RESEARCH QUICK TAKES

1.4: Speech understanding in background noise—Ensuring optimum feature benefit

Brian Taylor & Gus Mueller

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Ensuring that the patient obtains optimum benefit from advanced features for understanding speech in background noise . . .

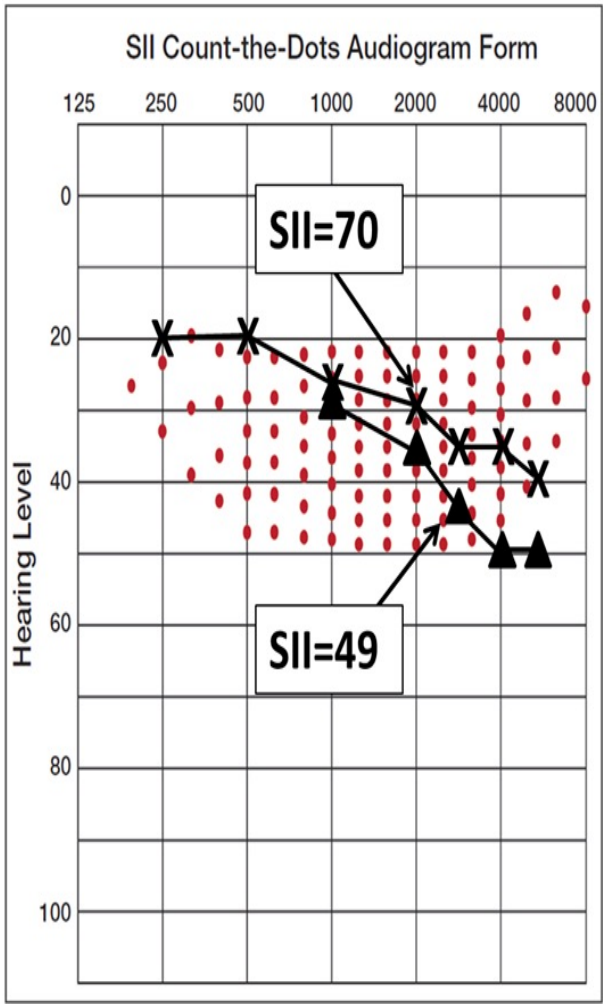
Three over-arching considerations:

Audibility

Audibility, and

Audibility!

Validated prescriptive methods are designed to give the appropriate balance of audibility and sound quality



If an HCP were to veer away from the validated fitting methods (e.g., use a manufacturer's proprietary fitting), there is a good chance that audibility will suffer.

Upper tracing is projected aided thresholds for a fitting to the NAL-NL2.

Lower plot is projected aided thresholds for a typical proprietary fitting.

Note large differences in SII, and we would also expect large differences in speech understanding in background noise

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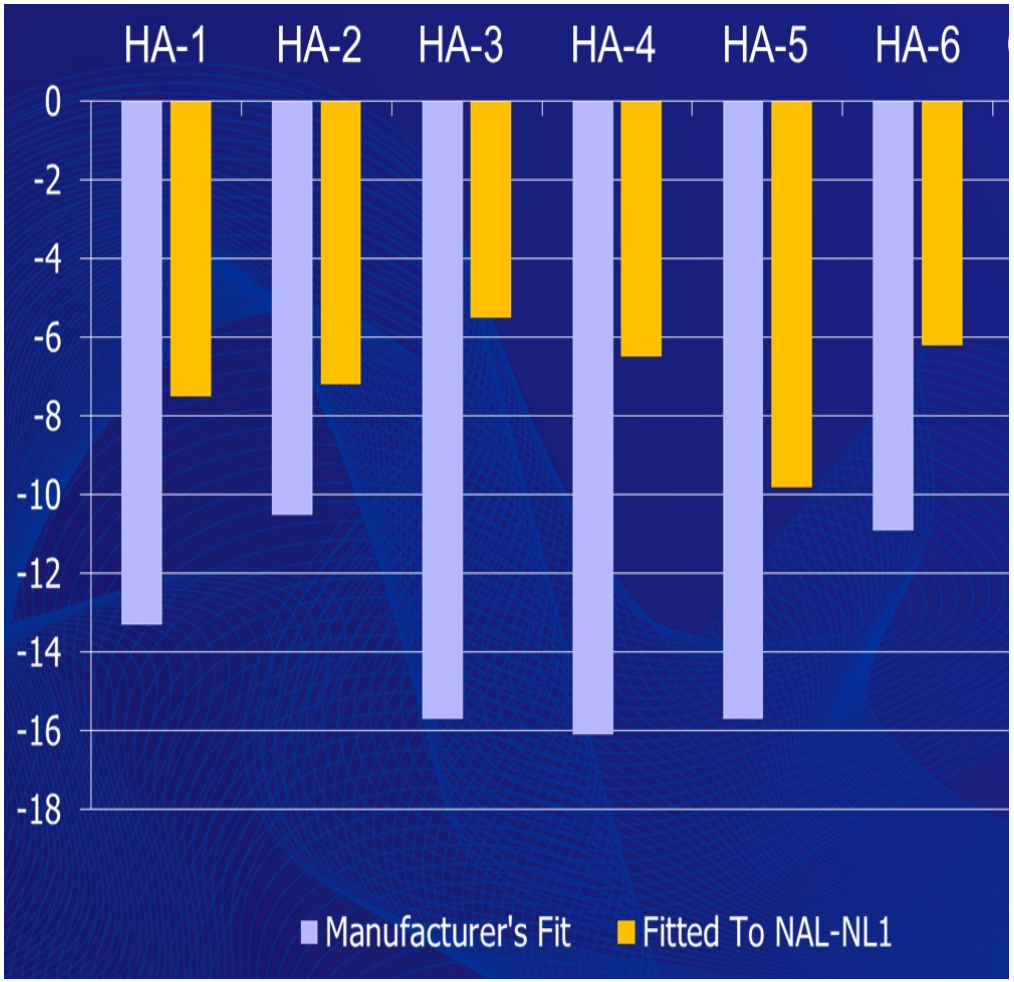
In fact, we have data showing the expected effects of not providing appropriate audibility . . .



From Leavitt & Flexer

- Premier hearing aids from the Big Six manufacturers, equipped with directionality and DNR.
- Programmed to either the proprietary fitting or to the NAL
- Shown is SNR Loss for the QuickSIN (down on the chart is "bad")
- The average SRT-50 across hearing aids went from 16 dB to 9 dB (a seven dB improvement), with improvement of 10 dB for two of the products.
- One product (HA-3) which appeared to have the worst technology when programmed to that

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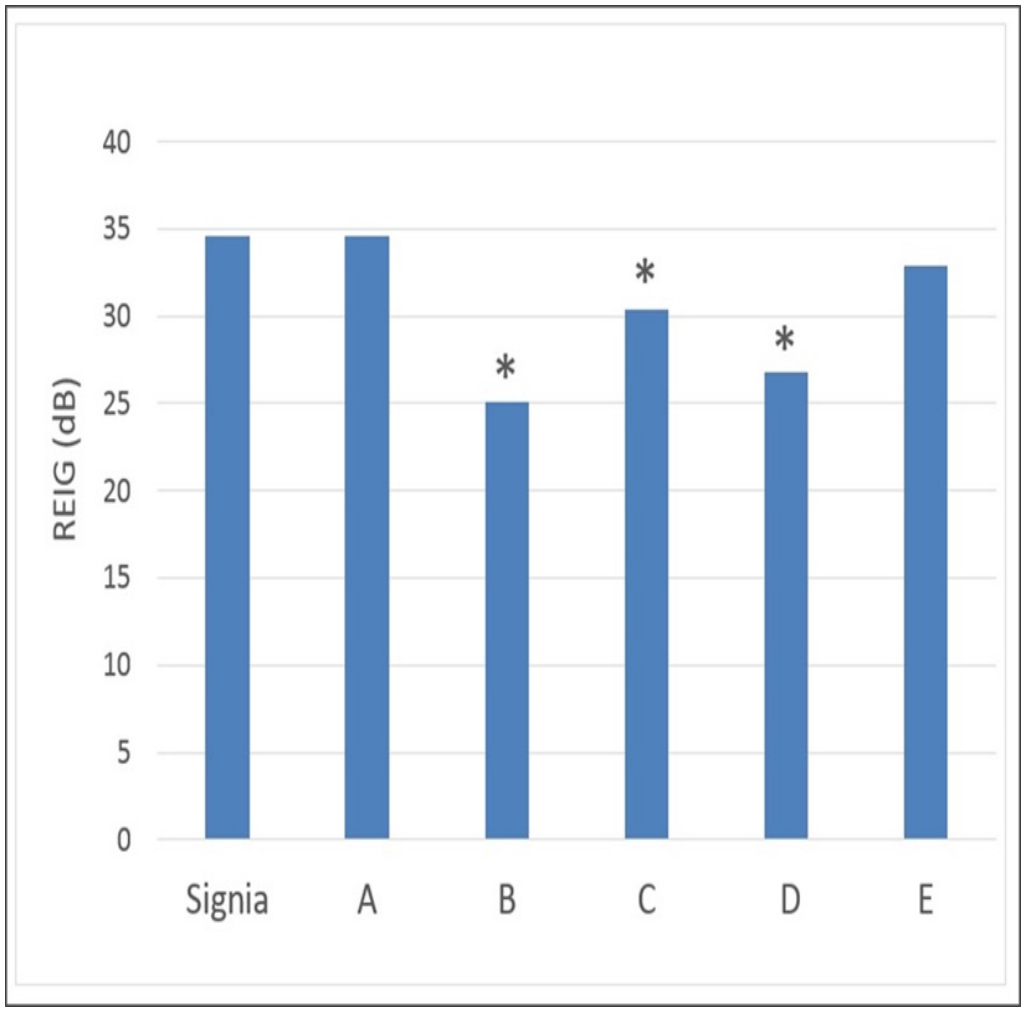
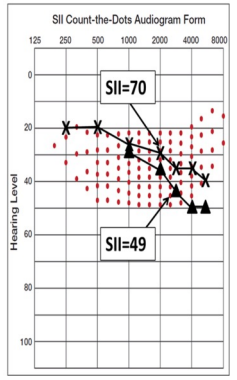
Related to audibility is adaptive feedback control:



Shown is "gain-before-feedback" when an open fitting is employed.

