

Rexton BiCore

A Solid Hearing Platform

Sound You Can Rely On

Introduction

Our daily lives are filled with a variety of activities. Whether it is the demands of a job, the dedication to raising a family, or even managing home finances, our lifestyles require constant attention. And despite continuous ways of making our lives more efficient, some form of effort is still required. The additional challenges brought forth by hearing loss should not increase that effort. To help keep life from being even more difficult, Rexton is pleased to introduce the BiCore platform.

BiCore is the latest technology from Rexton, building on a tradition of quality in both robust design and sound quality. BiCore does the hard work of making important sounds more accessible, while continuously striving to reduce unwanted sounds. Rexton BiCore is technology you can trust throughout the day.

Rexton BiCore incorporates three technological pillars to provide reliable listening for every situation (Figure 1). The Lifeproof™ design centers around robust construction and proven design. Clean Sound incorporates innovative sound processing elements to faithfully reconstruct the environmental soundscape for the hearing aid wearer. Reliable Technology builds on Rexton's proven sound processing to prioritize important speech sounds in even the most difficult listening environments.

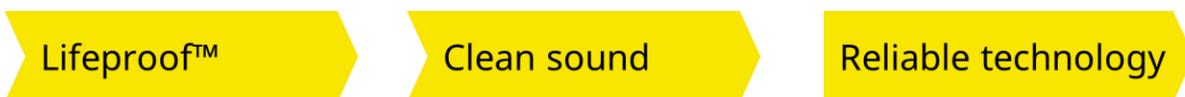


Figure 1. Three technological pillars of Rexton BiCore: Lifeproof, Clean sound, and Reliable Technology.

Lifeproof™

Hearing aids are generally subjected to challenging conditions in daily life. With most electronics, we take extra precautions to handle them with care, avoid getting them wet,

and protect them from adverse conditions. With hearing technology that is worn throughout the course of the day, the devices are exposed to any number of conditions including, but not limited to, sweat, sun, ear wax, and even falling. In any of these conditions, the hearing aids need to reliably continue to operate.

Rexton BiCore hearing aids are Lifeproof. The challenging conditions the hearing aids will face are known and testing the hearing aids for those conditions ensures they can continue functioning for the wearer. Rexton provides a battery of tests to mimic and often exceed these demanding situations.

-  Devices are strategically dropped for a free fall from heights consistent with falling from a wearers ear. This testing ensures durability against accidentally dropping or having devices dislodged from the ear.
-  Hearing aids are subjected to an assortment of creams, lotions, oils, cleaning agents and chemicals to ensure they hold up to the variety of external materials with which they may come into contact.
-  Sweat tests are conducted by exposing the hearing aids to a liquid mixture chemically designed to mimic sweat. The hearing aids are placed in a “sweat” chamber as well as a dripping condition to again simulate real life conditions. With a special coating over the microphone membranes, the mixture cannot permeate through to the components.
-  Heat and humidity testing are designed to ensure the hearing aid can withstand these more challenging environmental conditions.
- The mechanical structure of the devices is tested via presentation to intense sine waves and vibrations to exceed daily movement and transportation conditions.
- Ultraviolet radiation resistance is tested in sun exposure chamber with accelerated time to ensure durability against UV exposure through the life of the device.

These tests encompassing multiple conditions provide the confidence and security that Rexton BiCore technology is Lifeproof.

Clean Sound

Our days are spent in a variety of listening environments. For a portion of that time, speech communication is critical, and amplification is essential in providing intelligibility to the hearing aid wearer. Also, throughout the day and outside of communication situations,

other sounds are important for safety and environmental awareness. In all of these situations, the hearing aid must provide a true and clean presentation of those sounds.

Hearing aids do not simply amplify sound to make it louder for the listener. The incoming analog signal must be converted to a digital signal and then undergo manipulation from a multitude of algorithms often designed to emphasize speech and reduce unwanted background noise. That background noise can be steady state, transient or even speech noise. Additionally, some non-speech sounds such as music may be intended for listening. The various intensity levels also need to be calculated and amplified appropriately to provide audibility for the hearing loss. Along with this variety of sounds, conditions such as feedback also need to be addressed. And after all these sounds are processed by the appropriate algorithms, they need to be converted back to an analog signal for the impaired ear to receive and for the brain to process. These modifications of the environmental sounds can easily distort the wearer's perception of the environment. Rexton BiCore embraces this challenge with innovative clean sound processing to provide the wearer with accuracy and security for the listening environment.

