Phonak Field Study News.

Speech Enhancer significantly reduces listening effort and increases intelligibility for speech from a distance.

Research conducted at Hörzentrum Oldenburg showed that Speech Enhancer, part of Phonak SmartSpeech™ Technology, significantly improved understanding of soft, distant speech in quiet. Additionally, listening effort scaling showed significantly reduced listening effort for distant speech.

January 2023: Latzel, M., Lesimple, C., & Woodward, J.

Key highlights

- Recent market research has shown that the ability to hear soft speech in quiet is one of the top three most important listening situations for clients with hearing loss (Appleton, 2022). It is also a strong predictor for hearing aid benefit (Dillon et al., 2018).
- The current study showed that Speech Enhancer:
  - provides 23% better speech intelligibility for speech from a distance*
  - provides 18% better speech intelligibility for speech from an adjacent room**
  - reduces listening effort by up to 20% for soft speech from a distance***

*speech in a quiet environment from 4 meters
**speech in a quiet environment without visual cues at 4 meters
***speech in a quiet environment at 2,4 and 8 meters

Considerations for practice

- Providing clients with the ability to hear soft speech more clearly – from a distance or a neighboring room – may provide even more perceived hearing aid benefit.
- The benefits of Speech Enhancer include improved speech intelligibility, but also reduced listening effort, which may free up cognitive resources for purposes other than listening (Sarant et al., 2020).
- Speech Enhancer is activated by default for experienced users. If your client is a new user, think about turning on Speech Enhancer once they have acclimatized to their hearing aids.

Introduction

Improved audibility of soft sounds

Effective communication is a central part of our daily lives. It allows us to connect and relate to loved ones, friends, colleagues, study partners, travel companions, and our entire communities, in quiet and noisy environments. A recent hearing performance and sound quality survey conducted by Phonak found that the five most important speech understanding situations were 1:1 conversations in noise, group conversations in noise, soft speech in quiet, speech without visual cues and speech at a distance (Knorr, 2020). Hearing soft speech in quiet and at a distance were therefore ranked as two of the top five listening situations.

Appleton (2022) summarized results from a wide range of recent consumer surveys including MarkeTrak 10 (2019), EuroTrak Germany and UK (2018) and Hearing Tracker (2021) and found that 1:1 conversations in noise, group conversations in noise and soft speech in quiet were also ranked as either very important listening situations, or situations where hearing aid owners were least satisfied. Conclusively, hearing soft speech in quiet and at a distance are very important for people with hearing loss.

Interestingly, the self-reported ability to hear soft speech in quiet is also a strong indicator of hearing aid satisfaction. Dillon et al. (2018) found that if clients expressed significant difficulties in listening in quiet without hearing aids, they reported the largest benefits once hearing aids were fitted. In fact, listening in quiet was the largest incentive to acquire a hearing aid and indicated how satisfied clients were, once they were fitted. Audiologists are often looking for ways to improve speech understanding in noise, but these research findings indicate the importance of hearing soft speech in quiet as well as at a distance.

The potential benefits of Speech Enhancer

Phonak Lumity offers the adaptive SmartSpeech Technology feature Speech Enhancer (SE), which is designed to improve the audibility of soft input sounds such as a quiet voice or speech from a distance. SmartSpeech Technology is defined as a collection of features that are adaptively activated, in a seamless way to improve speech understanding and reduce listening effort in many listening environments (Appleton, 2020; Thibodeau, 2020; Latzel et al., 2022b). For more information on SmartSpeech Technology, see Woodward et al., (2022).

SE detects soft speech and increases the amplitude of the speech signal. It is only activated for low speech input levels of < 55 dB Sound Pressure Level (SPL) and Signal-to-Noise Ratios (SNR) higher than +10 dB. SE is active in the Speech in Quiet ('Calm situation') program of AutoSense OS, the automatic classification system in Phonak hearing aids, and provides up to 10 dB additional gain. SE is on by default in Calm situation whenever the experience level is set to 'Experienced user' or 'Long term user'. For new users SE can be switched on once clients have acclimatized to their hearing aids.

