Phonak
Field Study News

Motion-based beamformer steering leads to better speech understanding and overall listening experience

This paper is a summary of a study (Voss et al., 2020) which was conducted at Hearing Excellence Clinics in Burlington and Oakville, Ontario, Canada. The new walking detection algorithm, Motion Sensor Hearing, launched with Phonak Paradise hearing aids was assessed via subjective ratings and hearing performance, while out walking in a real-world setting. Both subjective rating and hearing performance were found to be better with Motion Sensor Hearing than without.

Appleton-Huber, J., August 2020

Key highlights

- Hearing aids use a motion sensor to detect if the user is walking and adapt the hearing performance features accordingly. This involves changing the beamformer settings to Real Ear Sound and deactivating Dynamic Noise Cancellation.
- Motion Sensor Hearing was tested during a real-world walk.
- Participants preferred Motion Sensor Hearing in terms of speech understanding, environmental awareness, overall listening experience and sound quality.
- Speech understanding with Motion Sensor Hearing was consistently rated higher and resulted in better performance than the algorithm without Motion Sensor Hearing.

Considerations for practice

- HCPs who fit clients with Phonak Paradise hearing aids should benefit from clients reporting improved sound quality, speech understanding and environmental awareness when out walking.

Introduction

The benefits of hearing aid features designed to ease listening in difficult stationary situations where the listener faces the talker, have been extensively investigated and well documented (Dillon, 2012; Hawkins & Yacullo, 1984; Kühnel et al., 2001; Lurquin & Rafhay, 1996; Pumford et al., 2000; Valente et al., 1995; Wagener et al., 2018). When walking side-by-side, the listener usually doesn't face the talker and hearing aids may not amplify sounds outside of the listener's visual field (i.e., a songbird in a tree to the side of the walking path). Research has shown that, for noisy scenarios with the sound source coming from the side, one or two omnidirectional microphones work better compared to binaural directional microphones (Hornsby & Ricketts, 2007; Kuk et al., 2005; Wu et al., 2013). Phonak Real Ear Sound, a microphone pattern designed to restore the natural directivity pattern of the outer ear by applying directionality only at high frequencies, combines the advantage of surround sound pickup while reducing front/back confusions which are common with omnidirectional microphones (Keidser et al., 2006, 2009).

Conventional hearing aids will activate a directional microphone system for speech in noise situations, regardless of listeners' status such as sitting, standing still or walking. When provided with information about the users activity, hearing aids can improve decision making and adjust the signal processing to address the listening needs of the user during walking. In Phonak Paradise hearing aids, the new Motion Sensor Hearing changes the beamformer settings to Real Ear Sound and deactivates the spatial noise cancellation feature, Dynamic Noise Cancellation, when both walking and speech are detected.

Objective

The aim of this study was to investigate whether the new hearing aid algorithm with Motion Sensor Hearing provides superior speech understanding and environmental awareness when walking, compared to a conventional algorithm without Motion Sensor Hearing.

Methodology

Participants

22 participants (11 male, 11 female) took part in the study. The average age was 79 years (*SD* = 6 years). Participation criteria were: a binaural, sensorineural, moderate to severe hearing loss as well as at least three months hearing aid wearing experience. The average audiogram of the study participants can be seen in figure 1. Furthermore, participants needed to self-report normal or corrected-to-normal vision, good cognitive abilities and good walking abilities.

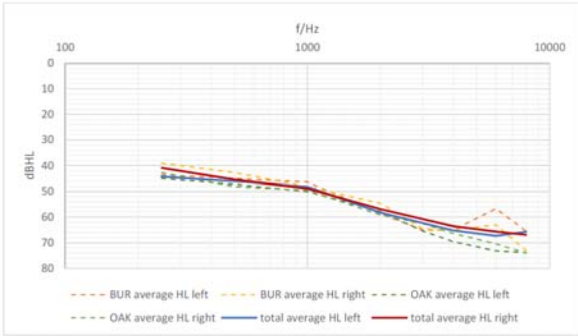

Figure 4: Average hearing loss of successfully completed participants

Figure 1. Average hearing loss of the 22 study participants.

Equipment

Participants were fitted with prototypes of Phonak Audéo Paradise rechargeable hearing aids and P Receivers with individually fitted length. Domes that occluded the ear canal were used to limit the entrance of unprocessed sound into the ear. The hearing aid microphones were covered with microphone windshields designed for smartphone microphones (Rycote microWindjammers) to mechanically block wind noise and thus avoid activation of the wind noise suppression, which would have deactivated the beamformer in the control condition.

