techTOPIC

Field Study on User Control of Directional Focus: Benefits of Hearing the Facets of a Full Life

The new Phonak feature, ZoomControl, accessible through the myPilot remote control, utilizes the wireless link between binaurally balanced microphones for real-time streaming within Exélia instruments. This allows the listener to select different focus directions, thereby enhancing speech understanding in noise for listening situations in which the speech signal originates from the *back or the sides* of the listener.

One of the key questions in the provision of such a system is "How does this improve upon an advanced speech-in-noise program that has a beam former oriented to the front?" In other words, is this feature *really* an improvement that benefits the end user?

In field tests with the new Exélia family of hearing devices, ZoomControl was scrutinized and compared to the Exélia speech-in-noise program, VoiceZoom, using the standardized Oldenburger Satztest (OLSA),[1] an adaptive noise test to detect changes in speech reception thresholds (SRT). VoiceZoom uses directionality with a design to better suppress multiple and moving noise sources. Results from the following field test showed significant improvements for speech intelligibility in noise in all relevant listening directions for ZoomControl compared to VoiceZoom when speech is not presented from the front.

Hearing System Rationale

Exélia is the new line of Phonak hearing instruments for individuals with a hearing loss ranging from mild to profound. Exélia is based on the latest wireless chip technology, the Communication Optimized Real-audio Engine (CORE) platform, providing new features such as SoundFlow, ZoomControl, wireless programming, and Bluetooth connectivity. The combination of performance, control, and connectivity is designed to provide an enhanced level of audibility and clarity.

ZoomControl is designed to allow Exélia wearers to set the focus of their hearing individually. To achieve the best focus possible for different listening situations, the system requires input from all microphones and high-speed wireless communication between the devices offered by the CORE platform.

Directional microphones are proven to be the only way to improve signal-to-noise ratio (SNR), but the benefits of directional microphones are based on the speech source being *in front* of the end user. The polar patterns of a common beam former are designed to cancel noise that enters the microphones from the side or the back, whereas the front direction is open for incoming signals, such as speech, in order to increase the signal-to-noise ratio (SNR).[2] Because speech signals do not always come from the front and facing the speaker is not always possible, a traditional front-focus polar pattern is limited because it has a null at 180° and only the target speech signal from the front is enhanced over the ambient noise. Therefore, it does not allow setting the individual focus of hearing. For example, when a hearing aid wearer is driving a car with a passenger talking from the side or back, the hearing system is using the standard speech-in-noise program with a cardioid pattern directed to the front (ie, the windshield). Users need to keep their concentration focused on the traffic, thus it is not possible for them to turn their head constantly toward the speech signal occurring at the side or from the back.

ZoomControl enables the hearing aid wearer to select the focus of the system in four directions: front, back, left, and right. If listening from the right or left sides is the chosen direction, due to very fast broadband data transfer function, the microphone signal of the chosen side will be transferred to the opposite hearing aid, avoiding the head shadow and therefore emphasizing the better SNR of the chosen side. The signal is then amplified with the accurate gain model for this ear. However, the microphones of the hearing instrument on the "non-focus" side receiving streamed data are attenuated.

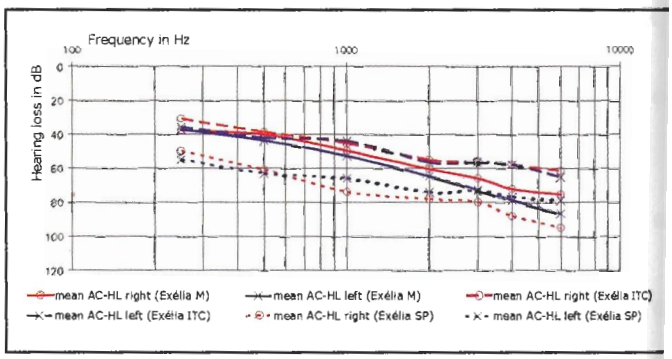

FIGURE 1. Average air conduction thresholds for all participating patients, itemized by hearing instrument model (blue = left; red = right).

