Phonak
Field Study News

AutoSense OS™ 4.0 - significantly less listening effort and preferred for speech intelligibility

This study conducted in Hörzentrum Oldenburg evaluated AutoSense OS 4.0 with the new Speech Enhancer feature and Dynamic Noise Cancellation. In situations with distant speech, the Speech Enhancer was found to significantly reduce listening effort and was clearly preferred with regards to speech intelligibility. Dynamic noise cancellation was proven to reduce listening effort in noise.

Appleton-Huber, J. / November 2020

Key highlights

- Speech Enhancer has been proven to significantly reduce listening effort, particularly when speech is from a distance.
- Subjects who compared Speech Enhancer ON versus OFF preferred ON with regards to listening effort and speech intelligibility.
- Dynamic Noise Cancellation was shown to improve listening effort.
- Listening effort scaling showed that listening effort decreases with increasing amount of Dynamic Noise Cancellation.

Considerations for practice

- Enabling Speech Enhancer will significantly reduce listening effort and therefore improve client satisfaction with their hearing aids especially in situations when speech comes from distance.

- Users have been shown to have different preferences with regards to noise cancellation. Clients are able to adjust the level of Dynamic Noise Cancellation via the myPhonak 4.0 app.

Introduction

Hearing speech in quiet has been found to be the biggest predictor of hearing aid benefit (Dillon, 2018). Therefore, a hearing solution which can even pick up soft speech in quiet is likely to lead to a well perceived benefit for the hearing aid wearer.

It is well known that understanding speech in noise is rated as one of the greatest difficulties experienced by people who wear hearing aids (e.g. Abrams et al. 2015). SNR-Boost, the spatial noise canceller within Phonak Marvel uses spatial cues to distinguish between speech from the front and surrounding noise. With this clear distinction, noise cancellation can be more appropriately applied to further enhance the signal-to-noise ratio for speech coming from the front. Furthermore, Brons et al., 2013 has shown that subjects differed in whether their overall preference was more strongly related to noise annoyance or to speech naturalness. Some users would like noise cancellation set at maximum. These users are less sensitive to artefacts in the sound quality because their primary goal is comfort. On the other hand, users who prioritize sound quality would like less aggressive noise cancellation to maintain natural sound awareness with no artefacts.

With the launch of Phonak Audéo™ Paradise hearing aids, the automatic operating system which controls all hearing performance features has been further improved. This latest version is called AutoSense OS 4.0. As well as all existing features, it has a Speech Enhancer, Dynamic Noise Cancellation plus Motion Sensor Hearing, proven to improve speech understanding when walking (Appleton-Huber, 2020; Voss et al., 2020).

The Speech Enhancer aims to help clients hear soft speech in quiet such as when speech is at a distance. It applies up to 10 dB additional gain when the detected speech is between 30-50 dB input level and the Signal to Noise Ratio (SNR) is at least +10 dB.

Dynamic Noise Cancellation is a spatial noise cancellation feature that works in combination with a directional beamformer to improve the signal-to-noise ratio in challenging, noisy situations. With Dynamic Noise Cancellation clients have the ability to set the strength in real-time to their individual preference using the myPhonak 4.0 app. This personalization means, each Paradise client can set the feature to their preference for comfort or audibility in a challenging environment.

Objective

The objective of this study was to evaluate the Speech Enhancer and Dynamic Noise Cancellation within AutoSense OS 4.0. Specifically, we wanted to see whether these features within Audéo P90-R hearing aids provide improved listening effort and sound quality in typical everyday life situations in quiet and in noise in comparison to previous technology.

Methodology

Participants

19 participants (10 male, 9 female) took part in the study. The average age was 71 years (standard deviation = 9.4 years). Participants had a moderate to severe hearing loss and had worn hearing aids for at least two years. Audiometry had been performed within the last year and the audiogram was available in the database of the Hörzentrum Oldenburg (figure 1). Participation criteria also required the participants to be interested in and have experience with using modern technology (such as smartphones or tablets). They also needed to be living with a partner.