Note that there is as much as a 10 dB difference between manufacturers

This could have a significant effect on the audibility of high frequency speech sounds.



From Marcrum et al

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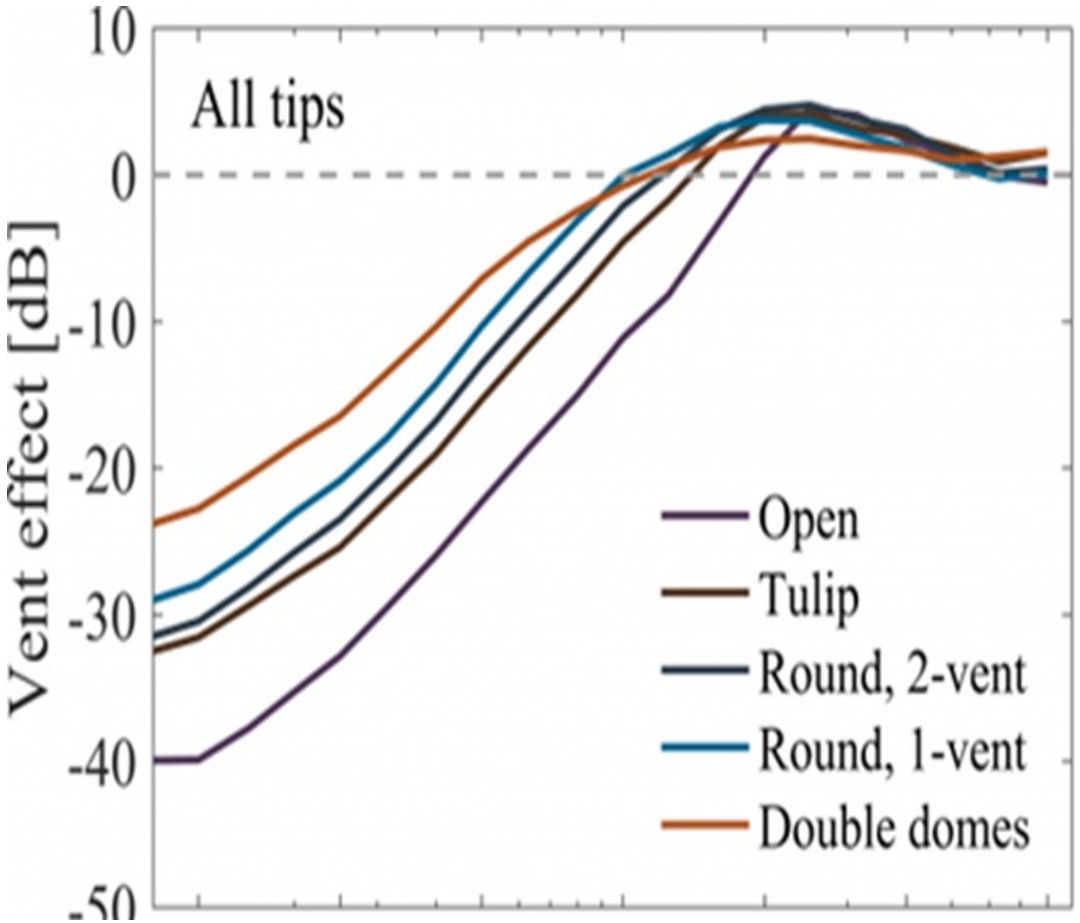
The “tightness” of the fitting also will impact the effectiveness of the hearing aid features:

If the fitting is too “open:”

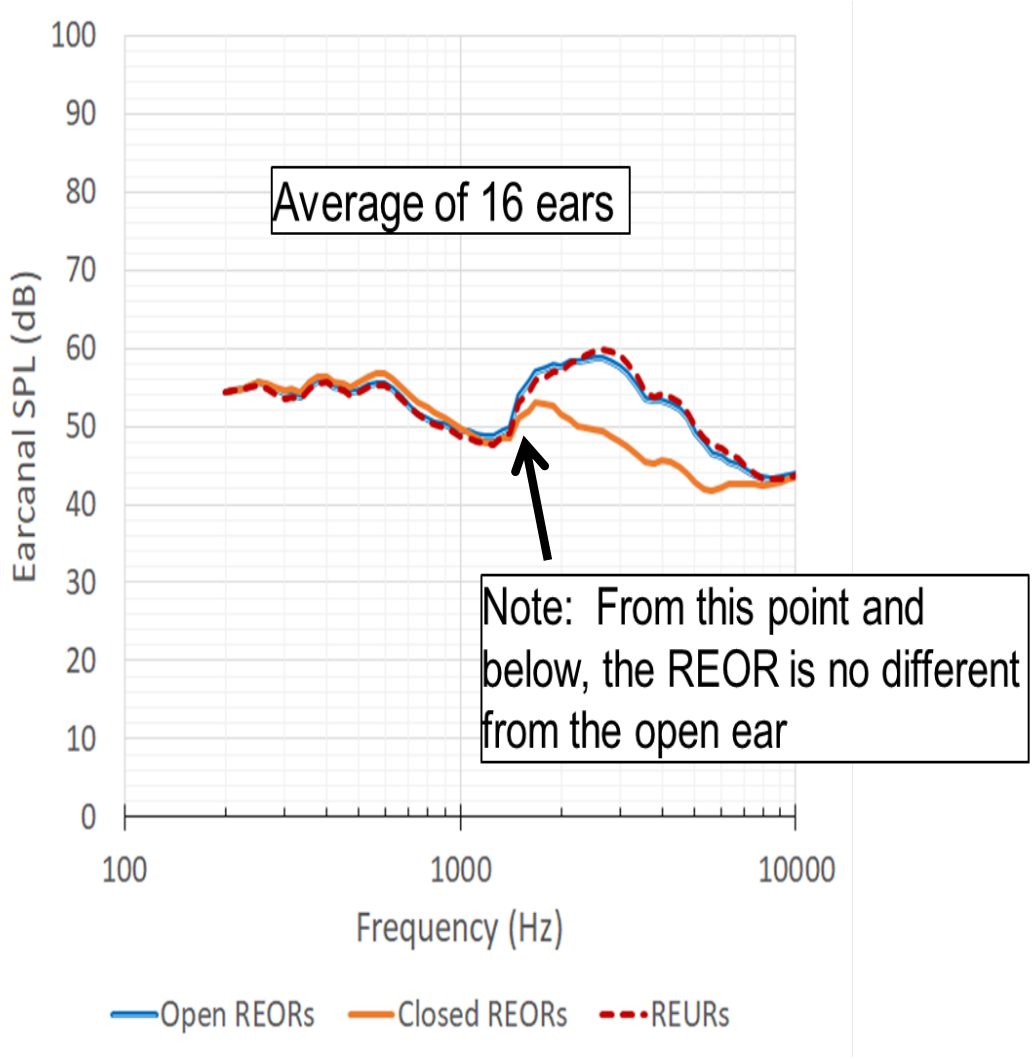
- Noise has a direct pathway to the eardrum
- The earcanal resonance will be maintained, which can give a 15-20 boost to the noise
- Amplified speech sounds will leak out of the ear

The venting/attenuation from instant-fit tips and domes is much different than advertised. “Closed is *not* Closed”



