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How to Navigate Naturally in a Noisy World

Tammy Stender, AuD, CCC-A

Learning Outcomes

1) Explain why it is so important for people to navigate as naturally as possible in the diverse and noisy listening situations we encounter on a daily basis.

2) Describe the three main technological advancements of ReSound directionality introduced in ReSound OMNIA.

3) Detail how a multiband directionality approach provides a myriad of benefits for a user to hear as naturally as possible, for their own voice as well as for all the sounds around them.

One of the biggest innovation challenges the industry faces is:

hearing in noise

BIHIMA Surveys Audiologist Panel on Issues Facing Hearing Industry, Jun 2019

hearing in noise

80% Of hearing aid users still challenged by hearing in noise*

Experienced users **struggle to find solutions that allow them to participate in conversations** without compromise or workarounds**

- *MarkeTrak 10, 2019*
- *** Fidelity Study – Barriers and Triggers, 2021*

What Do We Know about Hearing in Noise from Hearing Aid Users?

- Hearing aid performance including hearing in noise was the number 1 driver of hearing aid satisfaction and the biggest unmet need was sound issues including background noise.

(MarkeTrak 10, Picou, 2020)

What Do We Know about Hearing in Noise from Hearing Aid Users?

- Over 2000 current hearing aid users ranked hearing in noise as the most important attribute when purchasing a hearing aid.

(Manchaiah et al., 2021)

What Do We Know about Hearing in Noise from Hearing Aid Users?

- Hearing-in-noise came in last when respondents were asked to rate 17 listening situations with regard to hearing aid satisfaction (n= 536)

(EuroTrack, 2018)

Based on These Studies, Our Focus is Naturally…

Developing Better Technology for Hearing-in-Noise

To Help Individuals Navigate Naturally in a Noisy World

Introducing ReSound OMNIA

GN Making Life Sound Better

Feels natural

Adapts organically to the person for best wearing comfort all day long and ease of use

Sounds natural

Emulating both the natural hearing process and the natural way we listen as closely as possible, helping the brain to hear as nature intended

Connects users naturally

Inspired by the way we intuitively interact with other devices

Organic Hearing

Sounds natural, feels natural, and connects you naturally to the world

ReSound OMNIA
sounds natural…
But What IS Natural?

Spatial Cue Preservation

Binaural Listening

Speech Intelligibility

Spatial Cue Preservation Strategy: When You Need to Hear Around You

Binaural Listening Strategy: When You Want to Focus AND Maintain Awareness

Speech Intelligibility Strategy: When Understanding is Most Important

ReSound GN

GN Making Life Sound Better

Spatial Cue Preservation

Binaural Listening

Speech Intelligibility

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

360 All-Around

How Does ReSound 360 All-Around Achieve This Goal?

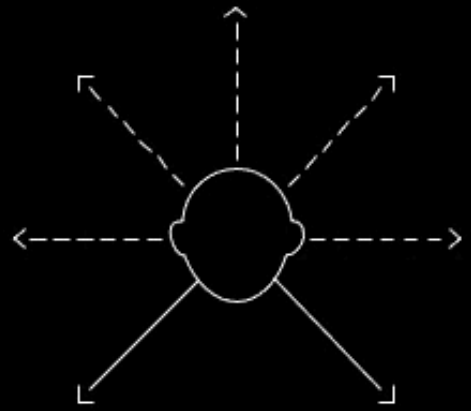
Widening our sound environment mapping

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

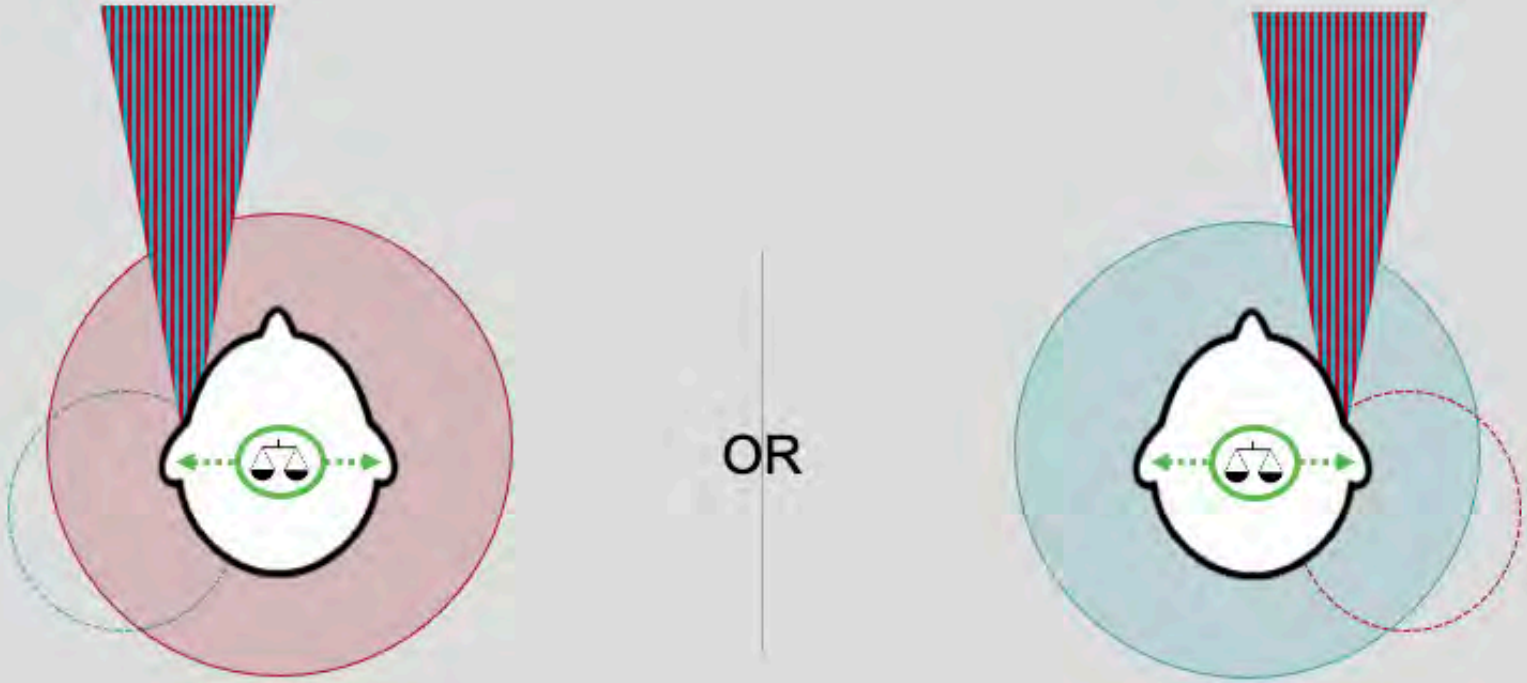
ReSound GN



Widening our sound environment mapping

Widening our sound environment mapping

360 All-Around



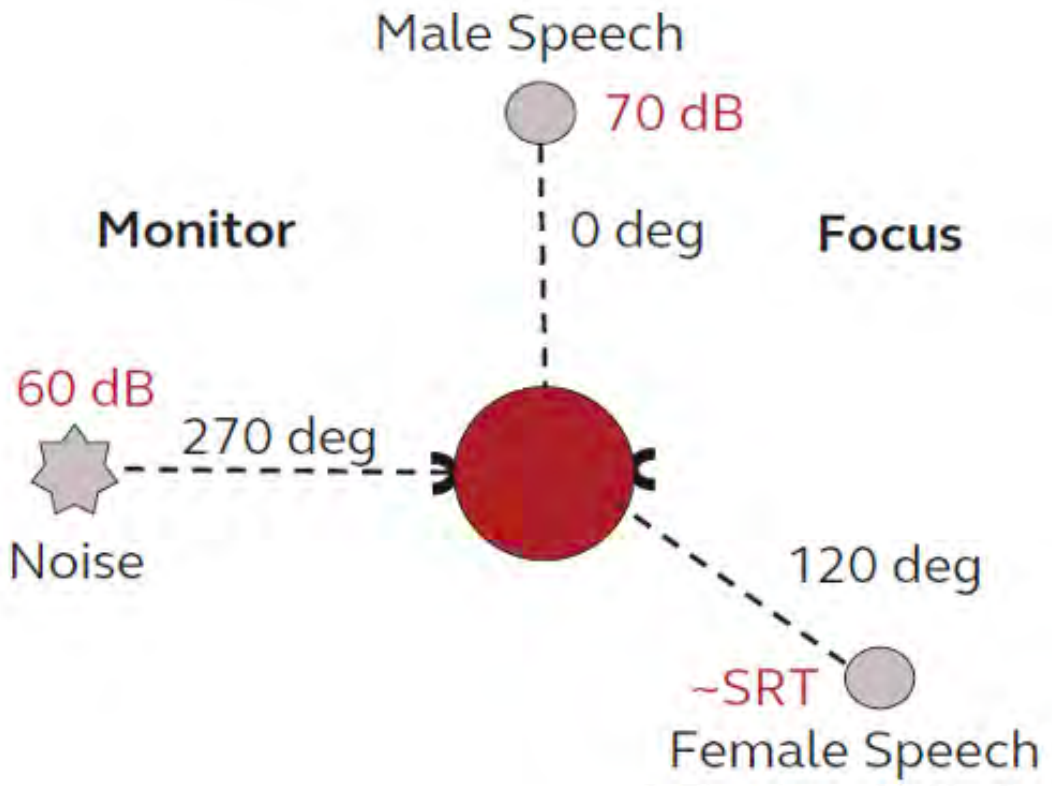
360 All-Around, when in Binaural Listening mode, streams the off-axis sound from the directional side to the omnidirectional side, providing more auditory awareness in difficult environments (like a popular café)

When Do You Want Multiple Strategies Available?