Hearing aids were set with two manual Speech-in-Noise programs: one with conventional beamformer steering (which activates UltraZoom when speech in noise is detected) and one with Motion Sensor Hearing (which activates Real Ear Sound if speech in noise and walking is detected). The toggle button on the hearing aid was used to change the program after each walk. The fitting was based on the air conduction threshold and the "Feedback and real ear test" in Phonak Target fitting software. The fitting formula used was Adaptive Phonak Digital with 100% gain. If participants complained about loudness, the overall gain was reduced or increased up to 3 dB.

Procedures

The study consisted of one appointment per participant, taking place at a hearing aid clinic either in Burlington or Oakville. Participants went on two short walks along a pre-defined track beside a busy street together with an experimenter and a research assistant. The average environmental noise level was 68 dBA. On one walk, the hearing aid was set to the program with the conventional beamformer steering and on the other walk, it was set to the program with the Motion Sensor Hearing. Program order was randomized and participants were blinded to the activated program. During each walk, participants completed a task to assess speech understanding, and environmental awareness.

Speech perception was assessed via two sound events: a story telling and two questions the participant had to answer while walking. The participants were instructed to not turn their head towards the speaker for both sound events. After each of these sound events happened, participants were asked to rate how easily they could understand what had been said in terms of clarity on a 5-point scale (Mean Opinion Score) (1 = very difficult, 5 = very easily). For the story-telling, the research assistant walked *alongside* the participant and told them a short story from the news. For the question, the research assistant asked the question from *behind* the participant. Typical questions were "what did you have for breakfast? what is your favorite color? " If the participant did not understand, the question was repeated if necessary.

Environmental awareness – the ability to detect, locate and recognize a sound - was assessed three times during each walk with three different sounds. Participants passed a hidden speaker with a motion sensor that triggered a sound (frog croak, cardinal call or telephone ring) to play upon detecting movement. Prior to this, participants were informed that this would happen and they should not turn their head towards the sound source. Once the sound had played, the experimenter would ask the participant if s/he heard a sound, which sound s/he heard, where it was located and how easily s/he could hear it. The participant indicated the location relative to where she was standing on a chart. To indicate how easily s/he could hear it, the same rating scale as in the speech perception test was used.

After each walk, participants were asked to rate their overall listening experience on a 5-point scale (1 = bad, 5 = excellent). They were also asked to indicate which program they preferred for speech understanding, environmental awareness and overall listening (A/B comparison test).

Results

Subjective rating and performance data were averaged, respectively, and presented in the boxplots below, showing median and the first and third quartiles as well as whiskers covering the range.

A t-test indicated significantly higher ratings for ease of understanding speech in walks in which Motion Sensor Hearing was enabled ($p < 0.01$, see figure 2). No difference between walks was observed for ease of localization.

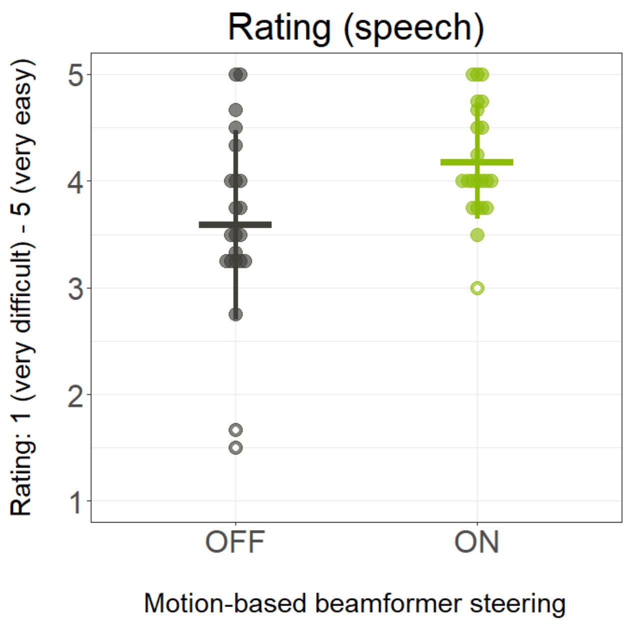

Figure 2. Subjective rating results for tasks related to speech. Ratings were done on a 5 point Mean Opinion Score (1 = very difficult, 5 = very easy). Horizontal lines indicate means and whiskers stretch to the 10th percentile.

A Wilcoxon signed-rank test indicated significantly higher performance for tasks related to speech understanding in walks in which Motion Sensor Hearing was enabled ($p < 0.01$, see figure 3). No difference in performance between walks was observed for tasks related to localization.