The goal of the following field study was to survey the benefits of ZoomControl in a standardized test setup for a group of participants with a moderate-to-severe hearing loss compared to the standard speech-in-noise program with the beam former oriented to the front.

Field Study

Subjects. The study was performed at the Phonak Hearing Center in Stäfa, Switzerland. A total of 28 test subjects participated in this study: 11 Exélia ITC wearers (ages 52-73 years, average 67.2 years); 12 subjects fitted with the medium-power Exélia M (age range 48-81 years, average 66.5 years); and 5 Exélia SP (SuperPower)

This article was submitted to *HR* by Myriel Nyffeler, PhD, a neurobiologist who serves as the international field study coordinator at Phonak AG, and Sven Dechant, an audiologist and validation manager in charge of conducting internal field studies at Phonak AG in Stäfa, Switzerland. Correspondence can be addressed to HREditor@ascendmedia.com or Myriel Nyffeler, PhD, at Myriel.Nyffeler@phonak.com.

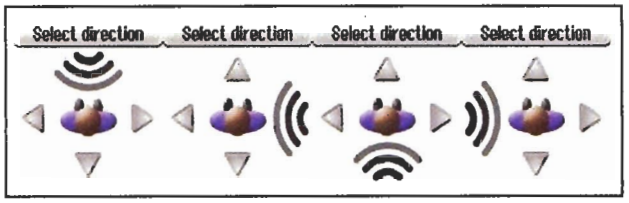

FIGURE 2. With the aid of myPilot, Exélia users are allowed to set the focus of their hearing by selecting ZoomControl to the front (A), right (B), back (C), or left (D).

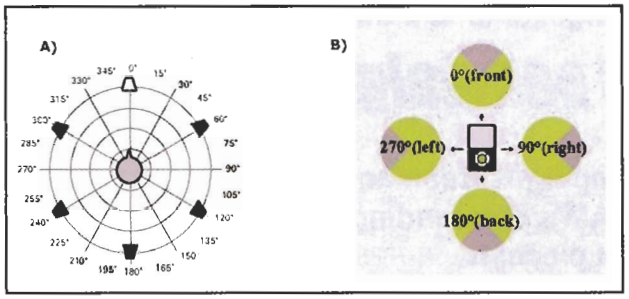

FIGURE 3. At left (3a): Test setup of the OLSA where the test subject faces the front. White = Speech signal from the front; Black = cafeteria noise. At right (3b): The four listening directions with ZoomControl.

subjects (ages 41-76 years, average age 61.2 years). The participants' previous experience with hearing instruments ranged from short-term users (6 months to 3 years) to long-term users (over 6 years). All subjects were fitted with custom earmolds or shells and venting according to their hearing loss. The average hearing losses of all participants for the different styles are shown in Figure 1 (page 24).

The new Phonak feature ZoomControl was tested in comparison with the automatically adaptive polar pattern of VoiceZoom. The devices were fitted according to programming recommendations. A precalculation based on the experience level of the test subjects and a feedback test was performed for all three hearing aid models.

Assessing Speech Intelligibility in Noise Using OLSA

With the OLSA, objective measuring procedures were used in this study, including the comparison of speech intelligibility in noise[1,3] of the three Exélia models using either ZoomControl or VoiceZoom and without hearing instruments. The myPilot is a command center for the device that can easily access the ZoomControl program. It not only works as a remote control, but offers full control of multiple functionalities of the client's hearing with access to ZoomControl, remote control functions, hearing aid status information, time, and alarm functions. Exélia utilizes the four microphone network and broadband audio data transfer of a binaural fitting to highly focus Exélia in one specific direction, while suppressing all signals in other directions. ZoomControl is a user-controlled feature activated on demand via the myPilot (Figure 2).

Speech intelligibility in a noisy environment was assessed by the OLSA. This test measures the SRT, which represents the SNR of 50% speech intelligibility, of five-item sentences with the following structure: Name-verb-number-adjective-object. Sentences are presented from the front (0°) against broadband uncorrelated cafeteria noise played from five background loudspeakers situated at 60°, 120°, 180°, 240°, and 300° (Figure 3a).

