PHONAK
life is on

A Sonova brand

Phonak Insight.

Phonak Audéo™ R Infinio outperforms competitors for speech in loud noise performance

Infinio Ultra introduces AutoSense OS™ 7.0, which automatically steers dedicated features more precisely to address the most challenging listening situation: understanding speech in loud noise. Tested under realistic conditions, Audéo R Infinio outperforms four other brands, generating the largest SNR improvement for speech from different directions – automatically.

Preuss, M., Ulloa Sanchez, D., October 2025

Introduction

In today's world, effective communication is essential, particularly in challenging listening environments. Market research underscores the importance of speech understanding in such listening situations. Recent surveys revealed that both hearing aid owners and non-owners ranked the ability to comprehend speech in noisy environments as paramount, with 1:1 conversations in noise and group discussions being the top priorities (Appleton, 2022). Furthermore, insights from over 200 hearing care professionals in the US and Germany highlighted that speech understanding, sound quality, and reliability are the most critical factors when selecting hearing aids for clients (Knorr, 2022).

Speech understanding in noise is a critical aspect of human communication, significantly influencing social interactions, emotional well-being, and overall quality of life. The ability to discern speech amidst competing sounds is not merely a convenience; it is essential for effective communication, particularly in environments characterized by high ambient noise levels, such as restaurants, social gatherings, or public spaces. Research indicates that individuals with hearing loss face considerable challenges in these settings, often leading to feelings of isolation and frustration (Abrams & Kihm, 2015).

Recent advancements in hearing aid technology have significantly improved the way users experience sound, especially in settings with both speech and loud noise. Features like AutoSense OS, for example, accurately detect a listening situation as speech in loud noise, utilizing sophisticated artificial intelligence to analyze the acoustic environment in real-time. Infinio Ultra is introducing AutoSense OS 7.0, AI trained with 18 times more sound samples, resulting in a 24% more precise adaptation to listening situations. The accurate classification of a sound environment as speech in loud noise enables features such as StereoZoom 2.0 and Dynamic Noise Cancellation to work synergistically, enhancing speech understanding (Latzel, 2022) and reducing listening effort (Appleton, 2020). This is particularly important given that hearing aid users require a better signal-to-noise ratio (SNR) than their normal-hearing counterparts to achieve comparable levels of speech understanding (Killion, 1997).

Another feature that clients benefit from in a speech in loud noise environment is SpeechSensor. A study by Walden et al. (2004) found that while 80% of target signals originate from the front, 20% come from other directions, highlighting the prevalence of listening situations where users may not be facing the speaker (Hayes, 2019). SpeechSensor identifies the location of dominant speech and shares this information with Autosense OS, allowing for adaptive directionality adjustments, improving access to speech from various angles in challenging listening environments. By activating Fixed Directional and Real Ear Sound microphone modes, when speech is located from the side or behind, respectively, SpeechSensor improves speech understanding and reduces the listening effort compared to StereoZoom (Latzel, 2022).

This paper describes a systematic technical study, examining how Audéo R Infinio performs in challenging listening environments when compared to premium devices from four key competitive products. We are particularly interested in analyzing the performance of the features, allowing us to gain deeper insights into the capabilities of the Audéo R Infinio and four additional premium devices.

To provide a more accurate representation of hearing aid performance in real-world scenarios, all hearing aids have been evaluated using their automatic programs (see section on hearing aid fittings). Noise is presented from all around, including the direction of speech, creating an ambisonic listening environment (see methodology). This approach ensures that the assessment reflects the typical acoustic environments and listening conditions that clients are likely to experience while using the devices. Additionally, it acknowledges the importance clients place on hearing aids that automatically adapt to varying listening situations without the need to change the hearing aid program manually (Knorr, 2022). Despite the preference of clients for automatic hearing aids, some manufacturers have introduced innovations in the space of Deep Neural Networks (DNN) that are limited to use within manual programs only to address this listening need. To generate additional insights, device A's manual program was also factored into these technical measurements, assuming clients know how to access it when needed, with the understanding that clients may need guidance on how to access the program effectively. While this program offers potential benefits, factors such as unfamiliarity, inconsistent use, and the possibility of misjudgment in activation may introduce some complexity and may influence the overall hearing experience.