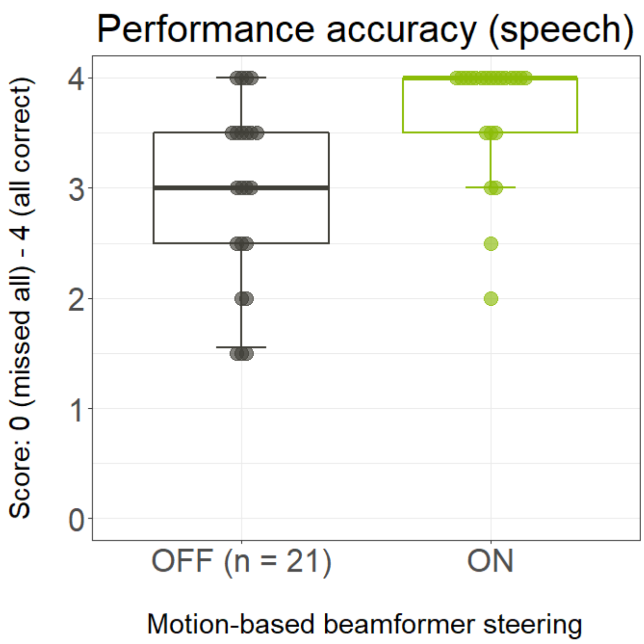

Figure 3. Performance results for tasks related to speech. Performance was scored from 0 (questions not heard and understood) to 4 (all questions heard and understood). Horizontal lines indicate medians and whiskers stretch to the 10th percentile.

A Wilcoxon signed-rank test indicated significantly higher ratings for overall listening experience in walks in which Motion Sensor Hearing was enabled ($p < 0.05$).

When asked which program they preferred for speech understanding, environmental awareness and overall listening (A/B comparison test), a majority of participants chose Motion Sensor Hearing in all three comparisons (figure 4). A one-sided exact binomial test for a 50% probability indicated a significant difference between the preference among the two test conditions, suggesting a preference for walks in which Motion Sensor Hearing was enabled when asked about speech, environmental awareness and overall listening.

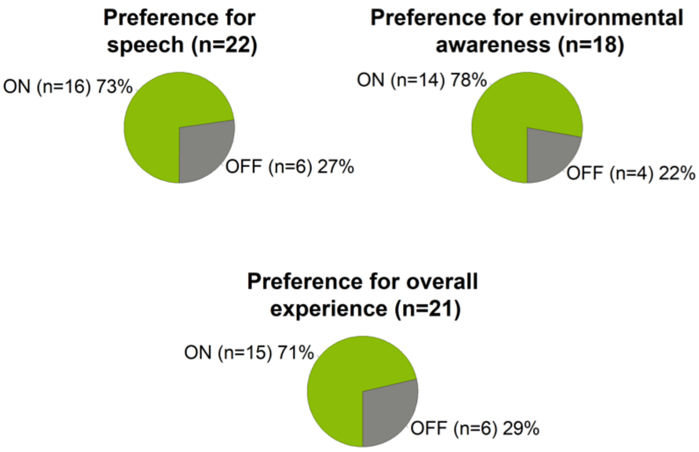

Figure 4. Preference results (A/B comparison) for speech understanding, environmental awareness and overall listening experience. Green = Motion Sensor Hearing ON. Gray = Motion Sensor Hearing OFF.

Conclusion

This study has found that the hearing aid algorithm with Motion Sensor Hearing was consistently rated higher for ease of speech understanding, than the algorithm without Motion Sensor Hearing. The study also suggests that speech is understood significantly better with Motion Sensor Hearing active. Participants indicated they prefer the setting with Motion Sensor Hearing with regards to speech understanding, environmental awareness and sound quality.

Overall, the study indicates that with the new motion-based beamformer steering in Paradise hearing aids, hearing aid wearers are likely to be able to benefit from better speech understanding and overall listening experience, when out walking on a busy street.

References

Dillon, H. (2012). Hearing aids (2nd ed.). Stuttgart, NY: Thieme.

Hawkins, D. B., & Yacullo, W. S. (1984). Signal-to-noise ratio advantage of binaural hearing aids and directional microphones under different levels of reverberation. Journal of Speech and Hearing Disorders, 49(3), 278-826.

Hornsby, B. W. & Ricketts, T. A. (2007). Effects of noise source configuration on directional benefit using symmetric and asymmetric directional hearing aid fittings. Ear & Hearing, 28, 177–186.