SE enables clients to experience more gain of soft speech inputs. In practice, this includes examples such as hearing a grandchild's soft voice; a partner speaking from another room; a chat with a friend over coffee or exchanging the latest news with a colleague across the desk in a large open-plan office. Indeed, with many of us living in more open-plan living, the importance of communication over greater distances has increased.

The importance of listening effort

There is some early evidence that people with hearing loss are more at risk of fatigue (Hornsby et al., 2016). While fatigue is a complex and understudied concept including emotional, cognitive and physical aspects, listening effort has become a useful tool to evaluate the real-world benefits of hearing aid features (e.g. Latzel et al., 2022a). In addition, a recent preliminary study evaluating the effect of hearing aid use on cognition in older adults (Sarant et al., 2020) found that reduced listening effort may free up cognitive resources for purposes other than listening. It is clear that listening effort is a useful outcome measure in addition to the more traditional outcomes such as speech intelligibility.

SE has already been investigated in a former study carried out at Hörzentrum Oldenburg, Germany (Appleton, 2020). The effects of SE and Dynamic Noise Cancellation on listening effort and speech intelligibility were evaluated for experienced hearing aid users with moderate to severe hearing loss. Due to social distancing during the Covid-19 pandemic, clients carried out the test measures at home. Distant (soft) speech-in-quiet recordings, which had been carried out in advance at the Hörzentrum Oldenburg, were presented to the clients at home using headphones. Participants rated whether SE ON versus OFF was preferred in terms of listening effort and speech intelligibility. SE ON was clearly preferred with regards to both listening effort and speech intelligibility for speech at a distance.

Study Purpose

The purpose of the present study was to further evaluate whether SE could benefit listening effort and speech intelligibility in realistic, controlled laboratory environments.

The key objectives of the current study were to evaluate whether SE:

1. provided better speech intelligibility for speech from a distance (4 meters) and from an adjacent room.
2. reduced listening effort with speech from a distance (2, 4 and 8 meters).

Methodology

Participants

22 subjects (14 male, 8 female) with moderate-severe hearing loss were recruited into the study. One dropped out, leaving 21 participants in total. All subjects were experienced hearing aid users. Phonak Audéo Paradise P90-R devices), a receiver-in-the ear hearing aid style with rechargeable batteries, were fit in order to evaluate SE. The average age of the participants was 76 years.

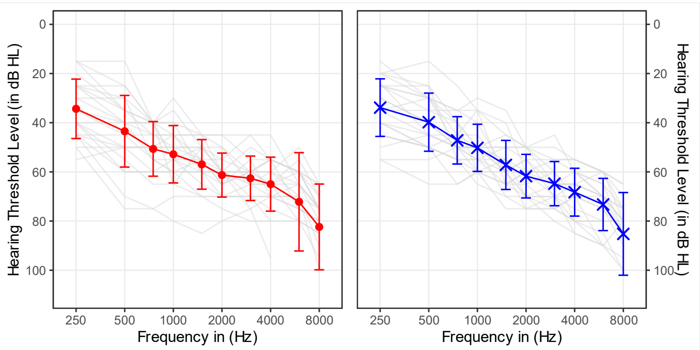

Figure 1: Mean hearing loss per frequency and ear for the 21 subjects who took part in the study.