Methodology

Measurement Setup

All measurements took place in an acoustically treated room with a reverberation (RT60) time of 0.15 seconds. Twelve Genelec 8020D loudspeakers (Genelec, Finland), were arranged in a circle with a 1.5 m radius, leading to a 30° distance between any two adjacent loudspeakers. A KEMAR mannequin (GRAS Sound & Vibration, Denmark) with anthropometric ears was placed at the center of the loudspeakers and oriented towards 0°. The center of the ear canal of the KEMAR mannequin was at the same height as the loudspeakers (1.3m). An RME M-16 DA converter (Audio AG, Germany) was used to send the audio to the active loudspeakers; an RME Fireface 802 USB soundcard (Audio AG, Germany) was used to record the audio from the KEMAR ear-canal microphones.

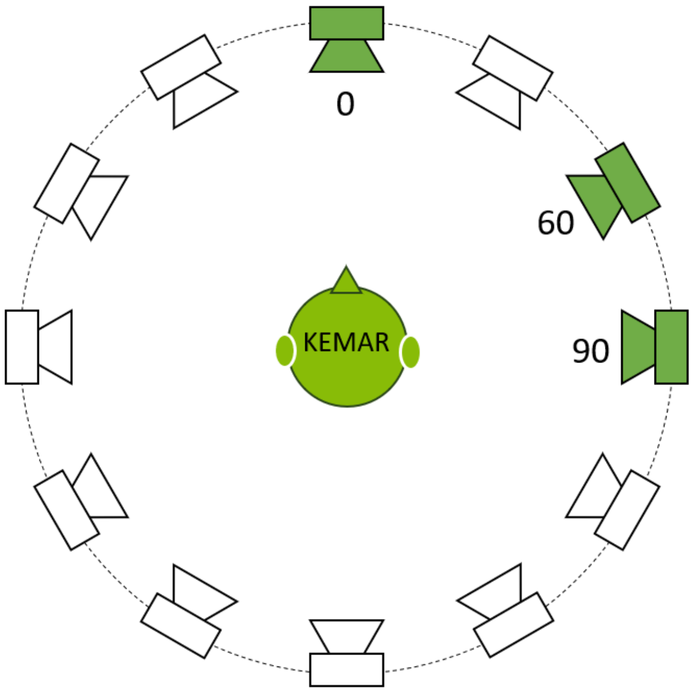

Figure 1. Top-down view of the setup: 12 Genelec 8020D loudspeakers were arranged in a circle with a 1.5m radius. A KEMAR mannequin with anthropometric ears was placed at the center of the loudspeakers and oriented towards 0°. The center of the ear canal of the KEMAR mannequin was at the same height as the loudspeakers. The ISTS signal was presented consecutively at individual angles of 0°, 60°, and 90°.

Background noise and target speech

The realistic cafeteria sound scene from the ARTE database was used as background noise (Weisser et al. 2019) and the scene was presented at 71.7 dB SPL.

The background noise was mixed with the ISTS speech signal (Holube et al. 2010) to achieve a free-field SNR of 0 dB SNR for the café scene. The ISTS signal was presented consecutively at individual angles of 0°, 60°, and 90° as shown in figure 1.

The ARTE scene is a Higher-order Ambisonics (HoA) recording. The ARTE recording was decoded and played back in the horizontal plane through all 12 loudspeakers. To overcome drawbacks like spatial aliasing of standard HoA decoding, the Coding and Multi-Parameterization of Ambisonic Sound Scenes (COMPASS) method was used for decoding of the continuous background signals (Politis et al. 2018).

