The essence of the SIN problem is that the primary speech signal and some secondary sounds (ie, noise) are essentially the same thing! That is, both speech and speech babble noise originate with human voices with similar spectral and loudness attributes, rendering the “SIN” problem difficult to solve. The signal-to-noise ratio (SNR) loss Killion11 reported people with substantial difficulty understanding speech in noise may have significant “SNR” loss. Of note, the SNR loss is unrelated to, and cannot be predicted from, the audiogram. Killion defines SNR loss as the increased SNR needed by an individual with difficulty understanding speech in noise, as compared to someone without difficulty understanding speech in noise. He reports people with relatively normal typical SNR ability may have difficulty understanding speech in noise 50% of the sentences spoken in noise, whereas people with mild-moderate sensorineural hearing loss may require an 8 dB SNR to achieve the same 50% performance. Therefore, for the person who needs an 8 dB SNR, we subtract 2 dB (normal performance) from their 8 dB score, resulting in a 6 dB SNR loss.

Beck and Flexer13 reported “Listening is about 3 dB, and they report for more people with relatively normal/typical SNR ability the smallest detectable SNR difference for a person with normal hearing is about 3 dB, and they report for more clinically relevant tasks, a 6 to 8 dB SNR may be required. In this article, we’ll address concepts and issues associated with understanding speech-in-noise, and, importantly, we’ll share results obtained while comparing SIN results with Oticon Opn and two major competitors, in a realistic acoustic environment. Traditional Strategies to Minimize Background Noise

As noted above, the primary problem associated with hearing loss and hearing aid amplification in understanding speech, is noise. The major focus over the last four decades or so has been to reduce background noise. Two processing strategies have been employed in modern hearing aid amplification systems to minimize background noise: digital noise reduction and directional microphones.

Digital Noise Reduction (DNR). Venema’s report (p 335) the goal of DNR is noise reduction. DNR systems can recognize and reduce the sign magnitude of steady-state noise or noise from other speech sources. Two processing strategies have been employed in modern hearing aid amplification systems to minimize background noise: digital noise reduction and directional microphones.

Directional Microphone Arrays (DMs). D-mics15 are the only technology proven to improve SNR. However, the likely perceived benefit from DNs in the real world, due to the presence of other background sounds, is often only 1–2 dB. Directivity Indices (DI) indicating 4–6 dB improvement are generally not “real world” measures. That is, DIs are generally measured on manikins, in an anechoic chamber, based on pure noise or broad band noise, and not the fast removal of noise between words and up to 9 dB of noise attenuation. Importantly, if speech is detected in any one of the listeners, they may require an 8 dB SNR to achieve the same 50% performance of understanding speech-in-noise, but that is not the case for the person who needs an 8 dB SNR, we subtract 2 dB (normal performance) from their 8 dB score, resulting in a 6 dB SNR loss. Wilson5 evaluated more than 3,400 veterans. He reported a more important consideration does not predict speech-in-noise ability, as the two tests (speech in quiet, speech-in-noise) reflect different domains of auditory function. He suggested the Words-in-Noise (WIN) test should be used as the “stress test” for auditory function. Beck and Flexer13 reported, “Listening is where hearing meets the brain.” They said the ability to listen (ie, to make sense of sound) is arguably a more important consideration does not reflect a more realistic representation of how people manage in the noisy real world, than does pure-tone hearing thresholds reflected on an audiogram. Indeed, as animals (including dogs and cats) “hear” better than humans, however, humans are apt to drop the food chain because of their hearing, but due to their ability to listen—to apply meaning to sound. As such, a speech-in-noise test is more of a test of listening than a hearing test. Specifically, listening in noise depends on a multitude of cognitive factors beyond loudness and audibility, and includes speed of processing, working memory, attention, and more.

McShefferty et al14 reported SNR plays a vital role for hearing-impaired and normal-hearing listeners. The most detectable SNR difference for a person with normal hearing is about 3 dB, and they report for more clinically relevant tasks, a 6 to 8 dB SNR may be required. In this article, we’ll address concepts and issues associated with understanding speech-in-noise, and, importantly, we’ll share results obtained while comparing SIN results with Oticon Opn and two major competitors, in a realistic acoustic environment. Background Noise

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differences (ILDs) and interaural time differ- ences (ITDs), such that the left and right ears receive unique spatial cues. Sockalingam and Holmgren® presented laboratory and real-world results demonstrating “strong user preference and statistically significant improved ratings of listening effort and statistically significant improvements in real-world performance resulting from Spatial Noise Management.”

