Superior speech clarity and access to speech cues

Oticon Intent™ competitive benchmark

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Summary
Unlike standard speech-in-noise test setups where noise comes from behind, real-life situations involve noise coming from all directions and often from the same direction as the speech signal. Here, we evaluate Oticon Intent™ against four top competing brands when simulating an intimate conversation in a diffuse listening situation with speech coming from the front or from the side. The results show that Oticon Intent provides superior support to users, with a speech clarity improvement of up to 4 dB compared to other brands, yielding up to 45% more access to speech cues in a realistic very complex sound scene. Oticon Intent is the only hearing aid that provides a speech clarity enhancement from speech coming both from the front and the side across varying levels of environment complexity.

Introduction
Conventional hearing aid technology faces limitations in busy environments like restaurants or family dinners, where separating speech from distracting noise is challenging.

This is because traditional directionality and noise reduction processing in hearing aids are geared towards enhancing front-facing speech and reducing noise from other directions.

However, in complex real-life environments, noise may come not solely from behind but also from other directions including the front. We report on a systematic technical evaluation of Oticon Intent and four other premium brands to compare the provided listening support for speech in a more realistic listening scenario than what is commonly employed.

Signal-to-noise ratio (SNR) enhancement
- An objective measure that estimates the additional contrast between the foreground speech and the background noise produced by the hearing aid. Increased contrast indicates clearer speech.
- Calculated with the phase-inversion method[1] as the output SNR difference between aided and unaided recordings, the latter serving as the baseline prior to any modification made by the hearing aids.

Speech Intelligibility Index (SII)[2]
- An objective standardized speech intelligibility metric to quantify access to speech cues, using weights based on the importance of each frequency band to speech understanding, thus reflecting human speech perception.
- Predicts speech intelligibility by considering factors such as speech signal clarity, background noise presence, and listener hearing ability. Higher SII values indicate improved access to speech cues and greater intelligibility chances.

Test setup
We simulated an intimate conversation in a busy restaurant and recorded the hearing-aid output using a head-and-torso simulator (HATS) (Figure 1).

- HATS positioned at the centre of a loudspeaker array in an acoustically treated sound studio.
- Oticon Intent and the latest premium hearing aids from four competing brands.
- All hearing aids set to default prescribed* settings for a moderate hearing loss (N3 standard audiogram[3]) with power domes to prevent direct sound from entering the ear canal.
- Outcome measures documented for the left ear.
- Foreground speech: A single talker positioned either directly from the front at 0° or 45° to the side and played at 65 dB SPL.
- Background noise level set to 60, 65 or 70 dB SPL,corresponding to a less complex situation at 5 dB input SNR, a complex situation at 0 dB input SNR, and a very complex situation at -5 dB input SNR, respectively.**

Note that the condition with speech at 45° is more challenging for hearing aids, as directionality alone is not sufficient to separate speech and noise originating from the same direction.

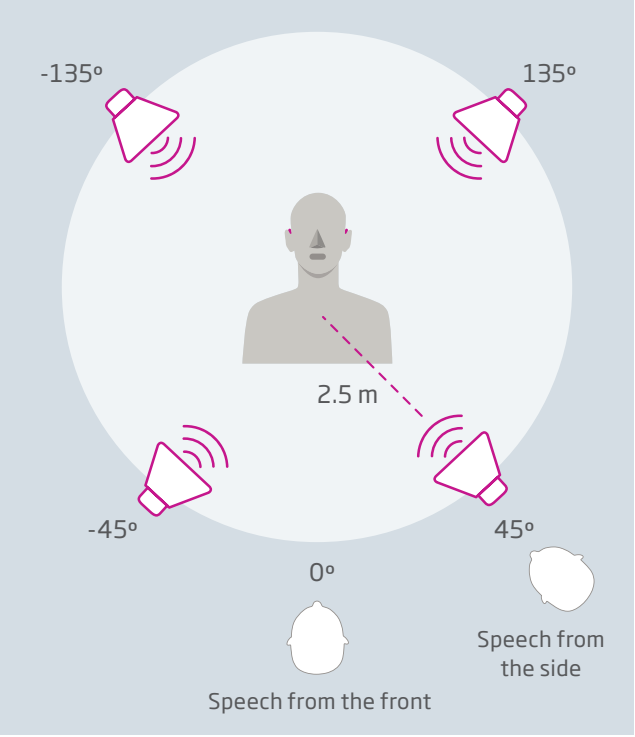

Figure 1: Sound set-up with speech originating from the front or the side and noise from the four loudspeakers.

Superior speech clarity
Figure 2 shows the measured output SNR enhancement for Oticon Intent and the four other brands in the complex and very complex situation.