The ISTS signal was convolved with the impulse response of the respective scene. The room impulse responses (RIR) were decoded using the Higher-order Spatial Impulse Response Rendering (HO-SIRR) method by McCormack et al. (2020). The reverberation times (RT60) were 1.1 seconds for the café scene. As described above, the room had an RT60 of 0.15 seconds, which was not accounted for in the decoding.

Stimulus presentation

Figure 2 shows an overview of the stimulus presentation. Before each measurement, 40 seconds of the ISTS speech signal and background noise were played to allow the hearing instruments to settle. The evaluation period was 30 seconds per Hagerman phase-inversion block, i.e. the first 30 seconds of the ISTS speech signal and cafeteria background noise were repeated with the respective Hagerman phase, leading to a total acquisition time of 130 seconds for the test condition.

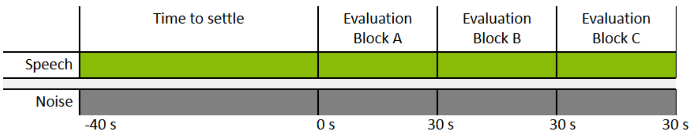

Figure 2. Stimulus presentation: Before each measurement, 40 seconds of the ISTS speech Signal and cafeteria background noise were played to allow the hearing instruments to settle. The evaluation period consisted of additional 90 seconds.

Hagerman and Olofsson Phase-Inversion Method

Hagerman and Olofsson (2004) describe a method to extract the signal and noise components of a simultaneous presented audio signal. For the Hagerman and Olofsson test, multiple recordings take place, whereas the phase of one signal (speech or the sum signal of the superimposed noise signals) is inverted between the measurements. This phase inversion method allows to separate the signal (S') and the noise (N') at the output of the hearing aid and the calculation of the signal-to-noise ratio (SNR'). The Hagerman error distance was greater than 15 dB (SII-weighted) for each signal investigated and for all measurement conditions, including all tested devices.

SII-weighting

The signal-to-noise ratio (SNR) improvement was frequency weighted based on the band importance function according to the speech intelligibility index (SII, ANSI S3.5/1997, Table 3).

Hearing aid fittings

For the hearing aid fittings, a symmetrical insertion gain of 10 dB in a frequency range of at least 100 Hz and 10.000 Hz was set up for all devices and a fully occluding ear coupling was selected. The real ear occluded gain (REOG) as well as the insertion gain were measured using pink noise. Across all devices, REOG relative to the unaided condition was at least 10 dB below the unaided level (i.e., ≤ -10 dB) from 100 Hz to 20 kHz, indicating a strong occlusion effect.

For each device, the proprietary fitting formula was used, and the highest experience level was chosen. The automatic program with default feature settings was applied for all devices. To accurately evaluate the performance and capabilities of each hearing aid under standardized testing conditions, the feedback management system was deactivated in each device to facilitate the application of the Hagerman and Olofsson (2004) method. The power output was set to its maximum level (MPO) and a compression ratio of 1:1 across all devices to eliminate the effects of nonlinearities.

Since manufacturer A does not allow activation of all features settings in the automatic program, a dedicated manual program was included during the measurements. This inclusion allowed for a comprehensive evaluation of the device's performance in challenging listening environments.

Results

Figures 3, 4, and 5 show the signal-to-noise ratio (SNR) improvement of each manufacturer's automatically activated hearing aid program when processing speech that was presented from different directions while in a loud noise field, as compared to the unaided condition. The higher the SNR, the better the hearing aid is at separating speech from noise, resulting in clearer speech for the client. The overall level and SNR used during measurements simulate a natural speech in loud noise environment, resulting in a high probability that hearing aids with sound scene analysis trigger settings for such a scenario. For Audéo R Infinio it was technically confirmed that this combination of speech

and noise results in the activation of the speech in loud noise program.
Figure 3 shows the SNR improvement with speech oriented at 0°. Audéo R Infinio achieves an SNR improvement at least 2.9 dB higher than the closest device's automatic program. Even the manual selection of a manufacturer's dedicated speech in loud noise program yields in a smaller SNR improvement. This highlights two primary advantages of Audéo R Infinio: it offered the largest SNR improvement when processing speech originating from the front when facing a conversation partner in noisy environments, while activating the Speech in Loud Noise program automatically through AutoSense OS.

