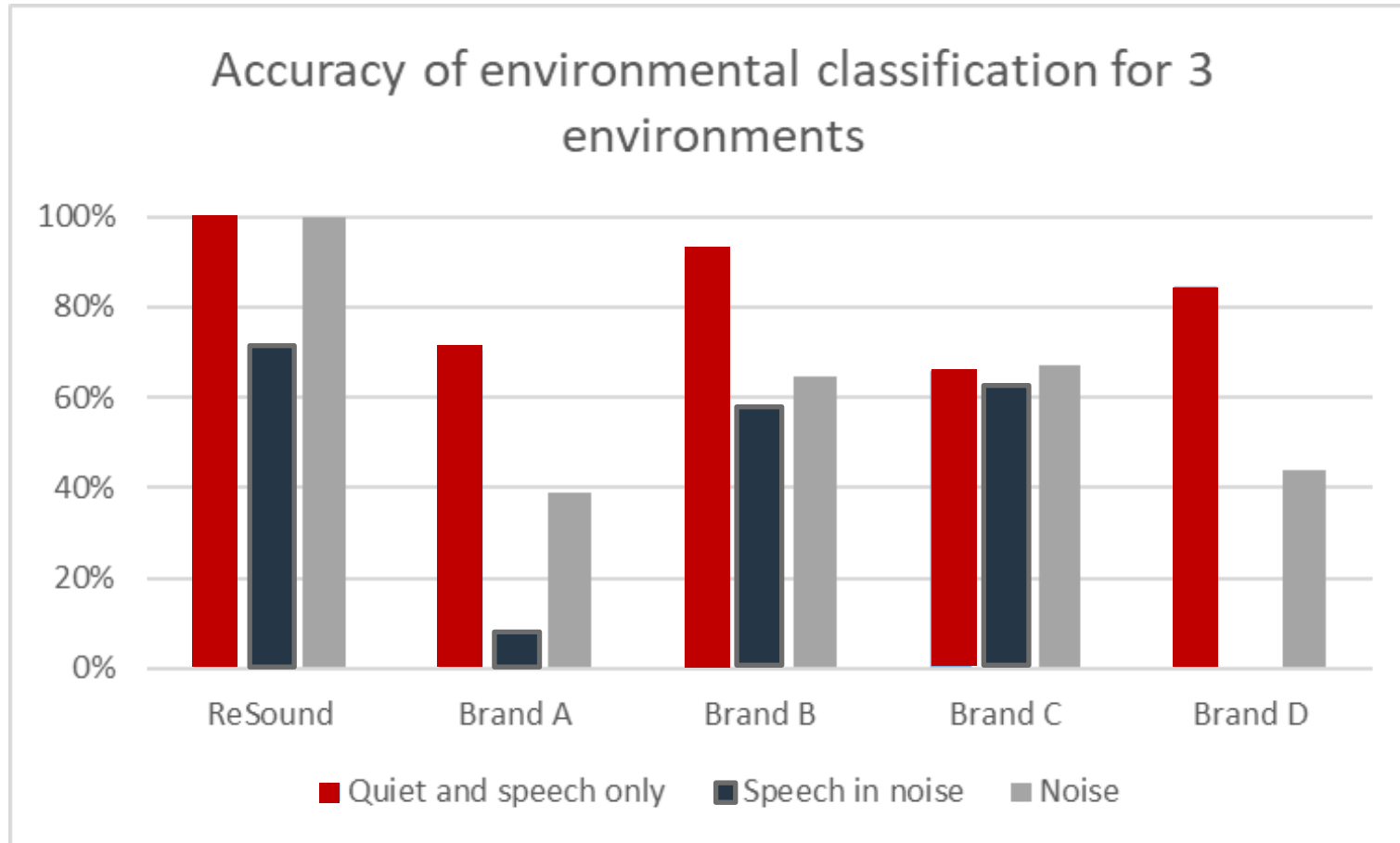
Operation of the hearing aid
automatically to turn on and off
features to benefit the user.

“Comprehensive assessment of environmental classification is essential when considering the cost of signal processing errors, the potential impact for typical wearers, and the information available for use by clinicians. The magnitude of differences among devices is remarkable and to be noted.”

Environmental Classifier: 7 Environments

Sound inputs	Loudness	Environments
Quiet	Less than 54dB	1. Quiet
Speech 	Less than 60dB	2. Soft speech
	More than 60dB	3. Loud speech
Speech in Noise 	Less than 75dB	4. Soft speech in noise
	More than 75dB	5. Loud speech in noise
Noise 	Less than 75dB	6. Moderate noise
	More than 75dB	7. Loud noise

Environmental Classification

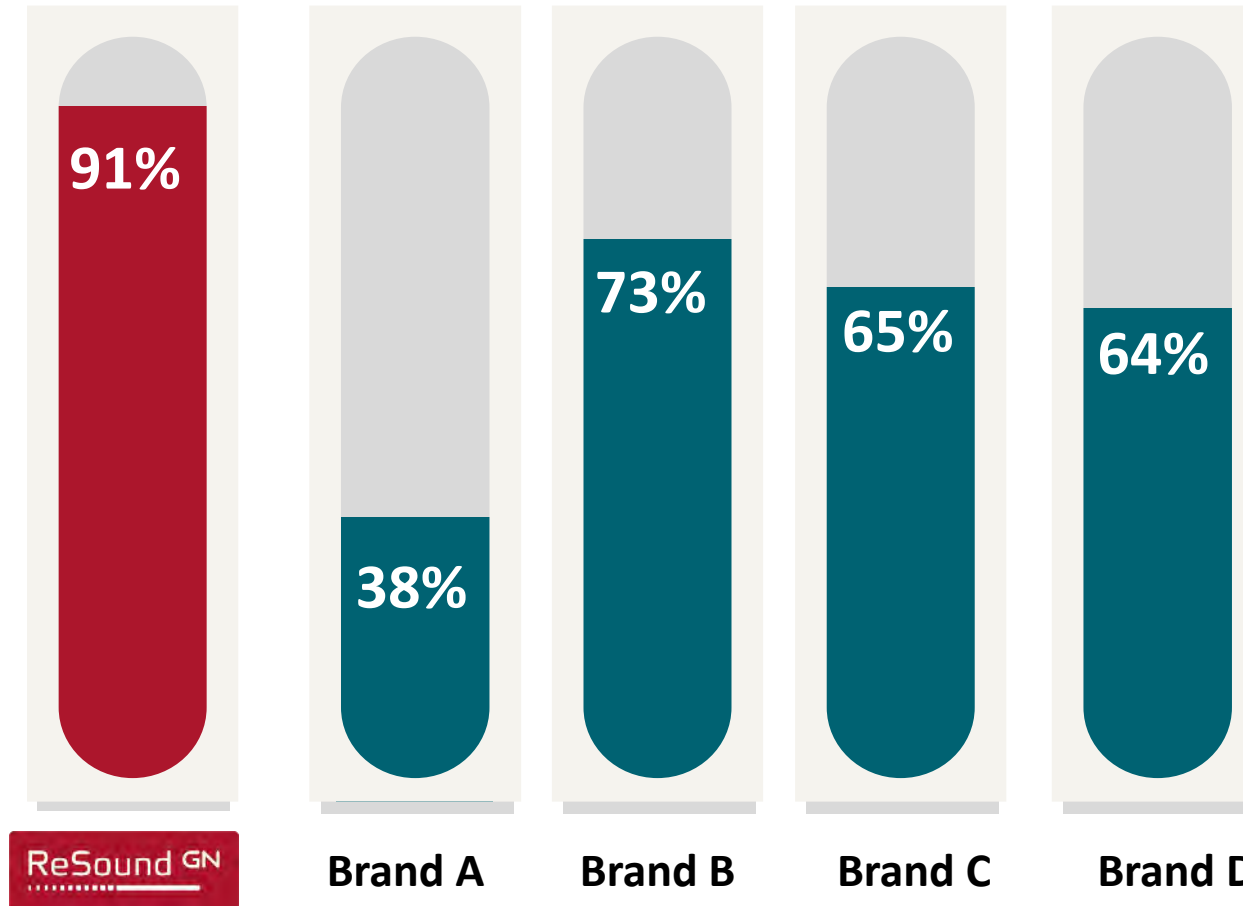


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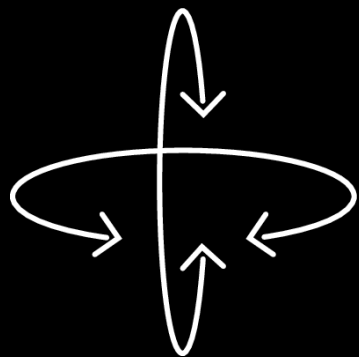
*Note: Brand D does not differentiate speech in noise from noise in data logging.

Industry's most accurate environmental classifier*

OVERALL ACCURACY



*Compared to other premium brands providing environmental classification data (Groth et al., 2023)



360 All-Around





Spatial Cue Preservation



Binaural Listening



Speech Intelligibility

**Purpose of ReSound 360 All-Around:
Support Natural Auditory Navigational Abilities**

How Does ReSound 360 All-Around Achieve This Goal?



Widening our
sound
environment
mapping



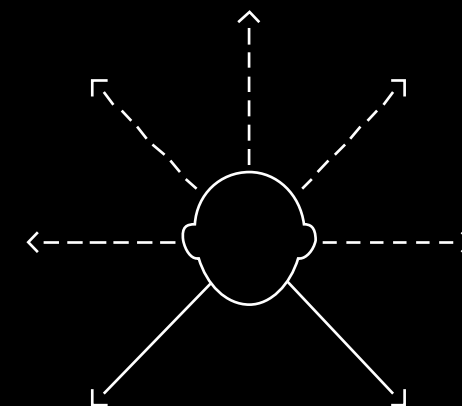
Speeding up our
processing and
steering for faster
mode detection and
selection



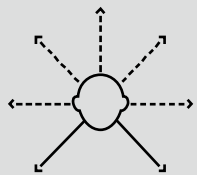
**Increasing the
precision** of our
beamforming for our
best speech clarity in
any environment



**All working at the same time across any sound environment,
enabling users to automatically tune into what they want to listen to
and not have the hearing aids choose for them**

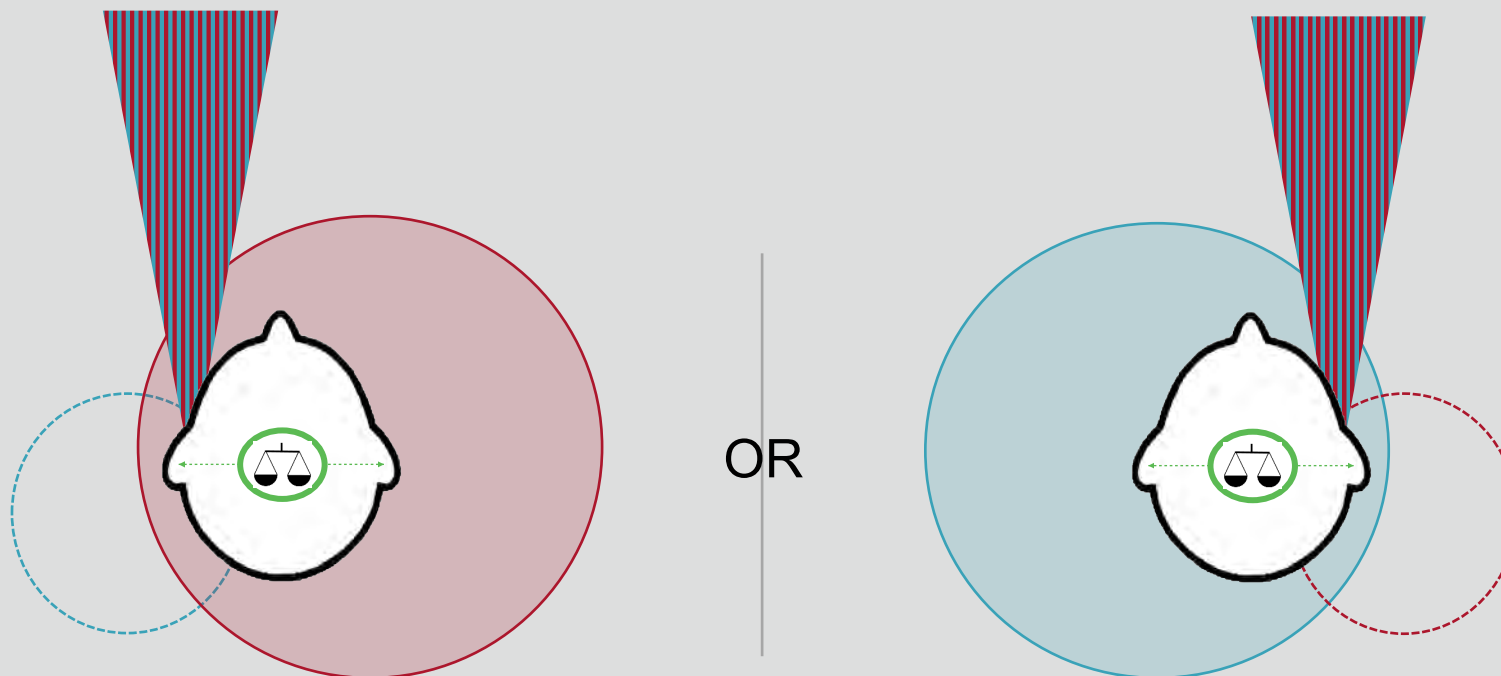


**Widening our
sound environment
mapping**

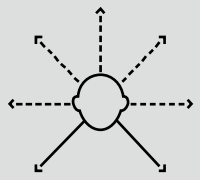


Widening our sound environment mapping

All Access Directionality 360 All-Around



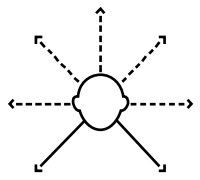
360 All-Around, when in Binaural Listening mode, streams the off-axis sound from the directional side to the omnidirectional side, providing more auditory awareness in difficult environments (like a popular café)



When Do You Want Multiple Strategies Available?