- **Complex situation**: For both speech from the front and speech from the side***, Oticon Intent outperformed all brands by up to 2.9 dB in terms of output SNR enhancement.
- **Very complex situation**: For both speech from the front and speech from the side***, Oticon Intent outperformed three out of four brands, with up to 3.8 dB improvement in terms of output SNR enhancement, and was on par with Brand D.
- Among all tested hearing aids, Oticon Intent was the only hearing aid that consistently adapted to environment complexity and provided an output SNR enhancement of at least 0.5 dB for a default fitting in all of the following cases (Table 1):
  - For speech from the front in both complex and very complex situations
  - For speech from the side and noise from the same direction as the speech in both complex and very complex situations
  - In a less complex situation with an input SNR of +5 dB****

** Feedback and transient noise management features were deactivated to ensure validity of the phase-inversion method.*
*** The calibration of the sound was performed with the reference point positioned at 0°.*
**** Output SNR was generally lower for all brands for speech from the side. This was in part because of the more challenging situation of speech being collocated with a noise source, and in part because speech was on the better-ear side, and therefore less processing was applied by the hearing aids.*
***** Additional measurements at 5 dB input SNR showed that only Oticon Intent (1.4 dB) and Brand A (1.2 dB) could still provide an output SNR enhancement above 0.5 dB in this less complex situation.*

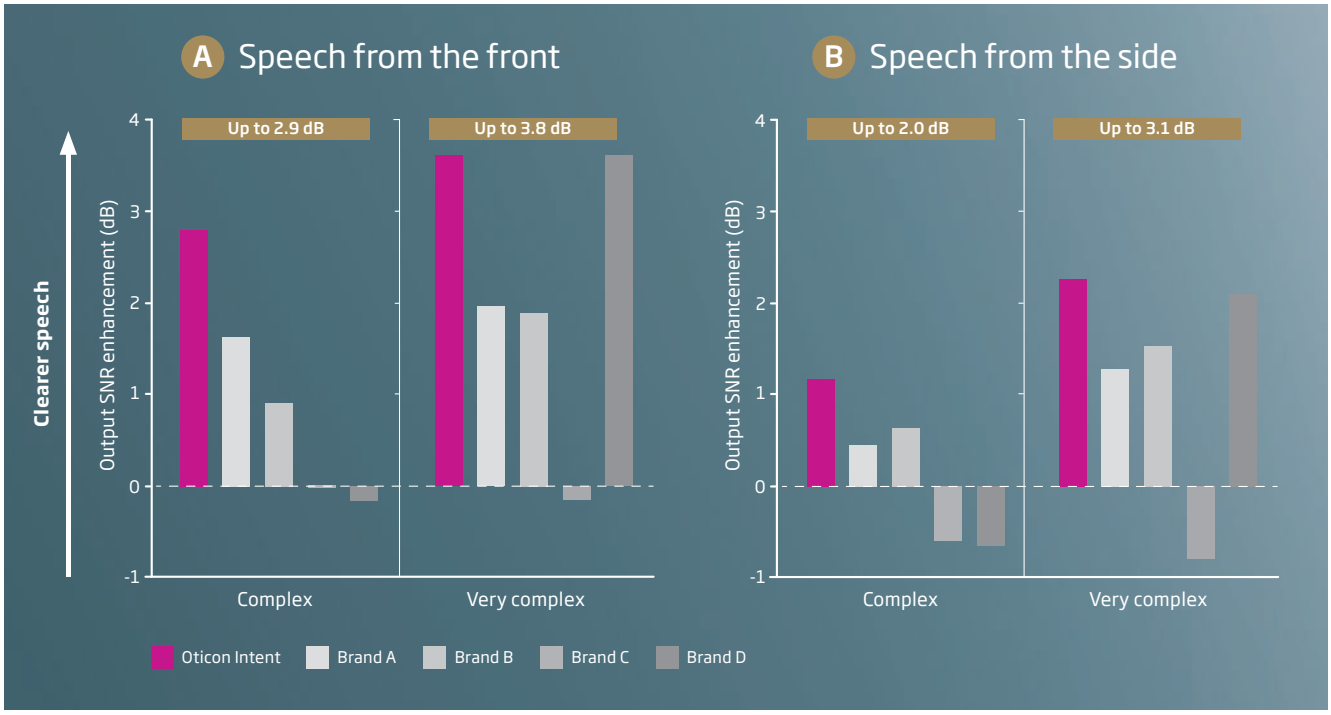

Figure 2: Output SNR enhancement for Oticon Intent and four other brands measured in a complex and a very complex situation for speech from the front at 0° (A) and speech from the side at 45° (B).

Speech clarity enhancement	Oticon Intent	Brand A	Brand B	Brand C	Brand D
In both complex and very complex situations with speech from the front	●	●	●		
In both complex and very complex situations with speech from the side and noise from the same direction as the speech	●		●		
In a less complex situation	●	●			
In an adaptive manner to environment complexity	●	●	●		●

Table 1: Summary of fulfilled criteria for each tested hearing-aid brand. Each dot indicates that at least 0.5 dB output SNR enhancement is provided by the hearing aid.

Improved access to speech cues

Figure 3 shows access to speech cues, as estimated from the SII, for Oticon Intent and the four competitor hearing aids in a complex and a very complex listening situation.

- **Complex situation**: For both speech from the front and speech from the side, Oticon Intent outperformed all brands, with a relative SII difference of up to 22% for speech from the front and up to 14% for speech from the side,* compared to Brand D.
- **Very complex situation**: Oticon Intent provided a relative SII difference of up to 45% for speech from the front and up to 28% for speech from the side*, compared to Brand C.

