Phonak
Field Study News

ActiveVent™ Receiver provides benefit of open and closed acoustics for better speech understanding in noise and naturalness of own voice perception.

Researchers at the National Acoustic Laboratories (NAL), Sydney, Australia, examined the benefit of the ActiveVent Receiver. Results showed ActiveVent provided a 10% speech intelligibility advantage in noise (compared to standard) and superior preference scores when listening to own-voice sounds. In addition, overall sound quality scores for audio streaming in quiet were superior for ActiveVent compared to a standard earpiece.

Matthias Latzel, Jorge Mejia, Teagan Young and Shin-Shin Hobi, April 2022

Key findings

- Speech intelligibility performance with ActiveVent closed provided on average 10% better results compared to both the ActiveVent open and the standard earpiece while listening to a frontal talker in a diffuse babble noise condition
- Own-voice naturalness rating in quiet showed similar ratings between ActiveVent open and standard earpiece solution
- Participants provided higher preference scores for ActiveVent closed compared to the standard earpiece solution while listening to audio-streaming in quiet listening situations

Considerations for practice

- When your clients want to hear better in noise or enjoy streaming, highlight ActiveVent as a possible solution
- Demo ActiveVent Receiver using the Universal SlimTip AV earpiece
- Demonstate the ActiveVent Receiver according to your clients'listening goals
- Help your clients acclimitize to ActiveVent Receiver by creating a manual Speech-in Noise or manual Speech-in-Loud Noise program with ActiveVent closed

Introduction

Hearing care professionals (HCP) are often faced with the dilemma of choosing between an open fitting to ensure the comfort of own voice or a more occluded fitting to optimize the benefit of directionality, especially in challenging background noise environments.

Vented earpieces and open domes in hearing aid fittings are the most effective way to reduce the occlusion effect, a sensation of increased loudness caused by bone-conducted low-frequency amplification through the cartilaginous portion of the ear canal. Open fittings limit the achievable output level of low-frequency amplification because of low frequency leakage (vent out effect) (Blau et al., 2008; Dillon, 2012), which could result in reduced benefit of features such as directionality and noise reduction, due to a reduced bandwidth of the amplified sound (Ricketts, 2000; Bentler et al., 2006; Goyette et al. 2018). In addition, open vents limit the maximally achievable gain because of acoustic feedback.

HCPs have found different ways to overcome this dilemma, for example, deep insertion of earmolds to reduce sound vibration of the soft tissue inside and hence reduce the occlusion effect. Other solutions are based on acoustic feedback canceling technologies whereby the receiver in the ear canal is acoustically coupled with a microphone inside the ear canal to produce feedback cancellation of own-voice sounds (Mejia et al., 2008; and Borges, et al., 2013). Another solution aims to decrease the vent effect by altering the size and length of the vent (Kuk et al., 2009). Although these solutions have been reported in the literature, none have been universally recognized, and the trade-off between the occlusion effect vs. vented or open fitting effects remains problematic in the industry (Winkler et al. 2016).

Phonak has developed a receiver that attempts to resolve this common dilemma. This first of its kind receiver incorporates a mechanically variable vent that can be electronically switched between open and closed states. Acoustically the active vent combines the properties of a fully occluded vent with a vent comparable to a standard 3.5 mm venting with a cut off frequency of around 1.5 kHz. Figure 1 shows the frequency response of the active vent transducer measured on an occluded ear simulator IEC 60318-4:2010.

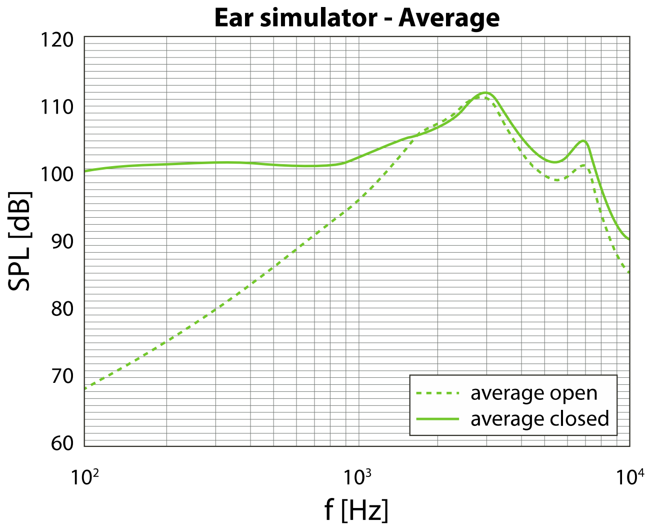

Figure 1: Frequency response of the ActiveVent Receiver recorded on an occluded ear simulator in the open and closed state.