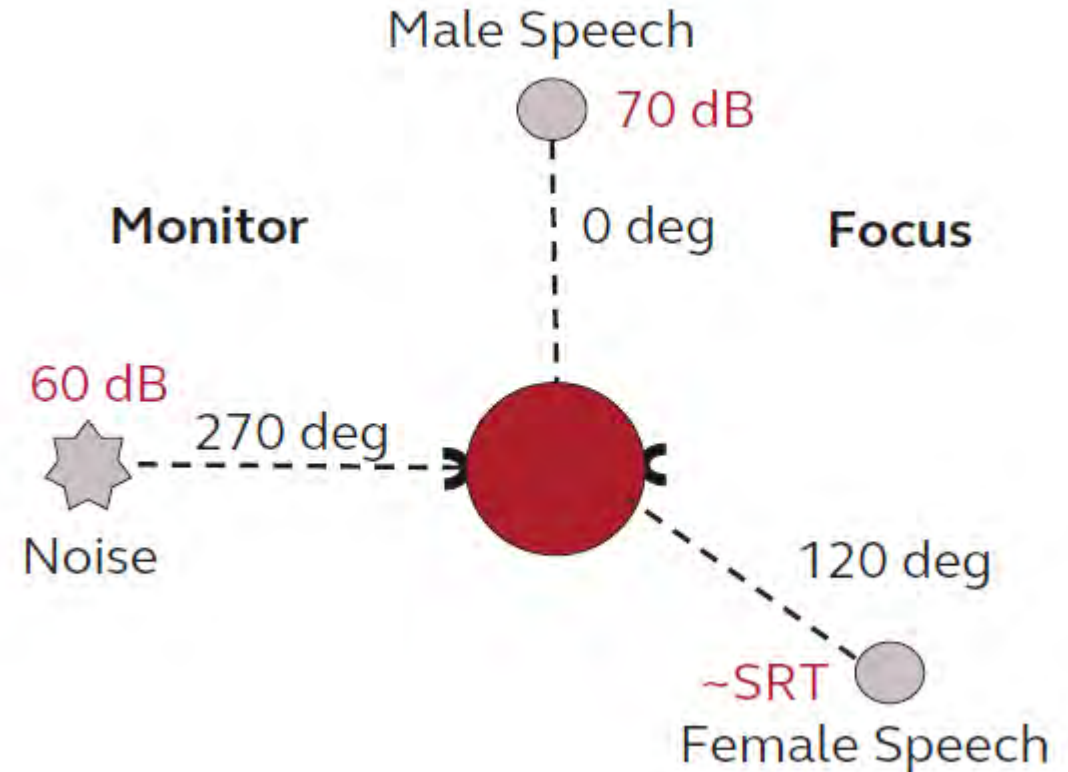


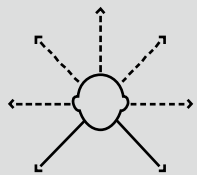
Café or other complex listening situation



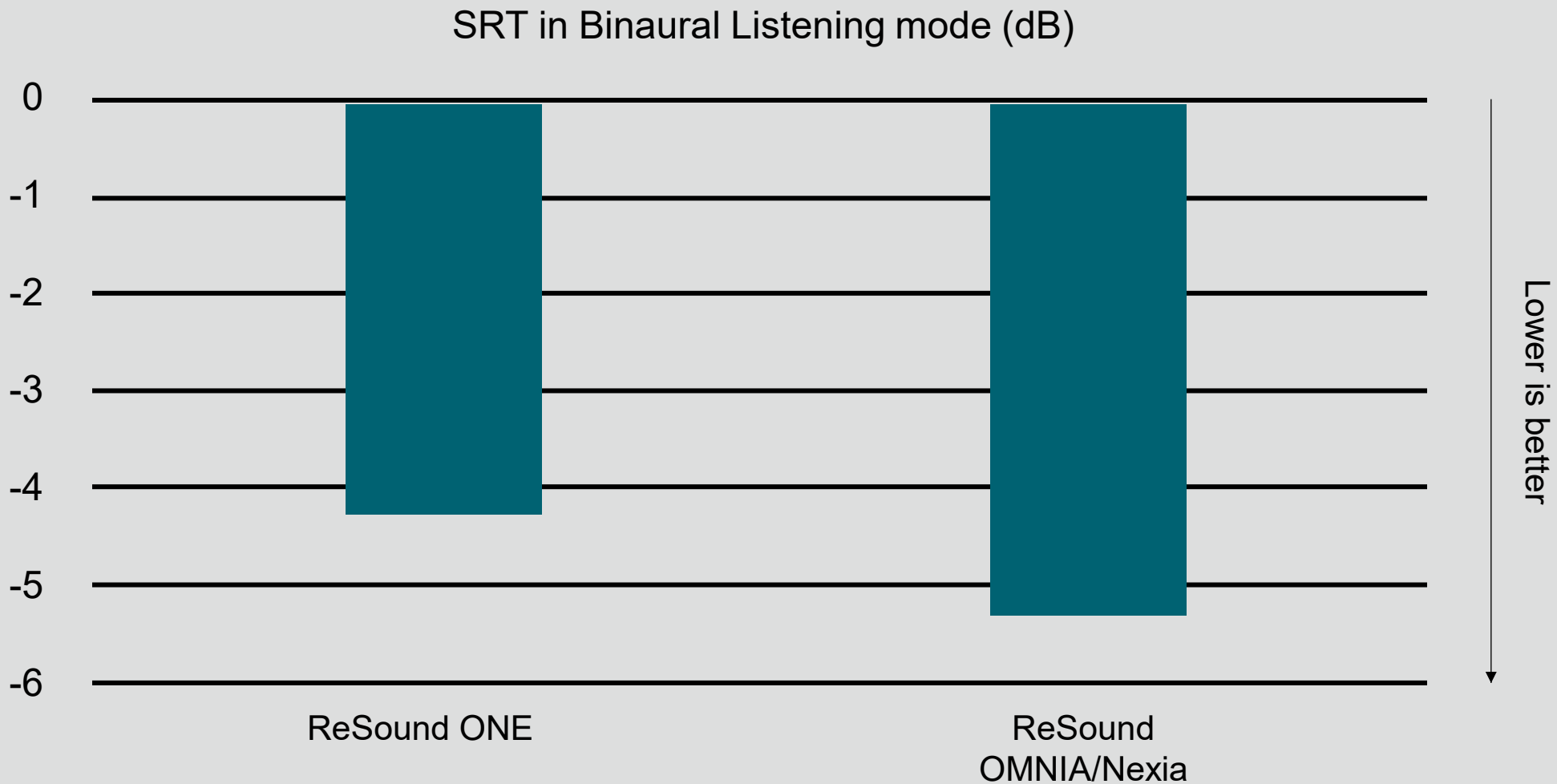
Widening our sound environment mapping

- Compared ReSound ONE All Access Directionality to ReSound OMNIA 360 All-Around
- Audiogram+ targets
- Power domes
- Listening conditions for Binaural Listening mode
- Target: Female Speech at 120 degrees
- Dantale II speech recognition in noise test
 - SRT test to determine 50% correct performance, resulting in a dB SNR score
 - Lower score = better!





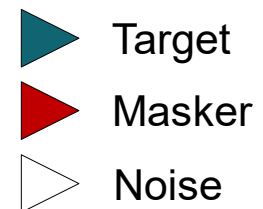
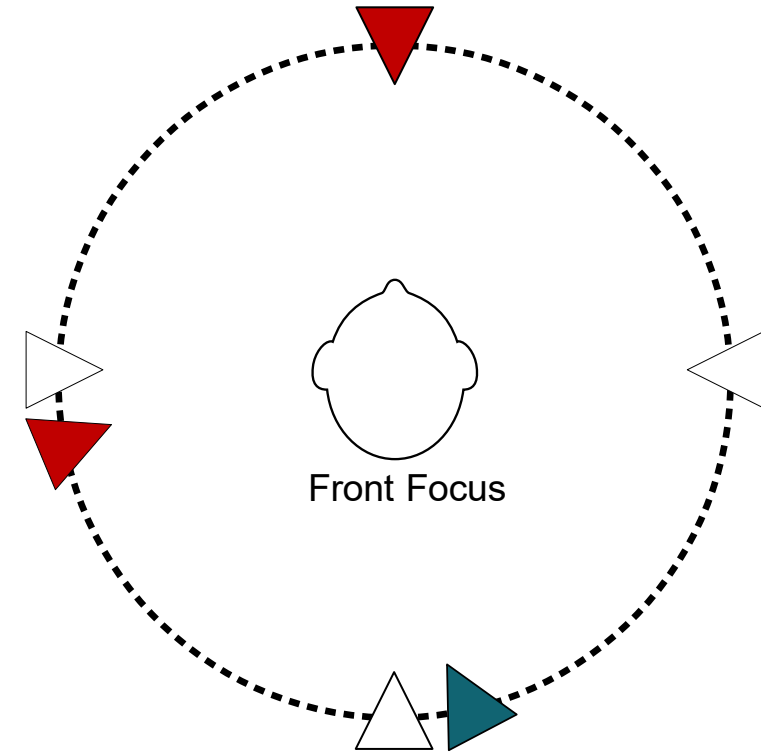
Widening our sound environment mapping



Off-Axis Hearing

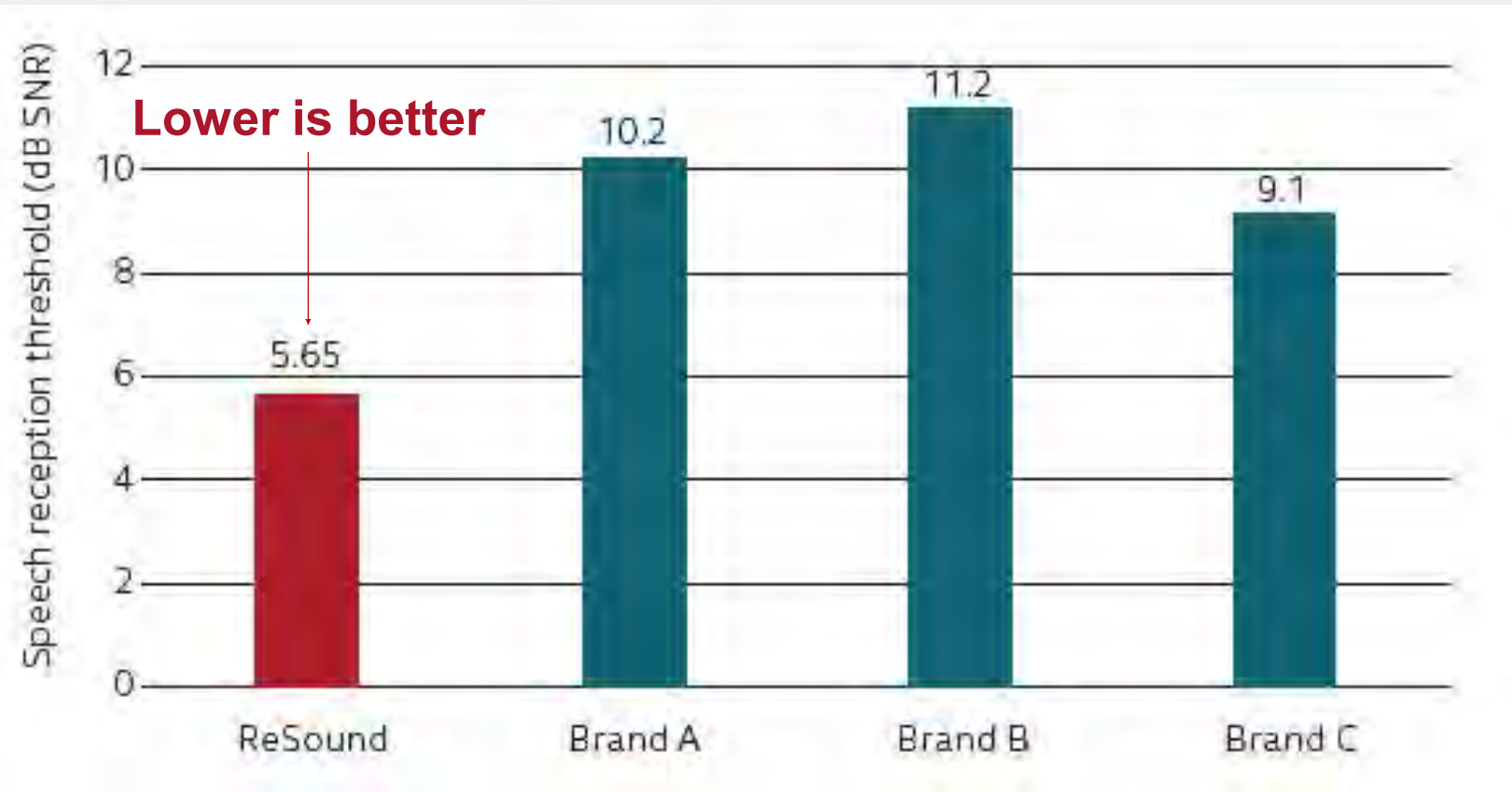
Industry best access to surrounding conversations

- Comparison to 3 other premium brands claiming access to sound all around
 - 4-microphone beamforming **or** conventional directional combined with strong noise reduction

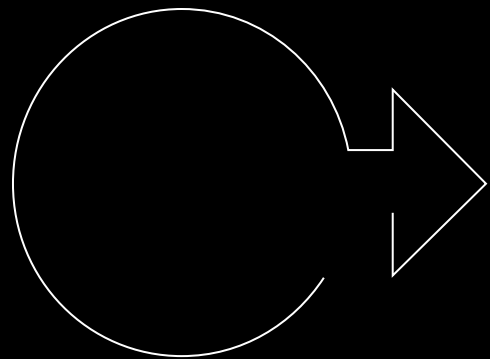


Results

- ReSound performs better than other brands when needing to access conversation from behind
- Average improvement in SNR was 4.4 dB
- **ReSound was at least 2 dB better in 88% of trials!**



Groth et al (2023)