A critical step in clean sound processing is maintaining a correct representation of the increasing intensity. BiCore utilizes new input stage processing and a new analog-to-digital converter ensuring that sounds up to 117 dB SPL accurately reflect changes in intensity.

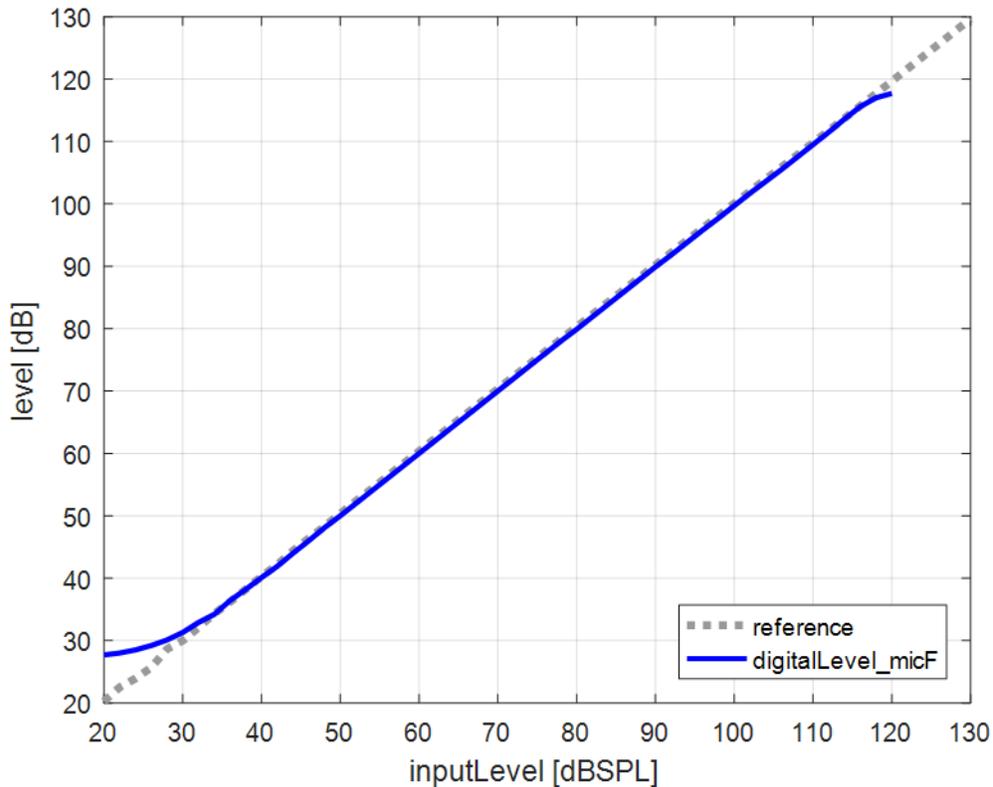


Figure 2. Input/Output curve for microphone + analog/digital converter showing linear performance up to 117 dB SPL input.

These improvements at the input stage of processing reduce distortions. The signal being analyzed, processed and amplified for the hearing aid wearer is a reliably converted from an analog to a digital signal. With clean sound processing, the wearer can be confident that the input signal is faithfully maintained during the initial conversion process.

Reliable Technology

The reliability in hardware design and the faithful representation of the input signal are highly important in hearing aid processing. However, what brings meaning to the hearing aid wearer is that the technology reliably provides audibility for all sounds in the environment without compromising on speech intelligibility. Rexton BiCore takes a multi-faceted approach to fulfilling the wearer's needs.

BiCore introduces the new Speech Preservation Technology (SPT). This builds on the history of binaural wireless processing in BiCore to provide a new strategy in providing superior speech processing in even the most difficult listening environments. This is accomplished by separating speech and noise.