The NAL investigation compared ActiveVent (MAV) to the standard earpiece coupling (STD) with a vent, as suggested by Phonak Target. The focus was on the following specific objectives:

- Determine the speech intelligibility benefit of ActiveVent (MAV) over a standard custom earpiece (STD) when listening to a frontal talker in diffuse background noise
- Determine own-voice sound quality benefit of ActiveVent (MAV) over a standard custom earpiece (STD) in a quiet environment
- Determine the sound quality benefit of ActiveVent (MAV) over a standard custom earpiece (STD) when listening to audio-streaming in quiet and in noise proposal by Phonak target. The average vent corresponded to 2.5 mm

Methodology

Participants

Twenty-three gender-balanced adult participants with bilateral mild to moderately severe hearing loss (Figure 2) were recruited from NAL's participant database.

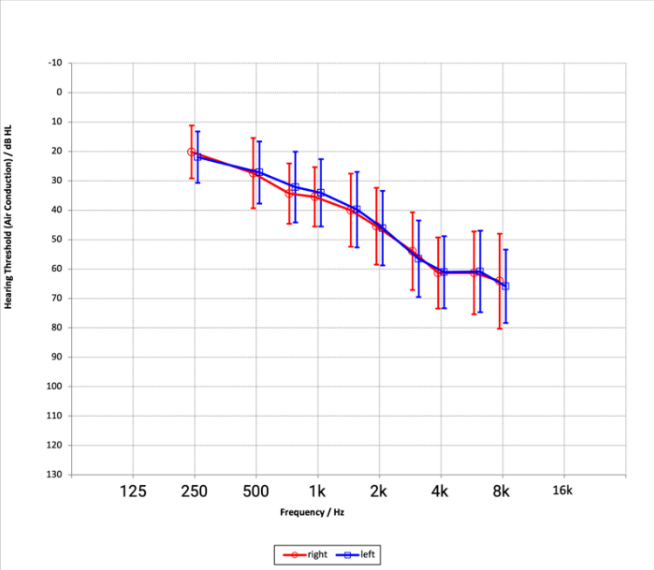

Figure 2. Average audiogram

Participants were fitted with two sets of Phonak Audéo P90 devices bilaterally:

- Set 1, MAV receivers with the compatible custom earpieces
- Set 2 standard receivers with compatible customized earpieces (STD) with a vent size according to the proposal by Phonak Target. The average vent corresponded to 2.5mm.

Speech in noise test:

This speech test was separated into two stages:

a) Estimation of individual fixed SNR:
Participants were presented with Bamford-Kowal-Bench (BKB) sentence test (Bamford & Wilson, 1979 from 0^{o} azimuth and with a noise level presented diffusely at 65 dB SPL using a 16 loudspeaker array (Figure 3). The speech level started at 75 dB SPL, then adjusted until the participants correctly recalled 50% of morphemes (Gitte Keidser et al., 2013). The test was repeated twice, and the score from the two repeated measures averaged. The subsequent tests were administered at a fixed SNR, referenced to the individually determined threshold for 50% intelligibility reduced by 1 dB SNR.

b) Speech recall performance:
Participants were presented with 64 BKB sentences and asked to recall what they heard at the individually designated fixed SNR.
Speech recall performance in all three conditions (MAV-C (closed), MAV-C (open), and STD (standard) using the SpiLN program were determined.