From Balling et al

The REOR is a good way to look at the degree of openness



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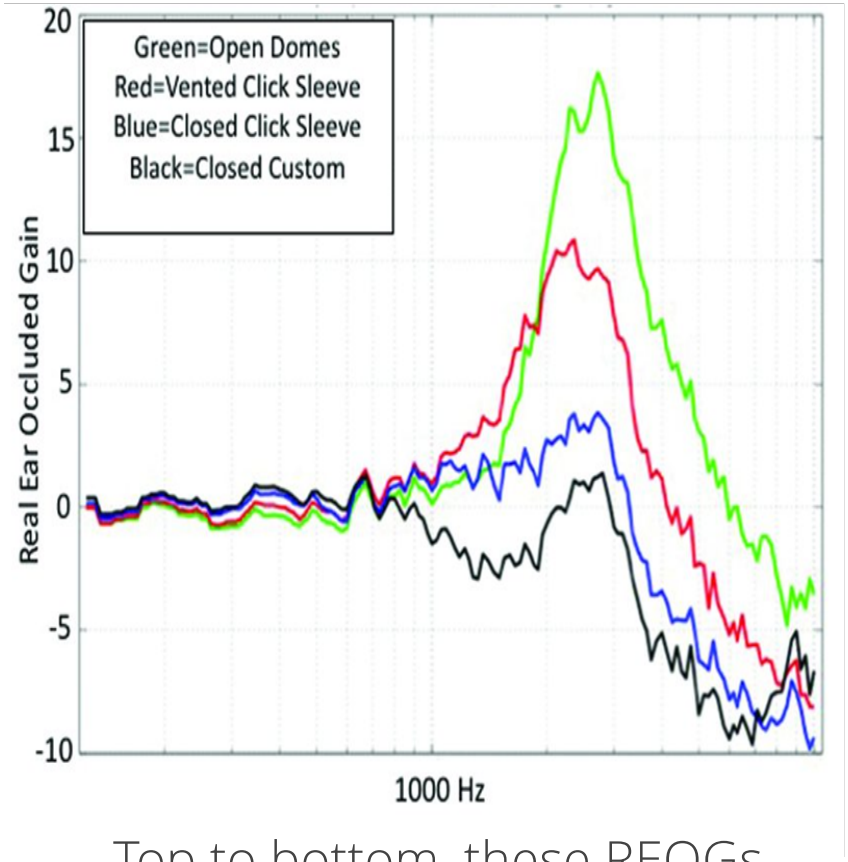
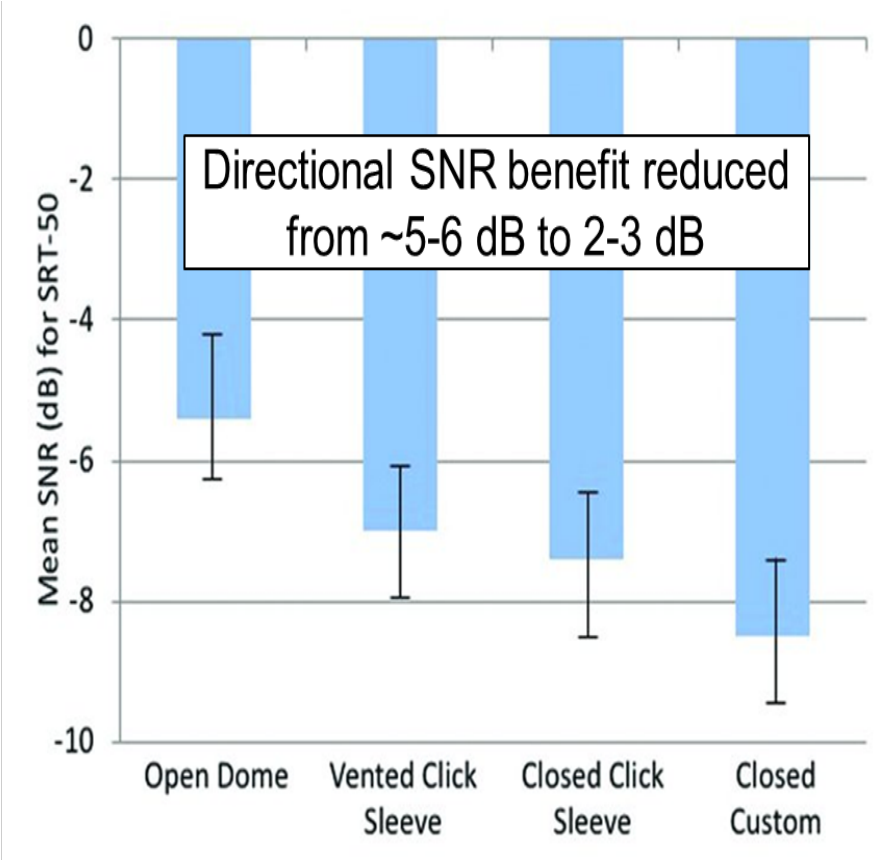
Openness can have a significant effect on directional processing . . .



Top to bottom, these REOGs correspond to the speech recognition results (left to right)



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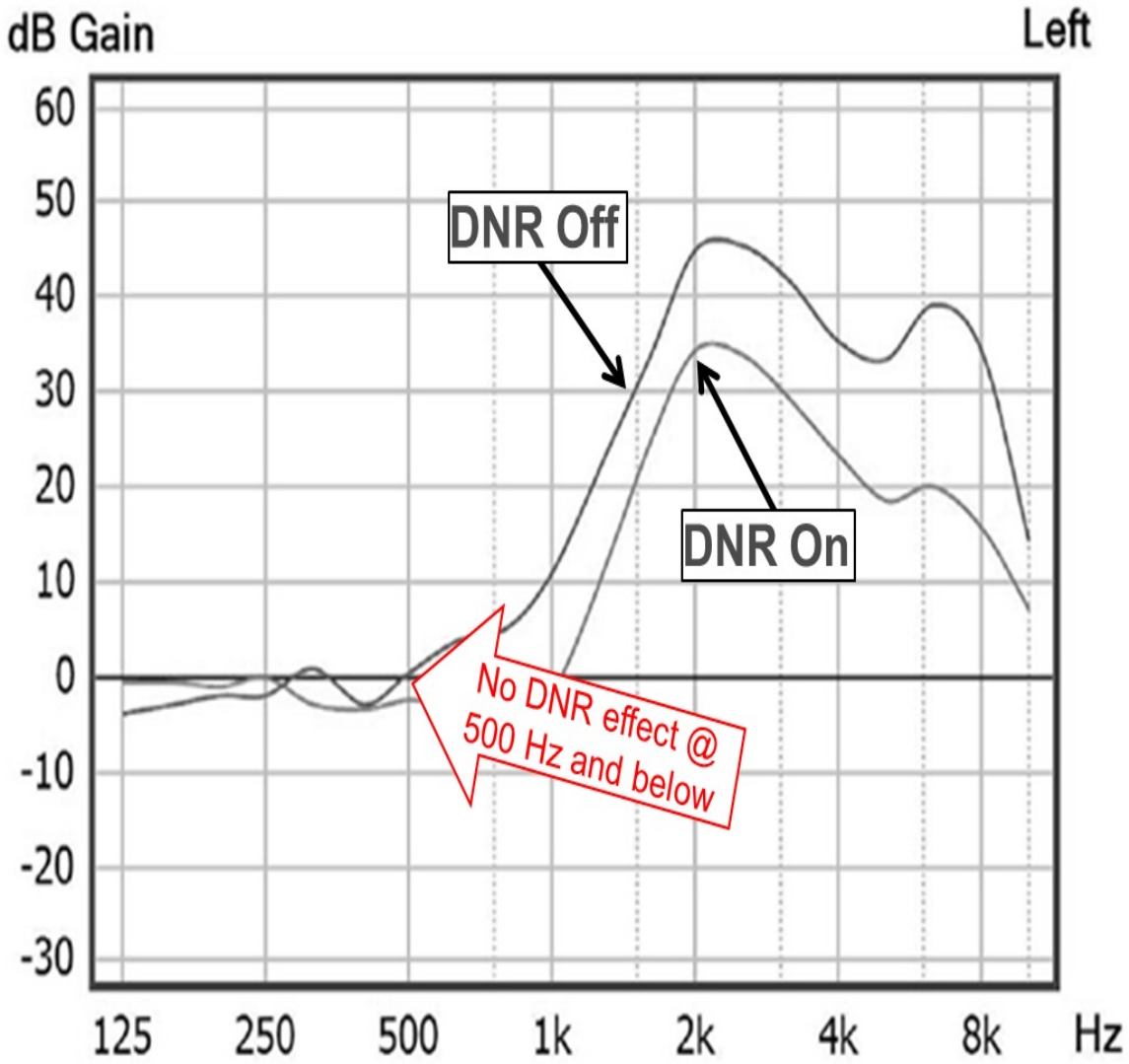
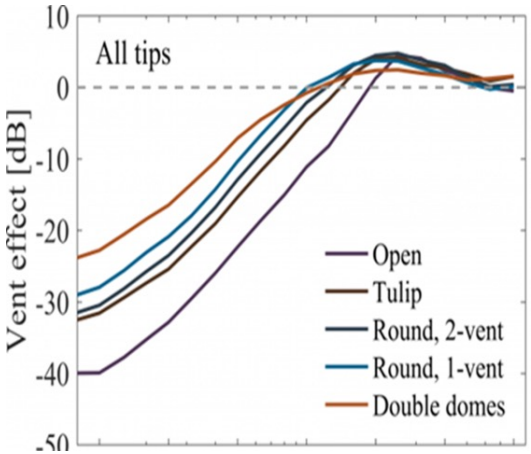
And, openness also can adversely effect DNR:





Which is related to this

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Three things to remember:

- Fit to a validated method to ensure audibility (real-ear verified of course)
- Pick a product with good feedback reduction (so that you can obtain that desired audibility)
- Keep the fitting as closed as possible (so bad things don't get in, and good things stay in)

. . . And, benefit and satisfaction will follow!


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RESEARCH QUICK TAKES

1.5: Speech understanding in background noise: Recent innovations and insights

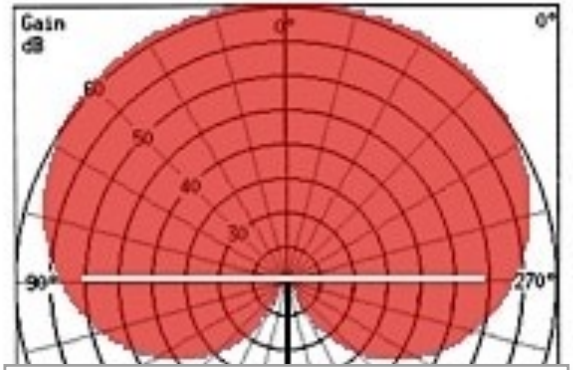
Brian Taylor & Gus Mueller

Some recent Innovations:

- Directional CROS and BiCROS processing from transmitter side
- Directional technology in a CIC product
- Using the patient's motion to help steer directionality

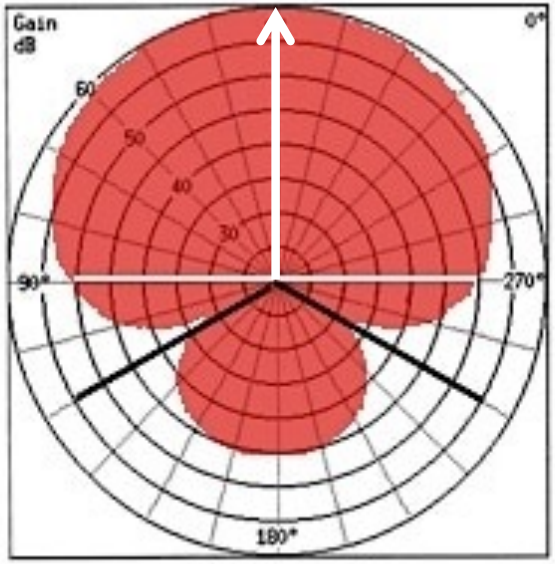
Quick Tutorial: What is a directional polar pattern?