**Speeding up our
processing and
steering for faster
mode detection
and selection**

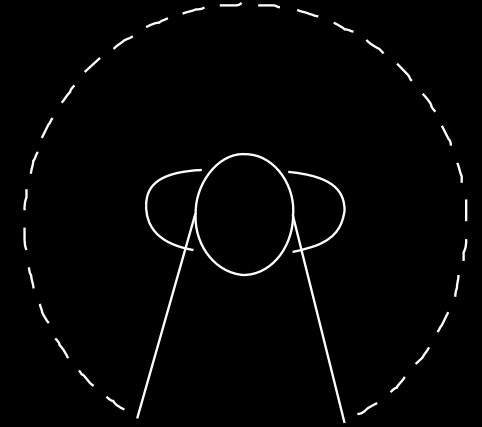


Speeding up our processing and steering for faster mode detection and selection

ReSound GN



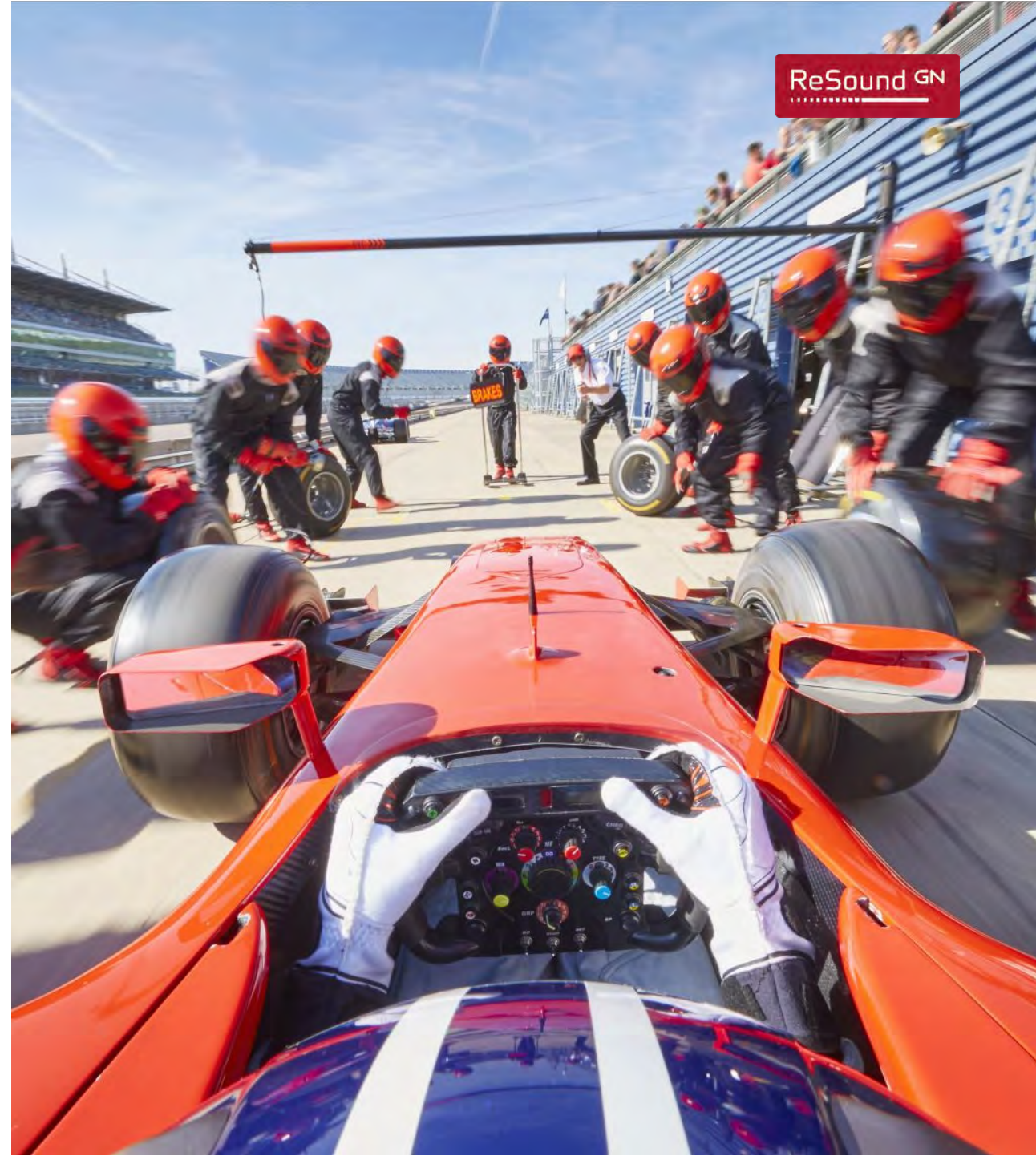
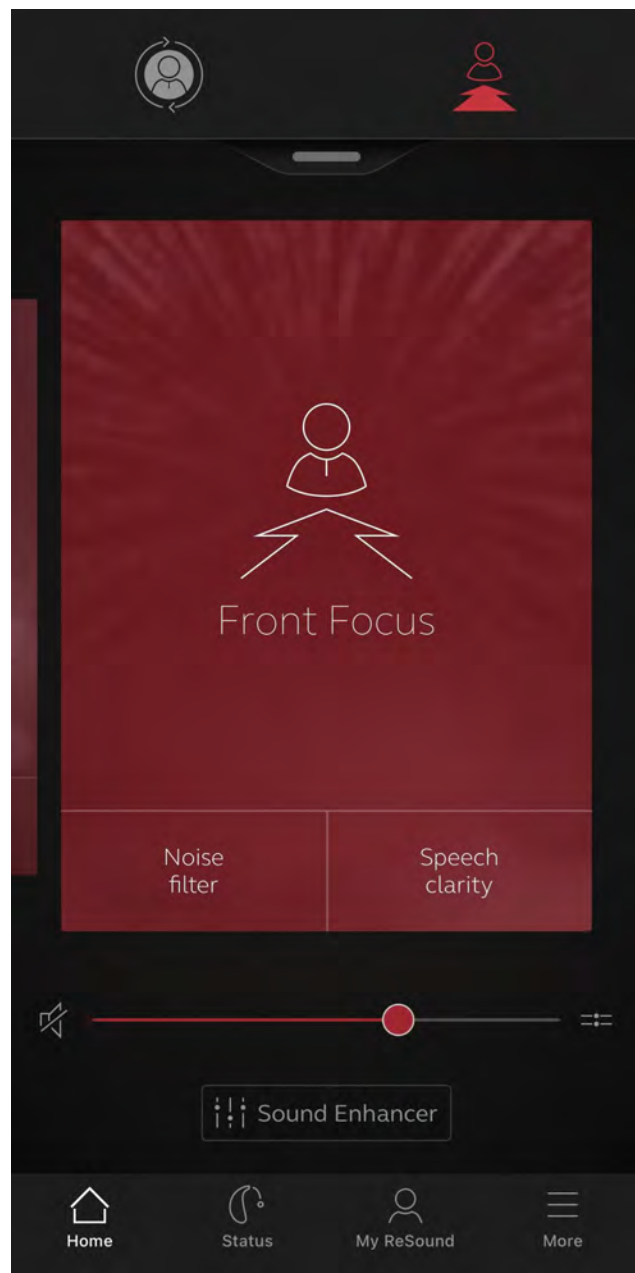
New steering system that switches 2X as fast, for clearer distinctions among listening modes



**Increasing the
precision** of our
beamforming for our
best speech clarity in
any environment

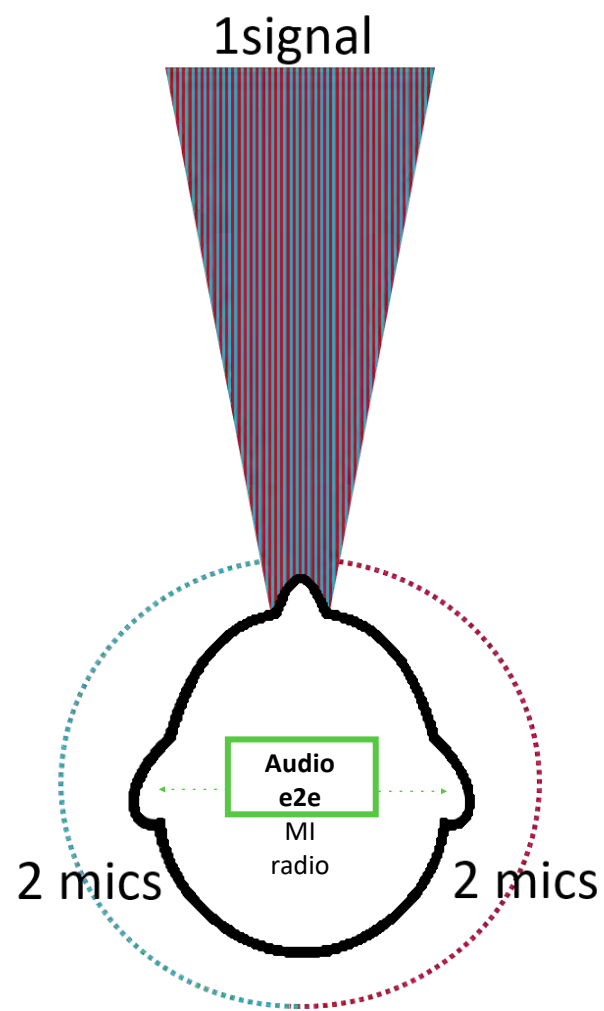
New ReSound Front Focus Program –

Selected by
the **Individual**
When They
Want to Be In
the Driver's
Seat!

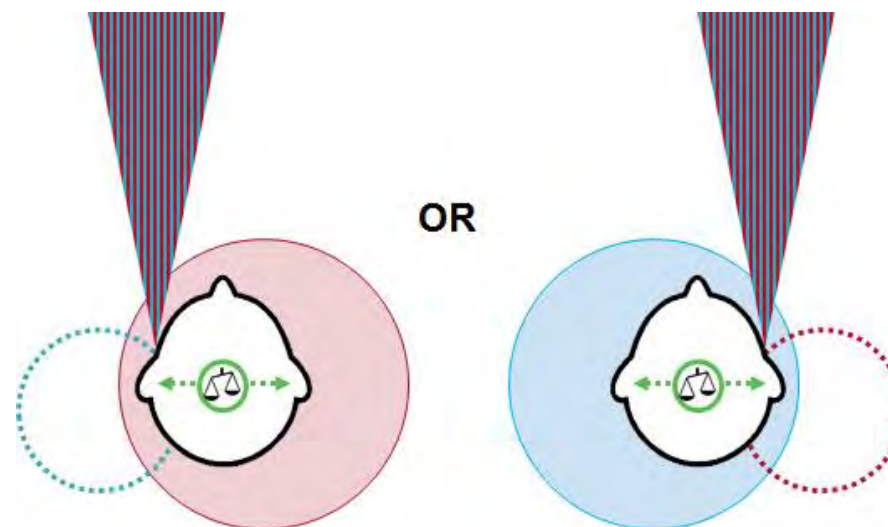


ReSound Binaural Beamforming Directionality – with Weighting to Help Users Hear Better in Difficult Noisy Situations

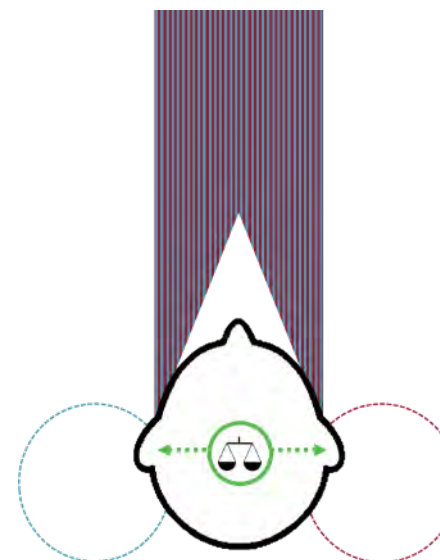
ReSound GN



Applied in Binaural
Listening Strategy



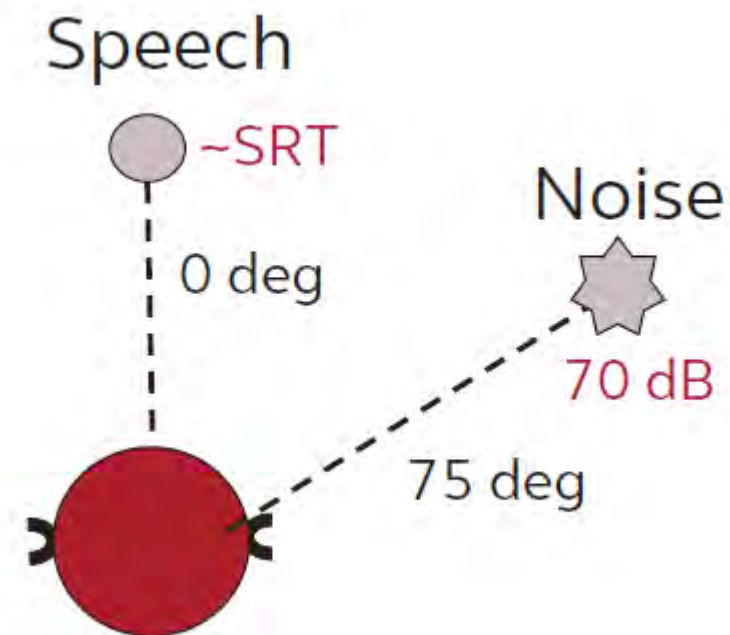
Applied in Speech
Intelligibility Strategy
and Front Focus
Program





Improvements to the binaural beamformer, providing even more precision for our best speech clarity

- Compared ReSound Ultra Focus (in ReSound ONE) to ReSound Front Focus (in ReSound OMNIA)
- Audiogram+ targets
- Power domes
- Set to ReSound Front Focus or Ultra Focus program
- Target: Speech at 0 degrees
- Dantale II speech recognition in noise test
 - SRT test to determine 50% correct performance, resulting in a dB SNR score
 - Lower score = better!