Sound quality of own voice:

Participants rated the sound quality of their own voice while the hearing aid was set to the Calm Situation program for all three conditions (MAV open, MAV closed and STD). While in quiet, participants were asked to utter the vowel sound /iː/ as in 'tree' with a constant vocal effort of approximately 65 dB SPL, measured by a sound level meter placed in front of the participant. Then participants rated the loudness and the naturalness of their voice and provided an overall score on a categorical scale ranging from 1 to 5.

Sound quality of audio-streaming:

The level of the audio-stream, presented via tablet, was around 68 dB SPL. The background noise selected for this test was street noise, presented at 65 dB SPL via the speaker array. The testing compared MAV versus STD, and the hearing aid microphones were also switched on (default setting). For our research purposes parts of the following test stimuli were used: two audio-visual stimuli ("Iron man lost in space monologue (from Avengers: End Game)" and a documentary film "Australian outback"), and two audio-alone stimuli ("Bass classic" and "When it hits you about time," which is a Jazz style of music). Participants were allowed to adjust the volume of the tablet to comfortable levels, but all subjects were satisfied with the initial setting. For each stimulus, the participants rated, on a scale from 0 to 100, the sharpness, naturalness, ability to concentrate on the audio stream, satisfaction with the loudness of the background noise, and provided an overall preference.

Figure 3: Picture shows the Speech in Noise Test setup: the sound-treated test booth with a 16-loudspeaker array, with a diameter of 1.6 meters. The participant sits at the center of the array.

Results

Speech in noise test:
There was a highly significant improvement in speech performance with MAV closed over MAV open or the STD condition. The average improvement in speech performance of MAV closed over MAV open condition was 10.9% ($p < 0.0000$). Similarly, the improvement of MAV closed over standard was 12.3% ($p = 0.0000$). Figure 4 illustrates the overall performance of MAV and STD solutions.

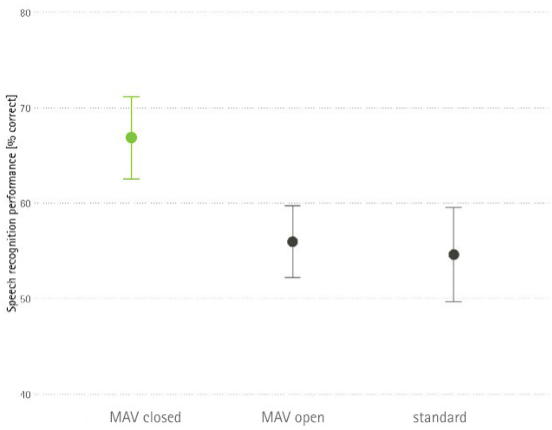

Figure 4: Illustration of MAV C (closed) MAV O (open) and standard (STD) performance measures for speech intelligibility. The figure shows the mean scores for word recall (morphemes) and the bars indicate 95% confidence intervals.

Sound quality of own voice:

Group correlation matrix results indicated a high correlation between the three sound quality attributes (loudness, naturalness, and overall sound quality) of the utterance of /iː/ in a quiet listening condition.
Because of the high correlation in figure 5, we indicate the outcome showing that MAV open and standard were comparable, and both provided significantly higher acceptability compared to MAV closed condition.

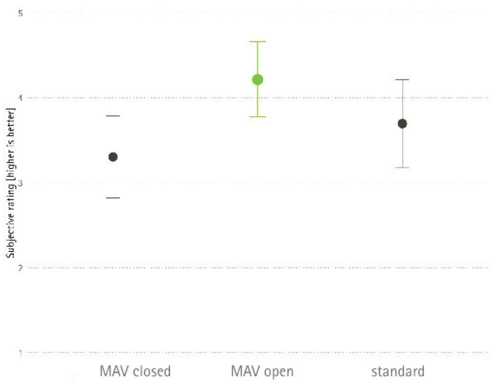

Figure 5: averaged scores of overall quality of over own-voice comparing ActiveVent open, closed and Standard (STD). higher number indicates a more positive score. The figure shows the mean scores and the bars indicate 95% confidence intervals.