Keidser, G., Rohrseitz, K., Dillon, H., Hamacher, V., Carter, L., Rass, U., & Convery, E. (2006). The effect of multi-channel wide dynamic range compression, noise reduction, and the directional microphone on horizontal localization performance in hearing aid wearers. International Journal of Audiology, 45(10), 563-579.

Keidser, G., O'Brian, A., Hain, J., U., McLelland, M., & Yeend, I. (2009). The effect of frequency-dependent microphone directionality on horizontal localization performance in hearing-aid users. International Journal of Audiology, 48(11), 789-803.

Kuehnel, V., Margolf-Hackl, S., & Kiessling, J. (2001). Multi-microphone technology for severe to-profound hearing loss. Journal of Scandinavian Audiology, 30(1), 65-68.

Kuk, F., Keenan, D., Sonne, M., & Ludvigsen, C. (2005). Efficacy of an open-fitting hearing aid. Hearing Review, 12(2), 26–32.

Lurquin, P., & Rafhay, S. (1996). Intelligibility in noise using multimicrophone hearing aids. Acta Otorhinolaryngol (Belgium), 50(2), 103–109.

Pumford, J.M., Seewald, R. C., Scollie, S.D., & Jenstad, L., 2000. Speech recognition in a diffuse noise using in-the-ear and behind-the-ear dual-microphone hearing instruments. Journal of the American Academy of Audiology, 11, 23-35.

Valente, M., Fabry, D., Potts, L. G., & Fabryt, D. A. (1995). Recognition of speech in noise with hearing aids using dual microphones. Journal of the American Academy of Audiology, 6(6), 440–449.

Voss, S., Pichora-Fuller, M. K., Ishida, I., Pereira, A. E., Seiter, J., ElGuindi, N., Kuehnel, V., & Qian, J. (2020). Evaluating the benefit of hearing aids with motion-based beamformer steering in a real-world setup. Preprint. https://doi.org/10.31219/osf.io/5xdpj (Paper submitted to the International Journal of Audiology).

Wagener, K. C., Vormann, M., Latzl, M., & Mülder, H.E. (2018). Effect of hearing aid directionality and remote microphone on speech intelligibility in complex listening situations. Trends in Hearing, 22, 1–12.

Wu, Y. H., Stangl, E., Bentler, R. A., & Stanziola, R. W. (2013). The effect of hearing aid technologies on listening in an automobile. Journal of the American Academy of Audiology, 24(6), 474–485.

Authors and investigators

External investigators

Kathy Pichora-Fuller has been a Full Professor of Psychology at the University of Toronto since 2005 and became Professor Emerita in 2020. She completed a M.Sc. in Audiology and Speech Sciences (1980). She translates her lab-based research on auditory and cognitive aging to address the rehabilitation needs of older adults who have sensory and cognitive declines. She is currently the President of the International Collegium of Rehabilitative Audiology. The American Academy of Audiology awarded her the 2014 International Award.

April Pereira is completing her Master's degree in Cognitive Psychology at the University of Waterloo. In her Honours Bachelor of Science from the University of Toronto (2019), her research focused on the cognitive and hearing ability of both younger and older adults.

Internal investigators

Jinyu Qian has been the Director Innovation Centre Toronto at Sonova Canada since 2018. She received a dual degree from the State University of New York at Buffalo-Ph.D. in communicative disorders and sciences and M.S. in electrical engineering in 2005. She continued her postdoctoral reach at the University of Pennsylvania. She has been working in various technical and R&D functions in the hearing aid and medical device industry in the U.S., China and Canada since 2008. She is currently an adjunct professor at the State University of New York at Buffalo.

Solveig Christina Voss completed her training as a hearing aid acoustician at the Academy of Hearing Aid Acoustics in Luebeck, Germany, in 2011. Until 2014, she studied hearing aid acoustics at the Luebeck University of Applied Sciences. Since 2014, she has been working in the Research & Development Department of Sonova in Switzerland, China and Canada.

Ieda Ishida is an audiologist with over 20 years of clinical practice and research experience. She earned her Ph.D. in Japan at Nagoya University in 2007, followed by 3 years of post-doctorate research at The University of British Columbia, in Vancouver, Canada. She is excited to currently be a research audiologist at the Sonova Innovation Centre Toronto.

The investigators would also like to acknowledge Connect Hearing Canada for its substantial contributions at the preliminary stage of this research.

Author

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 within Global Audiology at Phonak Headquarters.

sonova
HEAR THE WORLD