Traditional hearing aid processing relies on an initial analysis of the entire acoustic scene and then continuing to apply features such as noise reduction and compression from that point. This approach is comparable to trying to change the recipe when baking a cake after all the ingredients are mixed together. Trying to remove some flour from the mix is no simple task. However, changing the proportions of ingredients is manageable before they are mixed together. With this concept in mind, SPT takes advantage of the spatial separation between target speech sounds and competing noise. This directional analysis allows for processing of the speech and noise before they are mixed together. Target speech from the front is processed without the interference of surrounding noise. Additionally, the background noise is processed separately as well with different noise reduction and compression characteristics. With more appropriate re-creation of the sound environment prioritizing speech for the wearer, Speech Preservation Technology of BiCore can intelligently mix the two signals together. For the wearer, following a conversation in the listening environment becomes....a piece of cake.

Speech Preservation Technology is a key component in BiCore's proven SoundPro 2.0. SoundPro 2.0 allows the hearing aids to analyze and fluidly adjust to any listening environment. Where most hearing aids classify the listening environment into a limited number of situations based on modulation and intensity, SoundPro 2.0 dynamically adapts to the listening environment by including elements such as motion, signal-to-noise ratio, ambient modulation and even speech origin on top of the traditional elements. With SPT at the heart of SoundPro 2.0, the wearer can appreciate appropriate processing of the surround sounds while maintaining speech intelligibility. Furthermore, SoundPro 2.0 provides the opportunity to increase or reduce the separation between speech and competing noise to better satisfy the listener's hearing preferences (Figure 3).

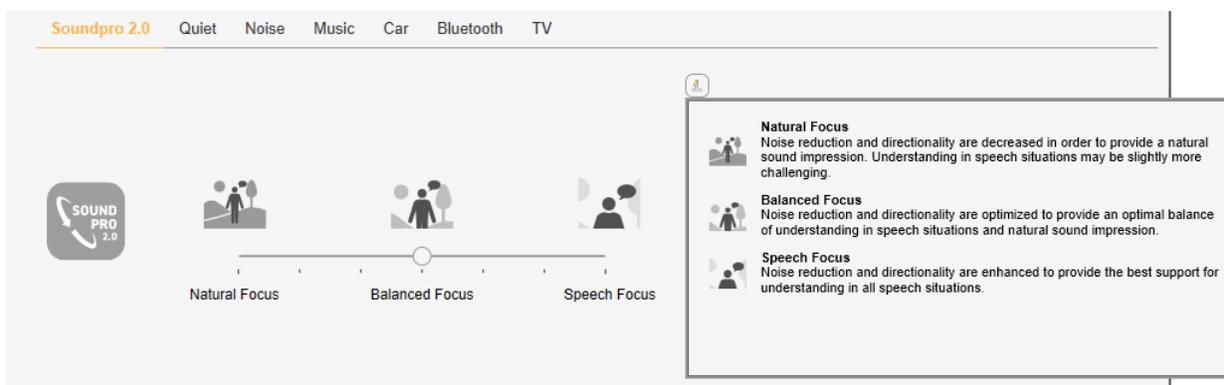


Figure 3. SoundPro 2.0 software interface to adjust the balance between speech and background noise.

Supporting SoundPro 2.0 with SPT is BiCore's binaural wireless link. The hearing instruments communicate with one another using high-speed wireless synchronization. Based on years of wireless experience, this latest iteration of the binaural link ensures a robust connection between devices to support the increased processing demands of the technology. With this proven, reliable, wireless connection, BiCore is binaurally stable to its core.

Rexton BiCore provides a sophisticated, yet highly reliable experience as it processes sound from start to finish (Figure 4). A strength of the platform is that it is built upon proven technology. That proof comes not only from the many wearers who have trusted Rexton technology, but also from putting the newest technology to the test in both laboratory and real-world conditions.

