

ReSound Clear Focus Outperforms Front Focus in Challenging Listening Situations

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Abstract

Hearing aids are commonly fit with both automatic and manually selectable listening programs. While the automatic program allows users to experience benefit of various sound processing features without the need to analyze their listening environment or take any physical action beyond wearing the hearing aids, the settings applied by the automatic program may not always match the user's intent. In addition, features may be "toned down" to provide a seamless, transparent listening experience. For cases where the user has a clear intent to optimize audibility of a talker in front, ReSound hearing aids provide strong noise management in the manually selectable program "Hear in Noise". With ReSound Vivia, an upgraded 4-microphone beamformer that extends the low frequency bandwidth of directional processing was introduced to the Hear in Noise program. It was anticipated that this could increase directional benefit in the Hear in Noise program relative to the legacy solution. A clinical study compared speech recognition in noise performance for people fit with the upgraded Clear Focus feature compared to the legacy Front Focus feature. A significant improvement in directional benefit of 1 dB was confirmed with Clear Focus.

One determinant of user satisfaction with hearing aids is related to whether they provide help in the varying situations where hearing difficulties are experienced. The more environments in which the hearing aids are found to be useful, the more likely the hearing aid user is satisfied.¹ There are two broad approaches to increasing the usefulness of hearing aids across listening situations. One is to provide automatic listening programs where the hearing aids analyze the listening environments and automatically apply and change settings to optimize benefit in each environment. The other – and more traditional – way is to provide multiple listening programs that can be manually selected by the user. Both approaches are commonly used today and are not mutually exclusive. Many users are fit with an automatic listening program intended for most daily use time as well as manually selectable programs for specific listening environments or needs. For example, optimum settings for music listening involve minimal signal modifications that will preserve dynamic range and fidelity; this is a different goal than settings for listening to human speech. Therefore, a pre-defined dedicated music listening program is available in most hearing aids today. Likewise, specialized programs for listening to speech in noise are common. In a study of hearing aid datalogging involving fittings from over 32,000 hearing aid users, nearly 58% of them were fit with more than one listening program. The greatest proportion of additional listening programs were for listening to speech in noise.²

Although manually selectable hearing aid programs have been readily available in hearing aids for nearly 30 years, they make more sense now than ever before for three important reasons. One is that the additional programs are simply more convenient to access. ReSound has set the standard in wireless connectivity in hearing aids at all technology levels which means that most users will have access to convenience features like ear-to-ear synchronization of programs when a program is activated on one hearing aid only as well as smartphone connectivity. With the latter, a connected app serves as a remote control that allows users to interact easily and effectively with their hearing aids and get the most out of the technology.³

The second reason that manually selectable hearing aid programs have increased in importance is that the decisions made by the automatic program may not always be consistent with the hearing aid user's listening intent. The algorithm which controls the settings that are automatically applied is based on analysis of the acoustic environment. While this allows a prediction of user intent with high probability, it does not guarantee alignment. This means that the settings applied, particularly in complex listening environments, may not be the most optimal for what the user wants to focus on at any given moment. Therefore, the option for the user to deliberately switch to the most optimum settings is smart.

The third reason supporting the fitting of manually selectable hearing aid programs is related to the effective noise reduction technologies that are available in hearing aids today, such as 4-microphone beamforming and single channel noise reduction based on deep learning. These types of features are often implemented in the automatic program, but their effectiveness may be softened or their activation may be limited to rare occurrences to ensure that jarring or unwanted changes in the sound do not occur. This can deprive the user of access to maximum effect of noise management features.

The ReSound approach to developing and applying hearing aid technology—rooted in the Organic Hearing philosophy—lets users rely on innate listening strategies in any listening environment. The automatic 360 All-Around program analyzes the acoustic scene and applies technologies that support how people naturally use their hearing in those scenes. However, the requirement for a transparent listening experience means that automatically applied changes must be gradual and their strength may be limited. As stated, directionality is one example. The 360 All-Around program uses a 3-band approach with strong 4-microphone binaural beamforming in the speech critical mid frequencies, a 2-microphone fixed directional response in the high frequencies, and omnidirectionality in the low frequencies. This approach yields impressive signal-to-noise ratio (SNR) improvement^{4,5} while preserving some binaural cues and ensuring seamless sound quality across the 360 All-Around listening modes.

In contrast, the user selectable “Hear in Noise” program in the most recent technology, the ReSound Vivia, makes use of an upgraded 4-microphone binaural beamformer where the low frequency directional response is extended to 250 Hz. Based on an earlier investigation that showed how increased low frequency bandwidth in directional processing could result in supplemental benefit of directionality in challenging listening situations,⁶ this upgrade has the potential to provide 1 to 2 dB additional SNR benefit. As implemented in the Hear in Noise program, this directional feature is called “Clear Focus”. The 3-band beamforming which is used in the 360 All-Around program in the ReSound Vivia is also used in the Hear in Noise program for legacy hearing aids and lower technology levels and is called “Front Focus”. The fact that these two versions of 4-microphone beamforming can be isolated in the Hear in Noise program allows us to document whether Clear Focus may provide the expected additional SNR improvement compared to Front Focus.

To learn how hearing aid users might benefit from the upgraded 4-microphone binaural beamformer a study focused on speech recognition in noise with Clear Focus and legacy Front Focus was carried out.

Methods

Participants

Twenty participants with mild-to-moderate bilateral sensorineural hearing loss participated in the test (14 male and 6 female). The test participants’ median age was 76 years with a 1st quartile of 68 years and a 3rd quartile of 79 years. The test participants were experienced hearing aid users and current users of premium Receiver-in-the-Ear (RIE) hearing aids. The median years of experience with amplification was 10 years (1st quartile: 5 years and 3rd quartile: 15 years).