Test Set-Up

The test hearing aids were fit according to the following parameters:

- Adaptive Phonak Digital (APD) prescription formula: gain level 100%
- Adaptive parameters: deactivated
- Frequency lowering systems: deactivated
- SE ON: Calm situation, SE (Maximum setting 20)
- SE OFF: Calm Situation, SE (Minimum setting 0)

The following outcome measures were used:

Speech intelligibility in quiet with SE ON versus OFF

Speech intelligibility was measured in a quiet, reverberant room using the Oldenburg Satztest, OLSA (Wagener et al.,1999). Speech material was presented in quiet from one loudspeaker at a distance of 4 meters (Fig. 2, right) and from an adjacent room with the door left ajar (Fig. 2, left).
In a first step, individual Speech Reception Thresholds (SRT) were measured using adaptive speech level. SRT is defined as the speech level (in dBA), where a participant is able to repeat 50% of the words correctly. Second, speech recognition scores (in percent correct) for the test conditions (SE ON/OFF) were measured using fixed presentation levels. For each participant, the individual SRT was used for the fixed presentation level.

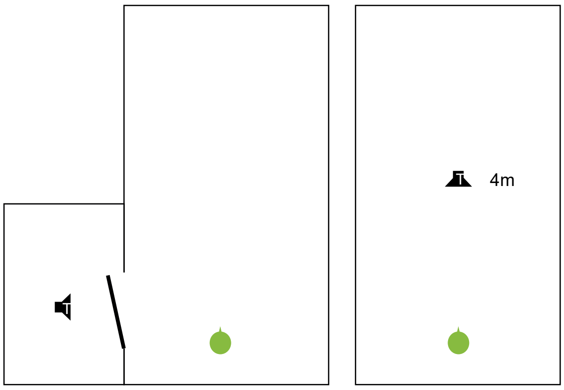

Figure 2: OLSA setup for SE benefit for talker ('T') from adjacent room (left) and distant talker (right).

Listening effort measurements with SE ON versus OFF

Listening effort was evaluated using a method based on the Adaptive Categorical Listening Effort Scaling (ACALES) test (Luts et al., 2010; Krueger et al., 2017). Participants scaled the perceived listening effort on a 13-point scale for OLSA sentences presented at 2, 4 and 8 meters (Fig. 3) measured from the subject's position in a quiet, reverberant environment (RT_{60} =0.8 seconds). This adaptive ACALES test allowed the subject to rate how much effort was required to understand the sentences presented at these different distances with equal output levels of the loudspeakers. The OLSA sentences were calibrated at a distance of 4 meters (A-weighted). The presentation level was individually determined using the individual SRT50 from the OLSA test in quiet plus 3dB (at 4 meters).

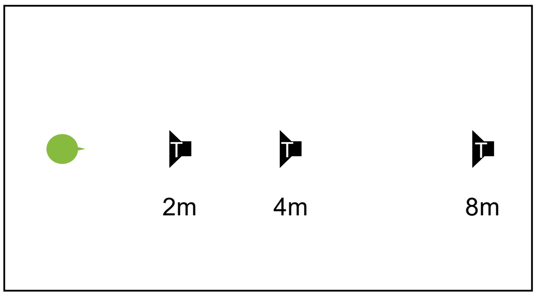

Figure 3: Schematic overview of the ACALES speech material presented via 3 loudspeakers ('T') at a distance from the subject of 2, 4, and 8 meters.

Results

Improved speech intelligibility in quiet for speech from a distance (4m) and from an adjacent room with SE ON

A rationalized arcsine transform was applied to the percentage scores of the speech intelligibility tests in order to make the results suitable for statistical analysis (Studebaker, 1985). The transformed scores are expressed in rationalized arcsine units (rau). The OLSA speech test results are shown in rau for a talker distance of 4 meters (Fig. 4) and from an adjacent room (Fig. 5) with SE ON and SE OFF. A t-test was used to analyze the speech intelligibility scores for SE ON versus OFF. Fig. 4 illustrates the significant improvement in speech intelligibility in quiet from a distance of 4 meters with SE ON ($t(20) = 9.93$, $p<0.001$). The mean speech intelligibility, converted back into percentages, increased from 44.8% to 67.7% when SE was activated, a mean improvement of 22.9%.