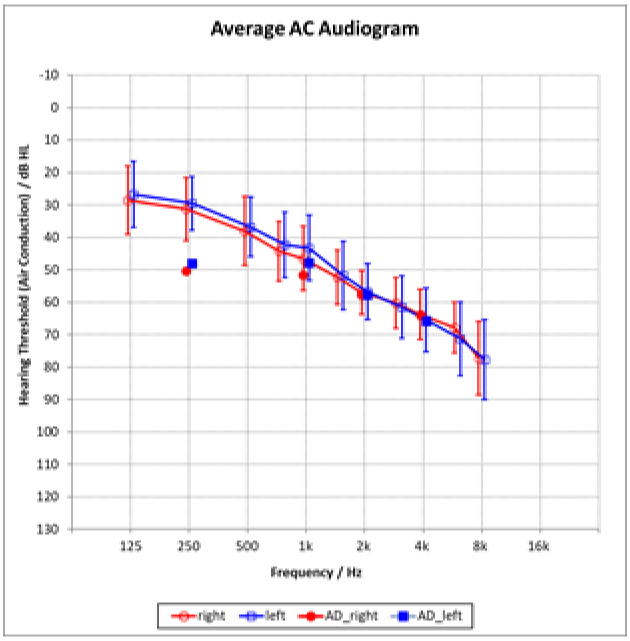


Figure 1. Mean audiogram of the study participants.

Equipment

As this study took place in April/May 2020 during the Covid-19 pandemic, social distancing measures in Germany meant that study participants could not attend clinic appointments. To avoid direct contact between the tester and the participants a "remote study setup" was designed and utilized. For this, a suitcase named the 'remote hearing lab' (figure 2) was sent or delivered to the study participants in their home. The remote hearing lab contained a tablet with a complete version of the fitting software Phonak Target combined with a NOAHlink Wireless and the individual sound recordings described below. Additionally the software to run the different audiological tests had been installed. It also contained headphones and a loudspeaker for listening to recordings, a built-in microphone to identify and adjust the presentation levels and an emergency 'off' button (for stopping the replay of the sound recordings if necessary).

Figure 2. The remote hearing lab which each study participant received at home.

Setup of the "Remote hearing lab"

To set up the remote hearing lab, the participants followed written instructions which were also provided with the suitcase. Additionally, the participant was supported by a tester who called them via videocall so that they could communicate with each other directly. To check for correct fitting of the devices in the ear canal and potential ear wax an "in-situ" audiogram was carried out via AudiogramDirect and the hearing aids. For better estimation of the acoustical environment of the participants' home, the system was calibrated using the loudspeaker and the built-in microphone by determining the absolute level of speech and the reverberation.

Test devices and fitting

Participants were also sent test devices – Phonak Marvel hearing aids (Audéo M90-R) and prototypes of Phonak Paradise hearing aids (Audéo P90-R), both fit with power domes. Both sets of devices had been programmed to their individual hearing loss (taken from the Hörzentrum Oldenburg subject database) based on the Adaptive Phonak Digital (APD) fitting formula (Latzel, 2013; Woodward et al., 2020). Audéo M90-R was fit with a default program of AutoSense OS 3.0 and Audéo P90-R was fit with the new AutoSense OS 4.0.

Environments

In preparation for the tests taking place in the participants' home, recordings were carried out in advance in the lab at Hörzentrum Oldenburg. Two different scenarios were simulated:
Scenario#1: Listening to distant (soft) speech in quiet.
An artificial head (KEMAR) was placed in the center of 16 loudspeakers (figure 3). The artificial head was fit with the test devices which were programmed according to the individual audiogram of the study participant. Oldenburg Sentence test (OLSA) speech sentences were played from the loudspeakers simulating four virtual distances (1, 2, 4 and 8 meters) and the output of the hearing aids at each of these distances was recorded for each participant individually. Recordings were made with two conditions: with Speech Enhancer ON and OFF.

Figure 3 . Setup for the speech recordings in the lab which were to be used in the remote testing.

Scenario#2: Listening to speech in noise.
The setup was the same as for scenario#1 but with the target signal from the loudspeaker at 0° being a recording of a female talker. The other loudspeakers presented background noise at a level of 68 dB (A). Recordings were

made with four conditions: Dynamic Noise Cancellation (DNC) set to minimum setting (MIN), DNC set to default setting (DEF), DNC set to maximum setting (MAX) (all using Audéo P90-R) and the default setting of the spatial noise reduction implemented in Audéo M90-R (SNR-Boost). Additionally, the ratio between speech and noise level (SNR) was varied using SNR – 3dB, SNR 0 dB and SNR +3 dB.

Audiological tests

Spontaneous acceptance and home trial: The participants self-assessed their spontaneous acceptance of both devices (Audéo M90-R and Audéo P90-R) directly after fitting. They also self-assessed their long-term perception of both devices in real life situations (at home) over a period of one week., via filling out a questionnaire.

