# REXTON REACH: MORE TALKERS, LESS NOISE

WHITE PAPER

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REXTON

# INTRODUCTION

When one considers the impacts of hearing loss on an individual, reduced speech understanding in noise is a notable challenge. Consequently, seeking ways to improve speech understanding in noise is a main goal of new hearing instrument innovations. In a 2021 survey of nearly 15,000 people, most of which reported that they had hearing loss, 88.3% of respondents rated “hearing friends and family in noise” as very or extremely important (Manchaiah et al., 2021).

Rexton strives to deliver reliable speech intelligibility with every generation of hearing aid. Rexton Reach exemplifies this goal with Multi-Voice Focus which prioritizes helping the hearing aid wearer focus on multiple talkers. This technology builds on Rexton's proven Speech Preservation Technology which separately processes target speech in the front of the wearer and the competing background sounds in the rear hemisphere. Where many hearing aids focus on single partner communication scenarios in relatively static noise situations, Reach is equipped with unmatched innovative processing to handle dynamic and challenging noise situations. These unique innovations combine to provide reliable speech processing in noise with one or more conversation partners. The hearing aid wearer can confidently engage in a variety of challenging communication situations. For more details, please see the Rexton BiCore (2021) and Rexton Reach (Sampaio, 2024) white papers.

As reported in the previously mentioned white papers, several investigations have demonstrated the benefits of Reach processing. One of the measures reported in the Rexton Reach whitepaper focused on the technical signal-to-noise ratio (SNR) measures of Reach as compared to those of an open ear as represented by Knowles Electronic Manikin for Auditory Research (KEMAR). The SNR improvement is an indicator of enhancement of speech over the background noise due to the hearing aid processing. In that investigation, Reach was shown to provide an 8.9 dB improvement for speech coming from the 0° azimuth and a 7.5 dB improvement for speech from a 315° azimuth over the SNR provided by the open ear (KEMAR). Since the time of those measurements, new competitive devices have entered the marketplace providing technologies like Deep Neural Network (DNN) based noise reduction. Although some of these technologies may offer promise in the future, the fundamental processing is limited to the single-stream processing and its inherent limitations. Rexton Reach provides a second generation of separate, direction-based processing with Speech Preservation Technology.

Rexton Reach was designed to provide improved speech intelligibility in challenging listening situations. A key focus has been these speech-in-noise situations because the research shows that these are considered the most difficult by hearing aid wearers (Picou, 2022). To further establish the strength and reliability of Reach processing with Speech Preservation Technology and Multi-Voice Focus, technical measures of SNR were repeated in comparison with other leading hearing aid technologies in the market.

# METHODS

The investigation was designed to assess the SNR performance of the hearing aids in a conversation scenario utilizing turn-taking with multiple speakers. The design incorporated the well-known Hagerman phase inversion technique (Hagerman and Olofsson, 2004) with multiple speakers for target speech and multiple speakers for interfering noise.

## HEARING AIDS

The Rexton Reach hearing aids were compared with four other manufacturer hearing aids reported as Brand A, B, C, and D. The most current premium RIC devices available from each manufacturer at the time of the investigation were selected. All devices were programmed to a symmetrical, flat 50 dB HL hearing loss, using the respective manufacturer's proprietary fitting rationale and default settings in their Universal program. No dedicated noise programs were used (see below for an exception for Brand A); thus, the outcomes represent each manufacturer's default analysis and technical implementation noise management for SNR improvement. Features such as frequency compression and feedback cancellation which manipulate signal phase were deactivated to prevent interference with the phase-inversion analysis technique to improve test reliability. All fittings were performed with closed couplings to the KEMAR manikin ears.

Brand A used a Deep Neural Network (DNN) noise reduction applied to an Artificial Intelligence (AI) co-processor-driven platform. In the case of Brand A, two test settings were considered. The first setting (A1) was performed with no change to the default setting. The additional measurement (A2) was also completed in a manual program where the DNN noise reduction was turned off.

As a baseline reference for the input SNR, recordings were also made in the open (unaided) KEMAR ears.