The goal of the participants is to repeat the sentences or words that are understood. The participants sit in the middle of the circle of speakers and are instructed to face a speaker that provides the speech signal first. The position of the speaker providing the first signal is randomized between trials. The noise intensity is kept constant at 65 dB SPL and the intensity of speech signals varies according to a standardized adaptive method.[4]

To measure the differences between the standard speech-in-noise program (VoiceZoom) and the new user-controlled system, ZoomControl, the subject's position in relation to the speech signal was varied by turning around in 90° steps. In order not to provoke unwanted changes in the room acoustics, the loudspeaker configuration was maintained during the measurements, but the subject's listening position was 0° (front), 90° (left), 180° (back), and 270° (right) angle to speech signal, measured in randomized order. Exélia's ZoomControl was used to focus toward the speech signal as depicted in Figure 3b.[3]

Results

In the described listening conditions, the results for participants wearing Exélia ITC show improvements in SRT of -2.2 dB when focusing to the left, -2.8 dB when using ZoomControl to the right, and -6.2 dB when changing the beam former to the back compared to the standard speech-in-noise program (Figure 4). When speech is presented from the back, the large difference between ZoomControl and VoiceZoom can be attributed to the fact that the effects of the standard beam former are designed to enhance signals from the forward (0°) position.

The results for the M model show similar characteristics. For this group, the benefit of ZoomControl compared to VoiceZoom are -1.5 dB when speech is presented from the left, -3.3 dB when the target is on the right side, and -6.3 dB when the signal is coming from behind (Figure 5).

Participants wearing Exélia SP with ZoomControl showed similar benefits in an environment where speech cannot be picked up from the front. The improve-

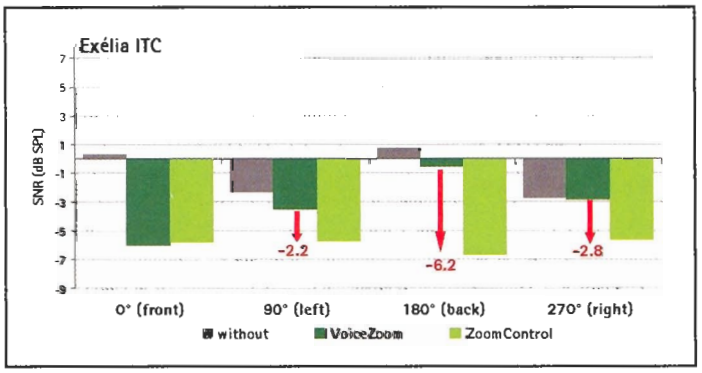

FIGURE 4. Results from OLSA test: Exélia ITC VoiceZoom versus ZoomControl.

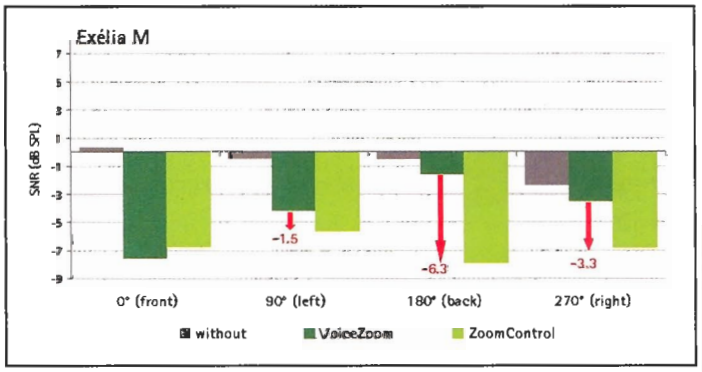

FIGURE 5. Results from OLSA test: Exélia M VoiceZoom versus ZoomControl.