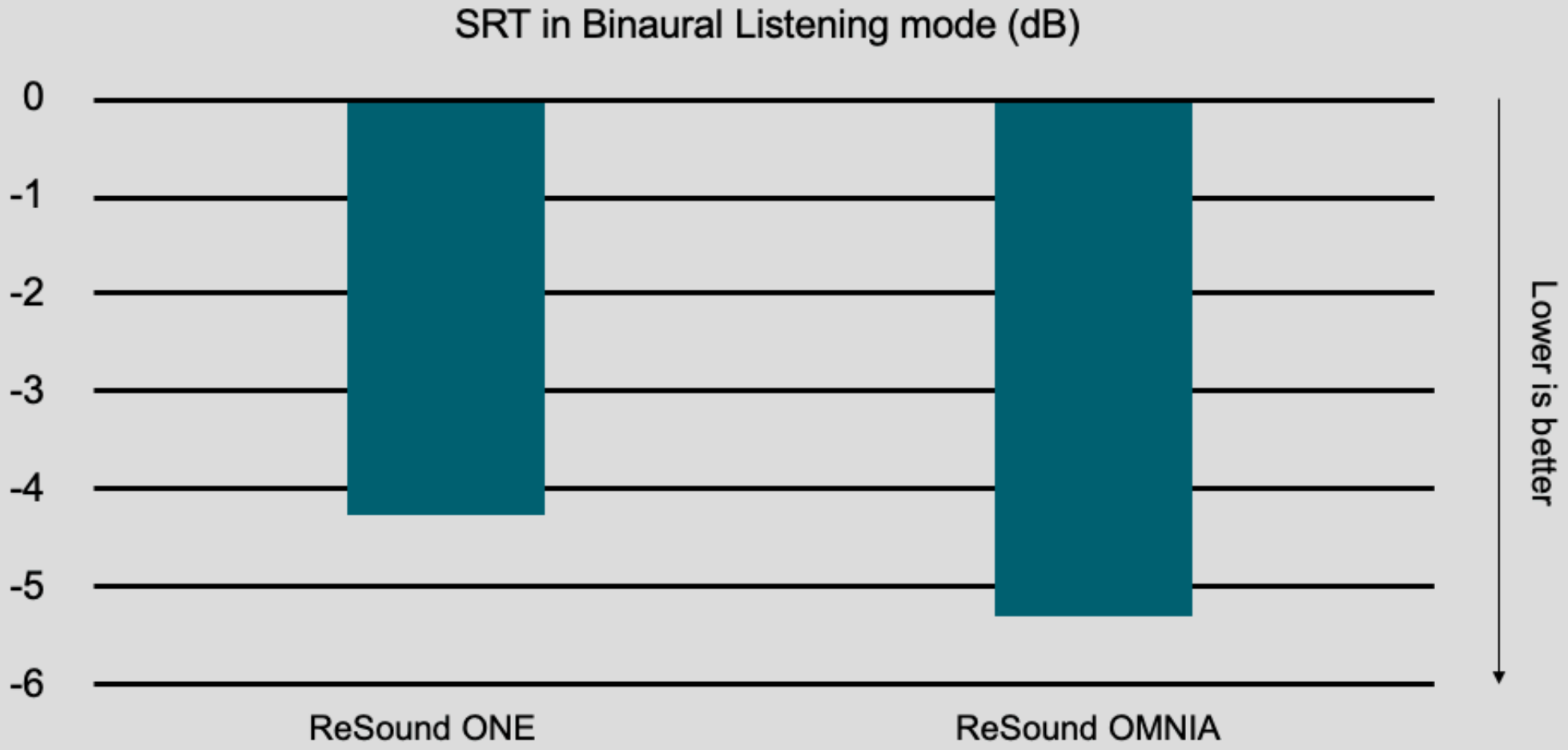
Café or other complex listening situation

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!

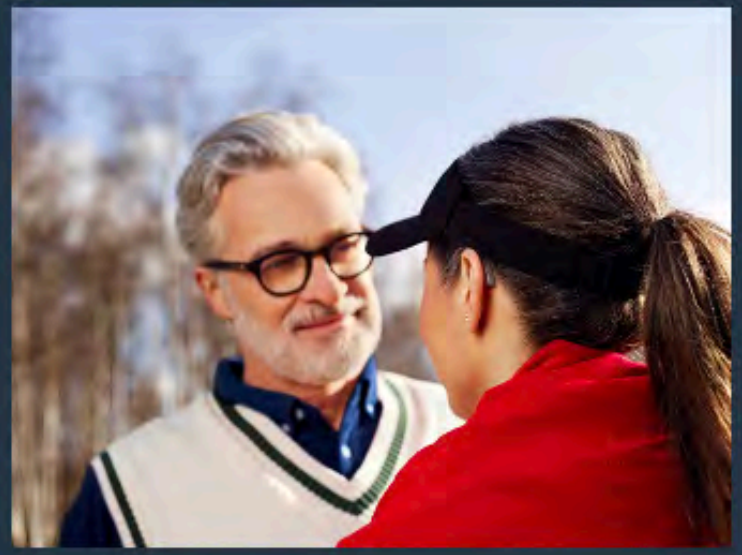


Widening our sound environment mapping



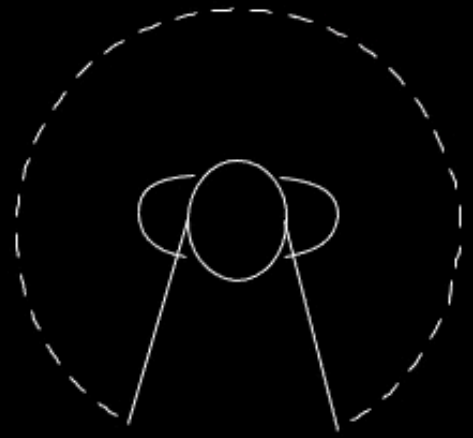
Speeding up our processing and steering for faster mode detection and selection

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



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

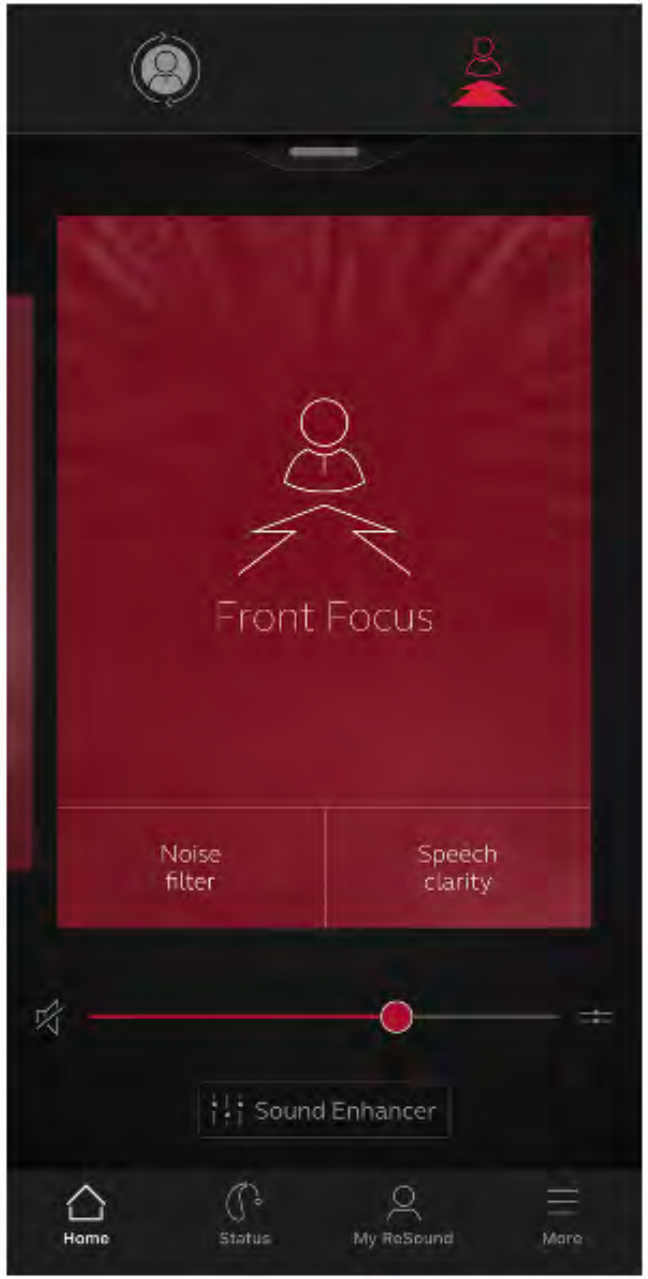
ReSound GN



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!