## HAGERMAN METHOD

The Hagerman phase-inversion technique is an often-used method of assessing noise reduction systems in hearing aids when both speech and noise are presented simultaneously. With this method, the speech and noise signals are presented to the hearing aids and the output signal (combination of processed speech and noise) is recorded. The input signals are presented to the hearing aids twice. For the second presentation and recording, the phase of one of the input signals is inverted. By summing and subtracting the recorded output signals and therefore isolating speech and noise, one can estimate the resulting SNR.

## MEASUREMENT SETUP

The measurement setup was designed around a KEMAR manikin in the center of a sound-treated room. Hearing aids were placed in a wearing position on the KEMAR ears. Four loudspeakers were each positioned one meter from the KEMAR. Two speakers, each positioned at 0° and 315° azimuths, presented the International Speech Test Signal (ISTS) (Holube et al., 2010) at a level of 76 dBA. The other two loudspeakers, positioned at 135° and 225° azimuths, presented a combination of pink noise and cafeteria noise as a background interferer at 72 dBA, resulting a +4 dB SNR test scenario. See Figure 1 for an illustration of the speaker and KEMAR setup.

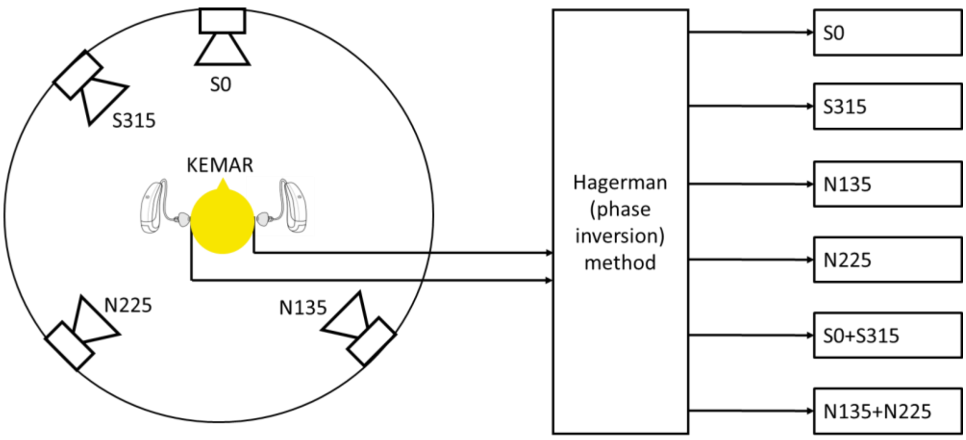


*Figure 1. Setup used for output SNR measurements. Speech (S) signals were presented from the two loudspeakers in the front hemisphere, and noise (N) signals were presented from the two loudspeakers in the back hemisphere. The signals processed by the hearing aids were recorded in the KEMAR ears, with and without phase inversion of each signal, and the Hagerman method was used to generate estimates of the various S and N signals, both alone and in combination.*

To represent a scenario with a hearing aid wearer and two conversation partners, target speech was presented in an alternating fashion between the loudspeakers at the 0° (S0) and 315° (S315) azimuth locations. An initial 50 seconds of the speech and noise signal was presented at the beginning of each recording to allow the hearing aids to analyze, adapt and stabilize to the speech and noise signals. After the initial 50 seconds, the target speech was presented twice from each loudspeaker at 10 second intervals for a total of 40 seconds. Figure 2 indicates the presentation pattern of the test signals.

