Field Study News

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Biometric Calibration: improving directionality for Phonak Virto™ B

Phonak Virto B introduces a new technology, Biometric Calibration, which customizes directionality to the individual wearer's specific concha anatomy to optimize hearing performance in noisy situations. This customization results in a 2 dB improvement in directionality, leading to better hearing performance where it counts the most.

Introduction

When it comes to custom hearing aids, hearing performance is a top priority. Hearing in noise is arguably the most difficult listening situation for individuals with hearing loss, and the most satisfied hearing aid users believe their hearing aids effectively minimize background noise[1]. However, customizing hearing performance is difficult when each ear has unique anatomical and audiological characteristics.[2] Virto B has taken custom hearing aids up a notch with Biometric Calibration. In the past the most custom aspect of a custom hearing aid was the physical fit in the client's ear canal. Biometric Calibration uses the ear impression collected by the hearing care professional (HCP) to customize not only the shell, but also the directional performance of the hearing aid.

In previous custom products the only parameter considered to individualize directional microphones was the microphone depth. Microphone depth is a determination of how deep the microphones sit inside the client's ear canal, e.g. for mini canal hearing aids the microphone placement depth sits flush with the client's tragus. While the microphone depth calculation has been an adequate tool to parameterize directional microphones, it was the most precise for larger custom form factors, like full shell hearing aids. The smaller and deeper the device microphone openings fit inside the ear, the more difficult it is to accurately parameterize the directional microphone. This shortcoming exists partially because the deeper the microphones sit inside the ear canal, the more the target signal is already altered by the anatomy of the ear and the directional microphones have less influence.

Biometric Calibration helps resolve this problem. The new Biometric Calibration algorithm extracts over 1,600 unique data points from the client's ear impression. These biometric data points are compared to an ear model that knows how the ear reflects sound. An algorithm determines the differences between the ear model and the individual's ear anatomy and the unique calibration settings are calculated which optimizes the directional sensitivity for their individual ear. The resulting directional beam generated when the client enters a noisy environment is more precise, as it has been calibrated to account for the individual's specific concha anatomy.

But the customized sound processing in Virto B is only as good as its hardware – directional Virto B models have new microphones. Pressure Gradient (PU) microphones are durable and stable over time. Based on internal technical analysis, they also have 10 dB less microphone noise (see figure 1.) in beamforming programs than their predecessor, the Pressure Pressure (PP) microphone.

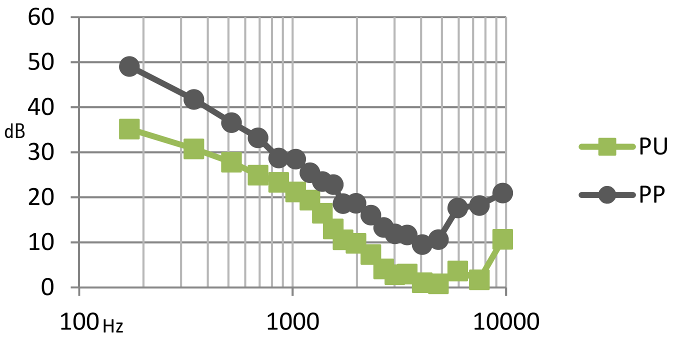


Figure 1. Microphone noise level (dB) across the frequency range.

With each ear hearing differently, could recommending a product (see figure 2) that customizes the directionality to the individual's pinna anatomy improve hearing performance?

Figure 2. Virto B-10.

An optimized beamformer that improves directionality would decrease more background noise and lead to an improvement in hearing performance. The purpose of this study was to investigate if Virto B hearing aids with Biometric Calibration provide an improvement in directionality compared to its predecessor, the Virto V.

Methodology

Two types of investigations took place: verification and validation.

Verification:

In the verification analysis, eight silicone ears were created based on hundreds of ear impression scans from 5 continents. Anatomical variations, such as pinna shape, ear canal volume, angle of outer ear protrusion, and concha reflection effect were incorporated into these ear shapes. Verification testing on this set of silicone ears was conducted in two ways: objective SNR measurements and polar plot directionality analysis.

Objective SNR measurements were conducted on the silicone ear set with Virto B90-10 and Virto V90-10 devices. Analysis was conducted in an acoustic lab built to minimize and equalize reflections from all directions. These two hearing aid models were specifically selected to measure the differences between the previous microphone depth calibration (Virto V) and new Biometric Calibration (Virto B). The directional size 10 model was selected as this deeper fitting device would have the highest potential for microphone depth discrepancies while also utilizing a PU microphone included in all Virto B directional models. Signal-to-Noise Ratio (SNR) measurements were collected using sentences from the Oldenburger Satztest (OlSa) with the target speech at 65 dB(A) and cafeteria noise as the background noise presented at 65 dB(A). A 12 speaker array with diffuse cafeteria noise (target speech at 0°, noise from 30° to 330°) was evaluated in the StereoZoom program along with a 3 speaker array (target speech at 0°, noise at ±90°) which was evaluated in the UltraZoom program. The Hagerman and Olofsson objective SNR measurement protocol was used.