The distance the plot extends from the center is the amount of gain

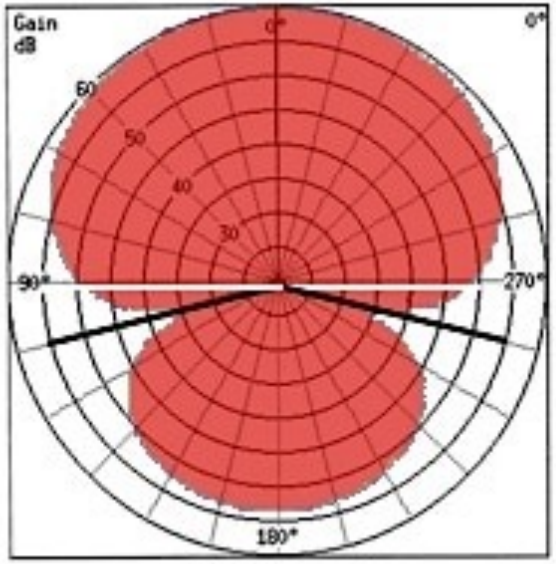


Where the plot is closest to center is point of maximum attenuation

Cardioid



Supercardioid



Hypercardioid

These are plots in the free field (anechoic chamber), NOT on the head (no head diffraction or shadow)

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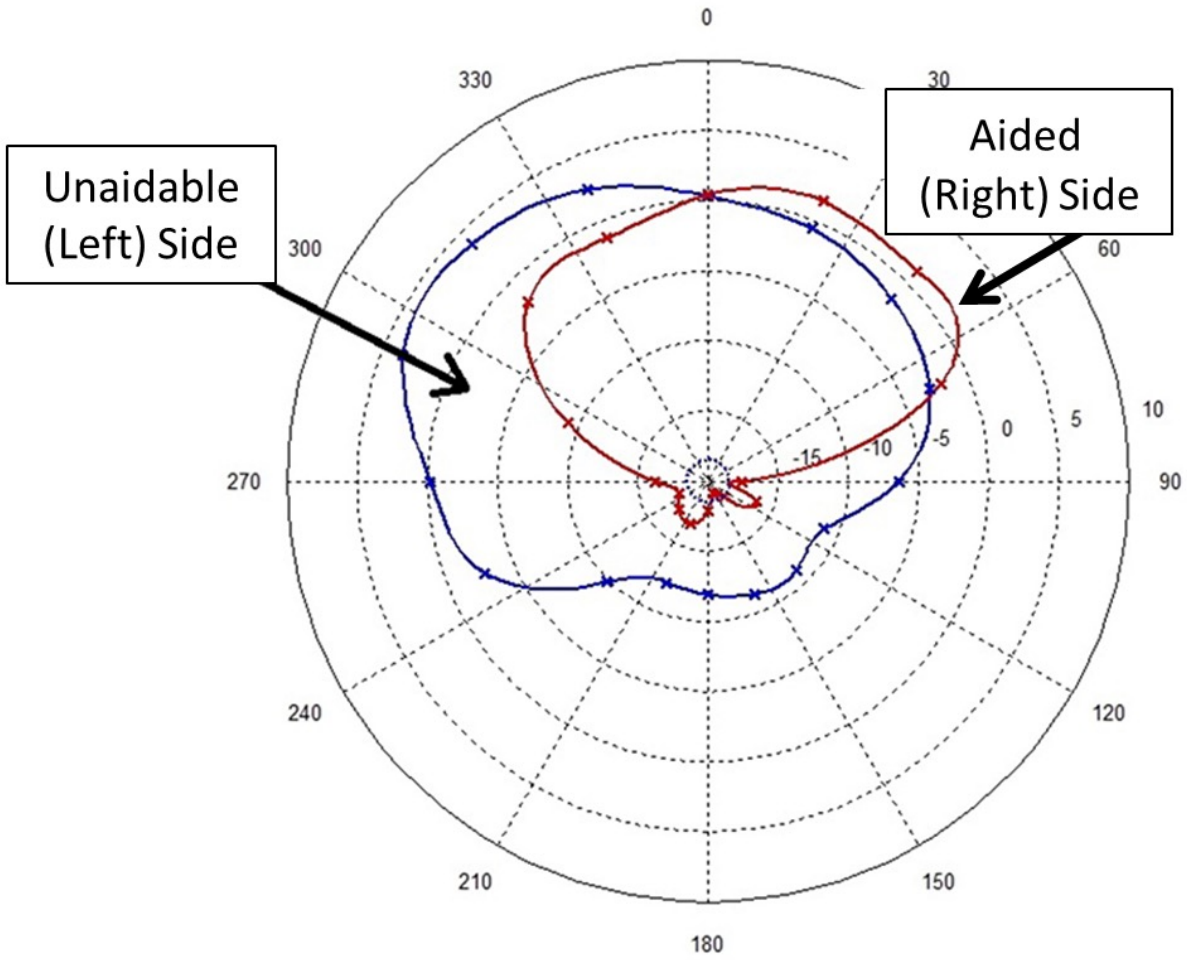
Polar pattern for the CROS transmitter and aided ear. Measurement obtained with the hearing aids fitted to the KEMAR



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Clinical speech-in-noise measurements for the new directional CROS system. Speech presented to transmitter side, noise to the "good" ear to create adverse listening situation.

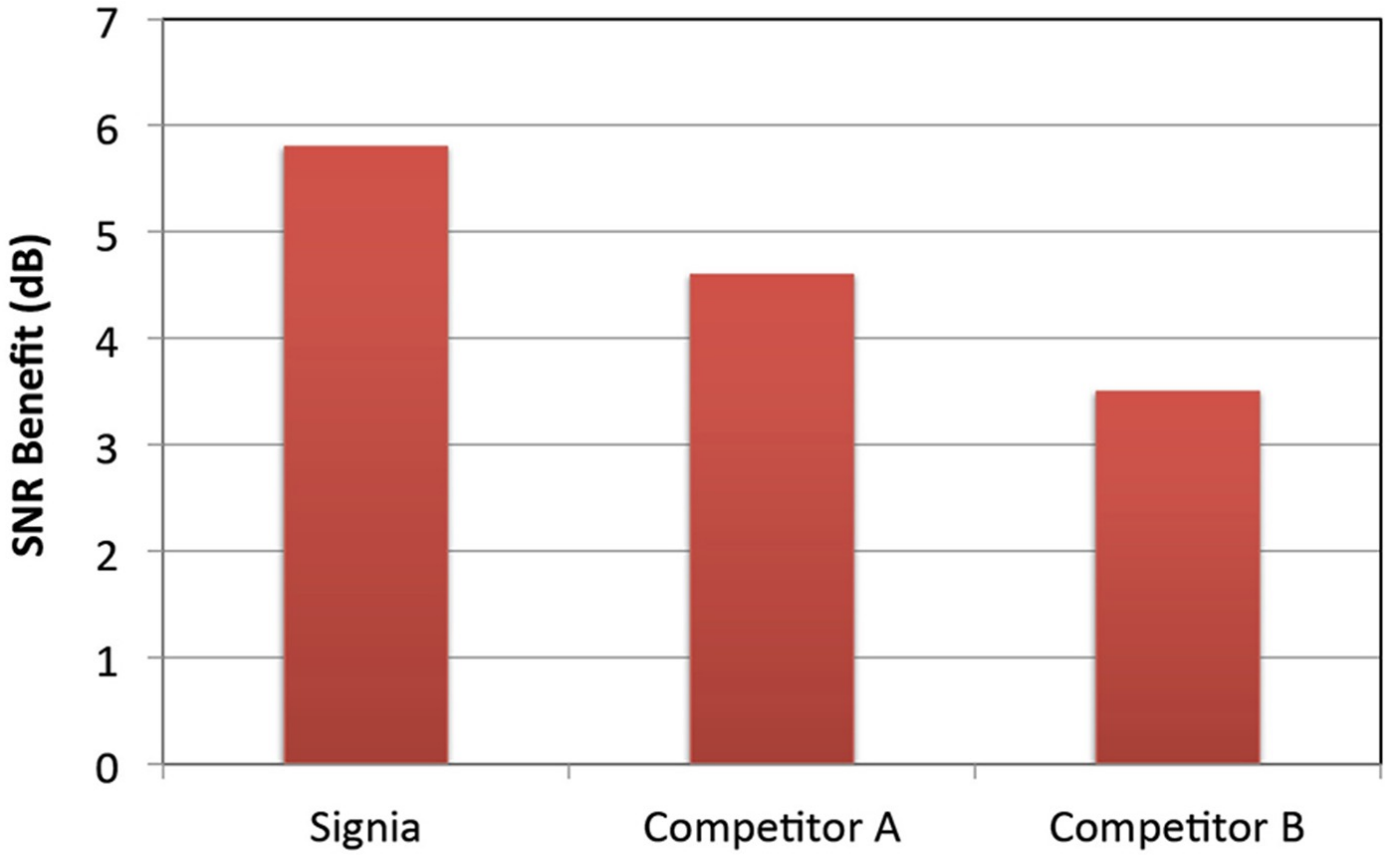


Figure 2. Signal-to-noise (SNR) benefit for the primax CROS for an adaptive speech test; transmitter microphone ON versus OFF. For comparison purposes, SNR benefit is also displayed for two competitor CROS models, taken from published research with these instruments.