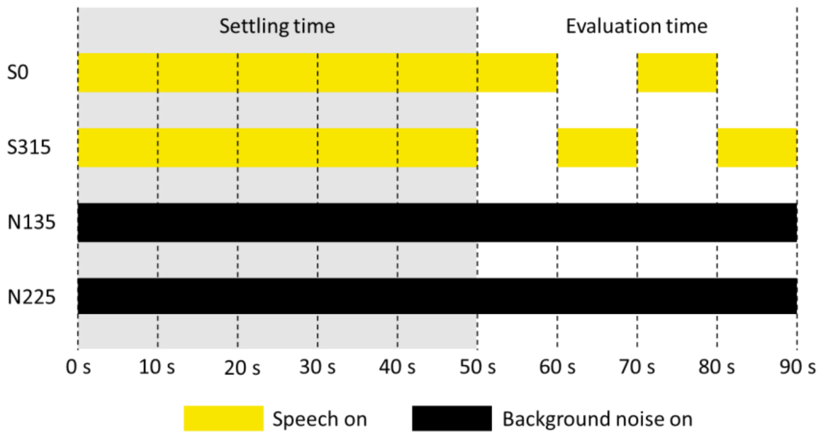


*Figure 2. Presentation of signals from the four loudspeakers. The signal presentation started at t=0. Recordings used for the analysis were started at t=50 seconds to allow enough time for the hearing aids to reach a stable working condition. The analysis was based on 40 seconds of recordings (evaluation time), including two sections of 10 seconds from each of the two talker locations (S0 and S315).*

Analysis of the recordings using the Hagerman phase-inversion method provided an output SNR of the hearing aids. Analysis results were reported for the left side hearing aid in consideration of the advantage to the respective ear due to the target speech being presented both directly in front of and to the left of the KEMAR manikin. The calculation of the conversation SNR was completed using (S0+S315) / (N135+N225).

# RESULTS

The SNRs measured for each hearing aid (conversation SNRs) are presented relative to the SNRs measured in the open KEMAR ear (unaided SNRs). SNR improvements were measured across the two loudspeaker positions for Rexton Reach and the other four key manufacturer hearing aids included in the investigation. As previously stated, two measurements for Brand A are reported as the default setting (A1) and the manual setting with DNN deactivated (A2). Figure 3 shows the relative SNR improvements of conversation SNR to unaided SNR for each hearing aid.

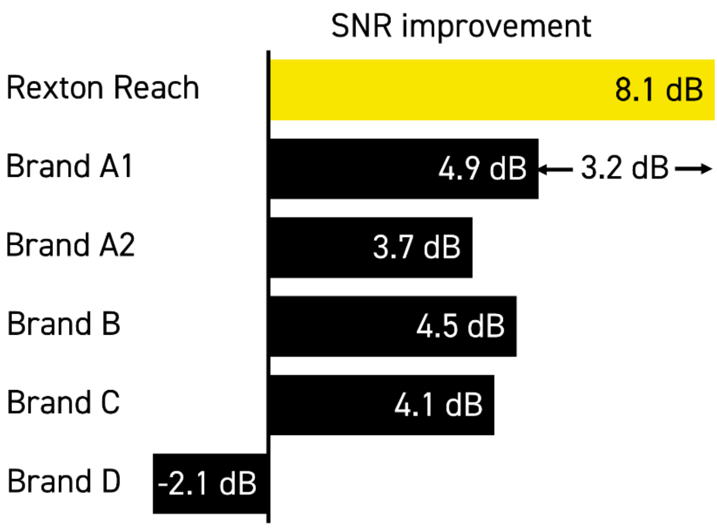


*Figure 3. Conversation SNR improvement, relative to the unaided condition, measured across the two talker locations, for Rexton Reach and the four other manufacturer hearing aids (Brand A, B, C, and D). All hearing aids were measured in their default Universal settings, except for Brand A2 which was measured in a manual program with the DNN noise reduction turned off.*

The conversation SNR improvement provided by Rexton Reach, compared to the unaided condition, was 8.1 dB. The SNR improvement measured for the other manufacturer hearing aids was as follows: Brand A1, 4.9 dB; Brand A2, 3.7 dB; Brand B, 4.5 dB; Brand C, 4.1 dB; and Brand D, -2.1 dB. The Rexton Reach result was 3.2 dB better than the best other manufacturers result (Brand A1).

# DISCUSSION

In this study, we investigated the output SNR performance of Rexton Reach and four other manufacturer hearing aids in a simulated group conversation in noise scenario. The scenario represented a common multi-talker situation in noise. The two target speech signals were presented from the front hemisphere while competing background noise was presented from two points in the rear hemisphere. The results indicated that Rexton Reach with a SNR benefit of 8.1 dB outperformed the other devices by 3.2 dB or better.

For Brand D, there is a notable decrease in benefit compared to the open ear. This is likely due to the device automatically applying asymmetric directional patterns. While this may not create a significant disadvantage for speech coming from the front, it clearly impacts a multi-talker scenario. None of the other devices tested implement this type of asymmetrical directional strategy.