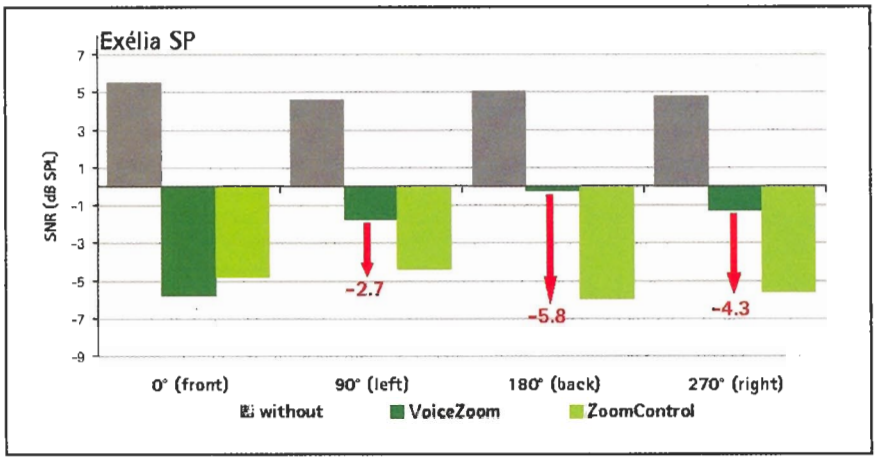

FIGURE 6. Results from OLSA test: Exélia SP VoiceZoom versus ZoomControl.

ments are -2.7 dB from the left, -4.3 dB from the right side, and -5.8 dB from the back (Figure 6). However, the decreased performance without hearing instruments added benefit in the function of ZoomControl.

A paired Wilcoxon Signed Ranks Test on dependent samples comparing comprehension scores led to significant improvement when using ZoomControl compared to VoiceZoom when the target signal was presented from either the right, the left side, or the back. However, with Exélia M, significance did not appear if the signal was presented from the left side. Nevertheless, improvements in speech intelligibility are present. For all other hearing instruments and directions, differences were statistically significant.

Improved Speech Intelligibility in Noise

Due to the real-time streaming made possible by the CORE platform, ZoomControl enables the end user to select four different focus directions, thereby significantly improving speech intelligibility in noise. The results of this test series substantiate significant improvements for speech understanding in noise for listening situations where the speech signal does not originate from the direction in which the end user is looking. The provided benefits can be observed for Exélia SP as well as for Exélia M and Exélia ITC and for all relevant directions. ZoomControl is able to enhance speech comprehension abilities in various environments where it is not always possible to face the speaker and the listening focus is not lying in the same direction as the line of sight.

Summary

This study demonstrated that the Exélia family with ZoomControl provided a significant measurable advantage for speech intelligibility in a noisy environment when compared to the VoiceZoom program, which automatically adapts polar patterns in each channel to selectively and simultaneously cancel multiple noise sources. However, the improvements in speech understanding can only be attributed to the improved perception of speech signals due to different focus directions when the signal is not presented from the front. ◗

References

1. Wagener K, Kollmeier B. Göttinger und Oldenburger Satztest. *Zeitschrift für Audiologie.* 2004;43:134-141.
2. Richards M, Moore BC, Launer S. Potential benefits of across-aid communication for bilaterally aided people: listening in a car. *Intl J Audiol.* 2006;45:182-189.
3. Wagener K, Kuehnel V, Kollmeier B. Development and evaluation of a German sentence test; Part I-III: Design, Optimization, and Evaluation of the Oldenburg sentence test. *Zeitschrift für Audiologie.* 1999;38:86-95.
4. Wagener K, BrandT, Kollmeier B. *Zeitschrift für Audiologie.* 1991;38:86-95.
5. Hawley ML, Litovsky RY. The benefit of binaural hearing in a cocktail party: effect of location and type of interferer. *J Acoust Soc Am.* 2003;115:833-843.

More at www.hearingreview.com

- In One Ear and Synchronized with the Other: Automatic Hearing Instruments Under Scrutiny, by David A. Fabry, PhD. November 2006 *HR.*
- Disparity Between Clinical Assessment and Real-World Performance of Hearing Aids, by Mary Cord, AuD; Deniz Baskent, PhD; Sridhar Kalluri, PhD; and Brian C. Moore, PhD. June 2007 *HR.*
- Adaptive Directional Microphone Technology and Hearing Aids: Theoretical and Clinical Implications, by David A. Fabry, PhD. April 2005 *HR.*
- Myths About Hearing in Noise and Directional Microphones, by Mead C. Killion, PhD. February 2004 *HR.*