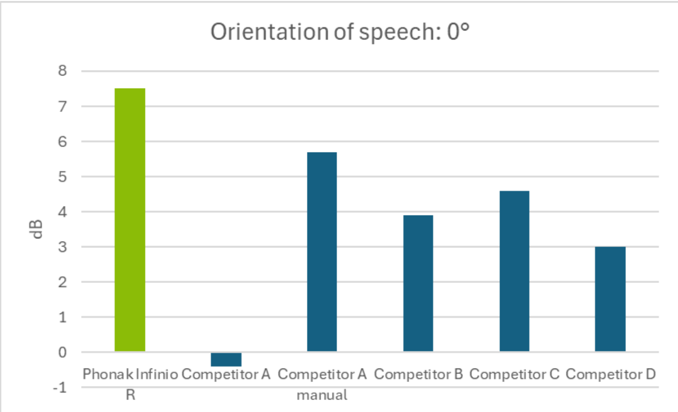

Figure 3: Device comparison: SII-weighted signal-to-noise ratio (SNR) improvements with respect to unaided. Results are presented for a fully occluded coupling and for the better ear. The speech signal was presented from 0° azimuth.

Figure 4 illustrates the performance of Audéo R Infinio in comparison to the other devices when processing speech oriented at 60°. It demonstrates a significant advantage, achieving a SNR improvement of 7.8 dB, exceeding the performance of devices A, B, C, and D, all of which demonstrate smaller SNR improvements, including the manual program offered by device A.

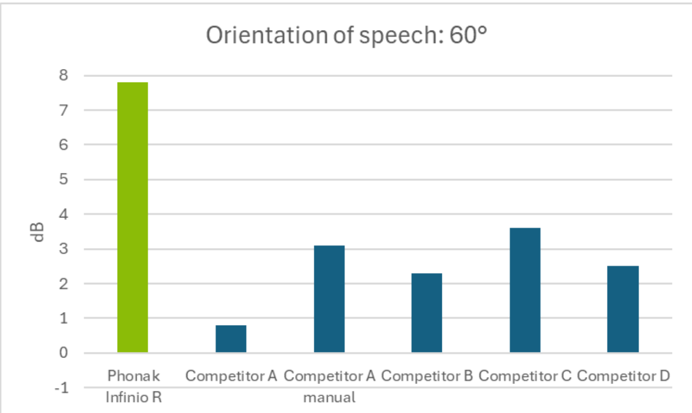

Figure 4: Device comparison: SII-weighted signal-to-noise ratio (SNR) improvements with respect to unaided. Results are presented for a fully occluded coupling and for the better ear. The speech signal was presented from 60° azimuth.

Figure 5 illustrates the performance of the Audéo R Infinio when processing speech oriented at 90°. For speech oriented at 90°, SpeechSensor will automatically enhance access to speech that is not coming from the front, by changing the microphone directionality from StereoZoom 2.0 to Fixed Directional, resulting in a seamless listening experience. Audéo R Infinio, again, demonstrates a clear advantage, achieving an SNR improvement larger than all other tested devices.