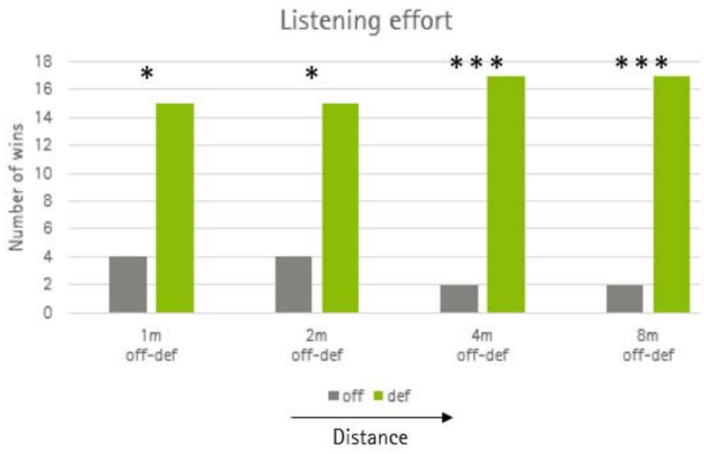
Paired comparison: The participants listened to the individual recordings made in the lab via headphones and judged which recording they preferred with regards to listening effort, loudness of speech, speech intelligibility, noise suppression, sound quality and overall preference comparing all conditions with each other for scenario#1. For scenario#2 only the conditions recorded with SNR of 0 dB were compared with each other.

Adaptive CAtegorical Listening Effort Scaling (ACALES): The participants listened to the individual recordings made in the lab via headphones and scaled the perceived listening effort for the different conditions separately. In this test all conditions recorded in scenario#1 and scenario#2 were presented and rated.

Results

The spontaneous acceptance test and the home trail indicated that Audéo P90-R was preferred over Audéo M90-R in most categories. The outcomes were not statistically significant.

Figure 4 shows results of the paired comparison test for Speech Enhancer when the participants were asked which setting they preferred regarding listening effort and speech intelligibility (it shows the number of wins). The graphs demonstrate a clear preference when Speech Enhancer was activated for both categories (listening effort and speech intelligibility). These significant observations were strongest when speech was at a longer distance.



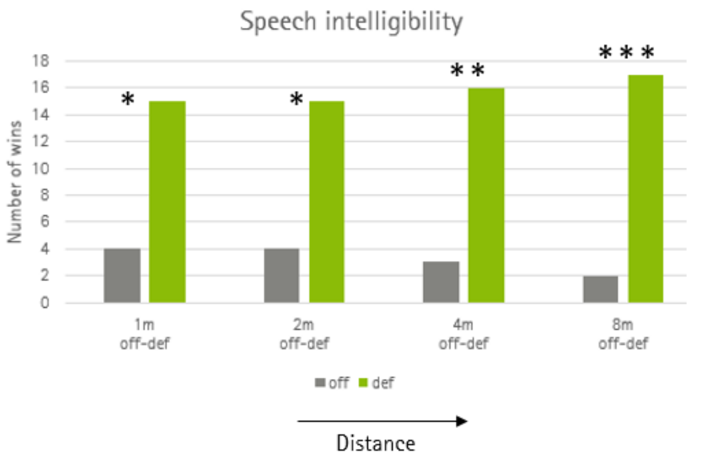


Figure 4. Paired comparison of Speech Enhancer ON versus OFF for the categories listening effort and speech intelligibility. Def = default (ON). Asterisks indicate statistical significance * = p<0.05, **= p<0.01, ***= p<0.005, ****= p<0.001. Number of wins means the number of times that condition was picked as the preferred option.

The comparison of the different settings of DNC with each other and the SNR-Boost implemented in Marvel did not show as clear results as the Speech Enhancer. Figure 5 shows the results of wins when each of the conditions were compared with each other with regards to speech intelligibility, noise suppression and listening effort. The results are not statistically significant but the trend which can be seen is in the expected direction. The suppression of noise is mostly preferred when DNC is activated (in DEF and MAX setting). This result was also reflected when participants were asked which condition they preferred regarding listening effort. Fortunately, the speech intelligibility is not reduced by use of DNC. Instead, the speech intelligibility trend goes in opposite direction to normal one-microphone noise reduction solutions as the results with the highest preference for speech intelligibility is that where DNC is at MAX setting.