Beck® reported spatial hearing allows us to identify the origin/location of sound in space and attend to a “primary sound source in difficult listening situations,” while ignoring secondary sounds. Knowing “where to listen” allows the brain to maximally listen to meaningful acoustic cues in speech signals. Likewise, Spatial Sound® LX helps the user locate, follow, and shift focus to the primary speaker via advanced technologies to provide a more precise spatial awareness for identifying where sounds originate.

The Oticon OPN SNR Study

In Pittman et al’s research, they stat- ed, “Like the increasingly unique advances in hearing aid technology, equally unique approaches may be necessary to evaluate these new features.” The purpose of this study was to compare the results obtained using Oticon Opns to two other major manufacturers regarding listeners’ ability to understand speech in noise. The goal of the amplification system, specifically for the Oticon Opn, is to make speech sounds more audible while preserving clear sound quality and speech details, such as spatial cues via ILDs and ITDs. It uses adaptive compression and combines linear amplification with fast compression to provide up to a 12 dB dynamic range window, preserving natural amplitude cues in speech signals. Likewise, Spatial Sound® LX helps the user locate, follow, and shift focus to the primary speaker via advanced technologies to provide a more precise spatial awareness for identifying where sounds originate.

The Oticon OPN 1 miniRITE with Open Sound Navigator set to the strongest noise reduction setting. Power domes were worn with each of the three hearing aids.

The results obtained with Opns were com- pared to the results from two other major manufacturers’ (Brand 1 and 2) solutions, using directionality and narrow directionality/beamforming (respectively). All hearing aids were fitted using the manufacturer’s fitting software and earmold recommendations, based on the hearing loss and other gathered data. The level of amplification for each hearing aid was provided according to NAL-NL2 rationale.

The primary measure reported here was the Speech Reception Threshold-50 (SRT-50). The SRT-50 is a measure that reflects the SNR level at which the listener correctly identifies 50% of the sentence-based keywords correctly. For example, an SRT-50 of 5 dB indicates the listener correctly repeats 50% of the words when the SNR is 5 dB. Likewise, if the SRT is 12 dB, the listener requires an SNR of 12 dB to achieve 50% correct. The goal of this study was to measure the listening benefit provided to the listeners in a real-life noisy acoustic situation, in which the location of the sound source (ie, the person talking) could not be predicted. That is, three human talkers and one human listener were engaged in each segment of the study. (Figure 1).

There were 25 separate listeners. Speech babble (SISI) and background noise (speech-shaped) were delivered at 75 dB SPL. The German-language Oldenburg sentence test (OLSAS) was delivered to each participant, while wearing each of the three hearing aids. The OLSAS Matrix Tests are commercially available and are accessible via software-based audiometers. We conducted these tests with an adaptive procedure targeting the 50% threshold of speech intelligibility in noise (the speech reception threshold, or SRT). As noted above, speech noise was held constant at 75 dB SPL, while the OLSAS speech stimuli loudness varied according to NAL-NL2 rationale.

Oticon’s Open Sound Navigator (OSN) with Multi Speaker Access Technology (MSAT) allows essentially the same word recognition scores as the best narrow directional protocols when speech originates in front of the listener, while dramatically improving access to speakers on the sides and, therefore, delivering an improved sound experience. OSN with MSAT effectively demonstrates improved word recognition scores in noise when speech originates around the listener.

The results of this study demonstrate that Oticon’s Open Sound Navigator provides overall improved overall word recognition in noise when compared to direction- al and narrow directionality/beamforming systems. We hypothesize these results are due to Multiple Speaker Access Technology, as well as the maintenance of spatial cues and many other advanced features available in Oticon Opns.

Figure 3. Average speech understanding of center speaker. The average SRT-50 for the hearing aid with directionality was significantly lower than the average SRT obtained with the linear hearing aid. The average SRT-50 obtained with the narrow directionality and Open Sound Navigator were each statistically and significantly better than directionality. The right-facing arrow indicates an approximate 20% word recognition improvement using either narrow directionality or Open Sound Navigator, as compared to directionality.

Figure 4. Left and right speaker results. The average SRT-50 obtained from speakers located at ±60° using directionally and narrowly directionally were not significantly different from each other. The average SRT-50 obtained with Open Sound Navigator was statistically and significantly better than those obtained with other technologies. The right-facing arrow indicates 15% likely improvement in word recognition with Open Sound Navigator as compared to directionality or narrowly directionally.

REFERENCES can be found in the online version of this article at www.hearingreview.com.

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Figure 1. Schematic representation of the acoustic conditions of the experiment.