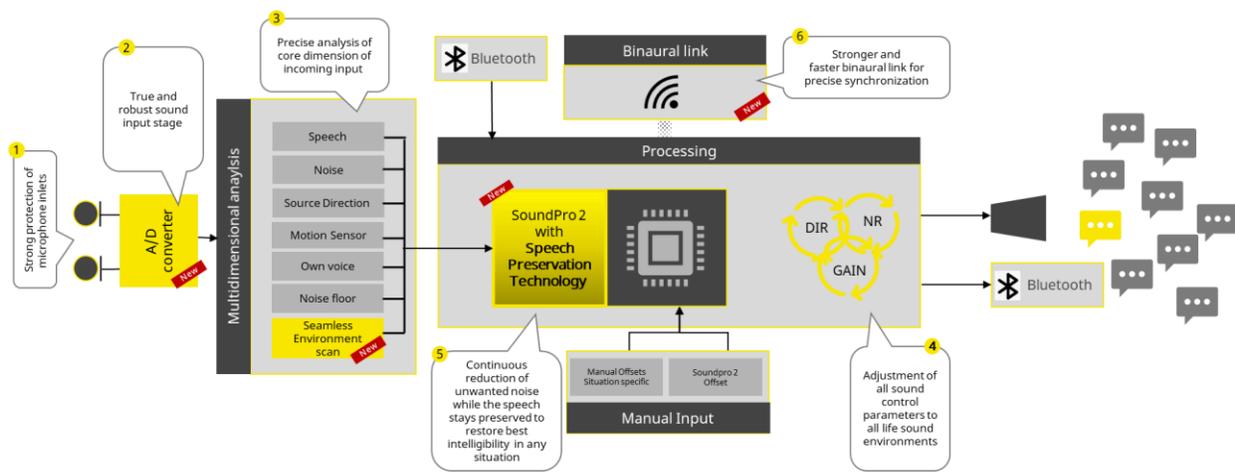


Figure 4. Diagram of BiCore processing pathway.

Research Support

A recent study was conducted on the BiCore processing in comparisons to other competitive devices on the market. Participants consisted of 16 adults (12 males, 4 females) aged 21 to 83 years (average 61.8 years). All were experienced hearing aid wearers with downward sloping sensorineural hearing losses, as indicated in Figure 5.

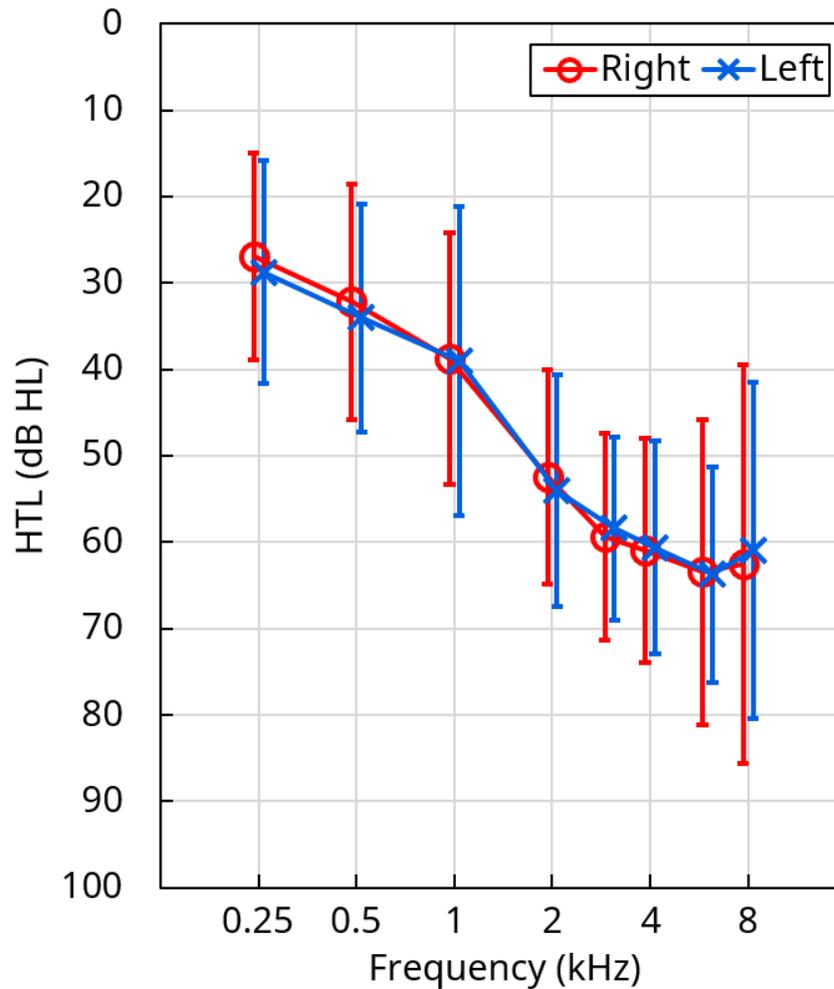


Figure 5. Average audiometric thresholds for right and left ears.