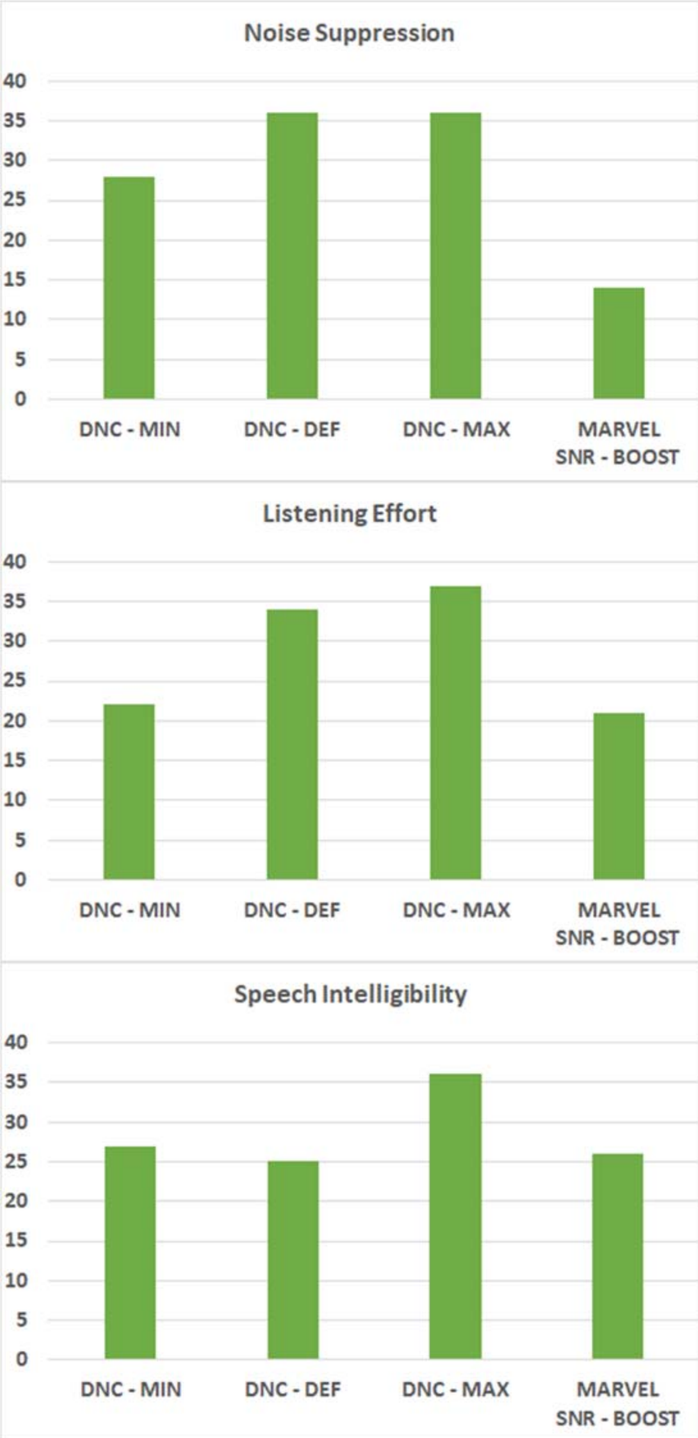


Figure 5. Paired comparison for DNC in the settings MIN (minimum) DEF (default) and MAX (maximum) and for Audéo M90-R with SNR Boost activated for the categories speech intelligibility, noise suppression and listening effort. Scale on the y-axis is the number of wins i.e. the number of times that it was picked as the preferred option.

The scaling of listening effort with ACALES provided reliable data as the listening effort was found to increase with increasing distance when the Speech Enhancer is switched ON and OFF according to test design and expectations. When comparing Speech Enhancer ON and OFF the results from the paired comparison could be reinforced. The listening effort when Speech Enhancer was active was more than 3(!) categories lower for all four distances than when it was de-activated (figure 6). These results indicated a huge difference between the two settings and demonstrated an unrivaled benefit of the new Speech Enhancer. This result was highly statistically significant (p = 0.000).

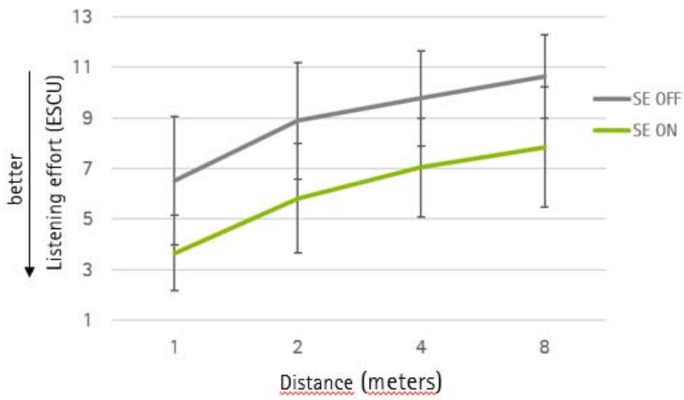


Figure 6. ACALES rating of listening effort for SE ON versus SE OFF. ESCU = Effort Scaling Categorical Unit. 1 = no effort, 13 = extreme amount of effort.