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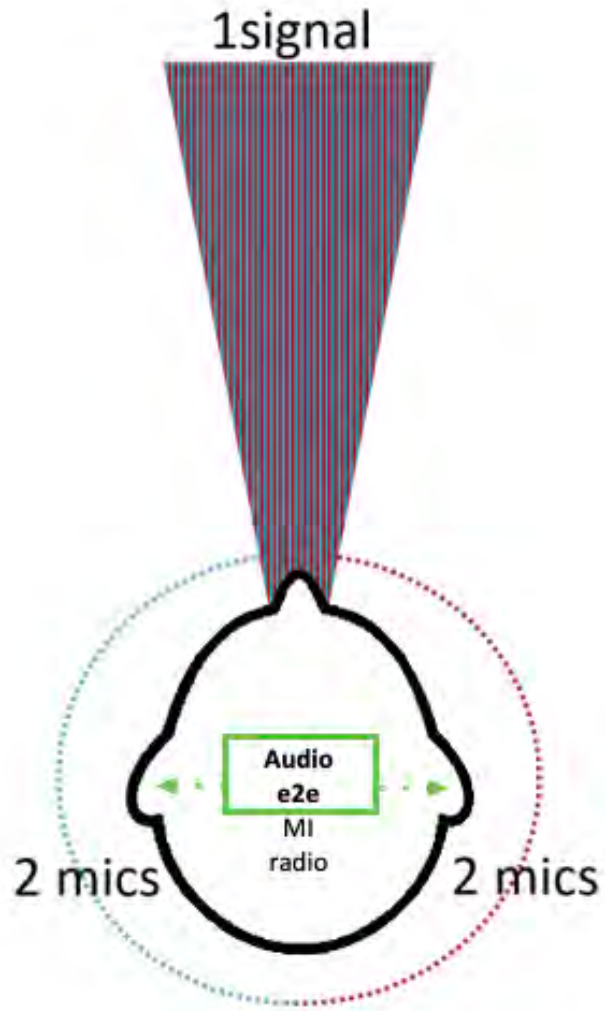
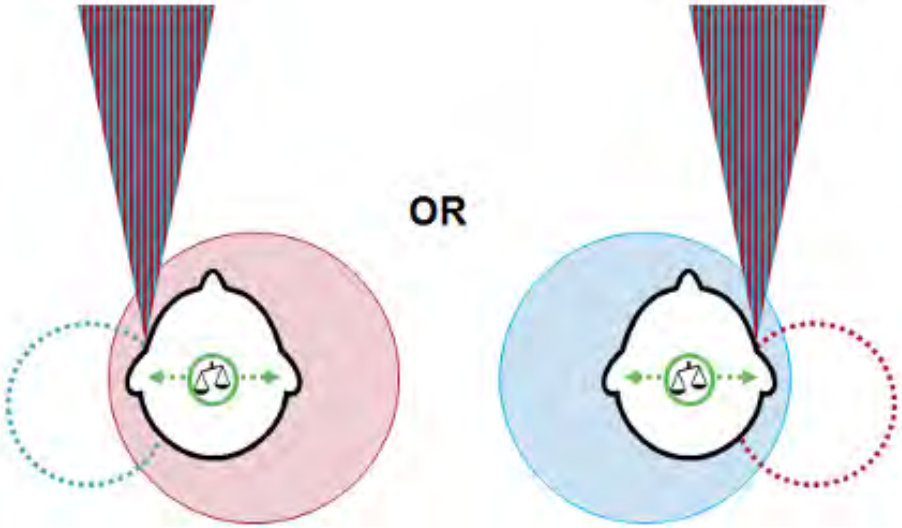
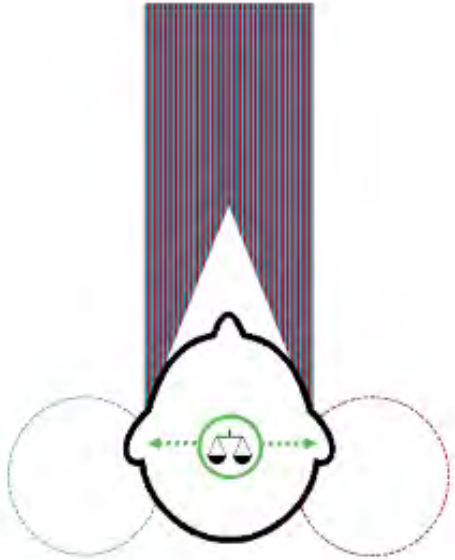
ReSound Binaural Beamforming Directionality – with Weighting to Help Users Hear Better in Difficult Noisy Situations



Applied in Binaural Listening Strategy

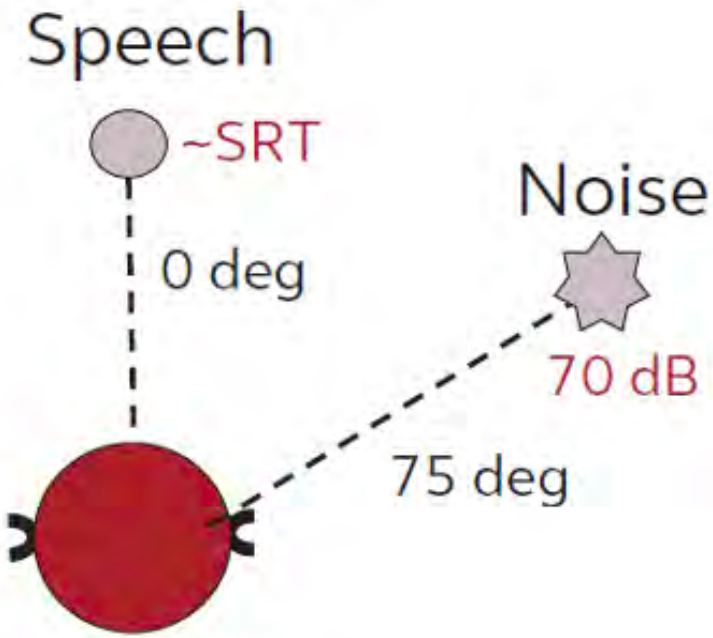


Applied in Speech Intelligibility Strategy and Front Focus Program



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!



Although there was little separation of the speech and noise, making it a difficult test, results revealed ceiling effects; both beamformers performed well!

To avoid ceiling effects and to truly validate the beamforming directionality, task was made **more** difficult, by applying a bandpass to the speech and noise from 500-4000 Hz.