BiCore processing was compared to two leading competitive products, programmed to default settings (frequency-lowering turned off). Bilateral fittings were completed with closed eartips and verified via probe microphone measurements to NAL-NL2 targets within +/-5 dB between 500 and 4000 Hz using the ISTS signal.

The selected communication scenario was designed to simulate a restaurant. Speech material was a modified version of the American English Matrix Test (AEMT, Hortech, 2014). Twenty sentences were presented unless there was not an observed convergence, in which case up to 30 sentences were presented. The score for each individual was the SRT at which 80% of the words were repeated correctly (SRT-80).

For this restaurant scenario, the new BiCore Speech Preservation Technology was compared in “on” and “off” conditions and with the two competitive devices. Participants were seated in the center of the audiometric suite, surrounded by 8 loudspeakers, all spaced at 45° azimuth intervals from one another. The target AEMT sentences were presented from directly in front of the participant at 0° azimuth. Five of the surrounding speakers presented a continuous, soft (45 dBA) ambient sound. To simulate a sudden burst of a sound for this type of environment, recorded laughter was presented randomly from one of three speakers (135°, 180° or 215°) at 76 dBA and discontinued just after the target speech presentation. This presentation of laughter from a randomly selected speaker and then target speech with the level of the speech adaptively varied for each presentation was repeated for the test. For the competitive hearing aid test, conditions were counterbalanced, and participants were assigned to a specific ordering. Training was conducted for the participants.

Results

For this restaurant condition with the BiCore processing with SPT “on” and “off”, results showed a strong, significant ($t(15) = 3.93, p < .01$) benefit for speech recognition with an improvement of 3.9 dB for SRT-80 (Figure 6). These results show a clear advantage for use of the BiCore processing for speech recognition in noise.

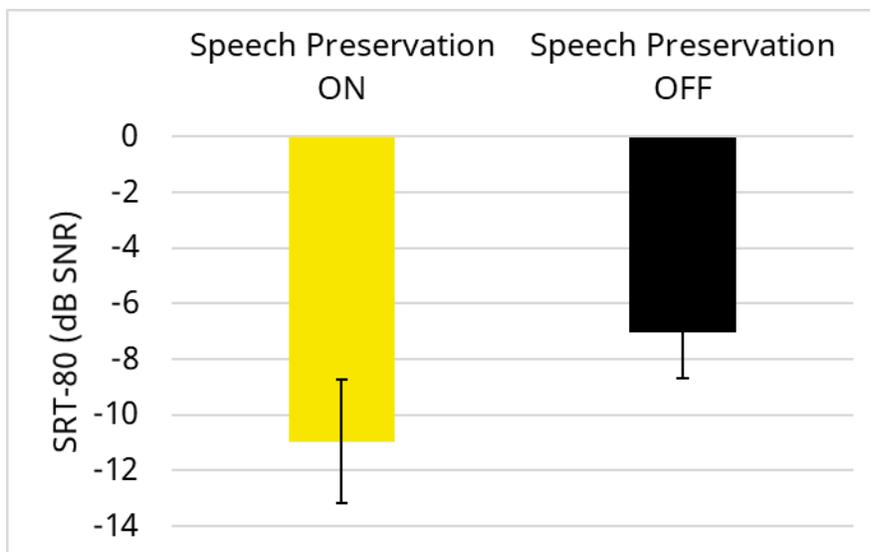


Figure 6. Restaurant Scenario. Mean AEMT scores (SRT-80) for BiCore Speech Preservation Processing “On” vs. “Off.” Error bars represent 95% confidence intervals.

Results for the competitive comparison of the BiCore processing “on” compared to competitor products (labeled “A” and “B”) are shown in Figure 7. Resulting mean SRT-80 data showed BiCore was superior to both Brand A (2.1 dB) and Brand B (7.3 dB). Statistical analysis using paired t -tests with Bonferonni corrections showed both differences to be significant ($t(15) = 2.72, p < .05$; $t(15) = 5.76, p < .001$).