Improvements to the binaural beamformer, providing even more precision for our best speech clarity

Omnidirectional
Front Focus
Ultra Focus

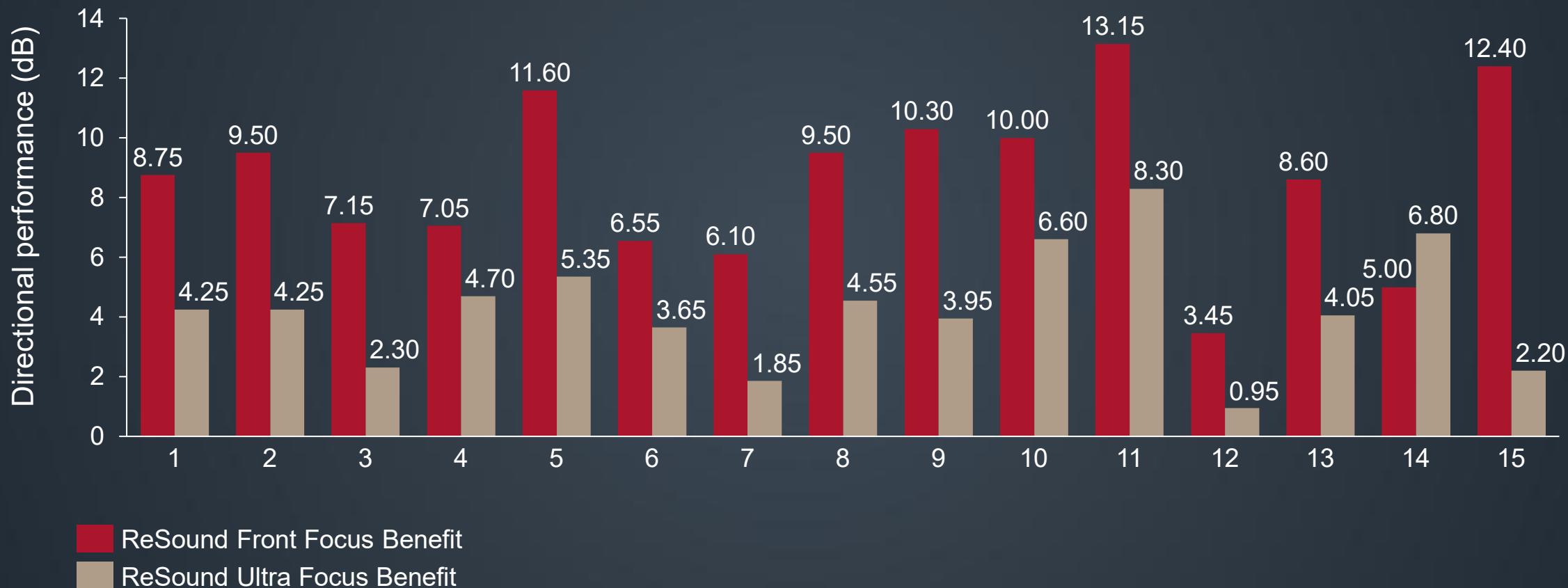


+4.25dB
better than omni

+8.61dB
better than omni



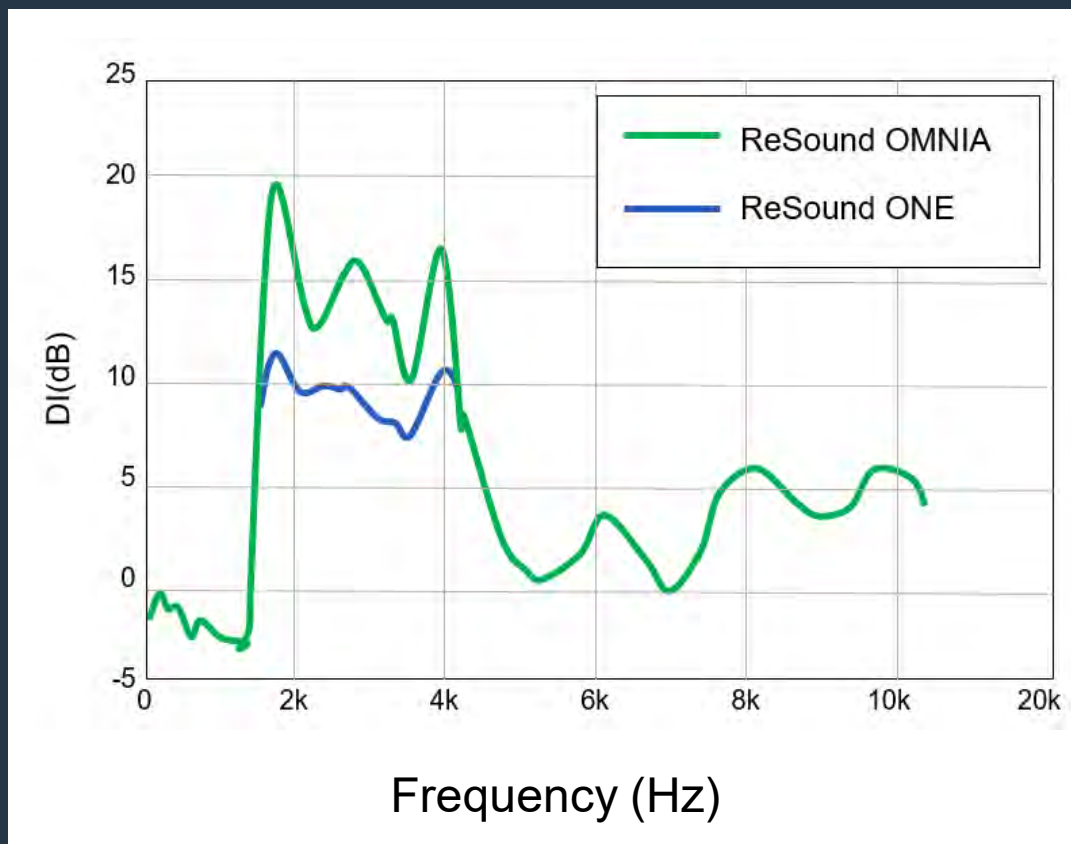
Improvements to the binaural beamformer, providing even more precision for our best speech clarity, compared to omnidirectional



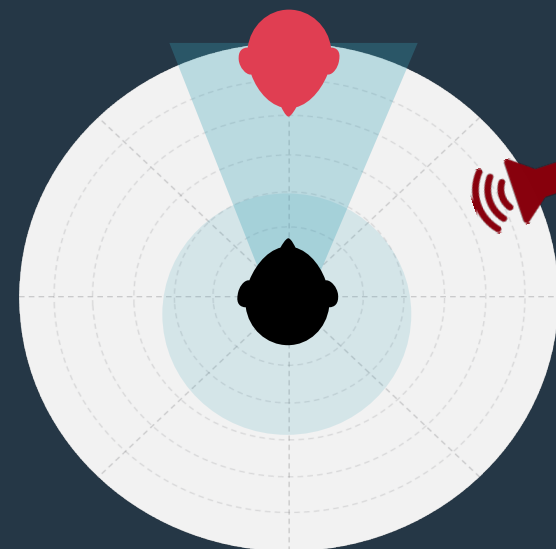
* Jespersen et al (2022)



Improvements to the binaural beamformer, providing even more precision for our best speech clarity



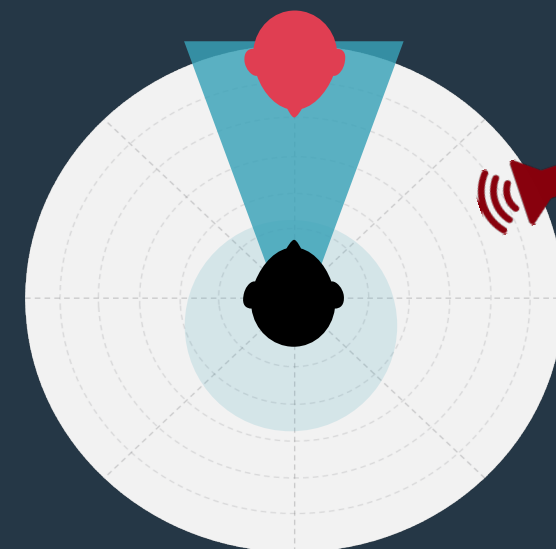
Better optimized for the head-related transfer function = better precision for better clarity



Ultra Focus

+4.25dB

better than omni



Front Focus

+8.61dB

better than omni



What Is the Difference in Directional Response between 360 All-Around and Front Focus in This Situation?

360 All-Around applies this response according to the environment (i.e., in Speech Intelligibility mode)

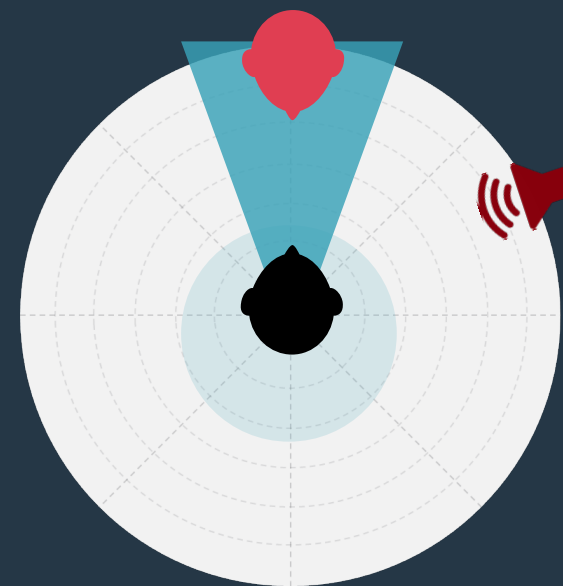
Front Focus is user-selected, when the user wants the best SNR

Possible differences between 360 All-Around and Front Focus:

1. Directional Mix setting (crossover frequency between omnidirectional and directional processing)

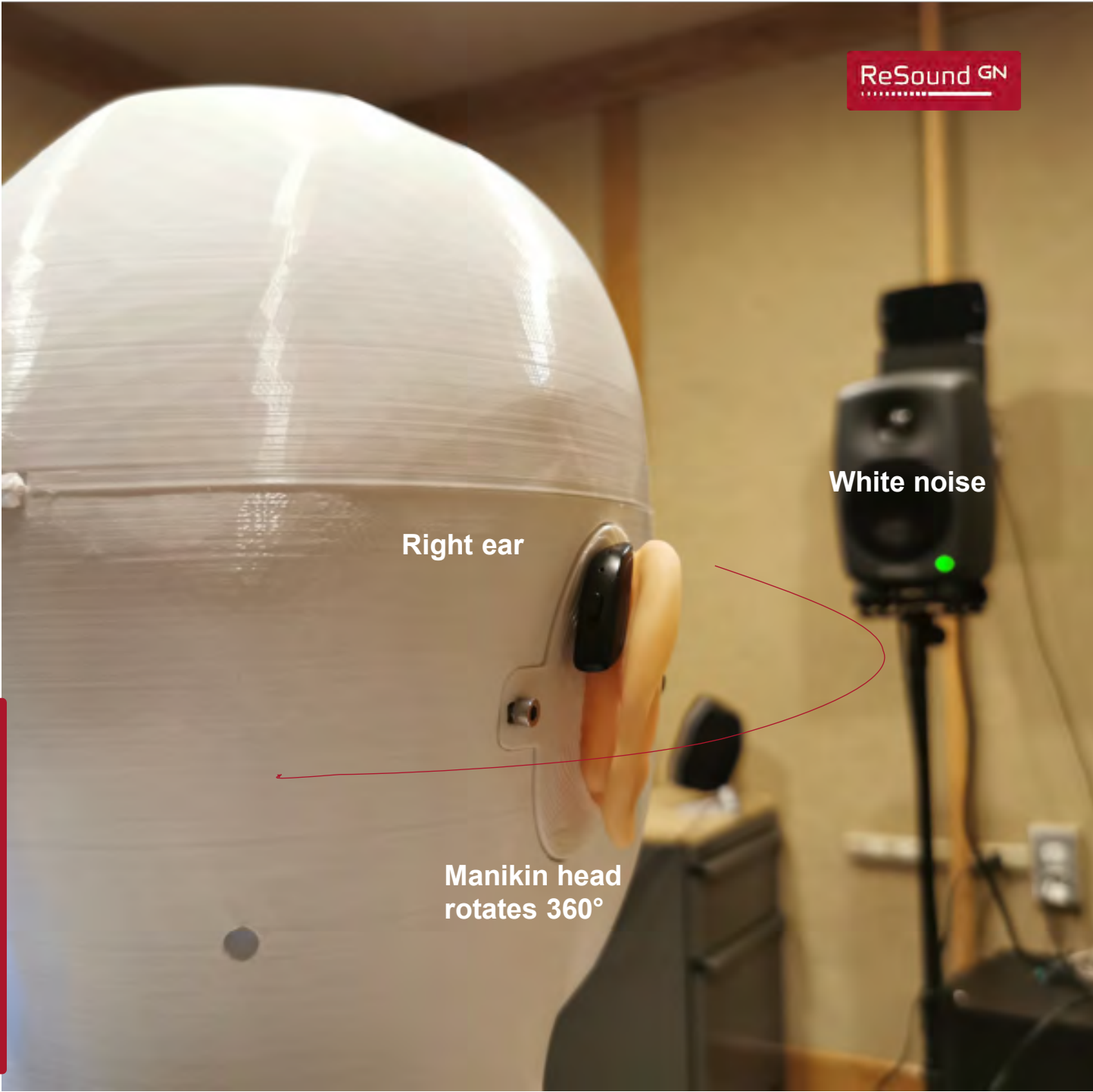
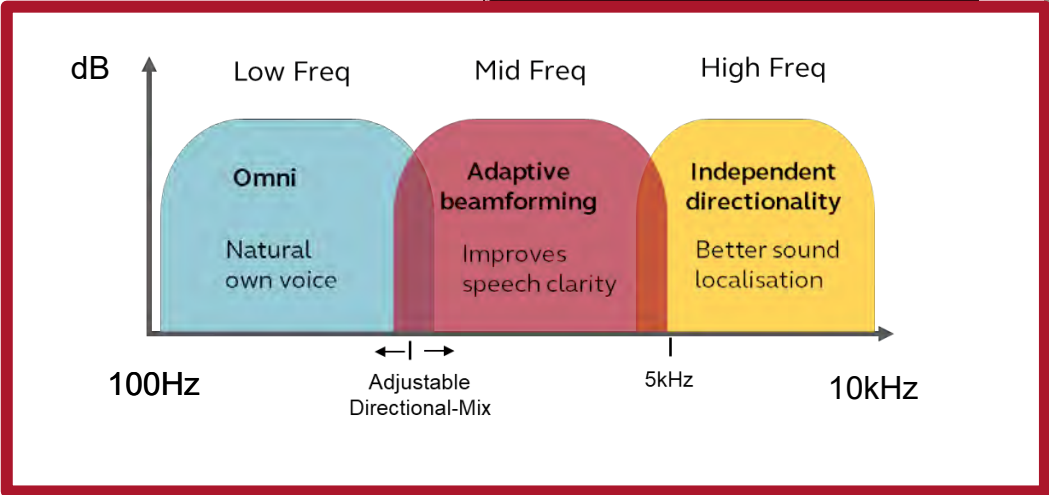
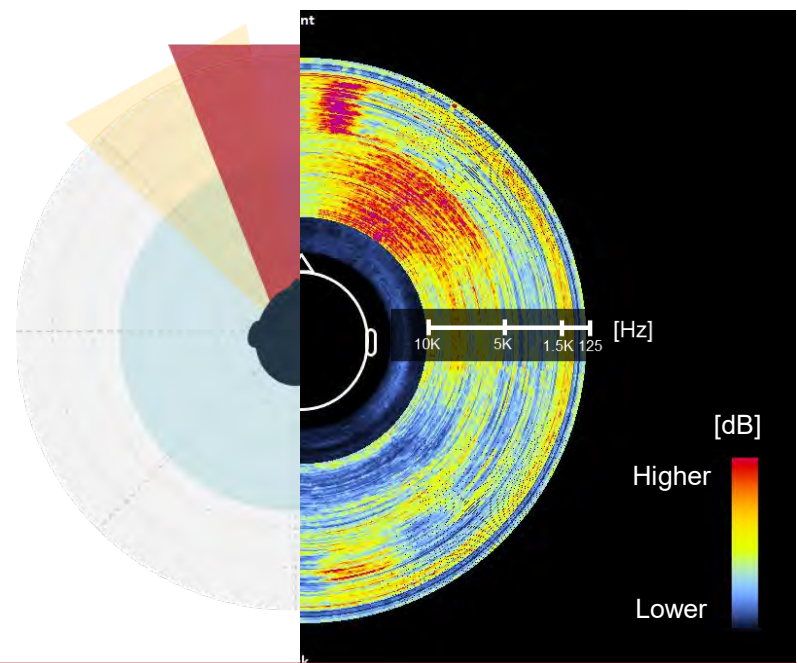
*2. Time constants (Front Focus uses Slow)
(Slow time constants can maintain temporal envelope of speech and short-term changes in spectral patterns of speech^{1,2})*