Hearing aids, fitting and test conditions

One pair of ReSound Vivia 7 miniRIE with Front Focus and one pair of ReSound Vivia 9 miniRIE with Clear Focus were fitted binaurally with power domes to optimize the 4-microphone binaural beamformer and noise reduction benefit. The only difference between the two pairs of hearing aids as fitted were Front Focus versus Clear Focus. The hearing aids were fitted to each test participant’s individual hearing loss and experience with amplification based on the proprietary Audiogram+ fitting rationale. The hearing aids were fitted with the Hear in Noise program. Table 1 summarizes the directional response and noise reduction characteristics of the Hear in Noise program with Clear Focus alongside those of the legacy Front Focus.

	Noise reduction system	Directional response
Clear Focus	Noise Tracker II	Binaural beamforming 250 - 5000 Hz
Front Focus	Noise Tracker II	Binaural beamforming 500* - 5000 Hz

*For miniRIE; the precise frequency depends on the hearing aid style.

Test material

The participants completed a speech recognition in noise test that is a slightly modified version of the Dantale II test.⁷ The test is comprised of 5-word sentences and was presented in a background of static speech-shaped noise at 65 dB SPL. Thirty sentences were administered for each test. The level of the speech was manipulated to determine a speech reception threshold (SRT) for 50% correct performance, resulting in a dB SNR score. A lower dB SNR score indicates better performance. The hearing aids tested have adaptive features that rely on identification of speech and noise in the environment. To ensure that all adaptive features were activated during testing, the Dantale II test noise was started 60 seconds before testing was initiated.

Test setup

Testing was completed with the participants seated in a sound booth with speech presented at 0 degrees azimuth, and static noise presented at 90, 180, and 270 degrees azimuth. The testing order of conditions and the sentence lists were counterbalanced across participants.

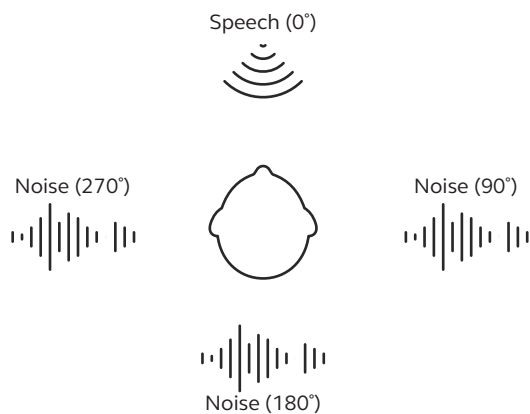


Figure 1. Test setup used for measuring SRTs with adaptive SNRs for a front talker in Front Focus- and Clear Focus modes with ReSound Vivia.

Results and discussion

Clear Focus provided a mean significant improvement of 1 dB in SNR for a SRT of 50% performance over Front Focus ($p < 0.00001$). This result confirms expectations based on the study mentioned previously.⁶ In that study, the effect of the Directional Mix setting—which sets the crossover frequency between directional and omnidirectional processing in the low frequencies—was found to change the amount of directional benefit for occluding fittings. As the directional processing was extended to lower frequencies by increasing Directional Mix, the measured directional benefit also increased. For each step up in Directional Mix, directional benefit was observed to increase about 1 dB. Because the difference in directional bandwidth between Clear Focus and Front Focus is similar to the difference between the crossover frequencies for two adjacent Directional Mix settings, Clear Focus was correctly anticipated to provide at least 1 dB more directional benefit than Front Focus.⁸

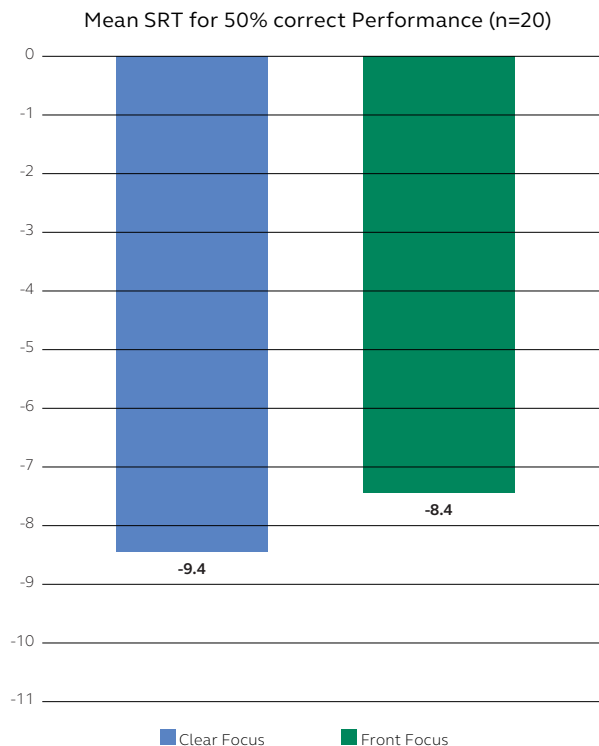


Figure 2. Test participants' mean dB SNR score for 50% speech reception threshold (SRT) with Clear Focus and legacy Front Focus. Error bars show 95% confidence intervals.

Conclusion

Directional performance of Clear Focus is significantly better than the legacy Front Focus. The improvement was 1 dB SNR, which for the Dantale II speech material would correspond to a 13% percent-point improvement in speech recognition score.⁸ This result supports the upgrade to Clear Focus in the Hear in Noise program for on-demand optimized SNR benefit in noisy environments where the user chooses to maximize a talker in front.

References

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