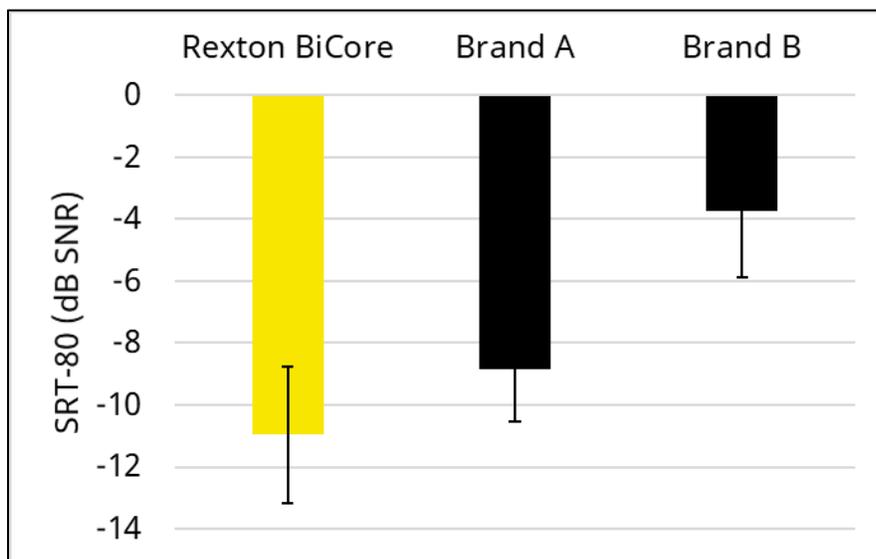


Figure 7. Competitor Comparison in Restaurant Condition. Mean AEMT scores for BiCore Processing “on” compared to Brand A and Brand B. Error bars represent 95% confidence intervals.

In these comparisons, BiCore processing shows more negative (better) results than the other aided conditions. The competing noise sources in these conditions were from the back, and these results are consistent with other results showing that hearing aids are effective in reducing unwanted noise presented from the rear hemisphere. Additionally, the competing laughter was selected, not as an effective masker for speech, but as a simulation of a typical, real-world competing sound. These test conditions may have contributed to the SRT values from this investigation being lower than those seen in other similar studies. However, these data clearly demonstrate the Rexton BiCore is effective at providing reliable amplification in difficult listening environments.

These results demonstrate laboratory performance and a controlled environment. However, it is important to consider the hearing aid wearer’s experiences in the real world. To measure these results, 18 experienced hearing aid wearers aged 28 to 91 years (mean age 74 years) were asked to complete a series of surveys over a four-week period comparing

their own hearing aids to Rexton BiCore hearing aids. Questions on the survey were taken from the Speech, Spatial and Qualities of hearing questionnaire (SSQ, Noble, 2004) which uses rating scale of 0 “not at all” to 10 “perfectly”. Respondents completed the survey rating their own hearing aids at their first office visit. They then wore the BiCore processing for two weeks and repeated the questionnaire based on their experiences with BiCore processing. They then switched back to their original hearing aids for one week and again completed the survey based on their original hearing aids during that most recent week. Finally, they wore BiCore processing for one week and again completed the questionnaire. Figure 8 shows results for weeks 3 and 4 comparing their own hearing aids, the BiCore processing, and data for normal hearing listeners.