Data showing benefit of BiCROS processing with new directional technology

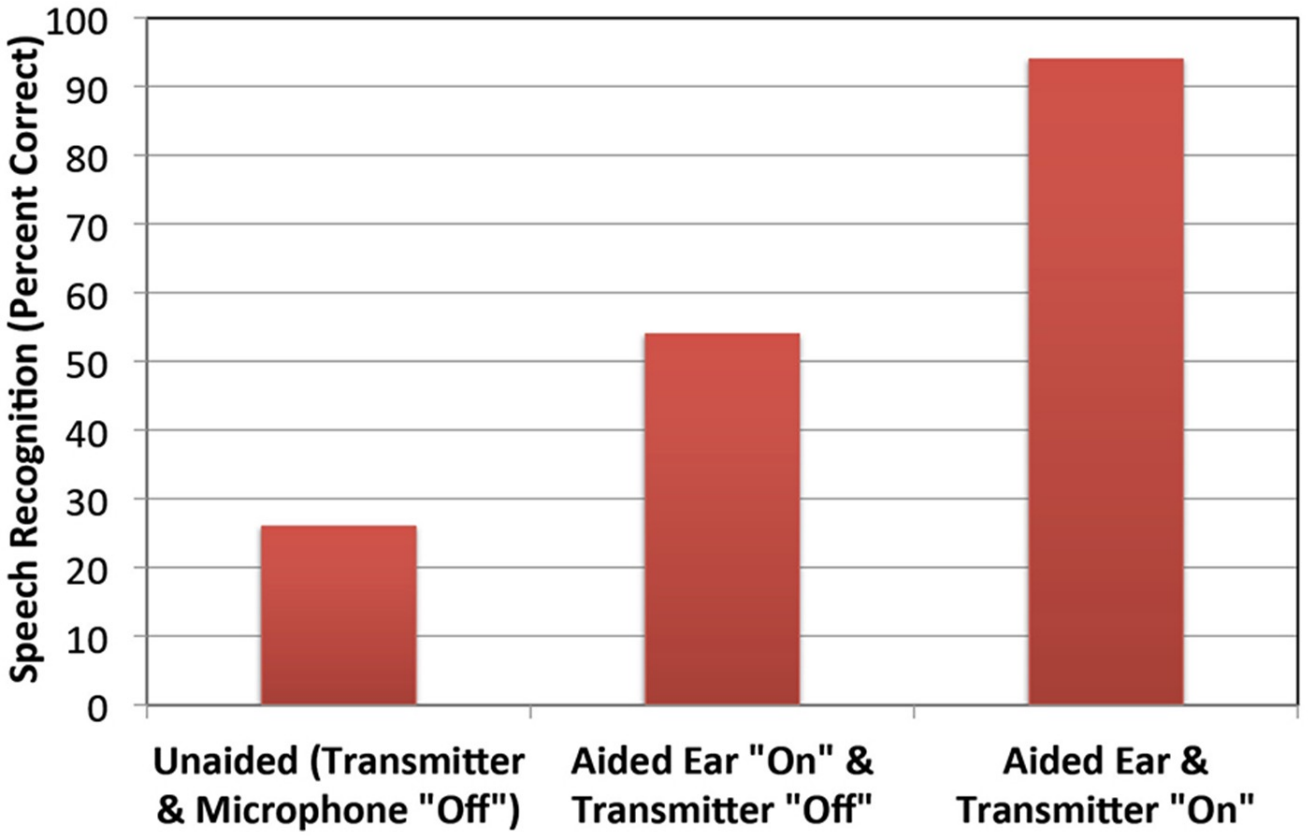


Figure 3. Mean speech recognition (percent correct) obtained for clinical testing of Signia primax BiCROS fittings for three settings: transmitter and receiver microphone off, receiver microphone on and transmitter microphone off, and both receiver microphone and transmitter microphone on.

Field study of new BiCROS processing: All participants users of competitive BiCROS instrument which also uses bilateral beamforming

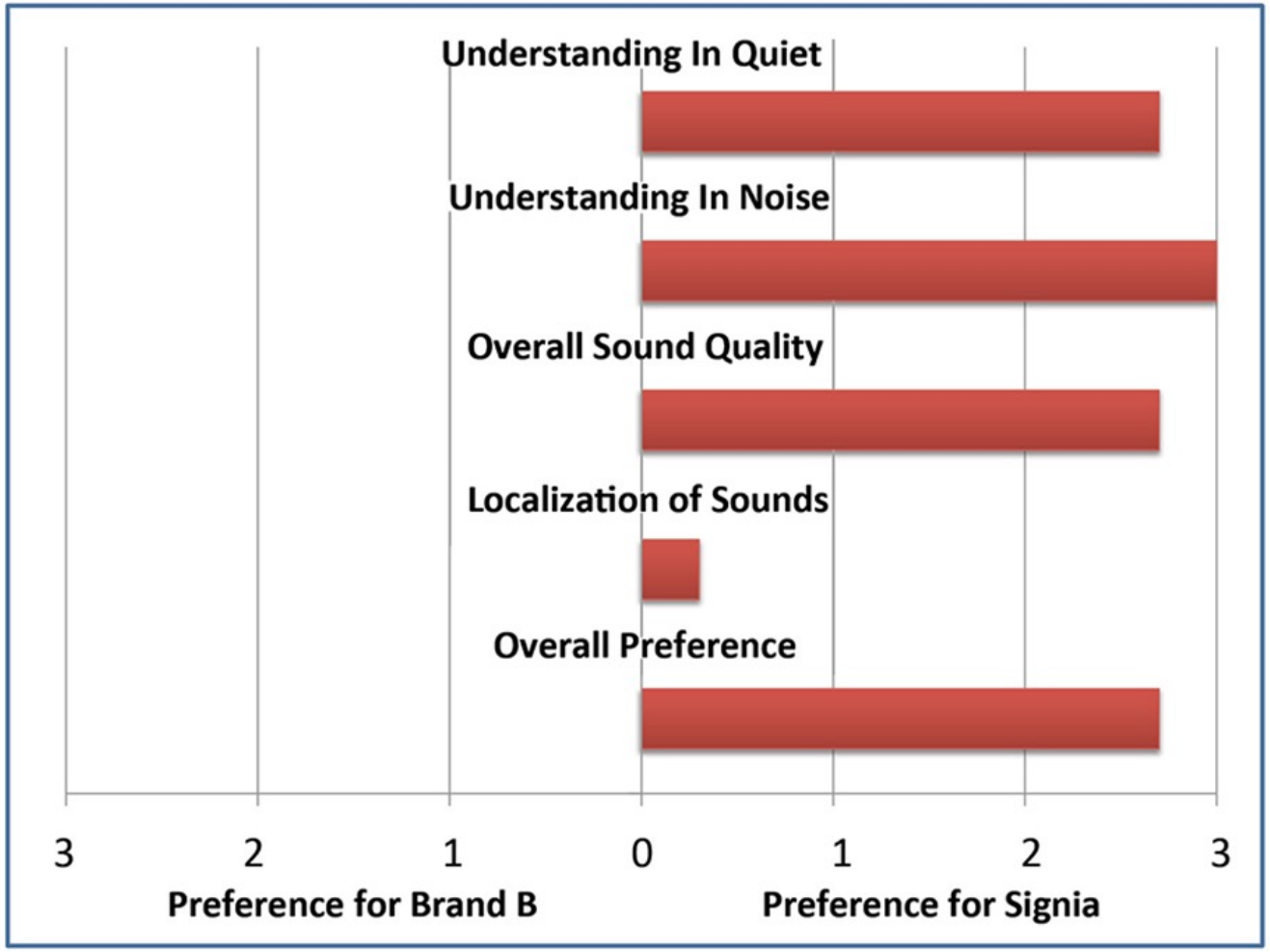


Figure 4. Mean subjective ratings following a field trial comparing the Signia BiCROS to the participants' personal Brand B BiCROS fittings.

Directional processing in a CIC product? Yes it's possible!

Bidirectional ear-to-ear wireless audio data transmission allows for careful weighting and combining both available microphone signals—that is, this only can be accomplished with binaural beamforming.

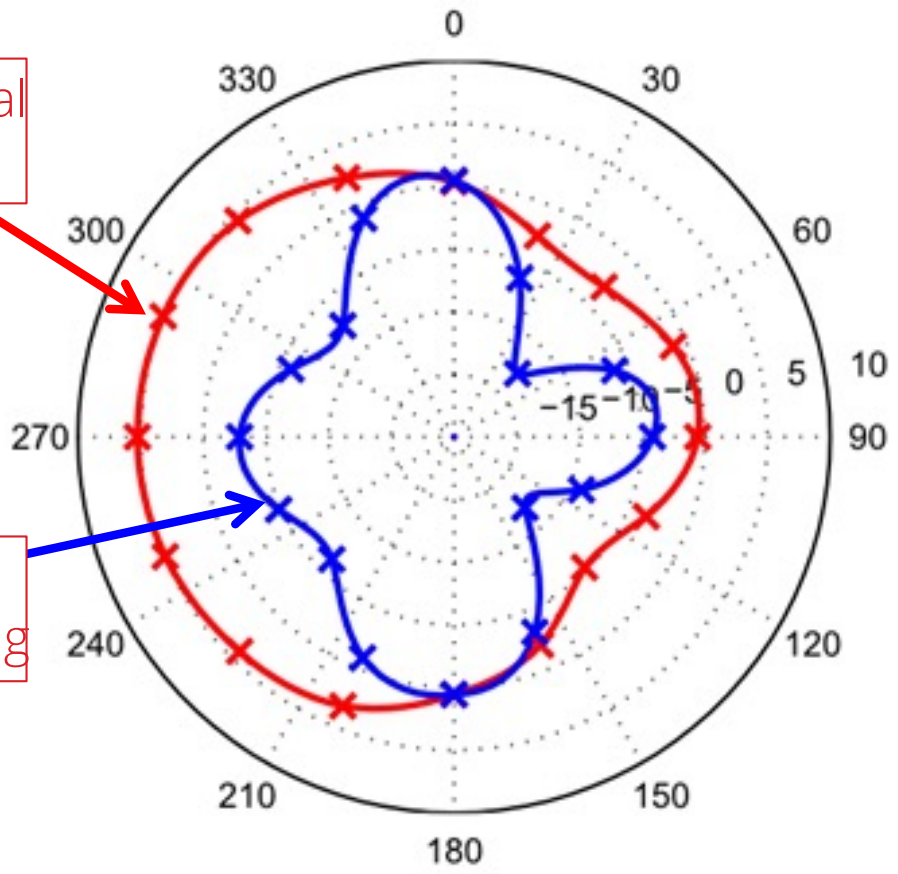
By imposing an appropriate optimization criterion for the adaptive weighting rule, it is possible to generate an enhanced output signal where interfering lateral noise sources can be efficiently attenuated, while the frontal desired signal remains untouched.