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

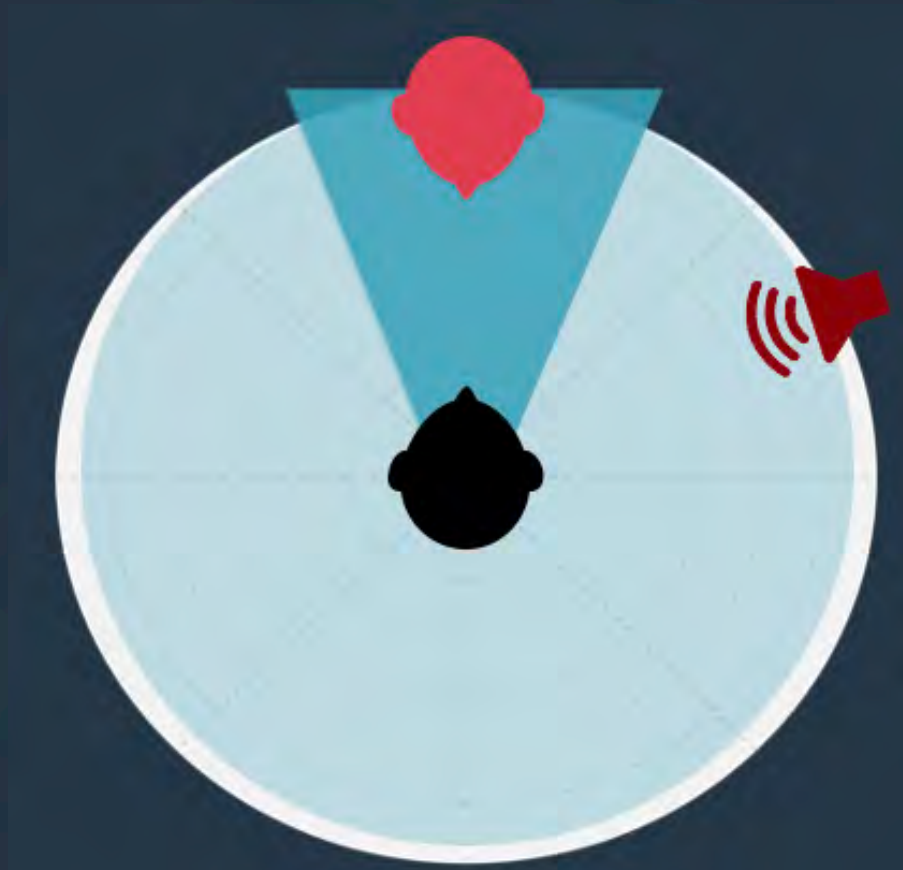
Omnidirectional

Ultra Focus

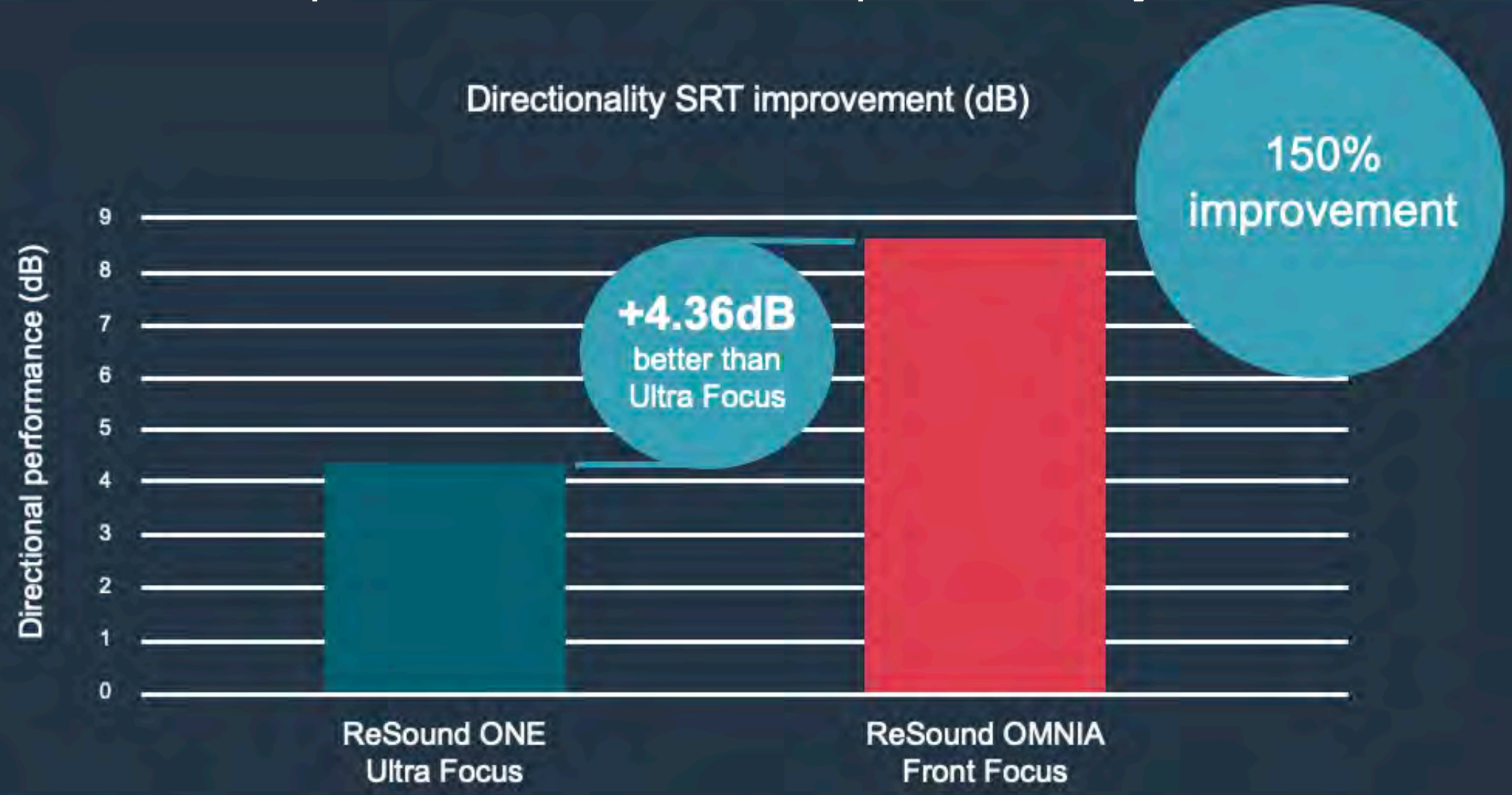
+4.25dB
better than omni

Front Focus

+8.61dB
better than omni



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



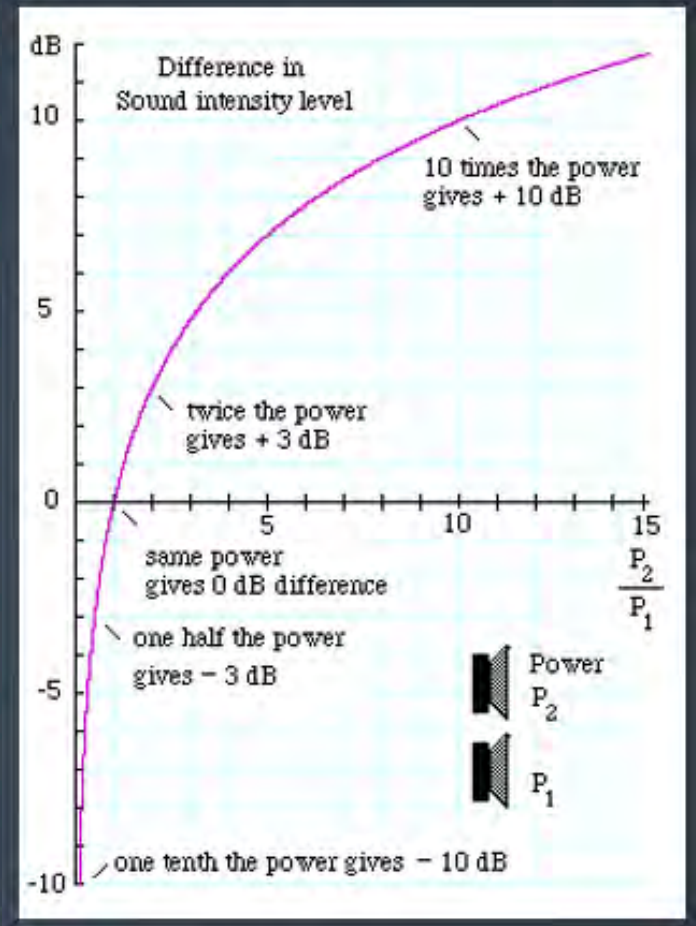
What is a Doubling of Intensity Equal in Decibels?

60 dB

+

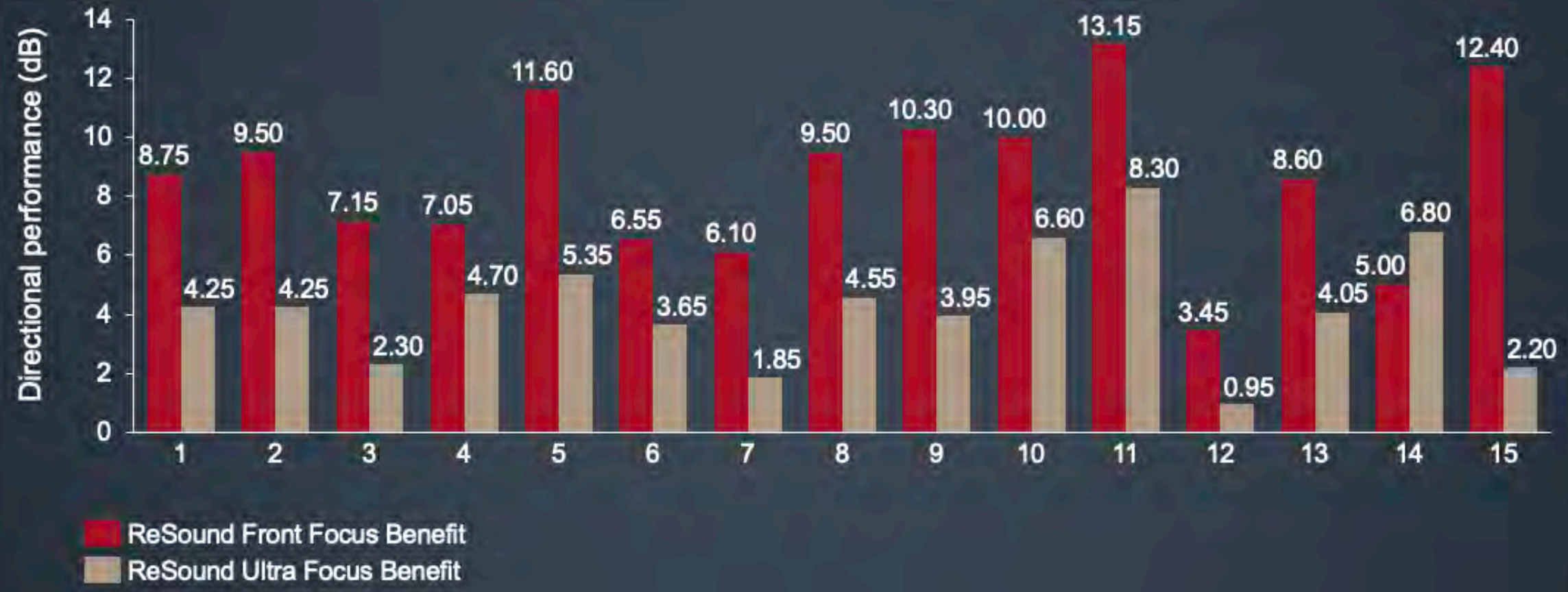
60 dB

= 63 dB



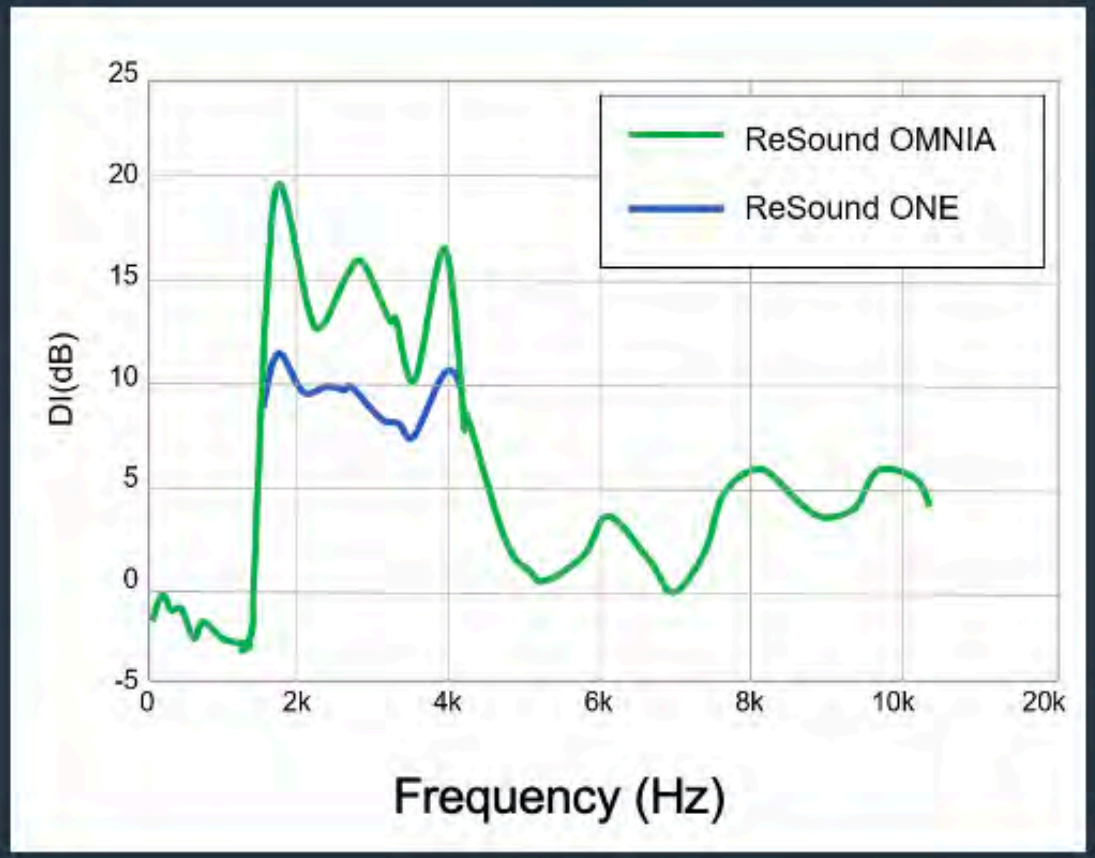
Thus, 4.5 dB represents ~150% better performance.