DID YOU KNOW?

Moresound Intelligence (MSI) 3.0 surpasses traditional technology by adapting the contrast between foreground and background sounds based on predicted user intent. Empowered by 4D Sensor technology, Oticon Intent assesses user intentions by combining data from motion and acoustic sensors, while the upgraded Deep Neural Network (DNN) 2.0 ensures superior noise suppression. Further details on the technological advances of MSI 3.0 can be found in Brændgaard/Zapata-Rodríguez et al. (2024)[4].

** Higher SII values are observed for speech from the side because the speech is located on the better-ear side, thus increasing the speech level at the hearing-aid input.*

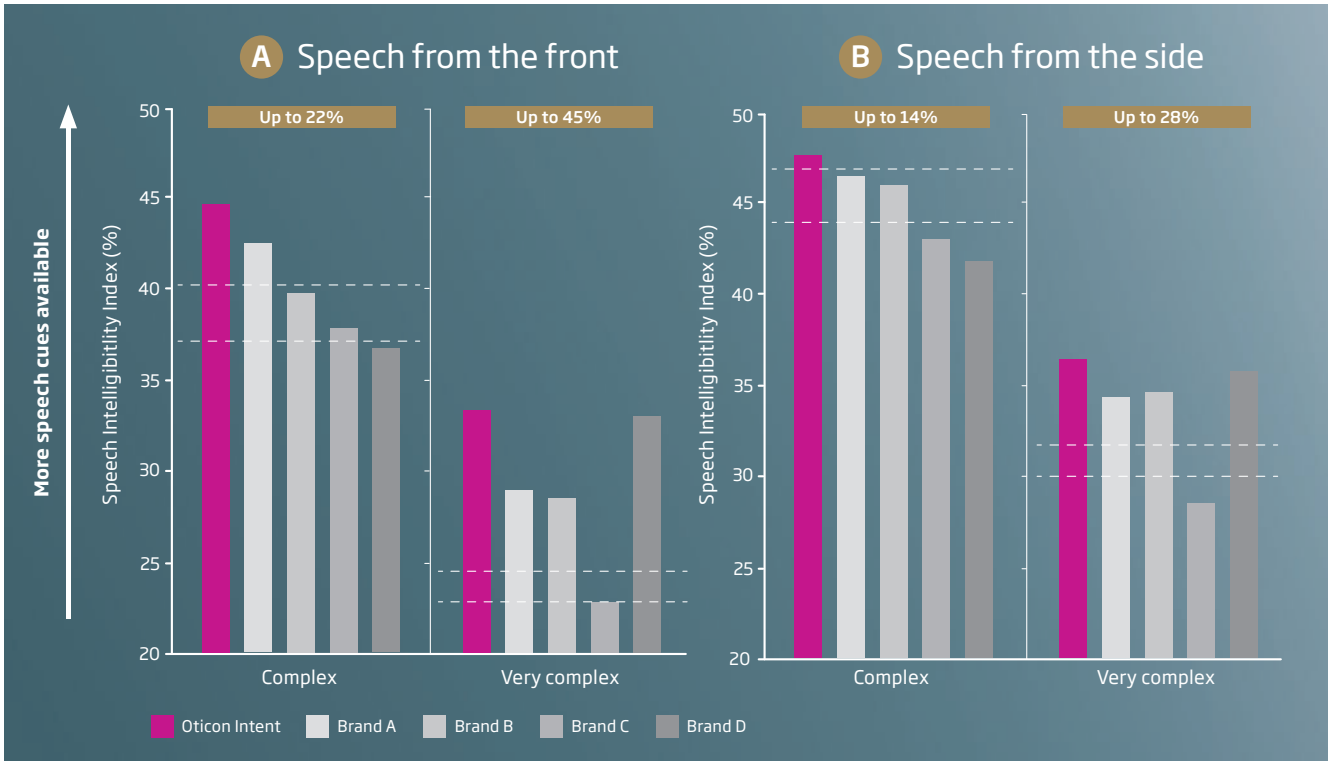

Figure 3: Speech Intelligibility Index for Oticon Intent and four other brands measured in a complex and a very complex situation for speech from the front at 0° (A) and speech from the side at 45° (B). The top dashed lines indicate the SII for a normal-hearing person without a hearing loss. The bottom dashed lines indicate the SII for a person with a moderate hearing loss not wearing hearing aids.

CONCLUSION

Oticon Intent offers superior speech clarity and access to speech cues compared to top brands, enhancing the user's ability to communicate more effectively in real-life scenarios, and when noise comes from the same direction as the speech. Such situations cannot be handled by traditional directionality, which further highlights the superior capabilities of MSI 3.0 with DNN 2.0.

REFERENCES

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4. Brændgaard, M./Zapata-Rodriguez, V., Stefancu, I., Sanchez Lopez, R., & Santurette, S. (2024). Oticon Intent - Technical review and evaluation. 4D Sensor technology and Deep Neural Network 2.0 in Oticon Intent. Oticon whitepaper.

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