*3. Noise reduction setting (Front Focus uses Moderate)
(Strong NR may adversely affect SNR, speech recognition and listening effort without significantly improving listening comfort³)*



1. Drullman et al., 1994
2. Kluender et al., 2003
3. Reinhart et al., 2017

Front Focus

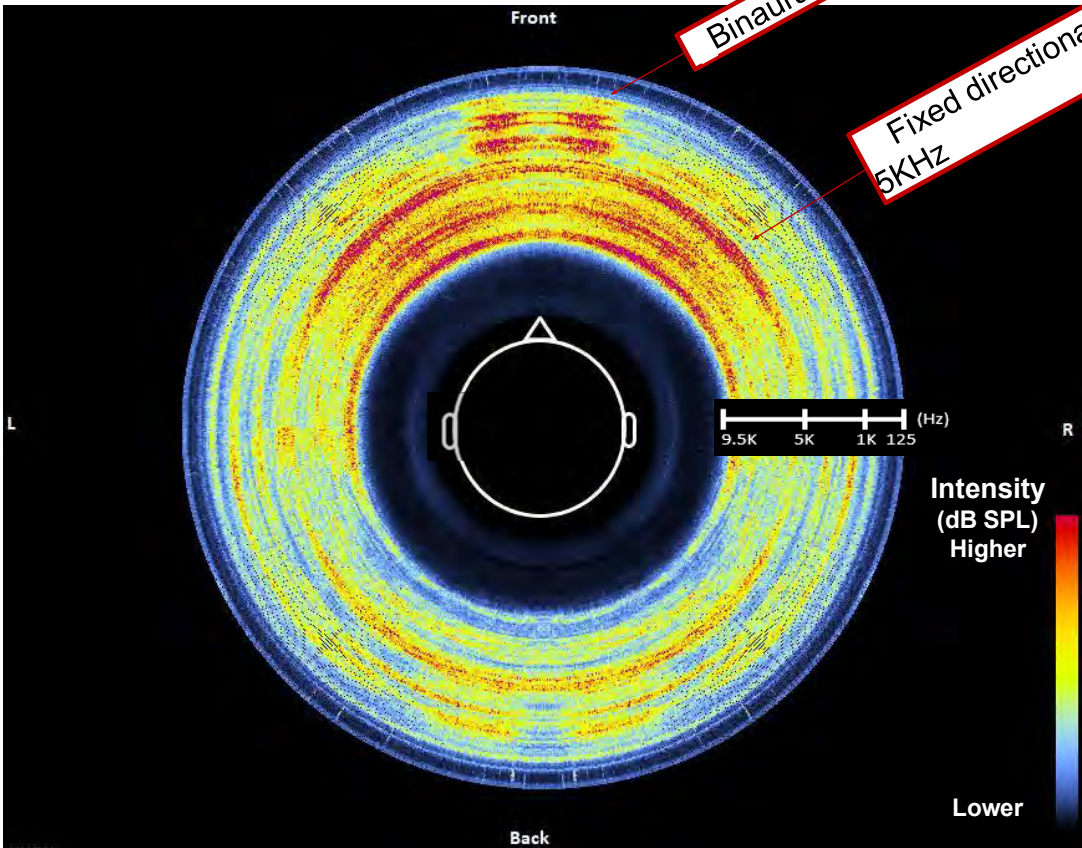


Directionality in Noisy Environment – Binaural

Center to edge of plot: High frequencies to low frequencies

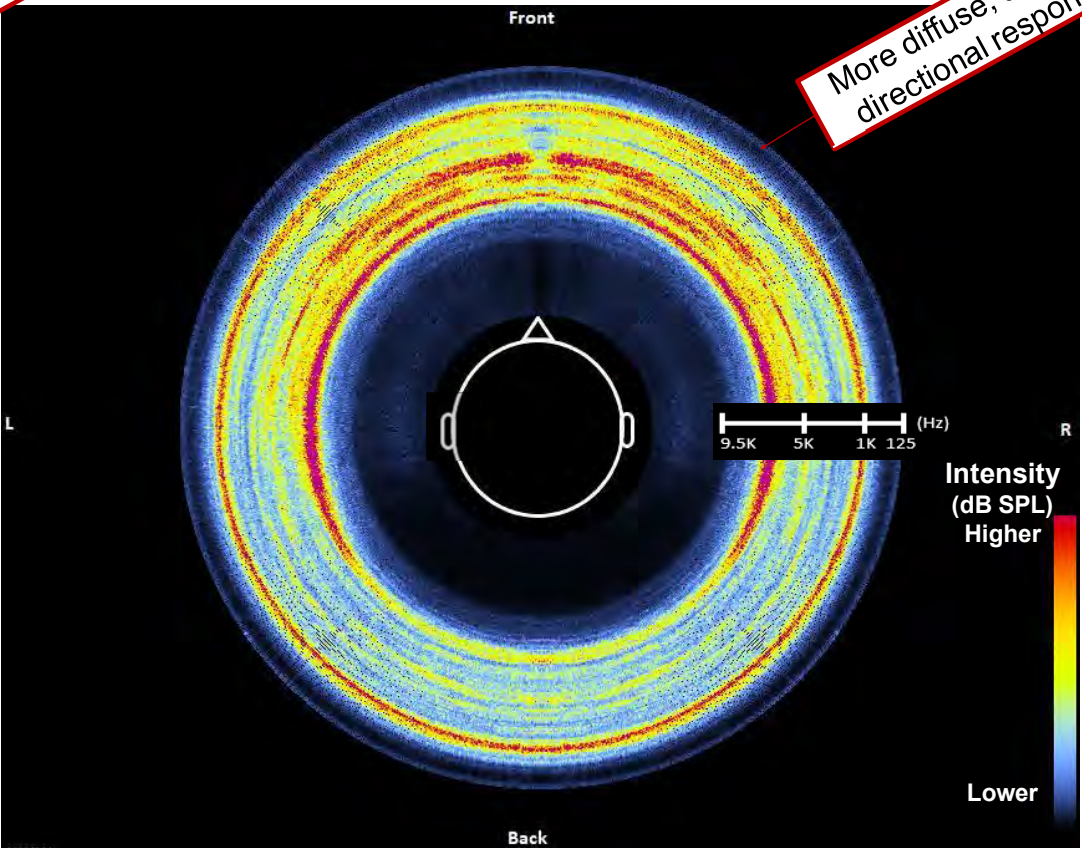
ReSound

Front Focus



Another Manufacturer

Binaural beamforming directionality

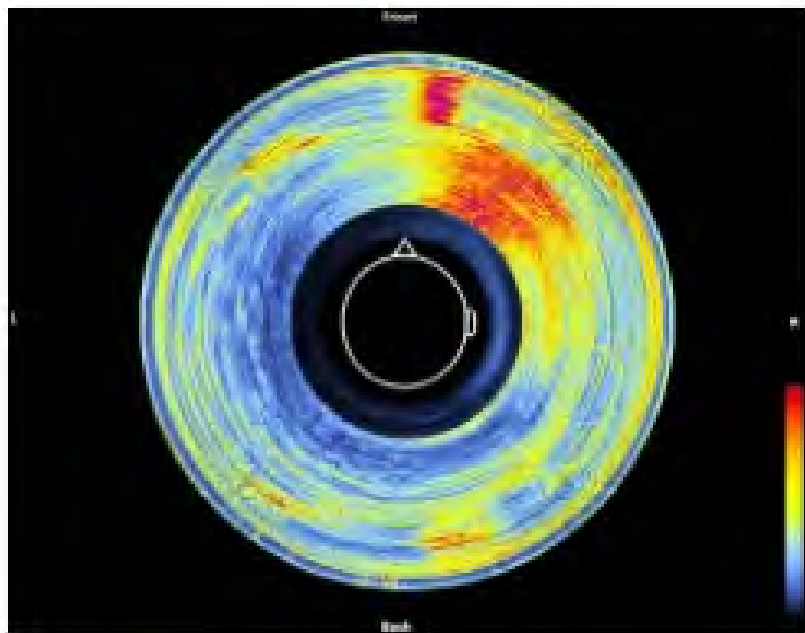


Note: More focused beamforming and multiband directionality

Spectrograms of Strongest Directional Settings

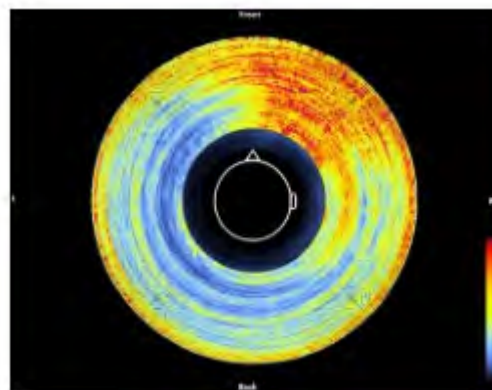
Per Manufacturer

ReSound Nexia

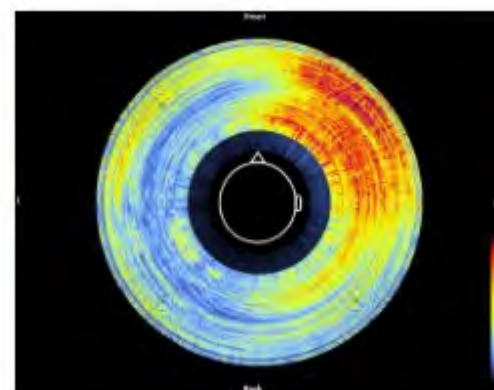


2 mic directionality systems

Manufacturer 1

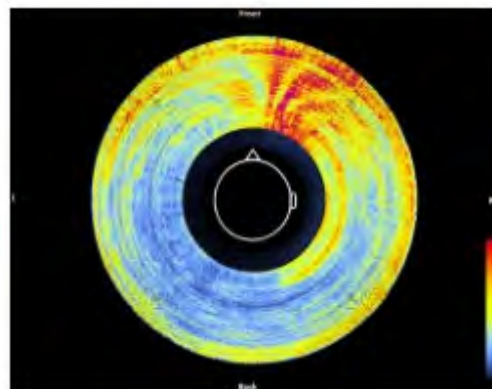


Manufacturer 2

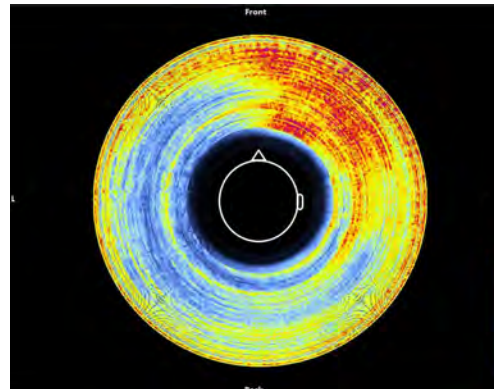


4 mic directionality systems

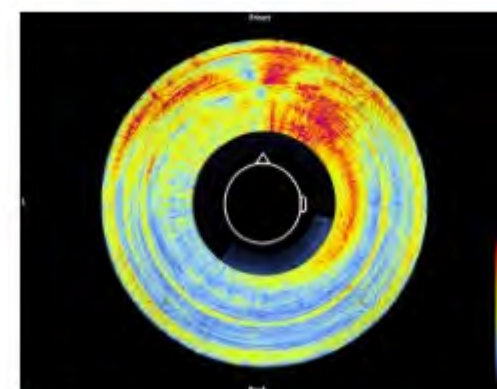
Manufacturer 3



Manufacturer 4

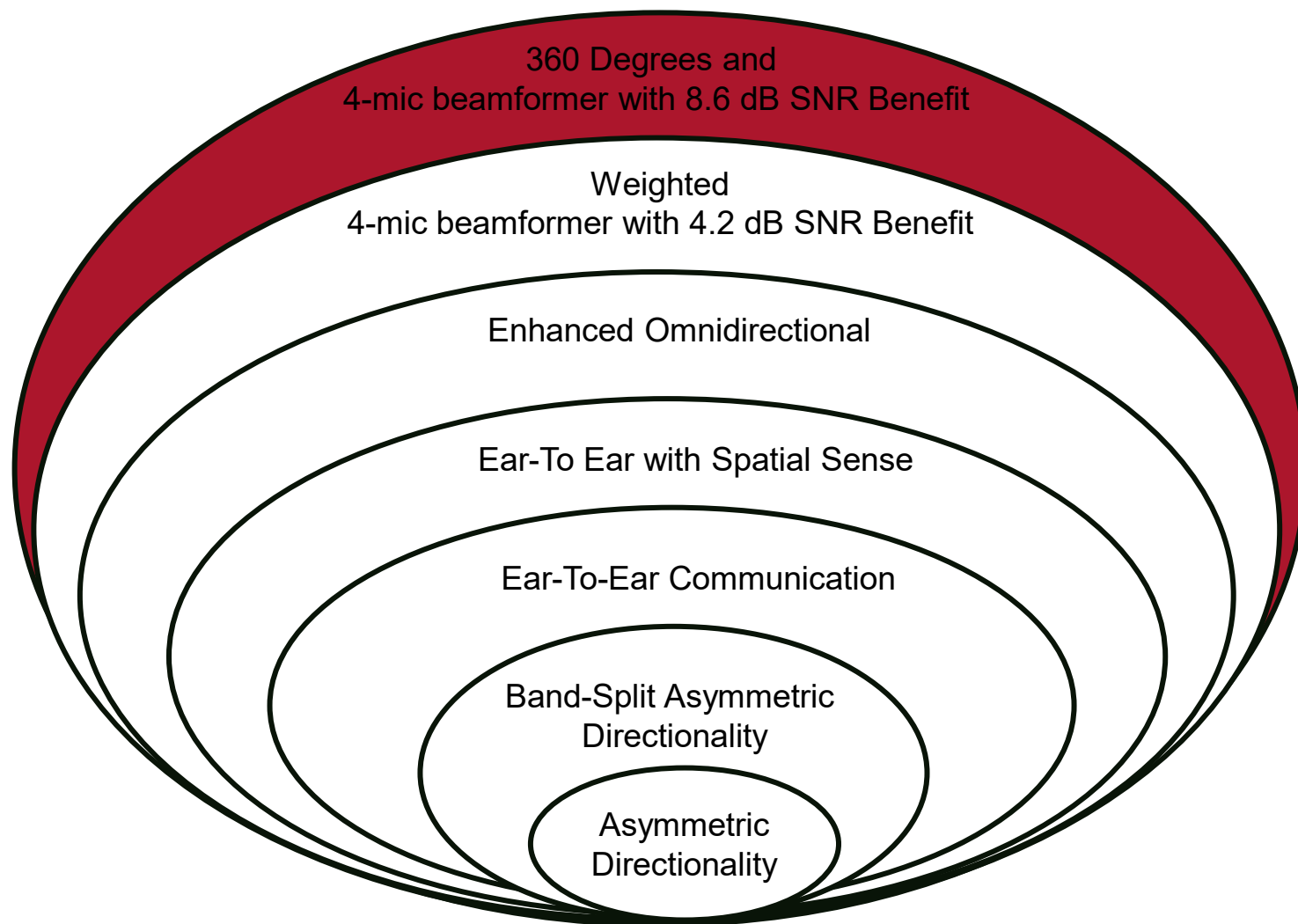


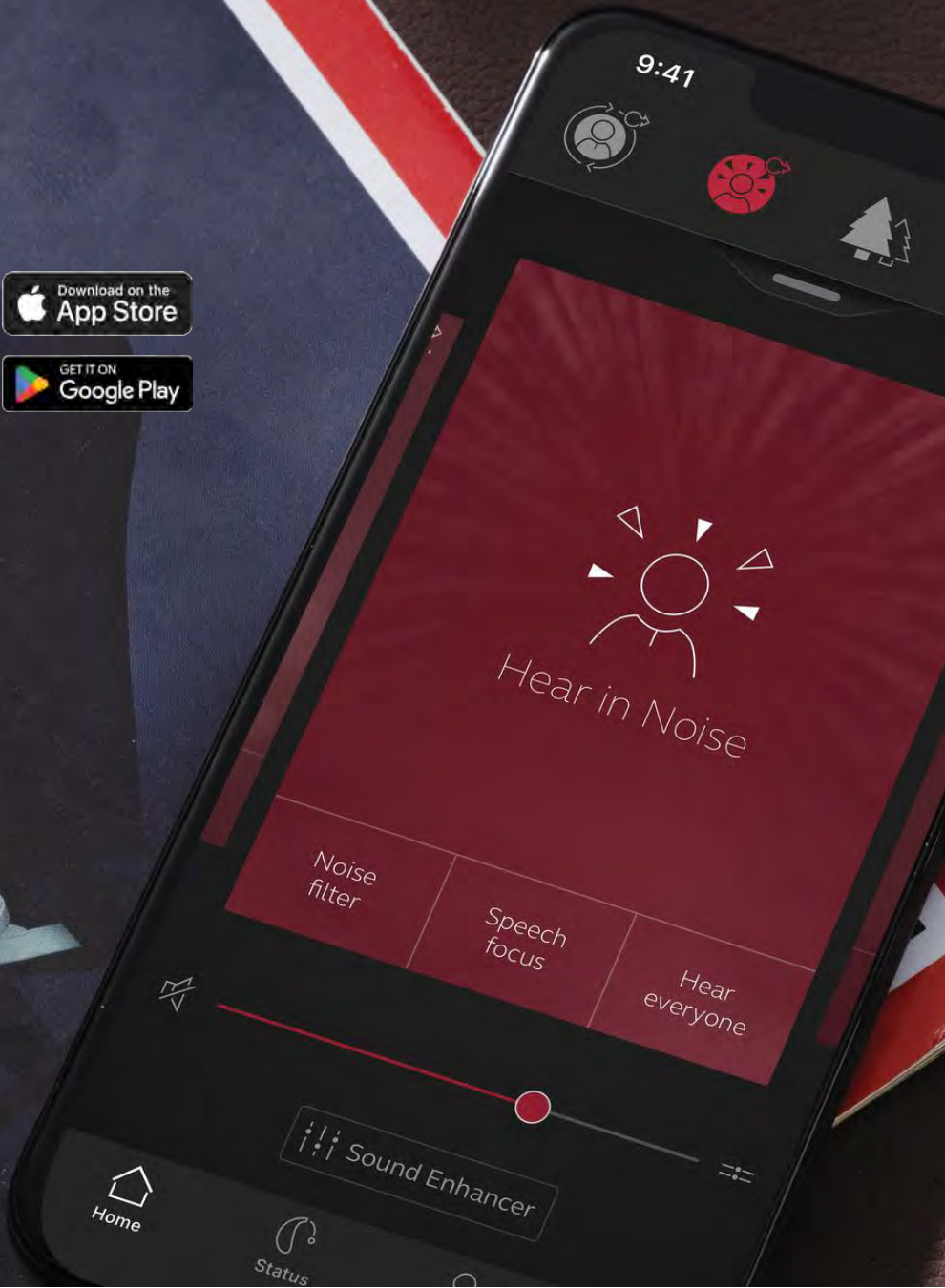
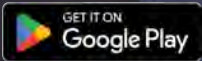
Manufacturer 5



360 All-Around is our 7th generation of directionality providing directional benefit without being cut off from the rest of the environment