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



* Jespersen et al (2022)

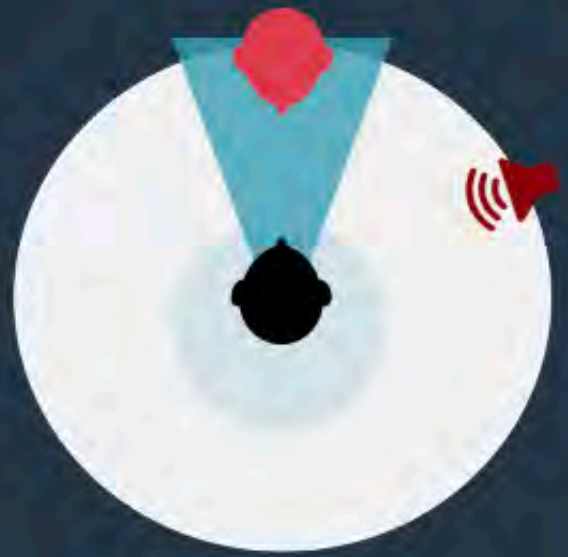
Improvements to the binaural beamformer, providing even more precision for our best speech clarity



Ultra Focus

+4.25dB

better than omni



Front Focus

+8.61dB

better than omni

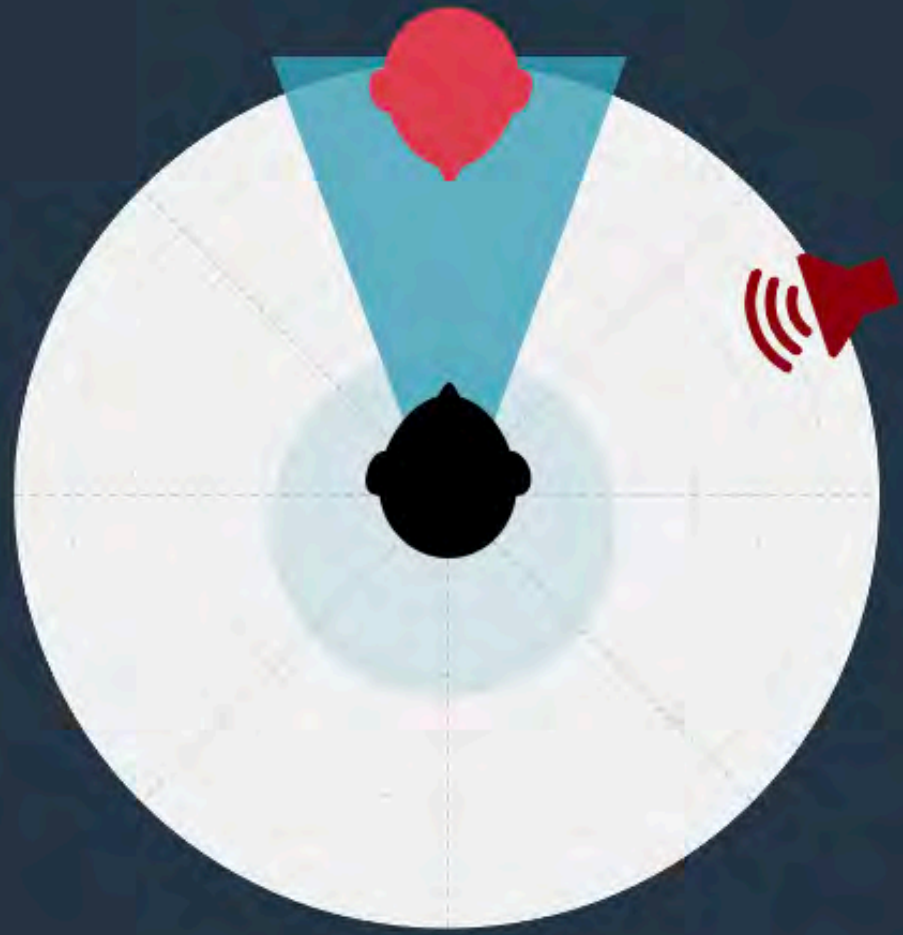
Better optimized for the head-related transfer function = better precision for better clarity

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!

The ONLY difference may be the Directional Mix setting (crossover frequency between omnidirectional and directional processing)