In the second verification analysis, polar patterns were generated on the same set of 8 silicone ears in an anechoic chamber (see figure 3) in the UltraZoom program. Each silicone ear was fitted with a B-10 and V-10, B-312 and V-312, B-13 and V-13, for a total of 48 hearing aids. UltraZoom is an adaptive beamformer, i.e., the beamformer automatically adjusts the null to achieve a maximal attenuation of unwanted noise. The polar patterns were measured with the following set up. One stationary loud speaker presented pink noise (unwanted noise) and a modified KEMAR wearing the silicone ears and hearing aids rotated around, stopping for measurements every 15°. At each angle, the intensity level at the receiver was measured and compared to the level at 0°, yielding the spatial attenuation pattern. Because UltraZoom automatically adjusts the null at each angle, the resulting polar pattern depicts the maximum attenuation of the unwanted noise at each angle.

Figure 3: KEMAR set up in anechoic chamber for polar plot measurement

Validation:

Following verification analysis, a one month investigation was conducted at two separate facilities: Phonak

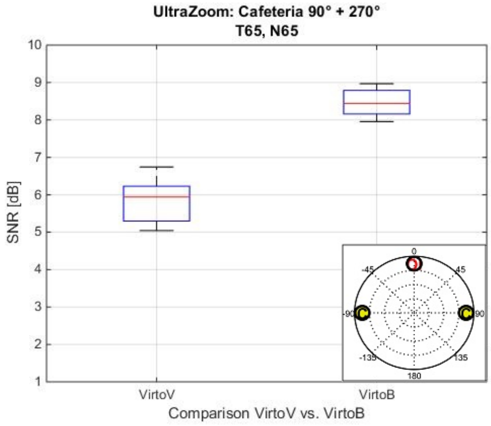
Headquarters in Stäfa, Switzerland and in Aurora, Illinois. The goal of validation was to determine if improvements seen in directionality during verification would result in a subjective benefit when worn by human participants with hearing loss. Subjects included 35 experienced hearing aid users with moderate to moderately-severe hearing loss. Each participant was fitted and tested with a power receiver Virto B90 10 or 312 and Virto V90 10 or 312 with Acoustically Optimized Vents (AOV).

All subjects wore the Virto B devices for a two week home trial and were asked to fill out a Hearing Comfort Questionnaire. In the questionnaire, the subjects were asked to rate different hearing situations (own voice, speech in quiet and speech in noise) for loudness perception, sound quality associated with typical negative and positive characteristics and the overall sound quality.

Results

Verification:

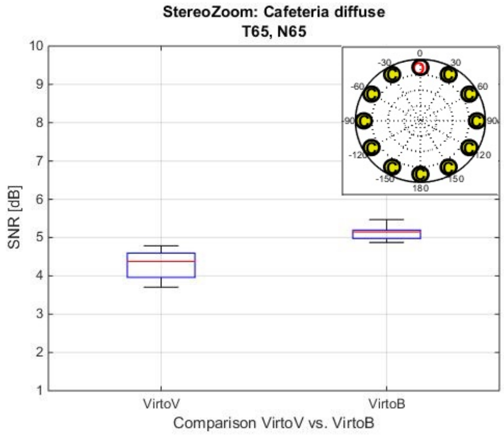
Figure 4 shows the results of the SNR measurement with UltraZoom. The results show an average of 2.62 dB SNR improvement from Virto V90-10 to Virto B90-10 across all 8 ears.



Median	5.94	8.44	
Average	5.84	8.46	**Diff: 2.62**

Figure 4. Box plot representing SNR values from Virto V90-10 and Virto B90-10 with the corresponding 3 speaker array (bottom right) in UltraZoom, OlSa sentences at 0° and cafeteria noise at ±90°.

The results of the SNR measurement with StereoZoom (see figure 5) show a 0.8 dB SNR improvement from Virto V90-10 to Virto B90-10 across all 8 ears. While this is possibly a statistically significant result, it is not considered clinically relevant.



Median	4.38	5.15	
Average	4.29	5.12	**Diff: 0.83**

Figure 5. Box plot representing SNR values from Virto V90-10 and Virto B90-10 with the corresponding speaker array (bottom right) in StereoZoom- 12 speaker array, OlSa sentences at 0° and diffuse cafeteria noise from 30° to 330°.