OMNIA, Nexia	360 All-Around
ONE	All Access Directionality
LiNX Quattro	Binaural Directionality III
LiNX ² , LiNX 3D	Binaural Directionality II
Verso, LiNX	Binaural Directionality
Alera, Live	Natural Directionality II
Azure	Natural Directionality





New Hear in Noise program

For clearer guidance when using the app



Restaurant

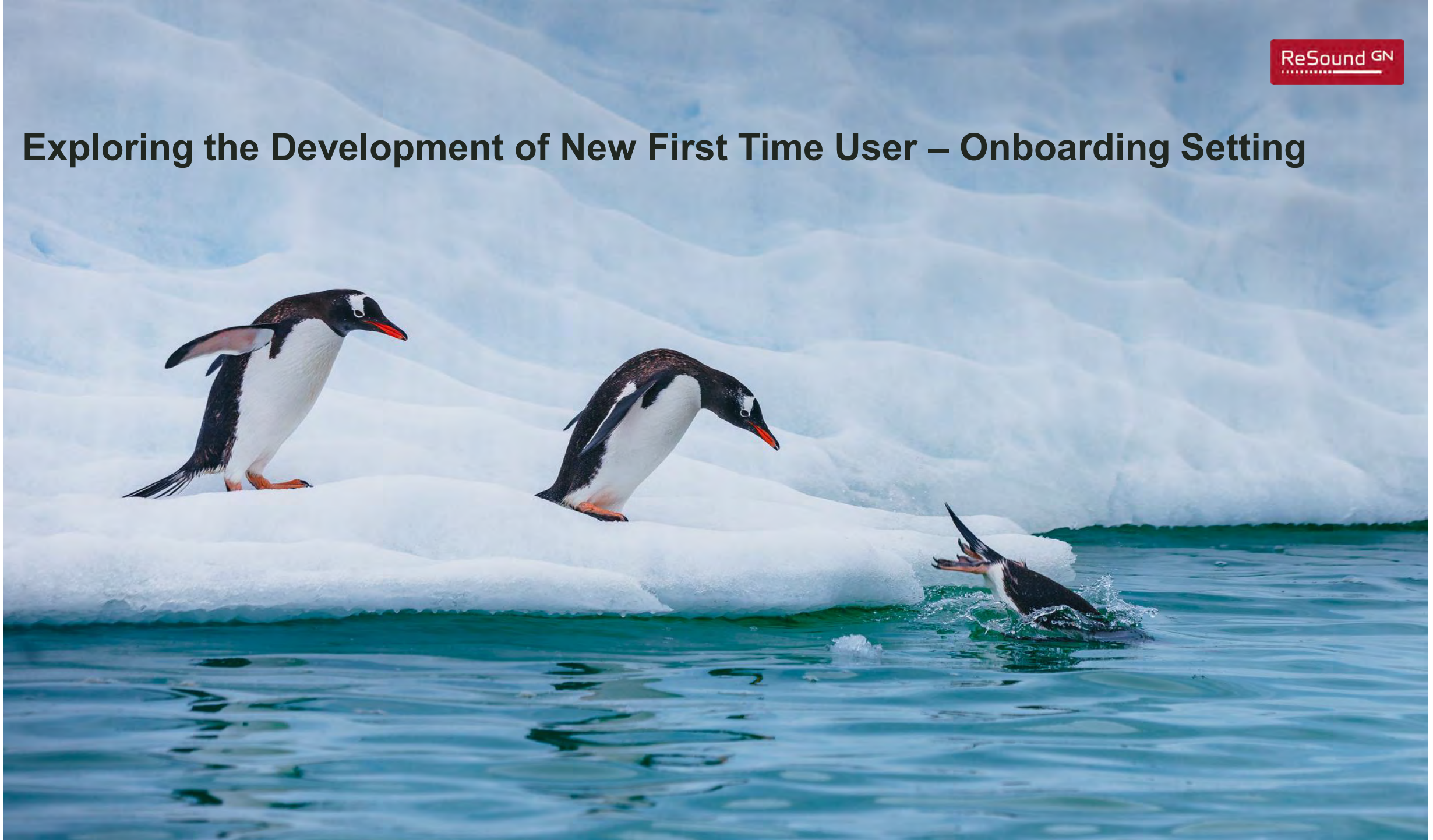


**Ultra Focus &
Front Focus**



Hear in Noise

Exploring the Development of New First Time User – Onboarding Setting



New First Fit to Optimize Comfort

95%

of first-time users
report challenges
getting started



Immediate acceptance is
important to acclimate



New hearing aid users
need an adjustment
period





ReSound Smart Fit 1.17

Goal: To make
onboarding your patients
easier



First Time User Study

- 11 people with no experience with hearing aids
 - Audiograms very close to the N3* standard audiogram, so same gains could be prescribed for all
 - 8 men, 3 women
 - Average age: 67 years
- Compared 3 ReSound gain settings:
 - First Time User
 - First Time User targets at 70% of prescribed gain
 - Experienced Nonlinear User at 70% of prescribed gain

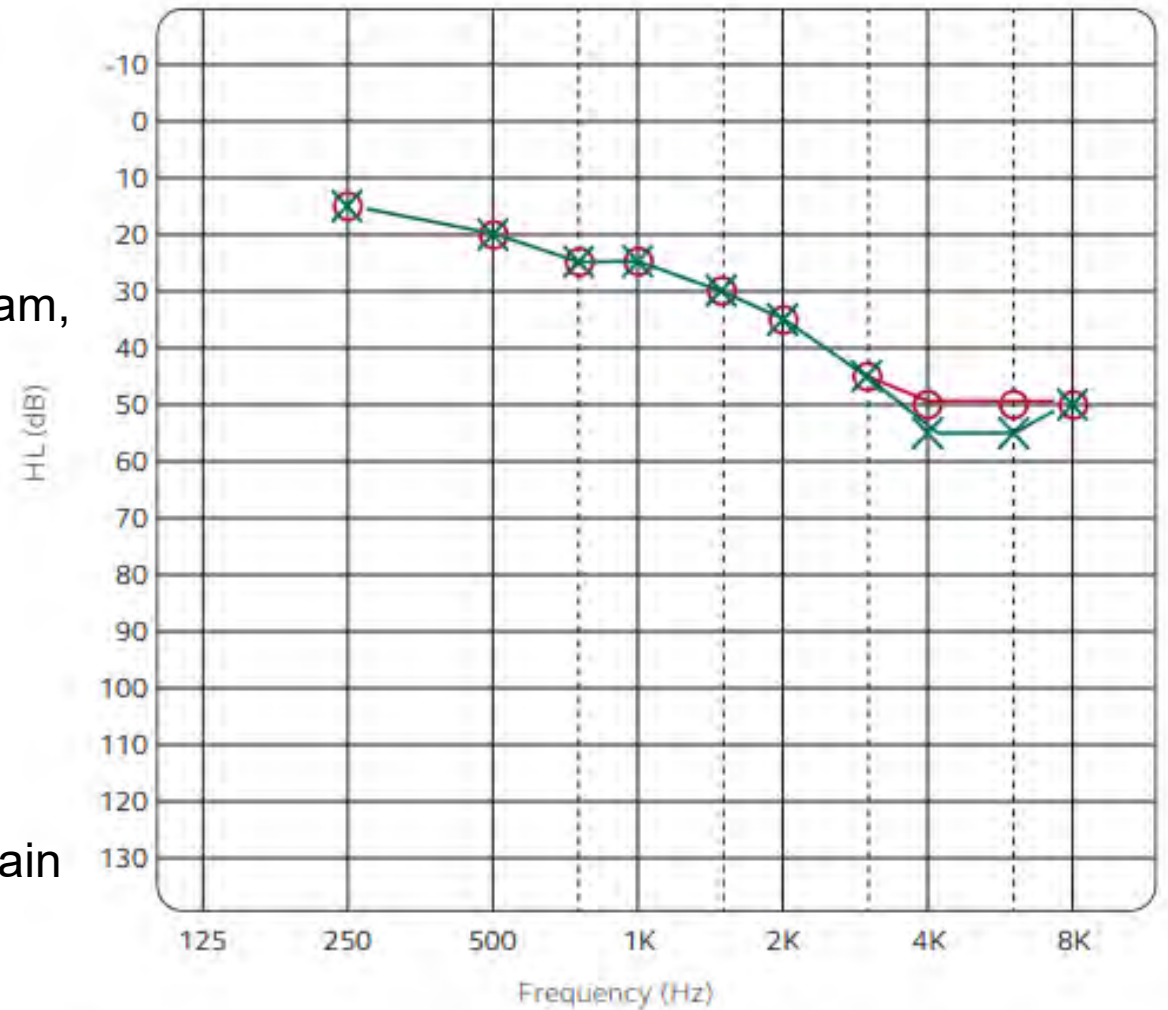


Figure 1. Average hearing threshold levels for participants in the listening test.