Because of the deep placement of the microphones, "free" directivity is obtained from the pinna, and the net result is total directionality nearly as good as obtained with dual-mic BTE RICs.

Polar pattern for CIC “OneMic” directional

Traditional omnidirectional processing

Directionality obtained through bilateral beamforming



Measurement for left CIC of bilateral fitting

Quick Tutorial: What is a directional hearing aid AI-DI?

The DI is the difference between the output at 0 degree vs. all the other azimuths around the listener.

If the output at 0 degree was 80 dB, and the average of all the other azimuths was 74 dB, the DI would be 6 dB.

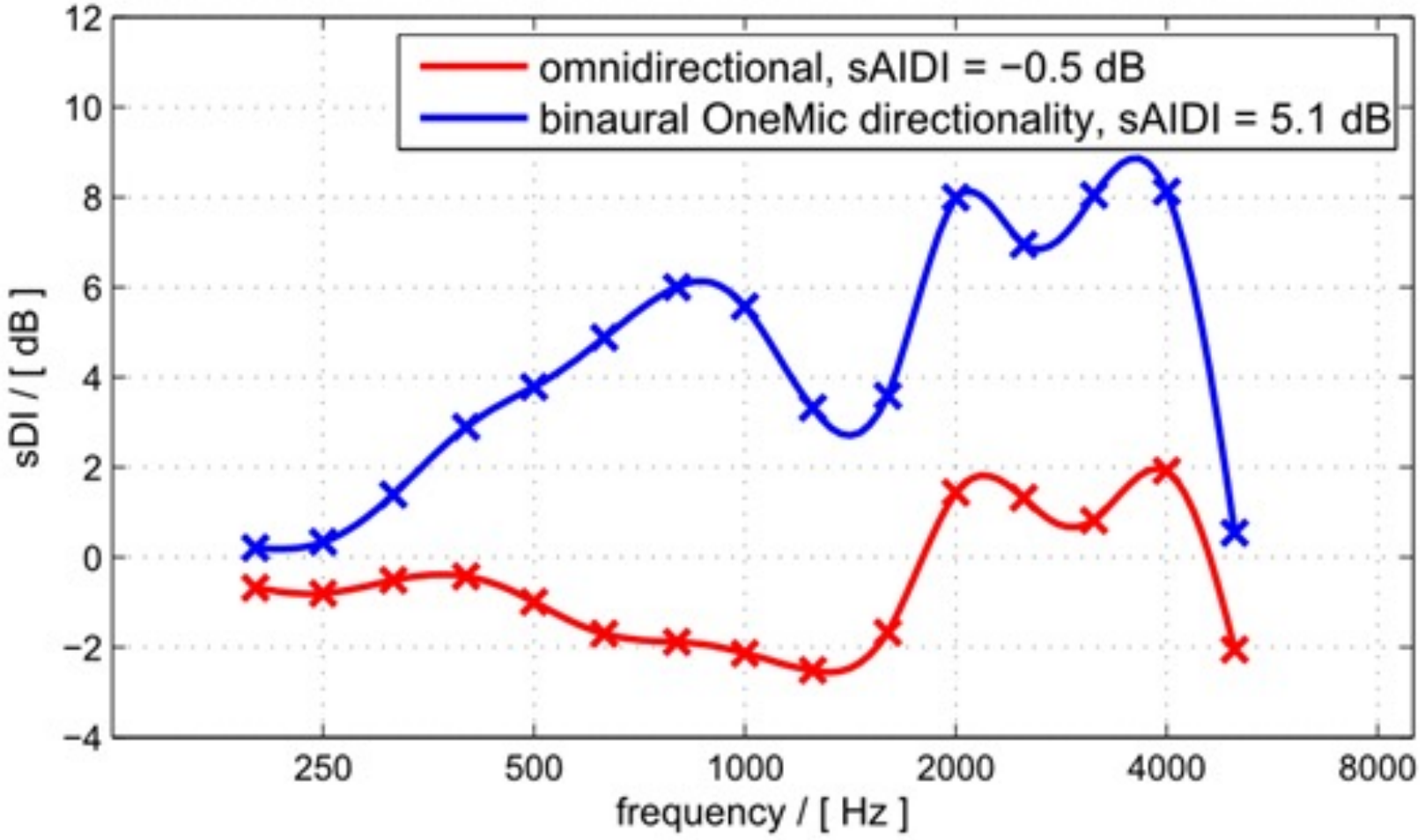
This is normally reported for key frequencies 500, 1000, 2000 and 4000 Hz, and then they can be averaged for a single DI

The AI-DI uses the values of the DI, but then applies a weighting which represents the importance function for speech:

- 500 Hz = 20%
- 1000 Hz = 23%
- 2000 Hz = 33%
- 4000 Hz = 24%

A hearing aid with a larger DI in the 2000 Hz area will have a larger AI-DI than DI, but usually the differences are small. The AI-DI is related to the SNR advantage of the instrument.

Resulting AI-DI for “OneMic” directionality



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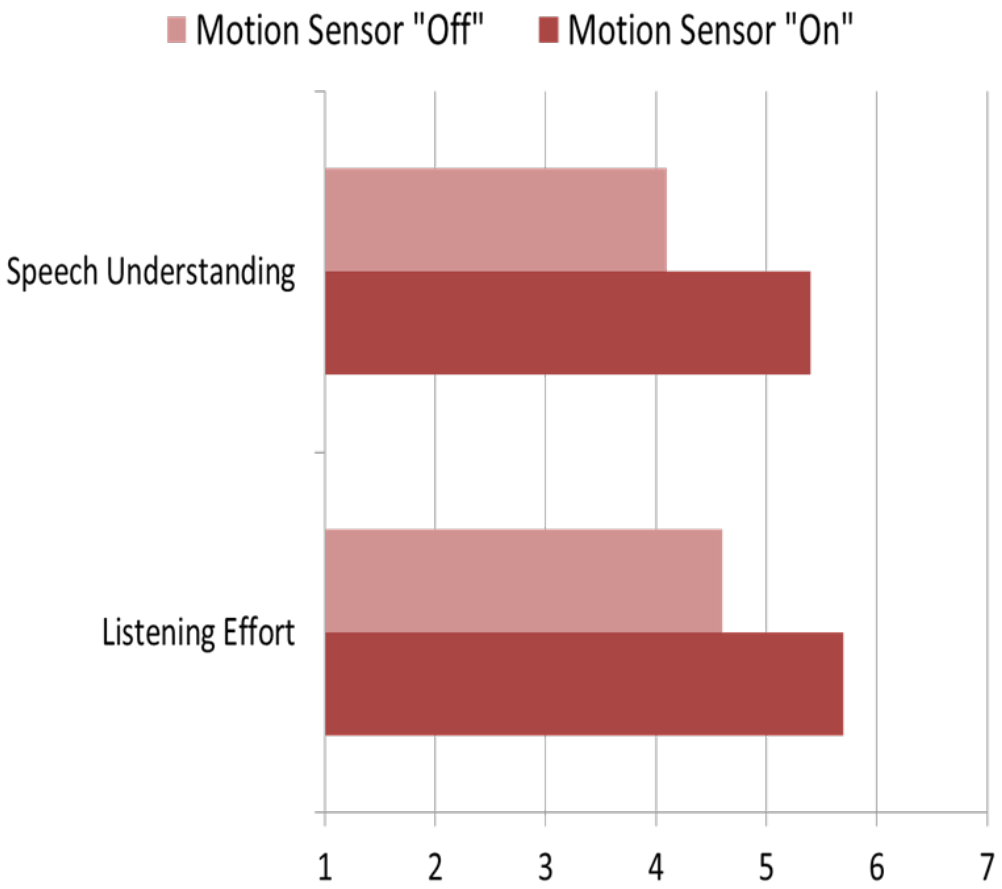
Motion-steered directionality

The degree of directionality for a given listening situation is determined by the hearing aid's signal classification system. Only recently has motion detection been made of part of this overall classification process.

It is generally assumed, that when a person is moving, they would want to hear sounds equally from all around, whereas, when stationary (with background noise present) directional processing is preferred.

An on-board accelerometer can determine when the hearing aid wearer is moving, and this information is then used by the signal classification system

Clinical testing of motion-sensor-driven directionality



Test Condition

- The participants faced the 0° speaker, with the target speech from the conversational partners randomly coming from either 110° (male talker) or 250° (female talker) at 68 dBA.
- Background traffic noise was presented from surrounding speakers (65 dBA).
- Participants rated speech understanding and listening effort for the two random talkers.

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RESEARCH QUICK TAKES

1.6: Speech understanding in background noise: Unique solutions from Signia

Brian Taylor & Gus Mueller

Two unique solutions from Signia to improve speech understanding in noise performance

- Enhanced acoustic scene analysis
- Augmented split-band processing

Attention to listening intent

In general, hearing aid processing has been designed to focus on what is assumed to be the primary intent of the user—listening to speech from the front. Often, however, this is not the primary intent.