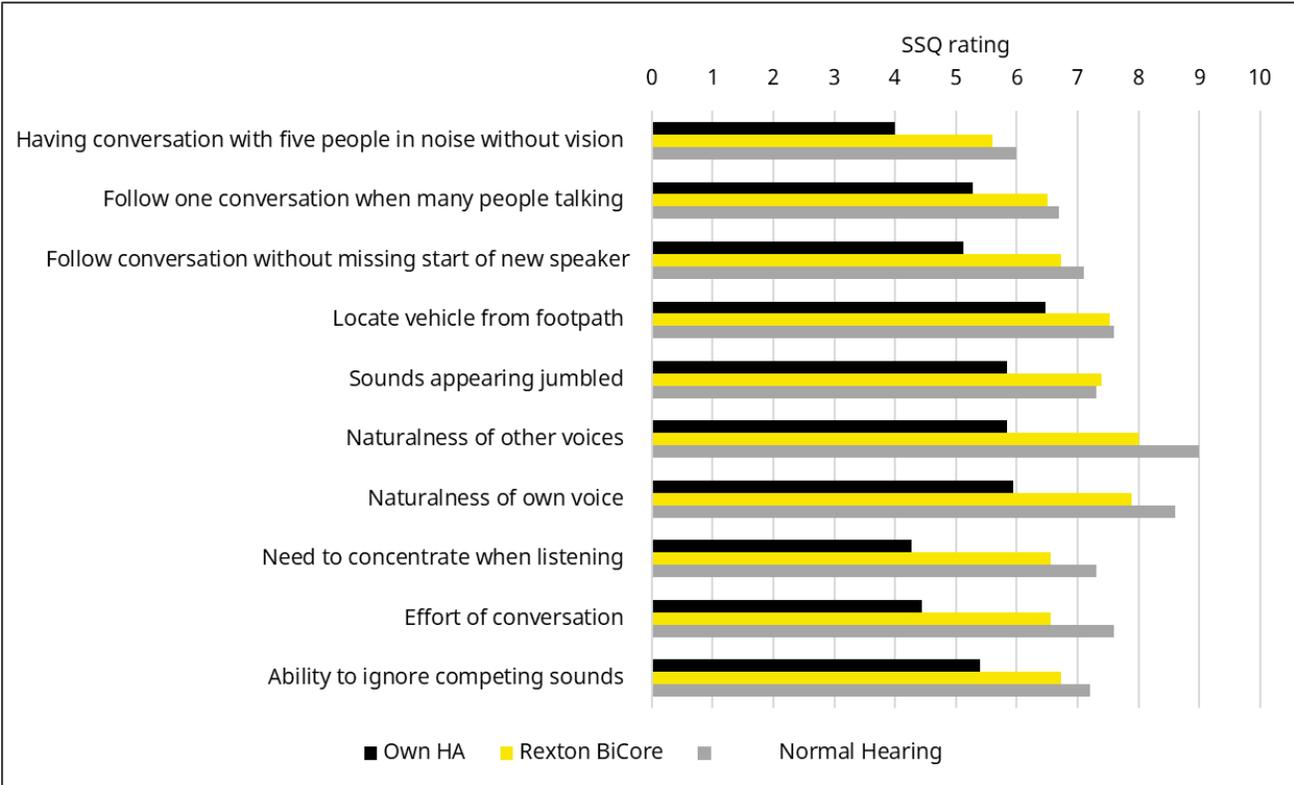


Figure 8. Mean SSQ data for Own Hearing Aid, Rexton BiCore, and Normal Hearing listeners. Own HA and BiCore data were collected immediately following one week of wearing the respective devices. Higher number represent higher levels of satisfaction.

Results show that for the ten SSQ questions measured, respondents consistently preferred the new BiCore processing by at least one scale point. In many cases, results of the BiCore processing were more like those of normal hearing listeners than to results with the Own

HA. Importantly, one must consider that mean results indicate that not even normal hearing listeners rate all satisfaction as “Perfectly” for any situations. Additionally, these high satisfaction ratings suggest that BiCore provides wearers with the confidence to hear well in a variety of real-world situations.

Summary

From the moment the user places the BiCore hearing aids on their ears, they can feel confident in the robust **Lifeproof** design. As sound enters the microphone, **Clean Sound** ensures it is accurately captured and converted to a digital signal, faithfully maintaining all the nuances of the listening environment. The **Reliable Technology** of BiCore analyzes the signal, considering the dynamic variations of the target speech within the soundscape, even when the wearer is in motion. Speech Preservation Technology supported by the proven binaural link improves audibility of the speech signal over the complex competing sounds. The result is that the Rexton BiCore platform helps the user listen with confidence knowing they will hear what is important in their world, even under the most challenging situations.

References

Hoertech 2014. International Matrix Tests: Reliable audiometry in noise.

Gatehouse S. & Noble W. 2004. The Speech, Spatial and Qualities of Hearing Scale (SSQ). *International Journal of Audiology*, 43(2), 85-99.

About Rexton

Rexton is a global hearing aid brand known for its reliability, established 1955. Rexton hearing aids are built to perform in all conditions, using proven hearing technology that is tested to the highest standards. Whatever life throws at its wearers, they can rely on Rexton.