*Bisgaard et al., 2010

Test Box Comparison with 2 Other Manufacturers' First Time User Settings

- The First Time User targets at 70% of prescribed gain were the lowest of the three ReSound hearing aid conditions, and they were found to be most similar to the other hearing aid brands' initial fittings for inexperienced hearing aid users. As such, it was chosen as the condition for comparison with the other hearing aid brands' initial fittings.
- All hearing aids were fit bilaterally on a KEMAR in a test booth with open domes, and the feedback management system was calibrated.
- 3 sound scenarios were played over a speaker at 0 degrees azimuth relative to the KEMAR and recorded in stereo from each device.
 - Piano music
 - Diner scene
 - Single female talker
- The first 30 seconds of each recording were deleted to allow any adaptive features in the hearing aids to settle.

Listening Test with 2 Other Manufacturers' First-Time User Settings

The listening test was carried out with the stimuli presented in stereo under headphones at a comfortable listening level determined by each participant.

Listening test

Which sample of piano music is most comfortable?

A

Listen

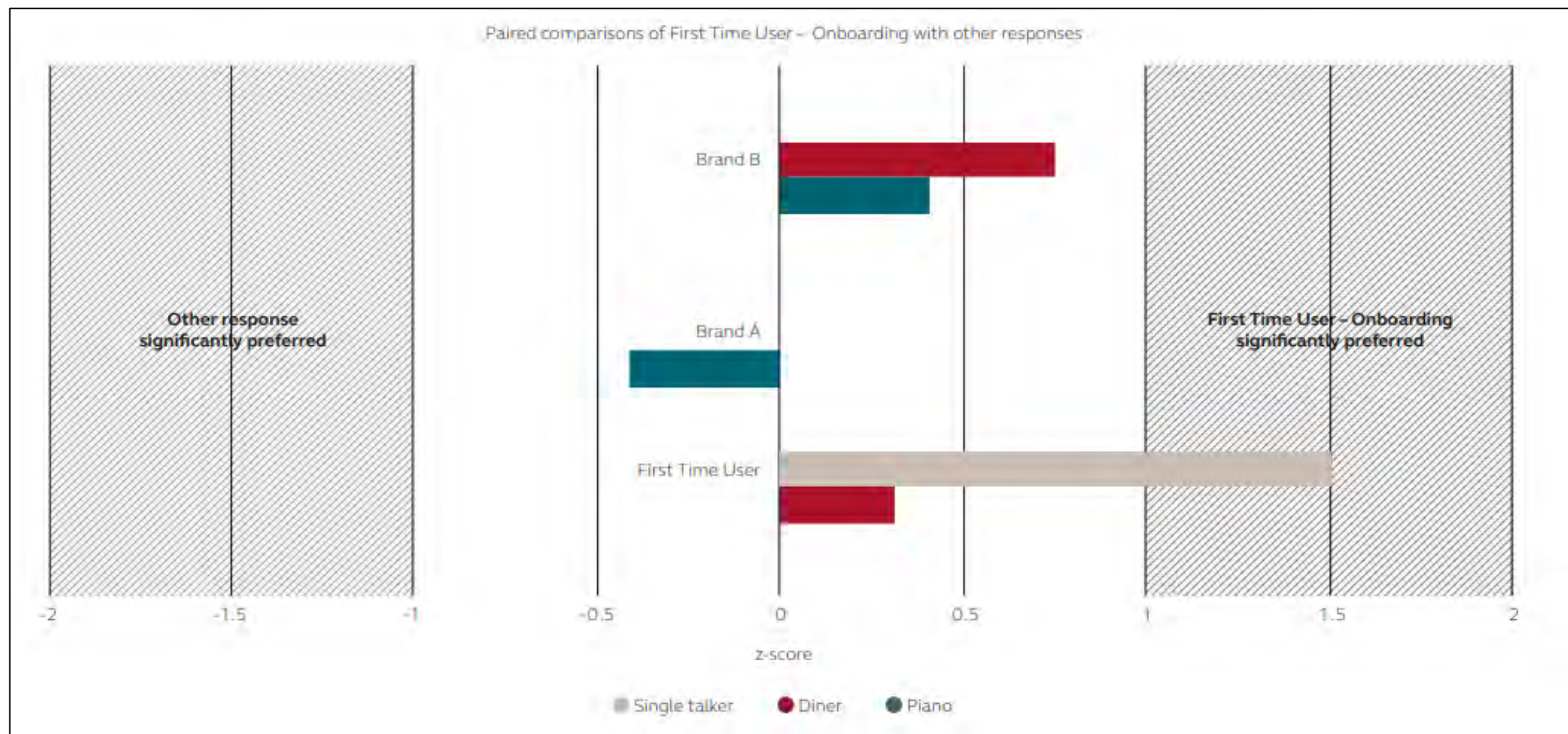
B

Listen

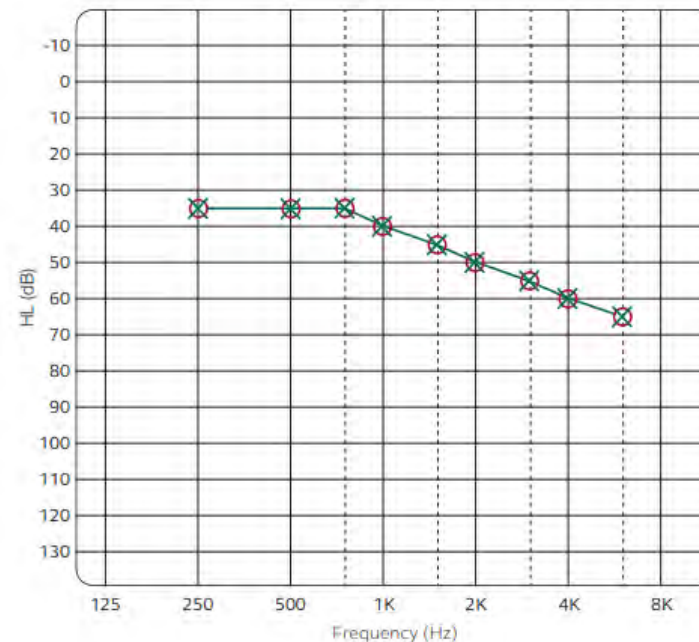
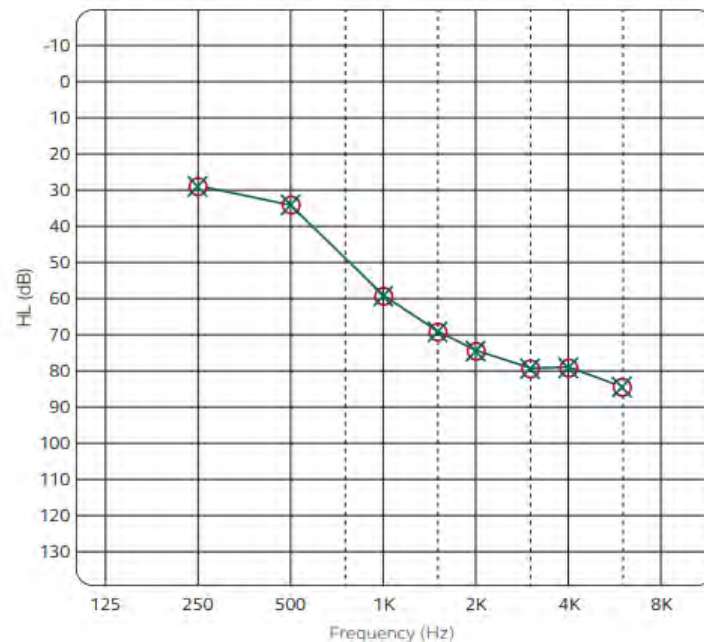
00:00

Submit

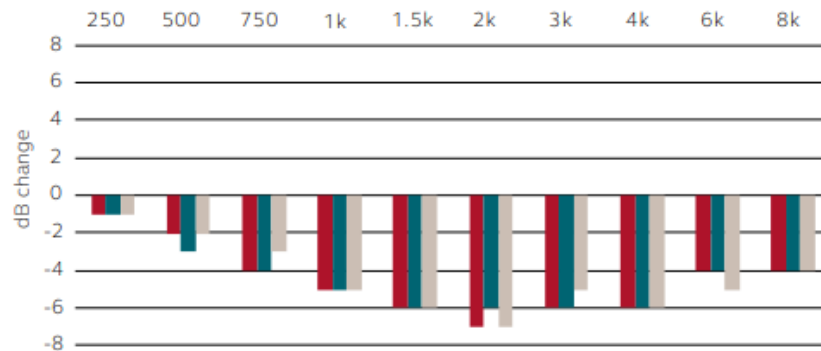
First Time User – Onboarding option was judged more positively or the same in all tests



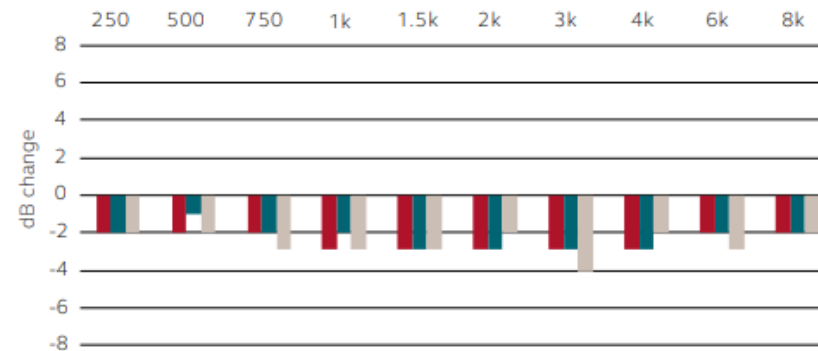
Impact on S3 and N3 Standard Audiograms



Difference between First Time User – Onboarding
and First Time User for S3 audiogram

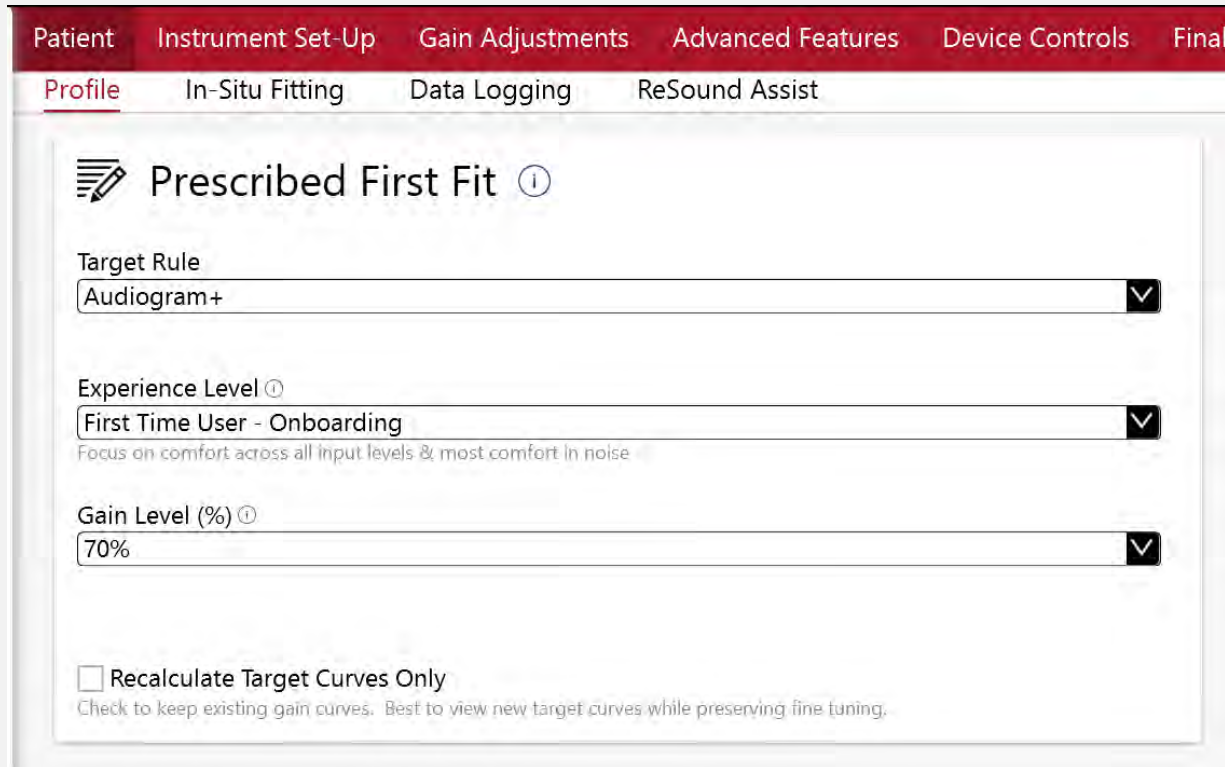


Difference between First Time User – Onboarding
and First Time User for N3 audiogram



● G50 ● G65 ● G80

New user profile for patients who prefer a more comfortable sound experience at first fit



The screenshot shows the 'Prescribed First Fit' settings in the ReSound GN software. The interface has a red header bar with tabs: Patient, Instrument Set-Up, Gain Adjustments, Advanced Features, Device Controls, and Final. Below this is a sub-header with tabs: Profile, In-Situ Fitting, Data Logging, and ReSound Assist. The 'Profile' tab is selected. The main content area is titled 'Prescribed First Fit' with an information icon. It contains three dropdown menus: 'Target Rule' set to 'Audiogram+', 'Experience Level' set to 'First Time User - Onboarding' (with a sub-note: 'Focus on comfort across all input levels & most comfort in noise'), and 'Gain Level (%)' set to '70%'. At the bottom, there is a checkbox labeled 'Recalculate Target Curves Only' with a sub-note: 'Check to keep existing gain curves. Best to view new target curves while preserving fine tuning.'

First-time User - Onboarding

Sets gain level to 70% of the First Time User, reducing overall loudness.

Sets "Impulse Noise Reduction" in Advanced Features to "moderate"

Replaces the profile "Comfort User", now with a more significant reduction in perceived loudness

A penguin is shown swimming underwater, its body angled upwards towards the left. The penguin's dark feathers are covered in water droplets, and its flippers are visible. It wears a white tracking collar with a small green light. The background is dark, with a rocky surface visible at the top. The overall scene is dimly lit, emphasizing the penguin's movement.