Navigating Naturally in a Noisy World

ReSound GN

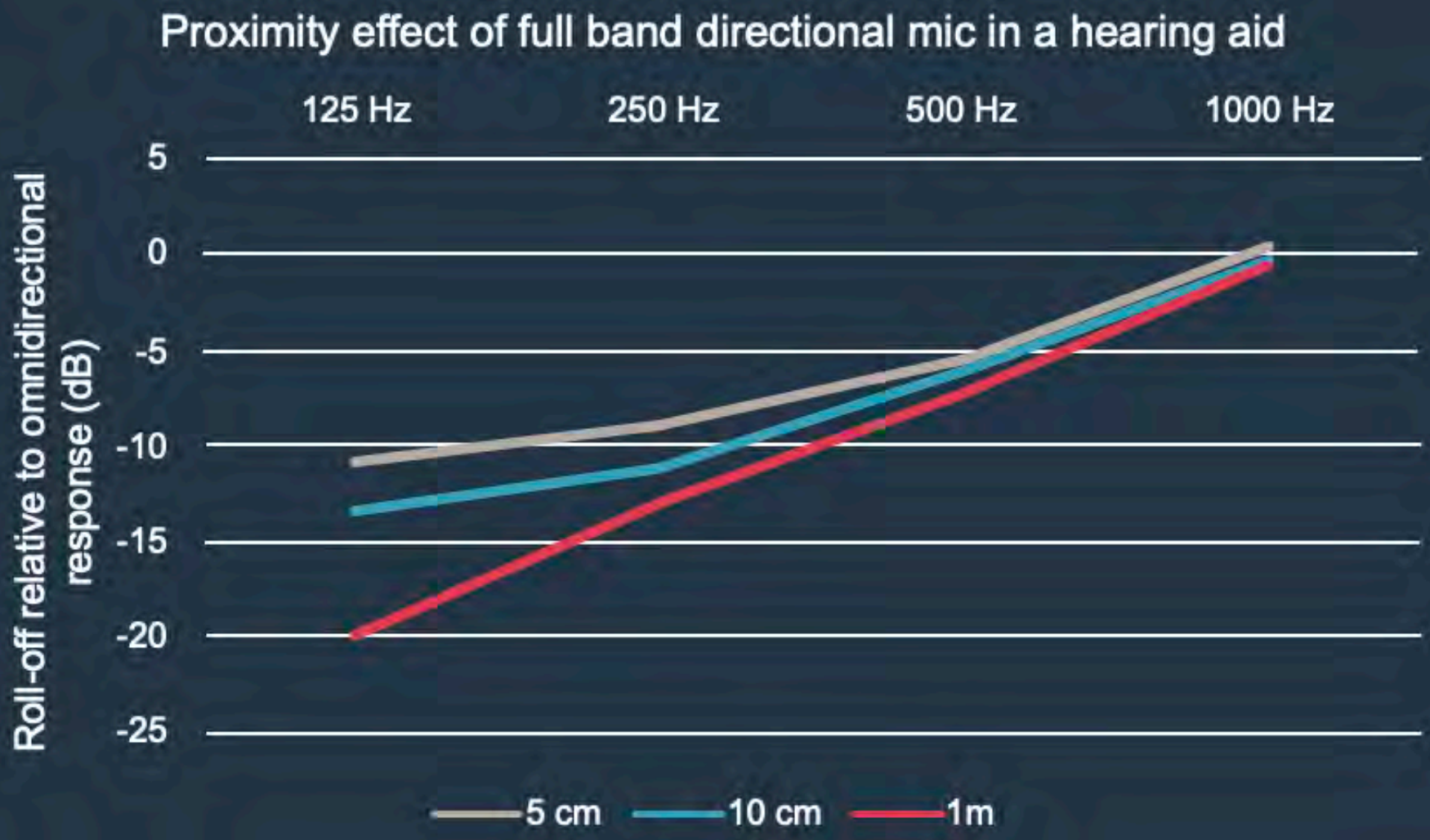
Scorecard

Hearing Others' Speech Well in Noise 

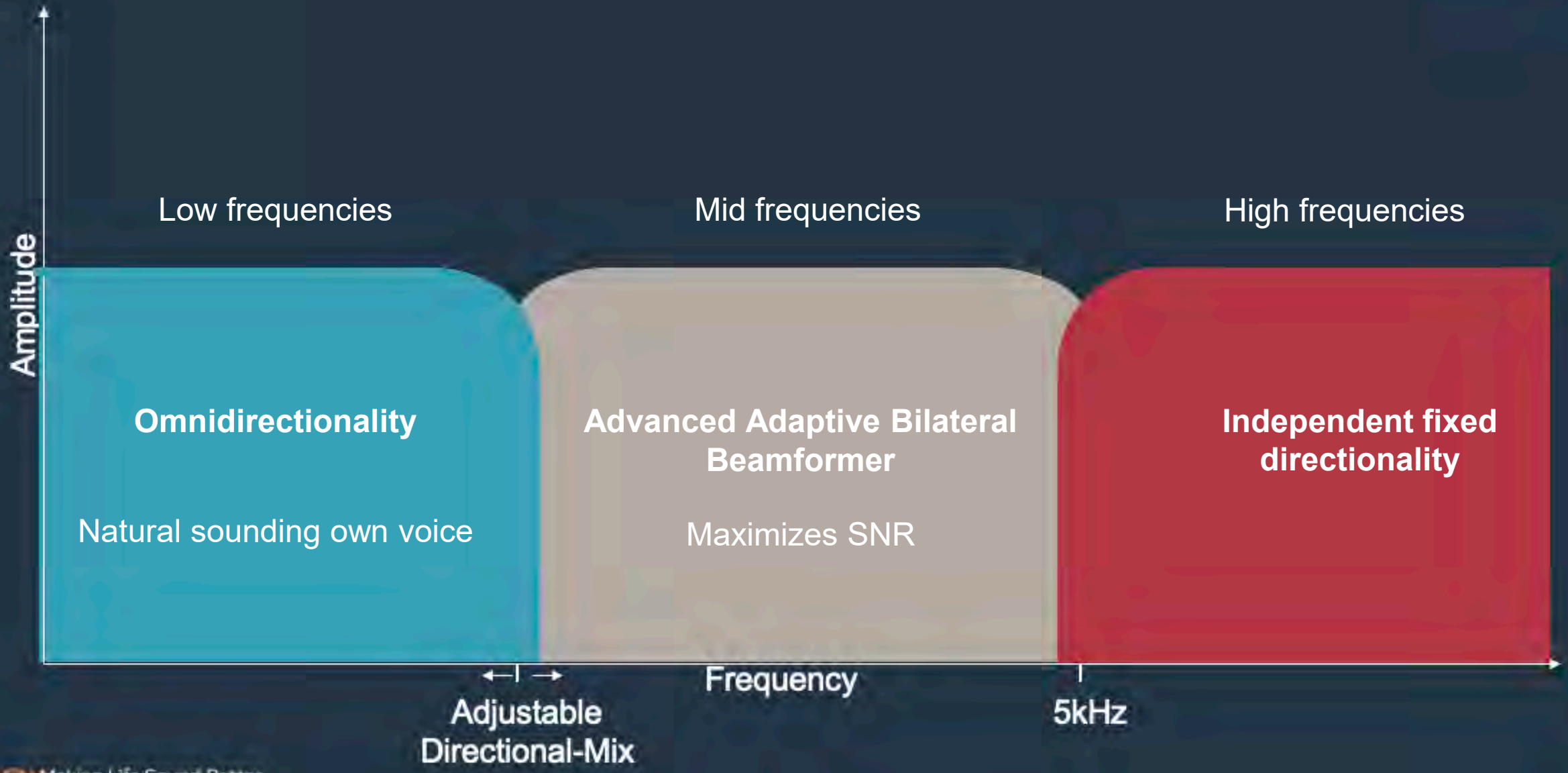
Hearing *Your Own* Speech in Noise 


ReSound GN
OH NO!

Sound Like Yourself



ReSound Multiband Directional Processing



Navigating Naturally in a Noisy World

ReSound GN

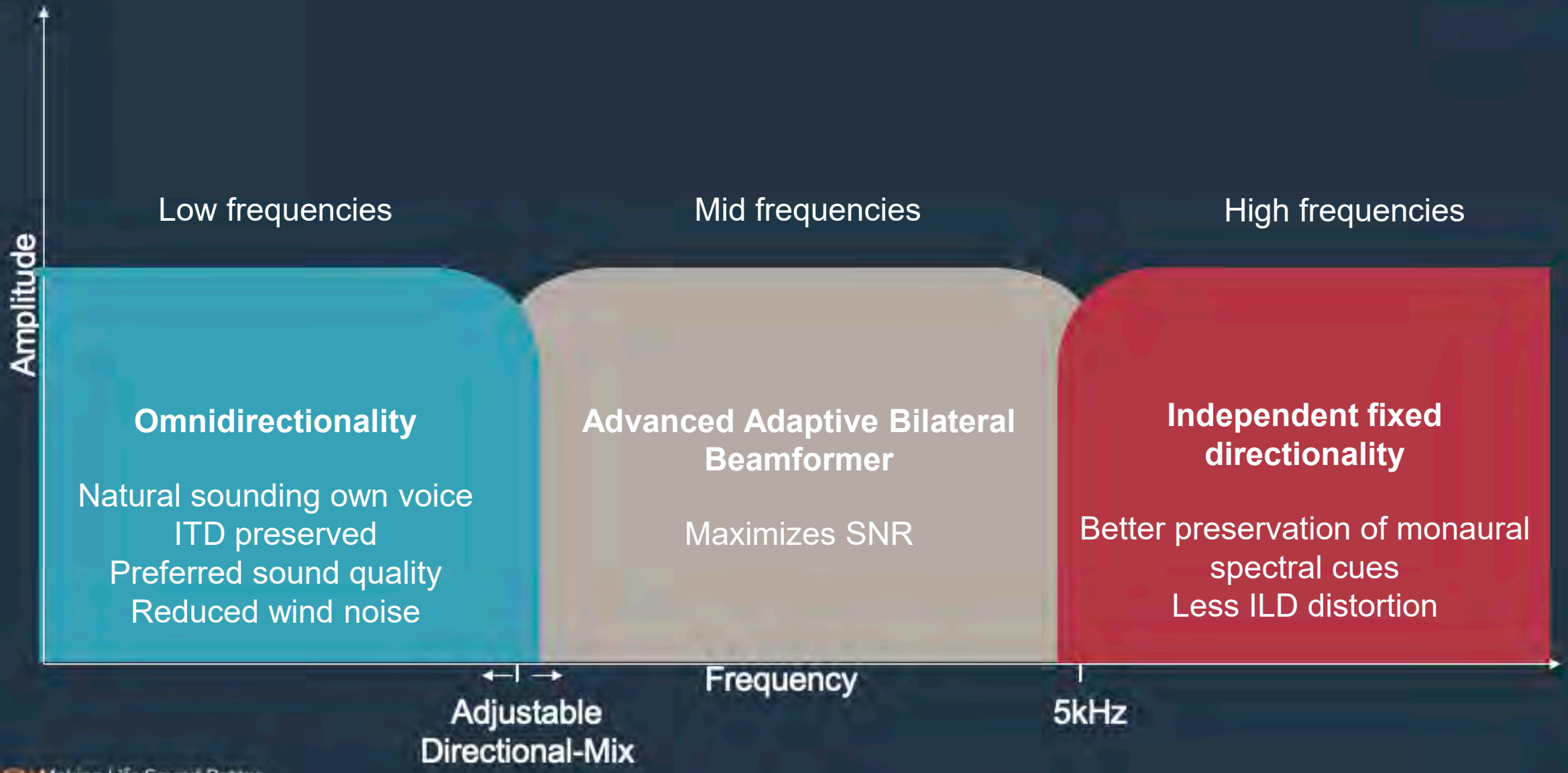
Scorecard

Hearing Others' Speech Well in Noise 

Hearing *Your Own* Speech in Noise 

Comfortable Navigation in Noise ?

Other Benefits of ReSound Multiband Directional Processing: Sound Quality and Spatial Hearing