The scaling of the listening effort of DNC in three different settings and in comparison to SNR-Boost revealed also strong evidence of the benefit of the new noise suppression algorithm (figure 7).

Comparison of different DNC settings: Listening effort decreases with increasing strength of DNC. This observation supports the idea to give the user access to adjust the strength of DNC individually using the myPhonak 4.0 app. While the observed difference between DNC in DEF setting and in the MAX setting is not statistically significant, the difference between DNC MIN and DNC MAX was proven to be statistically significant.

Comparison of DNC with Marvel with SNR-Boost (in Audéo M90-R) activated: When using Audeo P90-R with DNC MIN, the listening effort is slightly higher than when using the former noise reduction SNR Boost of Audéo M90-R (not statistically significant). When DNC is activated at DEF setting, the listening effort between the new and former system is almost the same. If the setting of DNC is set to MAX setting, the listening effort is clearly lower than when using Marvel with SNR-Boost. This result is statistically significant over the whole observed SNR range from –3 dB to +3 dB.

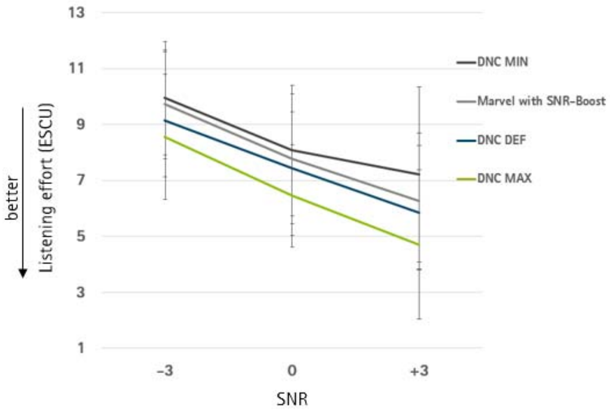


Figure 7. ACALES rating of listening effort for DNC in the settings OFF, DEF and MAX and for Audéo M90-R with SNR Boost activated. ESCU = Effort Scaling Categorical Unit. 1 = no effort, 13 = extreme amount of effort.

Conclusion

Results of this study showed that when the Speech Enhancer was activated, it was clearly preferred with regards to listening effort and speech intelligibility, particularly when speech was at a longer distance. Listening effort scaling further confirmed that use of the Speech Enhancer resulted in significantly less listening effort, particularly at distance.

Dynamic Noise Cancellation was shown to improve listening effort. Furthermore, listening effort scaling showed that listening effort decreases with increasing amount of DNC. If the setting of DNC is set to the MAX setting, the listening effort is clearly lower than when using SNR-Boost.

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Authors and investigators

External principle investigators

Dr. Michael Schulte has been with Hörzentrum Oldenburg GmbH, Germany since 2004, where he has been responsible for audiological studies in publicly funded projects as well as in cooperation with the industry. In 2002, he received his Ph.D. from the Biomagnetism Centre at the Institute of Experimental Audiology, University of Münster, Germany. From 2002 to 2003, he worked as a postdoc at the F.C. Donders Centre for Cognitive Neuroimaging, Nijmegen, Netherlands. Michael Schulte's research interest is in the evaluation of hearing systems with a special focus on listening effort.

Dr. Matthias Vormann received his diploma in physics in 1995 and his Ph.D. in 2011 from University of Oldenburg. Since 2005 he has been with Hörzentrum Oldenburg GmbH, Germany, where he works mainly in industrial research projects for hearing aid manufacturers. His interest is about new methods for measuring the subjective and objective benefit of hearing aids.

Müge Kaya has been working as a medical-technical assistant at the Hörzentrum Oldenburg since 2000, focusing on audiological hearing system evaluation, special audiological diagnostics, cross-project organization and subject acquisition.

Jan Heeren studied Physics at the University of Oldenburg, Germany, and graduated in the Medical Physics group in 2014. From 2012, he worked on several projects in the field of hearing aid evaluation and virtual acoustics at the University and the Hörzentrum Oldenburg. In 2016, he started in the R&D department at HörTech GmbH, Oldenburg, working on hearing aid evaluation methods. Apart from his scientific activities, he has conducted more than 500 events as a free-lancing audio engineer since 2008.

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.

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Jennifer Appleton-Huber received her M.Sc. in Audiology from the University of Manchester in 2004. Until 2013, she worked as an Audiological Scientist mainly in the UK and Switzerland, where she worked with adults and pediatrics, in the areas of hearing aids and cochlear implants. Her current role is Scientific Audiologist at Phonak Headquarters.