To better appreciate the advantage provided by the Rexton Reach processing, one can consider that a 3 dB increase in SNR corresponds to a doubling of the ratio between the intensity of the speech and the intensity of the noise. Thus, the observed 3.2 dB advantage on the output of the hearing aid means that Rexton Reach delivers more than twice the speech enhancement benefit in the noisy group conversation scenario than the best-performing other manufacturer.

It is reasonable to conclude that the advantage observed between Rexton Reach over the other premium hearing aids included in this investigation is primarily a result of Rexton Reach's Speech Preservation Technology and Multi-Voice Focus. The Speech Preservation Technology processes target speech and competing noise separately to better reduce the noise and enhance the speech signal. Multi-Voice Focus applies reliable, advanced analysis of the conversation, turn-taking, and the talker positions, continuously adapting to conversation partners and noise sources as they naturally fluctuate and alter in real time. These typical challenges were simulated in an accurate manner to a create a meaningful test setup.

It is also important to consider that not all listeners can incorporate the best communication strategies in difficult listening situations. It is often assumed that the hearing aid wearer can and will face each conversation partner. While this is likely achievable with a single partner scenario, this is not always the case with multiple talkers. Rexton Reach and Multi-Voice Focus assist the listener in overcoming this limitation for the wearer. The KEMAR manikin in this investigation is stationary, forcing one loudspeaker to always present from a side angle as the target speech alternated between loudspeakers. The benefit demonstrated by Rexton Reach highlights its ability to adapt to individual speech streams while managing the competing background noise. Traditional processing, such as that used by the other products in this study, is limited to the adaptations that can be applied to the input signal as a whole. This means that the speech and noise must be processed together, rather than separately. The processing challenge is also influenced by the timing requirements of keeping up with the brief, alternating turns of a multi-talker conversation. Speech coming from different directions may be treated as a single speech stream with different degrees of interfering noise, rather than as separate speech streams requiring individual analysis and processing. Rexton Reach treats the multiple speech signals and noise signals separately and dynamically, and consequently the wearer can feel more confident in such a listening scenario.

In challenging listening environments, it is important to ensure that the listener can rely on audibility of the speech signal. This is dependent on the SNR of that signal. Additionally, the clarity of the signal as well as the listener's ability to understand speech can strongly influence the listener's performance. In the real world, balancing these factors is paramount for communication. The hearing aid, importantly, needs to help manage the SNR of the situation. In this investigation, we focused on a situation that was representative of a real-world listening situation. Smeds et al (2015) reported on a +4.6 dB median SNR for speech in babble as a level where hearing aid wearers may start to struggle in conversation in noise. This would suggest a level where, if a hearing aid could not perform satisfactorily, then a wearer may disengage from communication. In this study we selected a comparable +4 dB SNR to represent such a level where communication would be affected, and consequently demonstrated that Rexton Reach is reliable in this critical area of communication.

# SUMMARY

In this paper, we have presented the results of a technical study on the SNR performance provided by Rexton Reach and four other premium manufacturer hearing aids. A technical assessment applying the widely used Hagerman phase-inversion technique was performed in an acoustic scene simulating a multi-talker scenario in competing background noise. The result indicated an estimation of the output SNR provided by the hearing aids in this two-talker setup.

Results illustrated the advantages of Rexton Reach with Speech Preservation Technology and Multi-Voice Focus. Rexton Reach provided an 8.1 dB SNR benefit relative to the unaided condition, and more than twice the speech enhancement benefit (3.2 dB SNR improvement) relative to the best-performing other manufacturer hearing aids in a noisy group conversation.

A hearing aid wearer needs to feel confident in the most challenging listening environments. The hearing aids need to be dependable. Hearing care professionals and hearing aid wearers rely on proven technology. This is why they reach for Rexton. Every voice matters.

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# RELY ON REXTON

We believe that nothing hearing related should ever be left to chance, both for the people with hearing loss, and those who depend upon them. We understand their challenges and we meet them with proven hearing technology that is made Lifeproof so it can be counted upon to perform reliably in even the harshest environments. At work, at home, during leisure time, exercise and in all weather, you can always **RELY ON REXTON**.

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