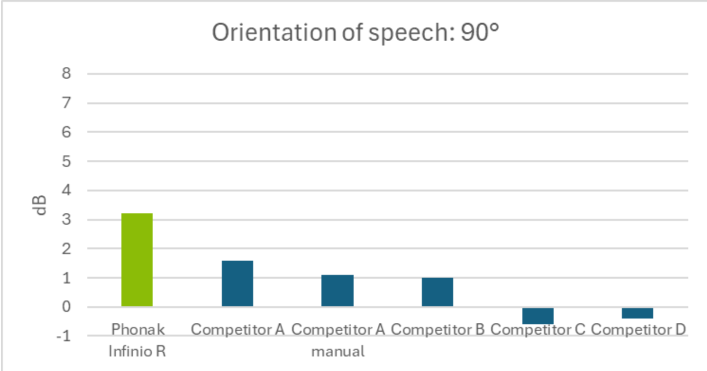

Figure 5: Device comparison: SII-weighted signal-to-noise ratio (SNR) improvements with respect to unaided. Results are presented for a fully occluded coupling and for the better ear. The speech signal was presented from 90° azimuth.

Trends across orientations

Audéo R Infinio consistently outperformed all tested devices across all three orientations (0°, 60°, and 90°).
Overall, this automatic performance, leveraging the capabilities of StereoZoom 2.0, Dynamic Noise Cancellation and SpeechSensor, achieves leading SNR improvement, which may translate to an optimal listening experience for clients.
As the orientation of speech moves from 0° to 90°, the overall SNR improvement decreased for all hearing aids. This suggests that the ability of all devices to separate speech from noise effectively decreases as the angle of the sound source changes.
Audéo R Infinio maintained the largest improvement even at 90°, indicating robustness to the challenges of complex listening environments.

Conclusion

Beneficial outcomes for clients arise from the combination of precise classification and the capabilities of sophisticated processing features. The results of these measurements show that Audéo R Infinio provided the largest SNR improvements across all tested devices and sound field orientations. In contrast, the other tested devices, including one that allows the use of a dedicated manual DNN program, exhibit lower SNR improvements compared to Audéo R Infinio.

This disparity indicates that the Audéo R Infinio is well-suited for real-world listening situations, effectively overcoming challenges by delivering larger SNR improvements for speech in noisy environments, whether the sound source is directly in front of the client or coming from the side. DNN-based denoising holds proven potential (Wright, 2024) which has driven growing interest in the approach. However, unveiling the full potential of DNN-based denoising depends on end-to-end integration that requires significant processing power & chip capabilities. It becomes evident that a DNN by itself, as introduced by other manufacturers to date, does not yield superior performance relative to the Audéo R Infinio feature set.

References

Abrams, H. B. & Kihm, J. (2015). An introduction to MarkeTrak IX: A New Baseline for the Hearing Aid Market. Hearing Review, 22(6).

Appleton, J. (2020) AutoSense OS 4.0 - significantly less listening effort and preferred for speech intelligibility. Phonak Field Study News. www.phonak.com/evidence

Appleton, J. (2022). What Is Important to Your Hearing Aid Clients…and Are They Satisfied? Hearing Review. 29 (6).

Hagerman, B., & Olofsson, A. (2004). A Method to Measure the Effect of Noise Reduction Algorithms Using Simultaneous Speech and Noise. Acta Acustica united with Acustica, 90, 356-361.

Hayes, D. (2019). Speech detection by direction. Unitron White Paper. Retrieved from: https://www.unitron.com/au/en_au/learn/speechdetection-by-direction0.html, accessed August 23rd, 2022.

Holube, I., Fredelake, S., Vlaming, M., Kollmeier, B. (2010). Development and analysis of an international speech test signal (ISTS). International Journal of Audiology, 49(12), 891–903.

Killion, M. C. (1997). The SIN report: Circuits haven't solved the hearing-in-noise problem. Hearing Journal, 50(10), 28-32.

Knorr, H (2022). Market Research ID # 4583. Please contact marketinsight@phonak.com if you are interested in further information.

Latzel, M., Lesimple, C., & Woodward, J. (2022). New implementation of directional beamforming configurations show improved speech understanding and reduced listening effort. Phonak Field Study News. https://www.phonak.com/evidence

McCormack, L., Pulkki, V., Politis, A., Scheuregger, O. & Marschall, M., (2020). Higher-Order Spatial Impulse Response Rendering: Investigating the Perceived Effects of Spherical Order, Dedicated Diffuse Rendering, and Frequency Resolution. Journal of the Audio Engineering Society, 68(5), 338-354.