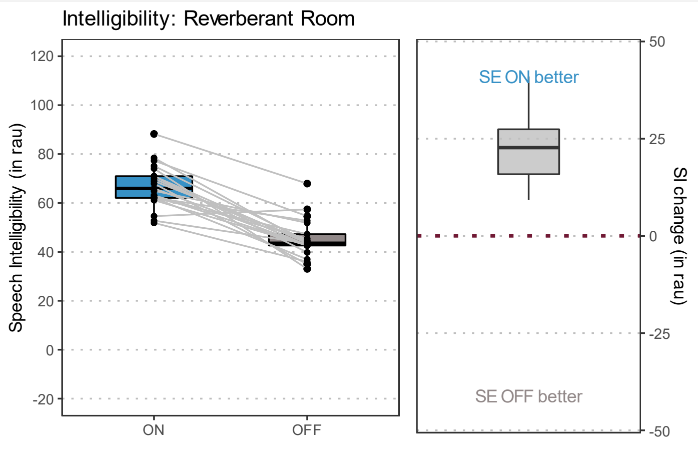

Figure 4: Absolute (left) and relative (right) results of the OLSA speech intelligibility test in a quiet, reverberant room at a distance of 4m with SE ON and OFF.

Fig. 5 shows the improvement in speech intelligibility with SE ON compared to SE OFF when the OLSA sentence test materials were presented from a quiet, adjacent room. A t-test was used to analyze the speech recognition scores. There was a significant effect of SE ON on speech intelligibility ($t(20) = 7.14$, $p < 0.001$). With SE ON, the mean Speech Intelligibility results, converted back to percentages, improved from 46.5% to 64.8% (an average improvement of 18.3%).

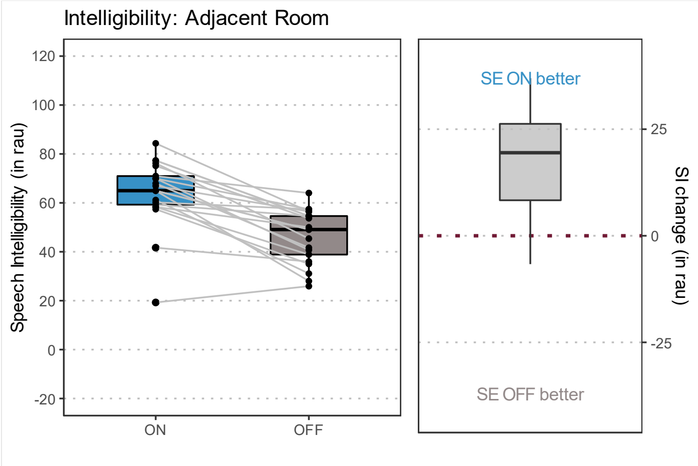

Figure 5 Results of the OLSA speech intelligibility test for speech in a quiet adjacent room with SE ON versus OFF.

Significantly reduced listening effort with SE ON for speech from a distance (2, 4 and 8 meters)

Perceived listening effort for soft speech in quiet at different distances was measured by presenting the material of the ACALES test via 3 loudspeakers at distances of 2m, 4m and 8m. Fig. 6 shows how subjects rated listening effort at the three distances with SE ON versus OFF on the 13-point scale. A Wilcoxon signed rank test was used for statistical analysis. With SE ON, subjects showed a significant median improvement of 2.3 Effort Scaling Units (ESCU) at 2m ($p = 0.001$, $r = -0.747$), 2.5 ESCU at 4m ($p = 0.001$, $r = -0.783$), and 2.2 ESCU at 8m ($p < 0.001$, $r = -0.787$). An equidistant step size on the ESCU scale corresponds to a percentage ratio of about 8% per ESCU. These results therefore correspond to a significant improvement of 18.3% to 20.8% in overall listening effort.