Diving Into a New World of More Inclusive Listening Experiences

Made for Bluetooth® Low Energy Audio and Auracast™

ReSound GN

**A new era that will make the world more hearing friendly
and accessible for everyone**



Choose language at
the Cinema



Conference venues



Public transport



Any TV you want



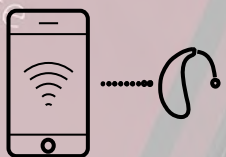
Electronic devices



Airports

Bluetooth® LE Audio

Calls and streaming from device



Direct connectivity to smartphone, tablets and computers for calls and streaming using Bluetooth Low Energy

Broadcasting



Stream sound to hearing aids using new TV streamer with Auracast technology and ready for Auracast Public Transmission

TV S



New TV-Streamer+

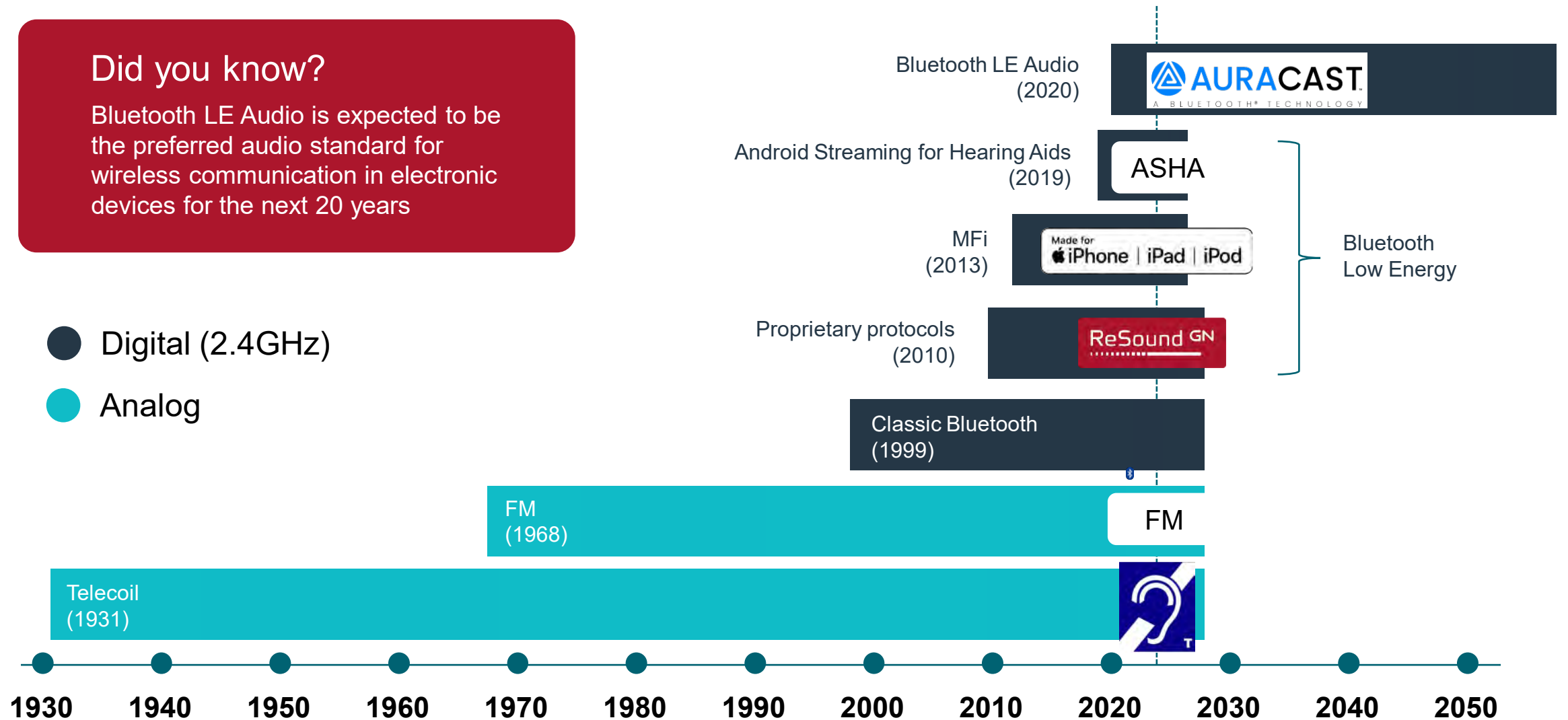
Current landscape

Did you know?

Bluetooth LE Audio is expected to be the preferred audio standard for wireless communication in electronic devices for the next 20 years

● Digital (2.4GHz)

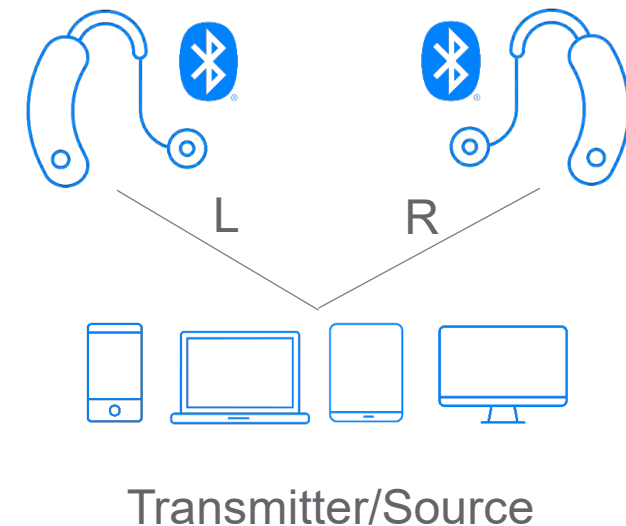
● Analog



The Solution: Standardization

Standardized Bluetooth LE Audio protocol

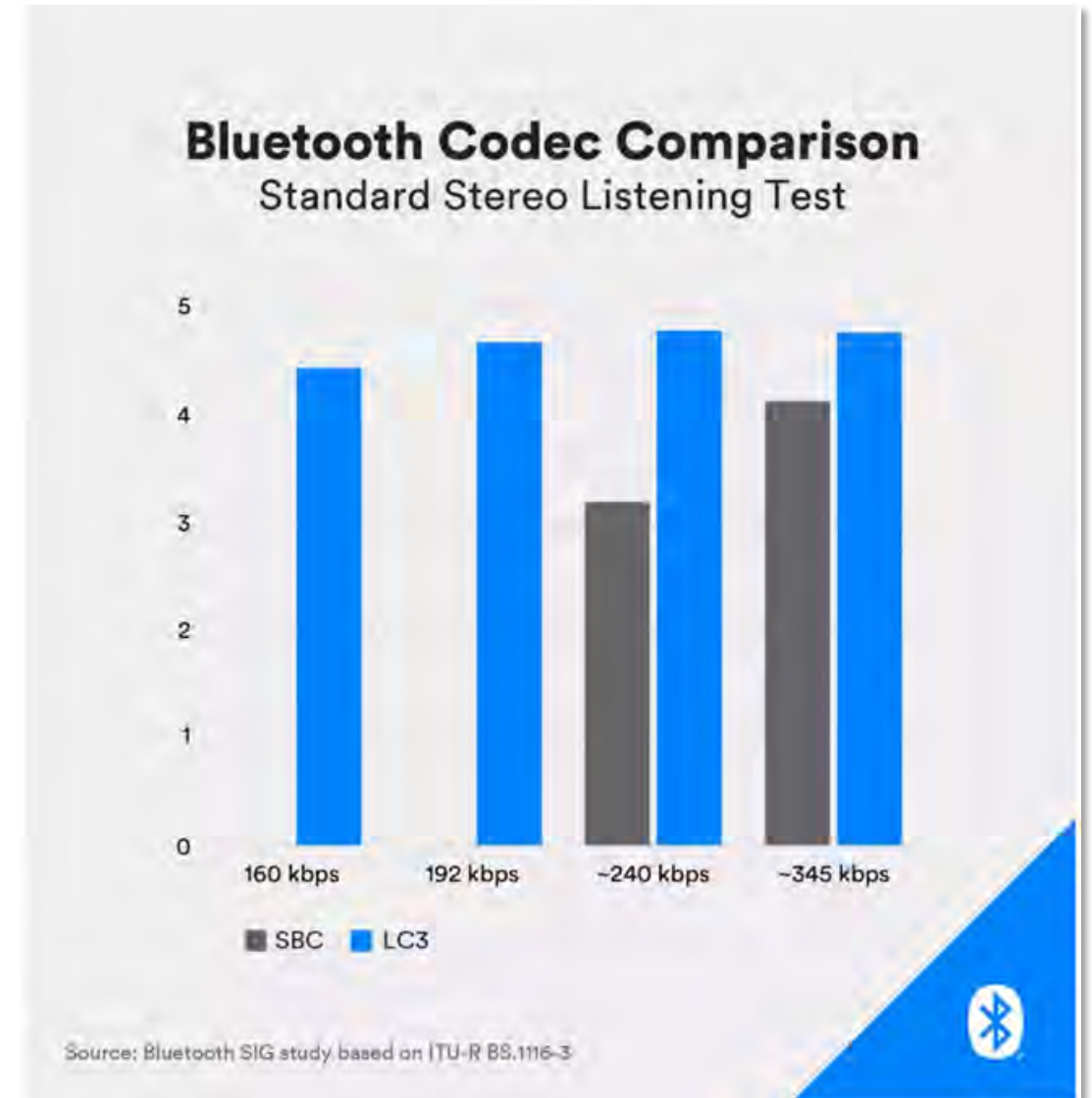
- New standardized profile for hearing aids (HAP)
- Better performance (quality, latency, power)
 - Low energy radio
 - New modern codec
 - Multi-streaming / binaural
- True, global interoperability
- More selection, choice, and accessibility



Better Sound Quality

Improved streaming audio quality at a lower bit rate

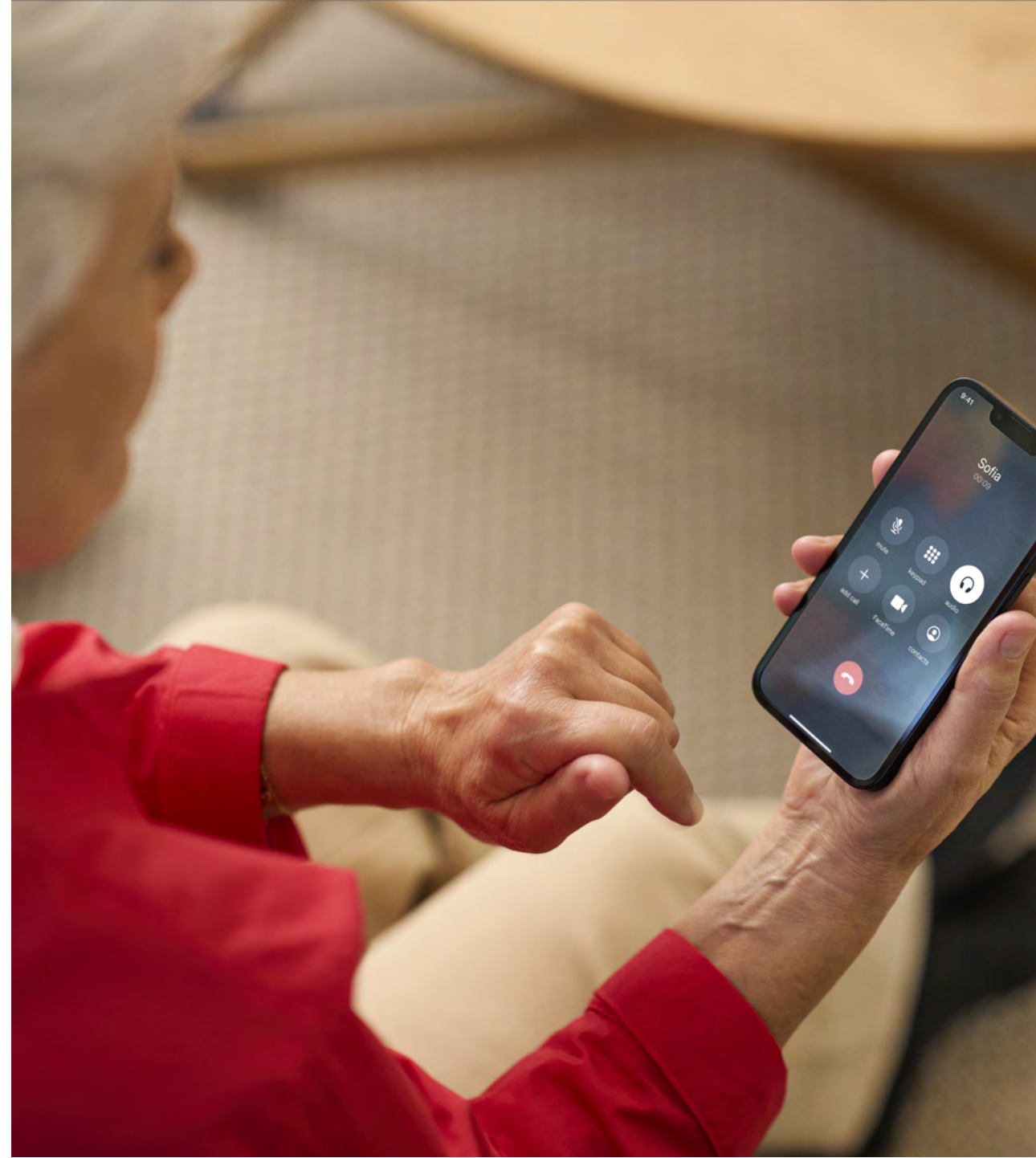
- LC3 codec will be compressing the audio
 - The degradation of audio quality will be imperceptible
 - Lower latency than any other form of Bluetooth®



Reduction In Battery Drain

Great news!

- Significant for end users who wear and/or rely on hearing aids all day
- Severe to profound losses
- 15-18 hours a day users
- Wireless transfer rate will be cut in $\frac{1}{2}$



Bluetooth[®] LE Audio for all

Auracast[™] broadcast audio is a Bluetooth[®] capability that will deliver great audio experiences for everyone - enhancing the way you engage with others and the world around you.



Share Your Audio

Shared listening and watching
from your personal device



Hear Your Best

Public address and
assistive listening



Unmute Your World

Public TV watching or immersive
digital signage

Thanks For Diving Into Research With Me!

Questions, or ... Deep Thoughts?



ReSound Nexia

Next-era Hearing



Top-rated for hearing in noise.
Smaller than ever. Ready for
Auracast™. And...

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