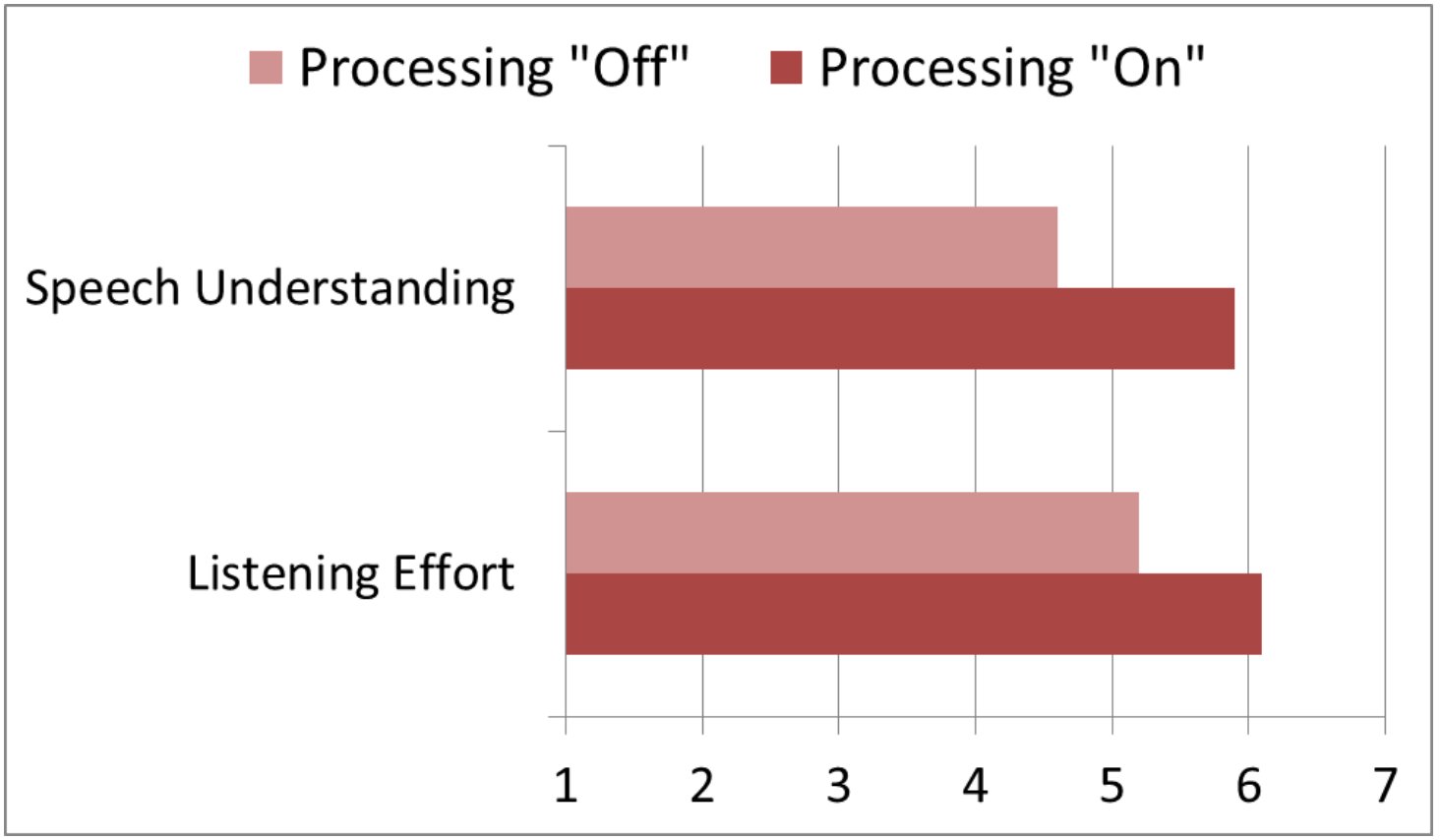
One area of interest centers on improving the importance functions given to speech and other environment sounds when originating from azimuths other than the front of the user, particularly when background noise is present. In general, identification and interpretation of the acoustic scene.

A new signal classification system was developed for the Signia Xperience platform, termed Dynamic Soundscape Processing

As part of the complete analysis, this approach considers such factors as:

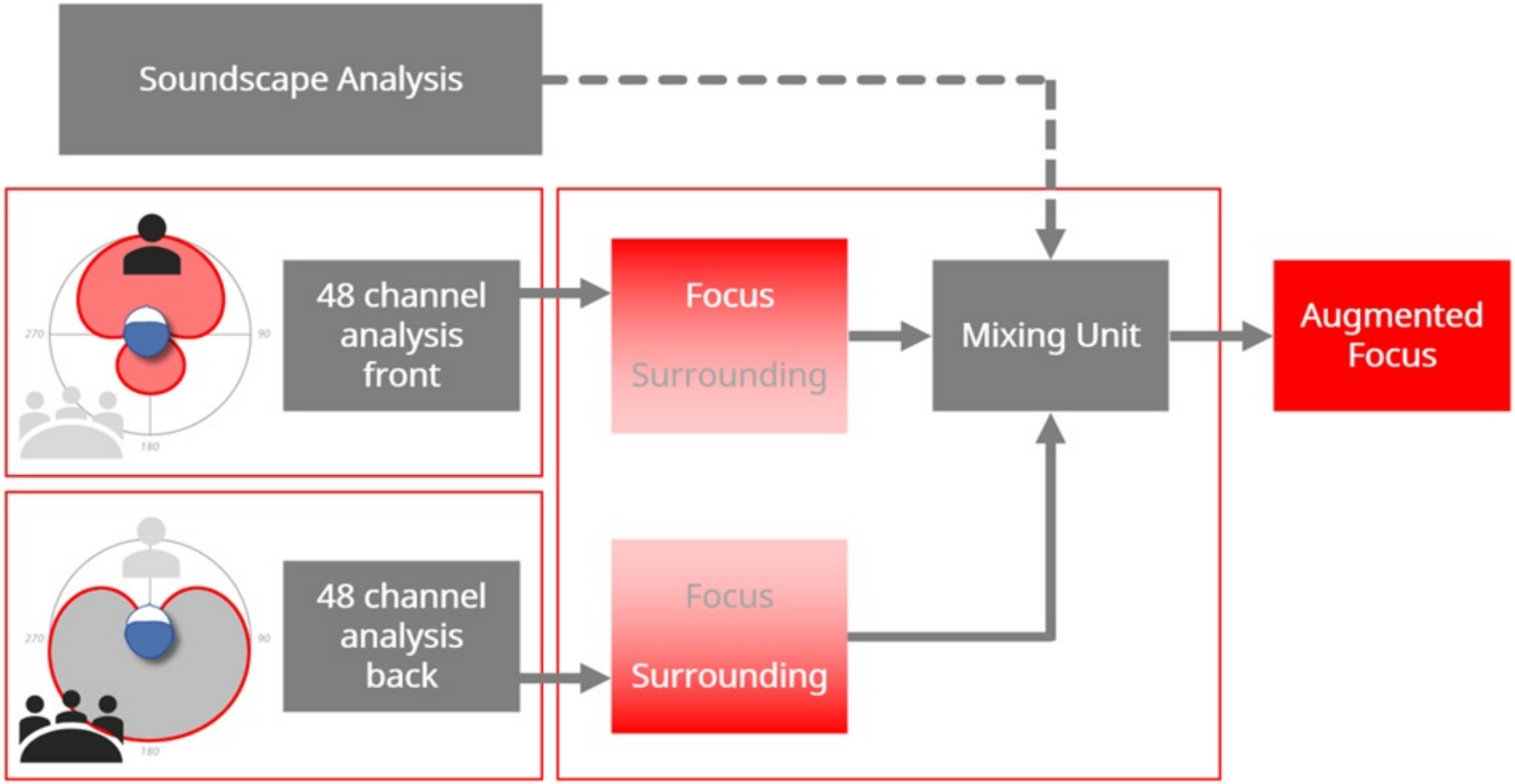
- Overall noise floor
- Distance estimates for speech, noise and environmental sounds.
- Signal-to-noise ratios
- Azimuth of speech
- Ambient modulations in the acoustic soundscape.