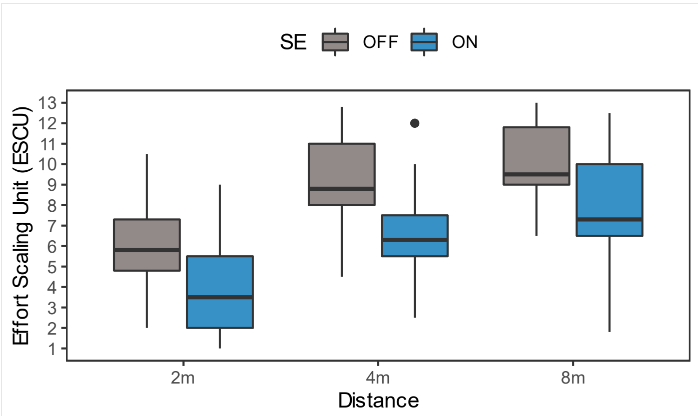

Figure 6: Listening effort ratings for soft speech in quiet from three distances with SE ON versus SE OFF.

Discussion

Market research has shown that hearing soft speech well in quiet and from a distance are two of the top five most important listening situations clients with hearing loss report (Appleton, 2022, Knorr, 2020). Difficulty hearing soft speech in quiet is also a strong predictor for hearing aid benefit (Dillon et al., 2018).

The current study evaluated whether the Phonak SmartSpeech Technology feature Speech Enhancer could increase speech intelligibility in quiet and reduce listening effort for soft speech at a distance or from an adjacent room. The results indicated significant improvements in both speech intelligibility and listening effort with SE activated. Specifically, SE provided up to 23% better speech understanding in a quiet environment from 4 meters. In addition, even from another room, speech intelligibility improved significantly by 18%. SE also reduced listening effort by up to 20% for soft speech from a distance.

These results support those from the former study carried out, during the Covid-19 pandemic in 2020, in participants' own homes (Appleton, 2020b). Results from the study indicated that SE ON was preferred in terms of speech intelligibility and listening effort for hearing at a distance in a quiet environment, and also significantly reduced reported listening effort.

Taken together, these improvements in speech understanding and listening effort with SE activated show convincing applications for the clinic. When evaluating the benefit of hearing aid features , typical outcomes are improvements of 10% better speech intelligibility and/or 8% less listening effort (one Effort Scaling Unit on the ACALES scale), to be clinically relevant. However, these results showed an even greater improvement of up to 23% for speech intelligibility and up to 20% for listening effort.

Conclusion

Speech Enhancer, one of seven Phonak SmartSpeech Technology features, aims to improve speech understanding and communication, which are so central to our daily lives. The results from the current study showed that SE provided better speech intelligibility for speech in a quiet environment, both from a distance (4 meters) and from an adjacent room. These are both important listening situations reported by clients with hearing loss in the extensive market research discussed. Furthermore, it is just as important to consider the effort it takes to listen and communicate effectively, especially for clients with hearing loss. The results also indicated that SE significantly reduced listening effort for speech understanding over distance.

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Authors and investigators

External 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.

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.

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Study Managers

Dr. Matthias Latzel studied electrical engineering in Bochum and Vienna in 1995. After completing his Ph.D. in 2001, he carried out his post-doc 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.

Christophe Lesimple studied music in Stuttgart, audiology in Lyon, and statistics in Paris and Bern. He is working as a research audiologist and contributes to various aspects of development including concepts, supporting clinical trials and analyzing data. Besides his activities with Sonova, he teaches audio analytics for machine learning at the University of Applied Science in Bern, hearing aid verification at the Akademie Hören Schweiz, and volunteers for a hearing-impaired association.

Author

Jane first joined Phonak HQ in 2005. In her role as Audiology Manager, Jane strives to provide evidence-based, impactful products, features and training. She has over 20 years of experience in audiology, working clinically in university hospitals in the UK and Switzerland, in hearing system and software development, and in training. She recognizes the importance of both technology and supporting the wider implications of hearing loss. Jane holds an MSc (Audiology) and BSc (Psychology) from Southampton University, UK.