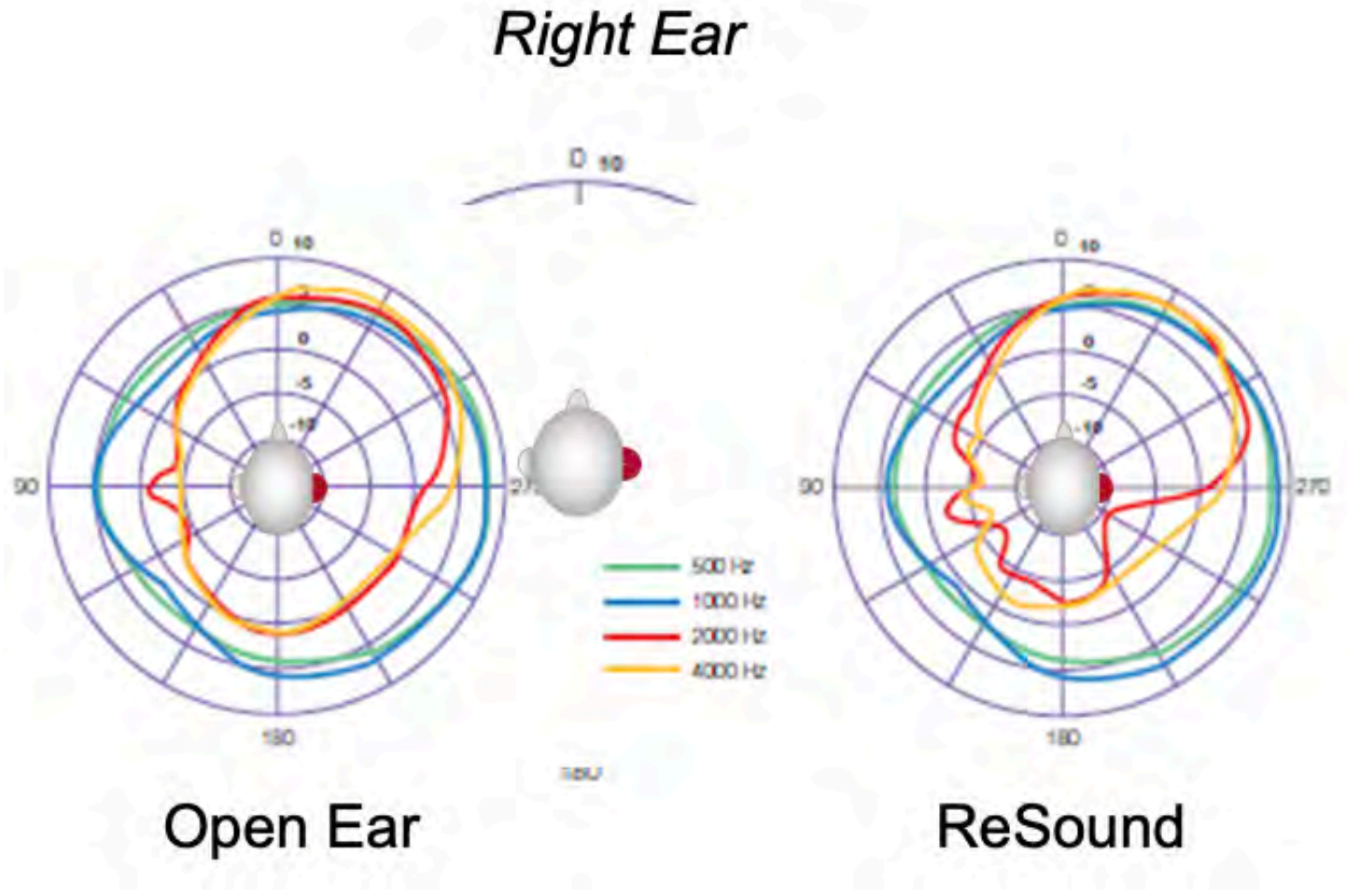
Head-Related Directional Characteristics: Impact on Localization Cues

Low frequencies travel around the head with limited intensity changes, in an omnidirectional pattern

- Interaural Timing Difference (ITD) cues, as sound waves travel around the head

High frequencies are affected by head shadow and are more like a directional response

- Interaural Level Difference (ILD) cues, as sound waves are attenuated by head shadow



Wind Noise Mechanics

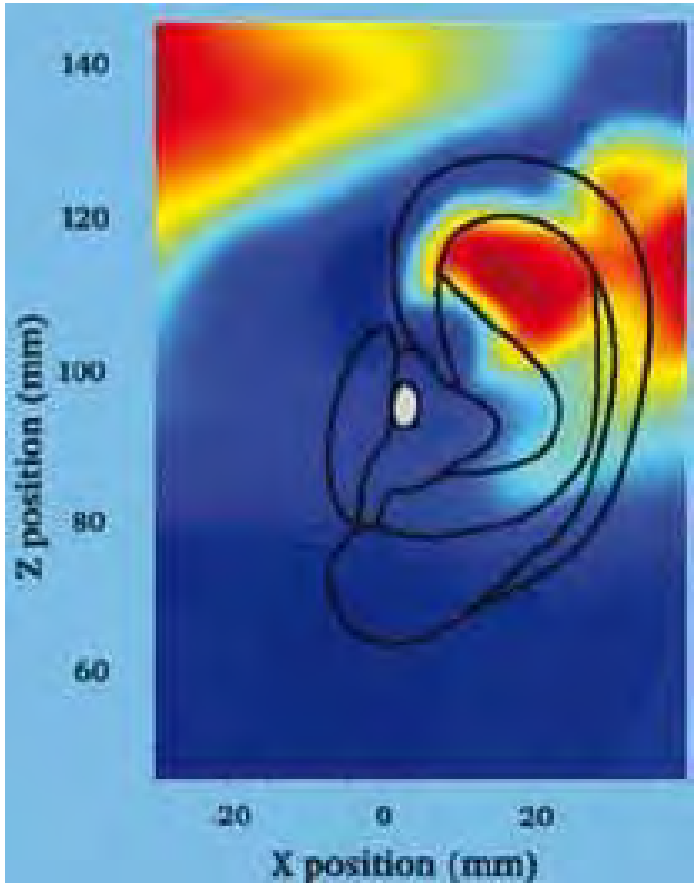
Hearing aid wind noise is caused by turbulent air flow around the microphone(s)

Results in movement of the mic diaphragm that will be amplified

- Turbulence contains pressure fluctuations, which are converted to electrical fluctuations by the mics

This amplification can overload the hearing aid, especially for **low frequencies**

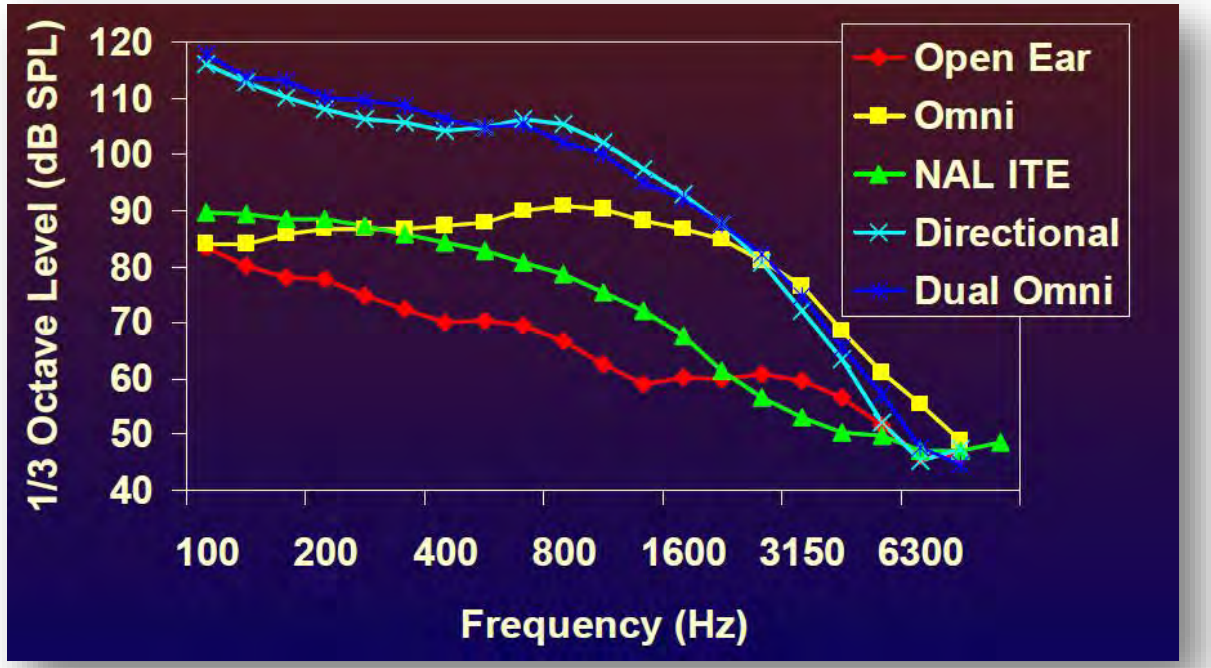
- Spectral peak of wind noise is around 100 Hz at high wind speeds (Larsson & Olsson, 2004) and tapers off around 3000 Hz



Omnidirectional Processing Helps Control Wind Noise

(Thompson, 2000; Kates, 2008)

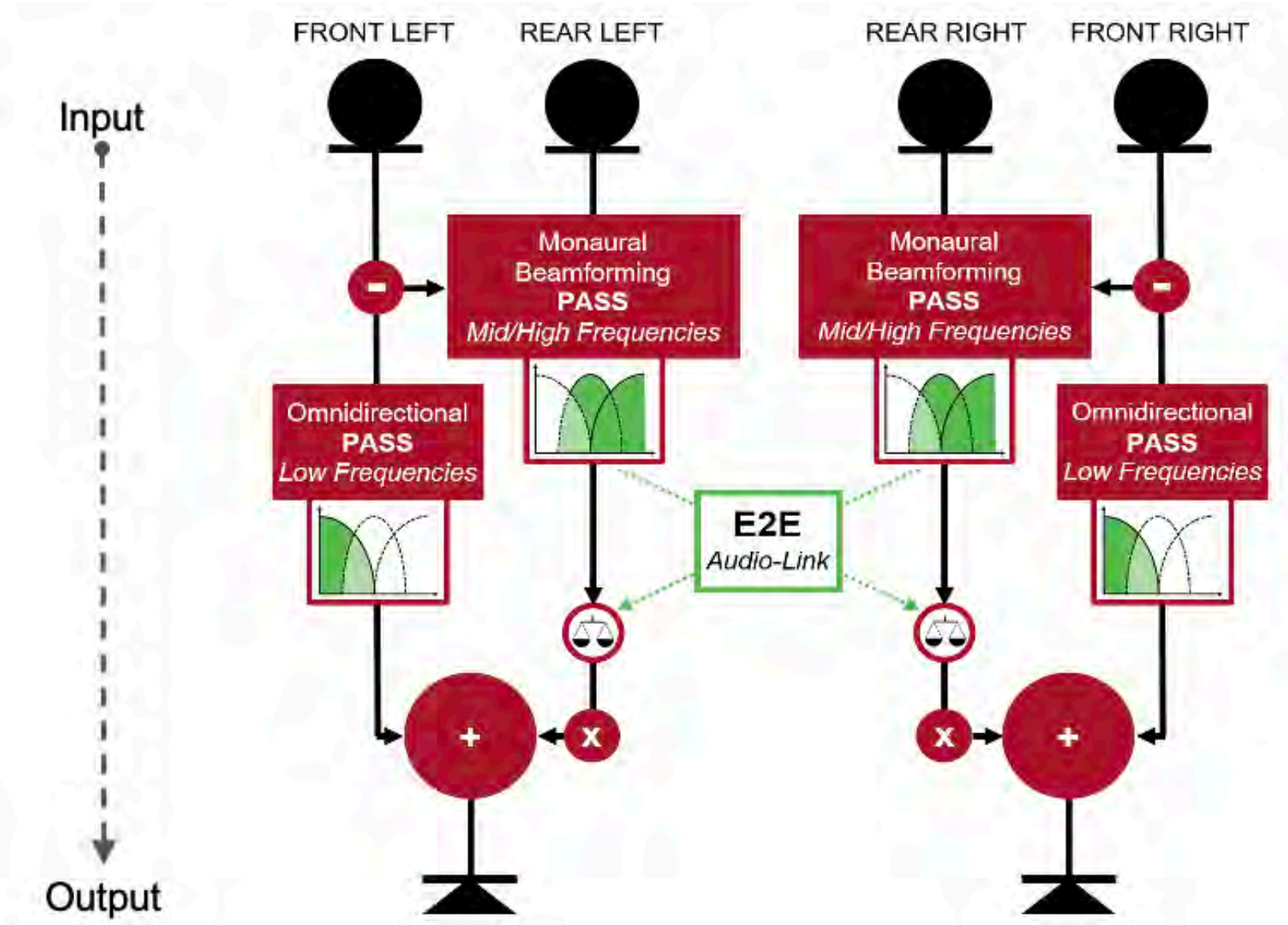
- Wind noise is spectrally low-frequency and spatially uncorrelated
- When wind is present, distinct air vortexes are created at each microphone of the hearing instrument
- Each of these vortexes is unique, so the signal at each microphone is unique and thereby uncorrelated
- Combining uncorrelated inputs at the 2 microphones of a directional hearing instrument results in an increase of the signal level