Sound quality of audio-streaming:

In quiet, participants were asked to rate the sound quality of the streamed signal in 3 domains: naturalness, ease of concentration on the streamed audio signal, and overall preference. Statistically significant differences were only observed in the overall preference between the MAV closed and STD solution. Figure 6 shows the overall preference scores. As shown in figure 6, the effect of MAV was 3.7 points ($p = 0.009$) higher compared to the standard earpiece**.**

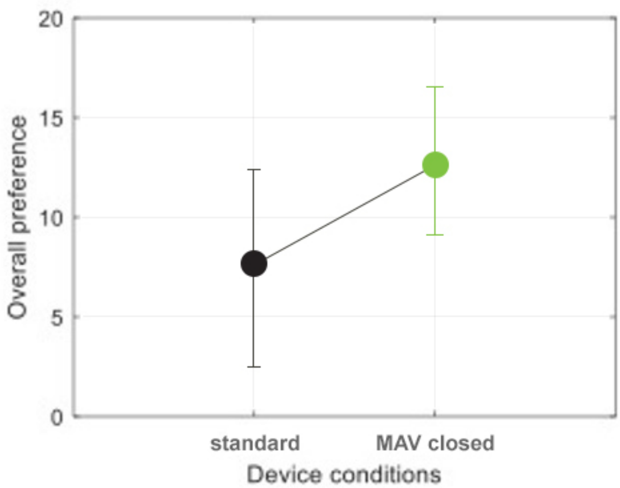

Figure 6: Overall preference scores for audio streaming in quiet with MAV closed and standard (STD). A higher number indicates a more positive score. The figure shows the mean and the bars indicate 95% confidence intervals.

In noise, participants were asked to rate the sound quality of the streamed signal in the same domains: as for the situation "in quiet." No statistically significant differences between MAV and STD were observed.

Conclusion

The purpose of the study was to evaluate the benefit of the new ActiveVent Receiver compared to the current standard earpiece.

The study demonstrated the superiority of the ActiveVent over the standard earpiece. The results showed an improvement of more than 10% in speech understanding when listening to a frontal talker in a diffuse babble noise condition. This is compared to the standard custom (STD) earpiece as suggested by Phonak Target. The perception of the own-voice with ActiveVent in the open state is comparable to standard earpiece, as consistently demonstrated by naturalness, loudness, and the overall sound quality ratings.

While listening to audio streaming in a quiet listening situation, the overall preference for the closed ActiveVent was proven superior to the standard earpiece solution.

In conclusion, the study supports that the ActiveVent receiver offers the benefit of both open and closed acoustics compared to standard receivers.

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Authors and Investigators

External Principal Investigator

Dr. Jorge Mejia is the heard of the signal processing department at the National Acoustic Laboratories in Sydney, Australia. Jorge completed his PhD. in psycho-acoustics from the University of Sydney in 2010, Master of engineering science (2004), and Bachelor of electorical engineering science (2001) from Queensland University of Technology, Australia. Jorge has several years of research and development experience working with the industry in algorithm development for hearing aids and assistive listening technologies.

Lead Research Audiologist

Taegan Young is a research audiologist at the National Acoustic Laboratories with ten years of experience in clinical and reserch audiology. In 2012, Taegan completed the Masters of Clinical Audiology at Macquarie University, following a Bachelor of Hearing and Speech Science from the University of Sydney (2009). Since joining NAL, Taegan has worked on and led a variety of projects with adults and children in area including auditory processing disorders, hearing assessment, hearing aid fitting, and hearing rehabilitation.

Research Audiologist

Sophie Morgan also contributed to the study as a research audiologist.

Study Coordinator

Dr. Matthias Latzel studied electrical engineering in Bochum and Vienna in 1995. After completing his Ph.D. in 2001, he carried out his PostDoc from 2002 to 2004 in the Department of Audiology at Giessen University. He was the head of the Audiology department at Phonak Germany from 2011. Since 2012 he has been working as the Clinical Research Manager for Phonak AG, Switzerland.

Author

Shin-Shin has been working at Phonak HQ as Senior Audiology Manager since 2006. In her current role she ensures end user and hearing care professional needs are taken into consideration during hearing aid product development. Originally from Australia, Shin-Shin earned her Audiology qualifications from the University of Melbourne (1997) and Bachelor of Science from Monash University (1996). She gained wide clinical experience in private practice, before making the move to Switzerland.