Clinical study of new processing

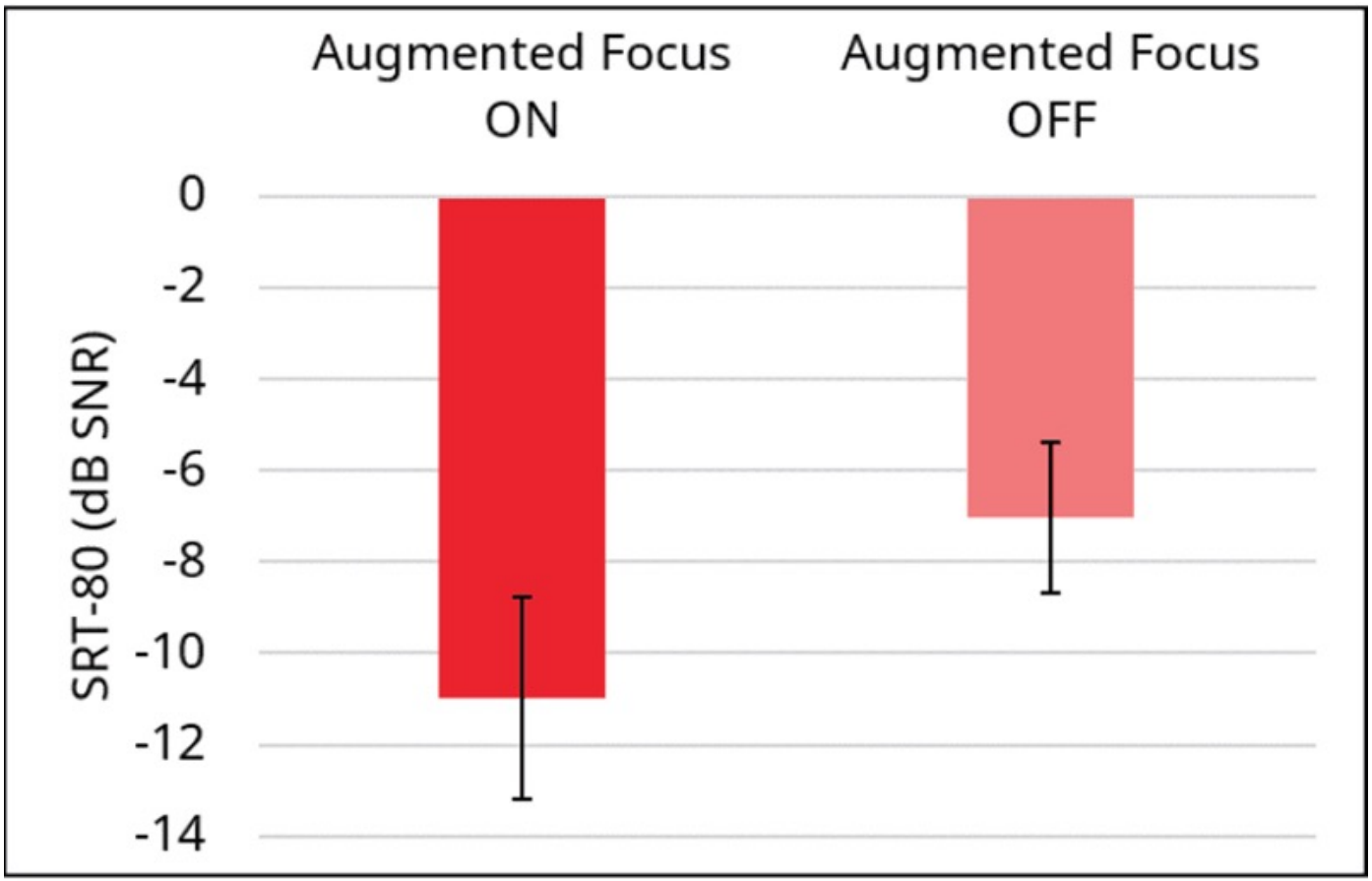


Background noise surrounding. Primary talker from front. Unexpected random talker from 110 degree. Ratings (1-7) are for understanding and listening effort for random talker (processing “on” vs. “off”.

Augmented Focus split-band processing

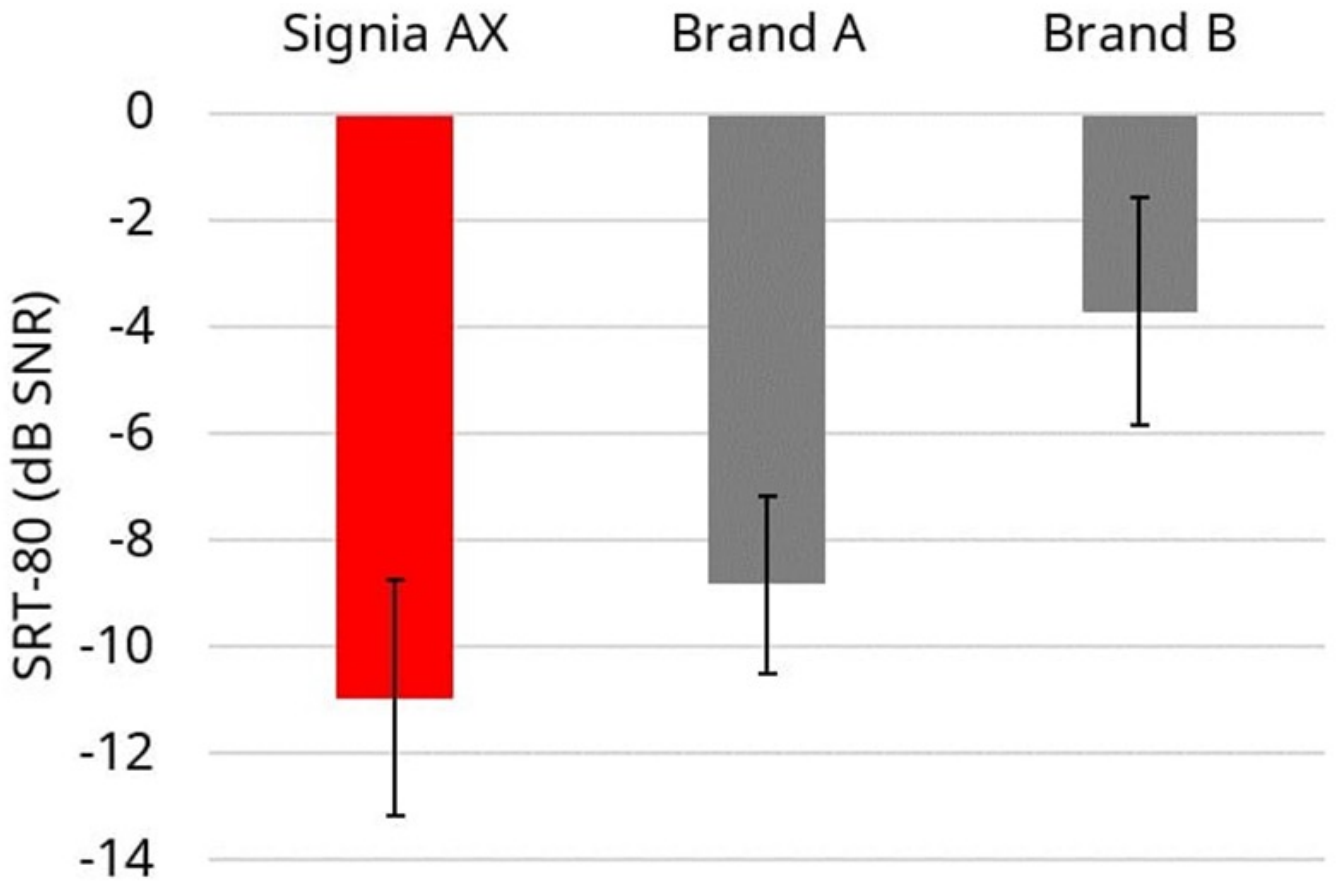


Clinical study of Augmented Focus



Listeners surrounded by background noise with bursts of laugher from various locations from behind. Target sentences from the front.

Comparison to competitive products



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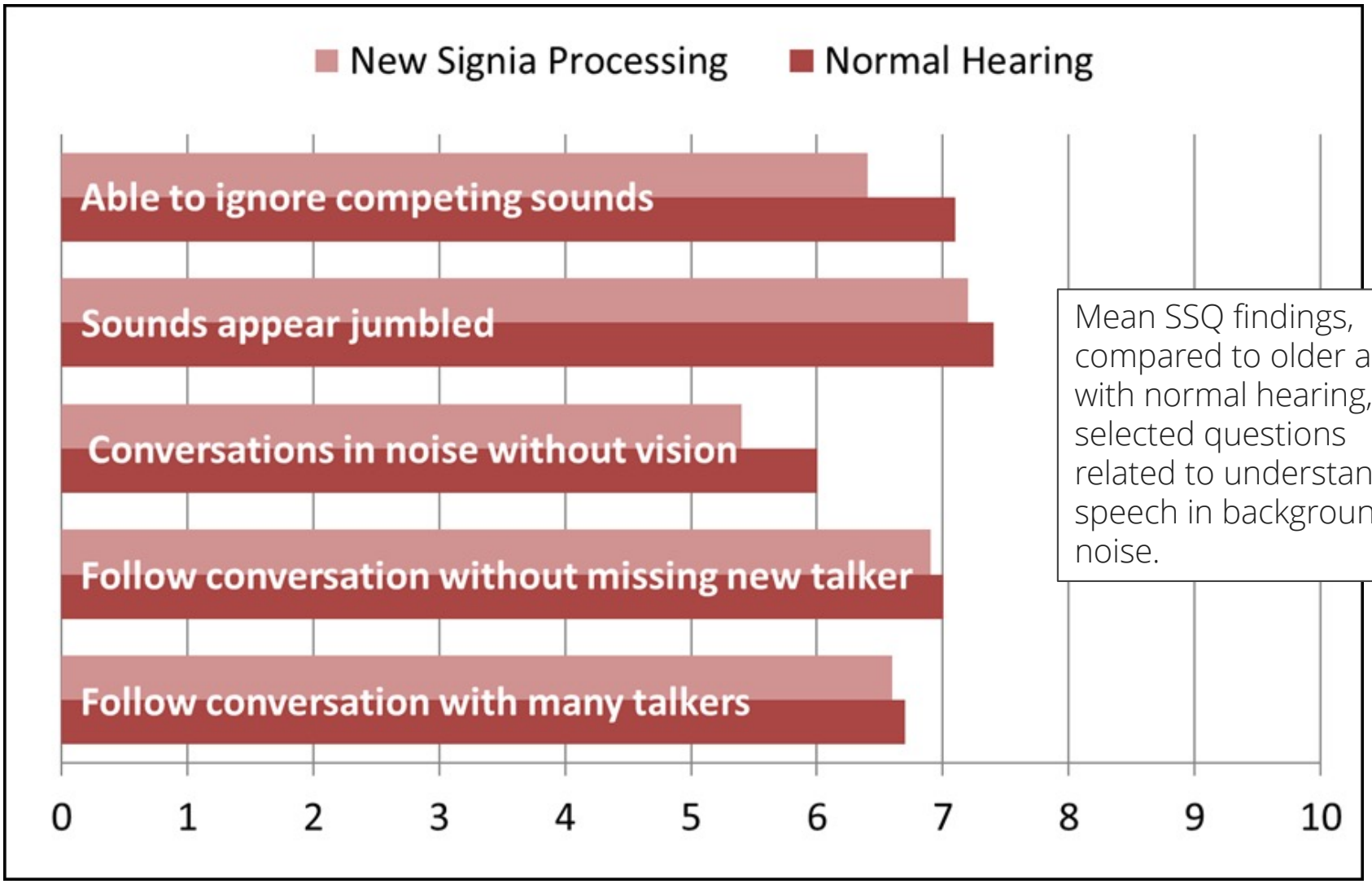
Results following several weeks of real-world listening with processing “On”



Mean SSQ findings, compared to older adults with normal hearing, for selected questions related to understanding speech in background noise.