Thompson & Dillon, 2002

- Thus, in a fullband directional hearing instrument (with low-frequency equalization), wind noise is amplified further

The ReSound Multiband Directional Processor



The green arrows indicate that the directional signal of the dual microphones of both hearing aids are weighted according to the hearing situation and added to the output signal in order to generate a stronger directional signal.

Navigating Naturally in a Noisy World

ReSound GN

Scorecard

Hearing Others' Speech Well in Noise

Hearing *Your Own* Speech in Noise

Comfortable Navigation in Noise

ReSound OMNIA

Ready to Play...

Guess
The
Answer!

Write it in the chat!

Which listening mode of 360 All-Around emphasizes naturalness and overall sound quality?

- Spatial Cue Preservation

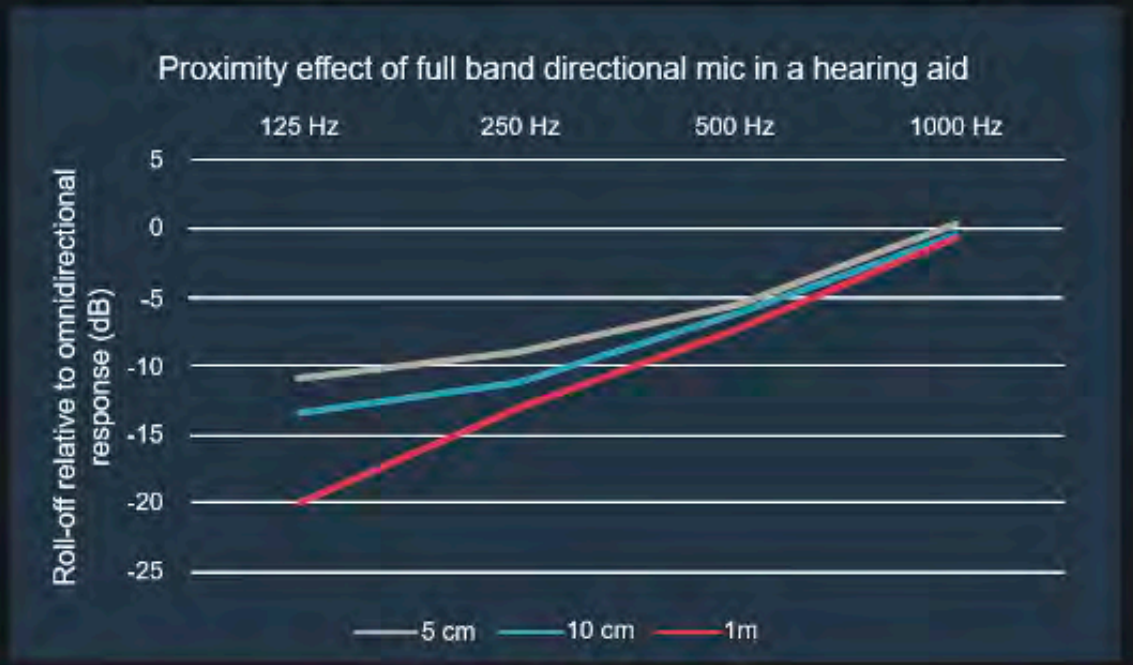
Which listening mode of 360 All-Around uses the brain's binaural processing to shift focus without losing awareness?

- [ ] Binaural Listening

Which listening mode of 360 All-Around provides the best SNR in noise when speech is in front?

▲ Speech Intelligibility

The proximity effect is...

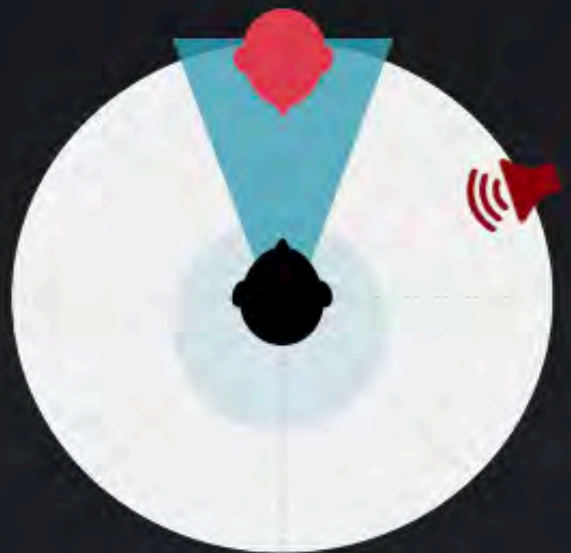


▲ A longstanding issue with directional microphones

◆ Made even worse when "bass boost" is applied

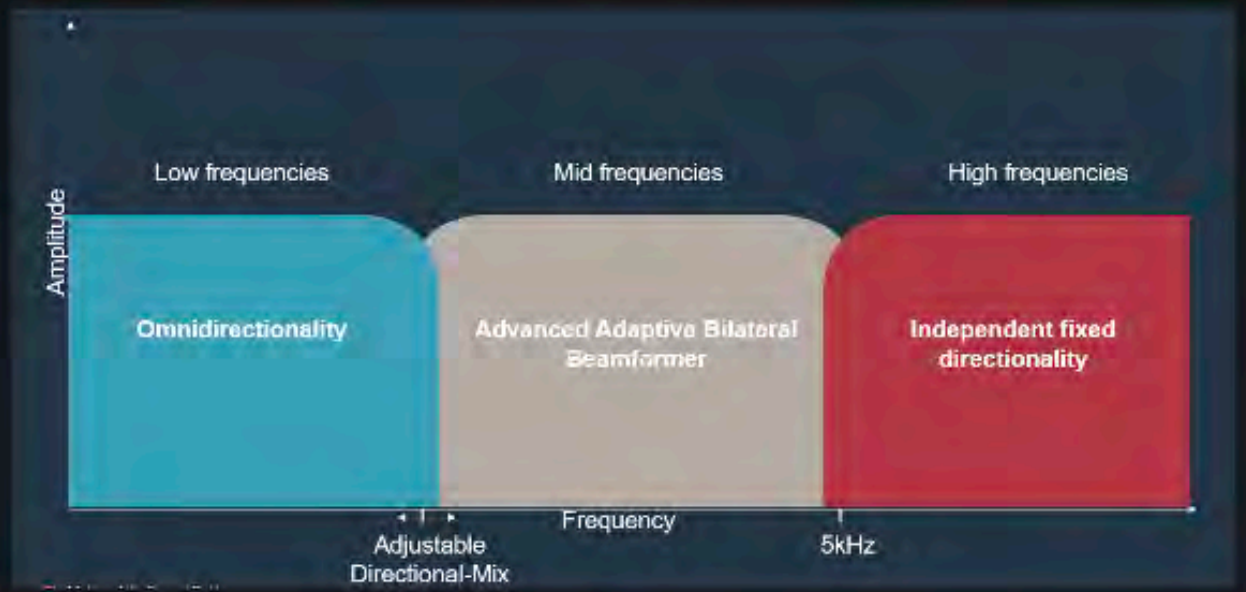
● Directional mics amplify LF sounds that are near more than far away

What new feature of ReSound OMNIA replaces Ultra Focus?



- Front Focus

What is an advantage of a multiband directional approach?



▲ **Better access to localization cues than fullband directionality**

◆ **Better sound quality as compared to fullband directionality**

● **More natural own voice perception as compared to fullband directionality**

ReSound M&RIE: Also a good option for ReSound OMNIA!

- Reduced listening effort
- Crystal clear phone calls & natural phone placement
- A more natural hearing experience through preferred sound quality
- Improved localization and depth perception that improves over time
- Increased wind noise reduction and better sound quality in wind

Ready to **hear the difference**?

Q&A

Tammara Stender

tstender@gnresound.com