Politis, A., Tervo S., & Pulkki, V. (2018). COMPASS: Coding and Multidirectional Parameterization of Ambisonic Sound Scenes. IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP)

Walden B. E., Surr R. K., Cord M.T., & Dyrlund O. (2004). Predicting hearing aid microphone preference in everyday listening. J Am Acad Audiol. 15(5):365-96.

Weisser, A., Buchholz, J. M., Oreinos, C., Badajoz-Davila, J., Galloway, J., Beechey, T., & Keidser, G. (2019). The Ambisonic Recordings of Typical Environments (ARTE) database. Acta Acustica united with Acustica, 105, 4, 695-713.

Wright, A., Kuehnel, V., Keller, M., Seitz-Paquette, K., Latzel, M. (2024). Spheric Speech Clarity applies DNN signal processing to significantly improve speech understanding from any direction and reduce the listening effort. Phonak Field Study News retrieved from https://www.phonak.com/evidence

Authors and investigators

Michael Preuss, Senior Audiology Manager at Phonak HQ

Michael joined Phonak HQ as an Audiology Manager in 2020. Drawing on his experience as a lecturer at the Academy of Hearing Acoustics in Lübeck and his personal experience with hearing loss, Michael provides audiological input during product development and conducts in-depth expert training sessions. He holds a B.Sc. in Hearing Acoustics from the University of Applied Sciences in Lübeck, Germany.

Diego Ulloa Sanchez, Hearing Performance Engineer

Diego's current focus is on the development and verification of acoustical product performance in hearing aids and accessories. He earned both his B.Sc. and M.Sc. in Health, Science, and Technology from ETH Zurich, where he completed his Master's thesis at Sonova in 2020. Prior to his current role, Diego served as a Clinical & Technical Specialist in the field of cochlear implants.

PHONAK life is on

A Sonova brand

Phonak Insight.

One-page summary

Phonak Audéo™ R Infinio outperforms competitors for speech in loud noise performance

Infinio Ultra introduces AutoSense OS™ 7.0, automatically steering dedicated features more precisely to address the most challenging listening situation: understanding speech in loud noise. Tested under realistic conditions, Audéo R Infinio outperforms four other brands.

Preuss, M., Ulloa Sanchez, D., October 2025

Key highlights

- Utilizing AutoSense OS 7.0, which automatically steers features such as StereoZoom 2.0, Dynamic Noise Cancellation and SpeechSensor more precisely than ever before, Audéo R Infinio enhances speech clarity, and reduces listening effort, particularly in challenging environments (Latzel, 2022).
- Audéo R Infinio outperforms four other brands, achieving the largest SNR improvement in challenging listening situations. A DNN by itself, as introduced by other manufacturers to date, does not yield in superior performance relative to the Audéo R Infinio feature set.
- Audéo R Infinio maintains the strongest SNR performance even when speech is oriented at angles up to 90°, demonstrating its effectiveness in diverse listening scenarios.

Considerations for practice

- Effective communication in noisy environments is crucial for social interactions and emotional well-being, with speech understanding in noise being the number one listening need of clients (Appleton, 2022).
- Audéo R Infinio is a top choice for those prioritizing speech understanding in noise, as it offers the highest SNR improvement across multiple directions, enhancing speech clarity in real-world settings.
- Audéo R Infinio automatically adjusts to different listening situations, enhancing the user experience without the need for manual activation.

Latzel, M., Lesimple, C., & Woodward, J. (2022). New implementation of directional beamforming configurations show improved speech understanding and reduced listening effort. Phonak Field Study News.

https://www.phonak.com/evidence

Appleton, J. (2022). What is important to your hearing aid clients… and are they satisfied? Hearing Review, 29(6), 10-16.