Figure 6 shows the results of the polar plot measurements representing the averaged spatial attenuation between 100 and 6600 Hz. Averaged across all eight devices and across the back hemisphere of each device, the maximum attenuation is -18.11±0.96 dB for the Virto B-10 and -15.96±1.08 dB for the Virto V-10. The average difference, tolerances aside, is 2.15 dB.

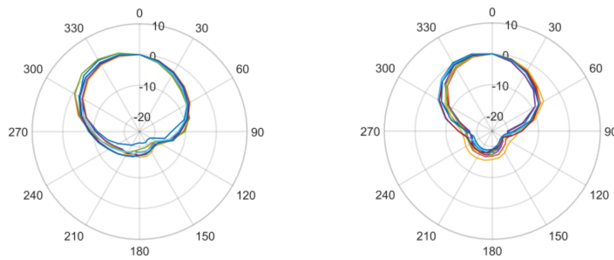


Fig 6. Collated broadband frequency responses in UltraZoom for Virto V90-10 (left panel) and Virto B90-10 (right panel). Results are the spatial attenuation pattern between 100-6600Hz.

Validation:

After combining questionnaire results from both test sites, five participants were excluded after it was reported they did not experience listening to Speech in Noise during the study. The results (see figure 7) indicate that over 60% of participants rated Speech in Noise sound quality as either "very" or "extremely" natural with the Virto B hearing aids.

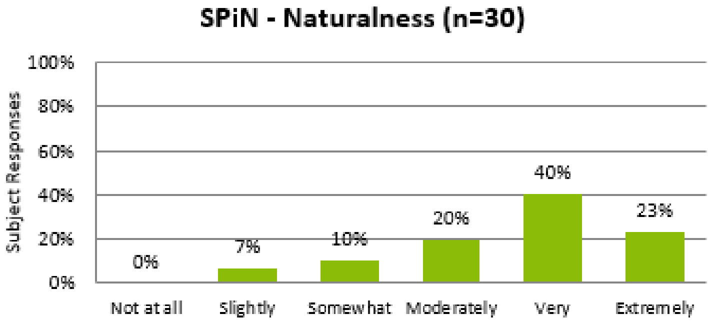


Fig 7. Home trial questionnaire results for perceived Speech in Noise naturalness, from CH and US combined.

More than 80% rated Speech in Noise clarity as either "very clear", "clear", or "moderately clear". Over 80% of participants perceived their own voice clarity as either "extremely clear" or "clear". All of these positive attributes comes with more than 70% of participants rating their overall satisfaction with the hearing aids as either "satisfied" or "very satisfied".

Conclusion

Each ear is unique, each ear hears differently. Virto B with Biometric Calibration takes the individual's ear anatomy in consideration to optimize directional performance for their ear. However, Virto B is not just Biometric Calibration, it's the sum of its parts; Biometric Calibration, new PU microphones, and Belong platform improvements, including new AutoSense OS. This verification study found that the Virto B resulted in an average of 2 dB better directionality than hearing aids that have not been Biometrically Calibrated leading to better hearing performance.

References

1. Abrams H.B. & Kihm J. (2015). An Introduction to MarkeTrak IX: A New Baseline for the Hearing Aid Market. Hearing Review. 2015;22(6):16.
2. Zhong, X., Xu, X., & Zhang, J. (2014). Influence of small and large pinnae on virtual auditory perception. ICSV 21, 13-17 July, Beijing, China.

Investigators

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Thomas studied electrical engineering in Aachen and worked in Acoustics and ProAudio before he joined Hearing Aid business at Interton in 1998. He started at Sonova AG in 2010 as a hearing performance engineer where he optimized beamformer related feature topics.

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After receiving his Ph.D. from ETH Zurich for his thesis about artificial hearts, Gregor started at Sonova AG in 2016. He works as a hearing performance engineer focusing on directionality.

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Carina undertook an apprenticeship as a Hearing Care Professional from 2006 to 2009. From 2009, she worked as an HCP then studied Hearing Technology and Audiology at the Jade University in Oldenburg, completing her Bachelor of Engineering in 2014. She wrote her bachelor thesis at Phonak AG in 2014, and returned to the custom product team in 2016.

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Daniela undertook an apprenticeship as a Hearing Care Professional from 2008 to 2011. Beginning in 2011 she studied Hearing Acoustics at the University of Applied Science in Lübeck, completing her Bachelor of Science in 2014. She started working at Phonak AG as a Validation Manager in 2015.

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Rachel began her employment as a Hearing Care Professional at Sonova AG in 2012 and received her Doctorate of Audiology from the University of North Texas in 2013. She is now the Audiology Manager for In-the-Ear products at Phonak Headquarters in Stäfa, Switzerland.

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