Phonak Field Study News.

Phonak Audéo Sphere™ Infinio is preferred by clients during real-world use.

Sphere Infinio hearing aids were put through real-world testing to gain more insights into the ecological benefit of Spheric Speech Clarity. Real-world usage provided valuable insights, complimenting the technical and objective lab studies, on the performance of Sphere Infinio against two key competitors and to the previous speech in loud noise solution.

Miller, A., Wright, A., Zhu, X., Kuehnel, V., Latzel, M., and Seitz-Paquette, K., October 2024

Key highlights

- Sphere Infinio was preferred over two key competitors' products in a local metropolitan cafe.
- Sphere Infinio with Spheric Speech Clarity was preferred more often than StereoZoom 2.0 in a live, loud metropolitan café.
- Speech was rated as clearer and more natural when wearing Sphere Infinio with Spheric Speech Clarity than when wearing competitive devices in a loud café.
- Real-world preference data match data obtained in the lab.

Considerations for practice

- Spheric Speech Clarity can increase satisfaction in noisy environments. HCPs should encourage clients to re-explore and re-engage in environments they drifted away from, due to previous conversation difficulty.
- Based on user needs assessment, some clients, particularly those who are often in challenging communication situations, may benefit from reduction of the activation level of Spheric Speech In Loud Noise program (Autosense OS program options tab in Target 10.0 or newer). This leads to Spheric Speech Clarity activating at lower SPL level.

Introduction

Hearing aid manufacturers have continuously invested in advancing technology to address one of the highest priorities for those with hearing loss: understanding speech in complex and noisy environments (Wright et al., 2024). Despite advances in directional microphones and noise reduction algorithms, satisfaction has remained low (Appleton-Huber, et al., 2022).

Sphere Infinio features the DEEPSONIC chip to run Spheric Speech Clarity, a large DNN-based speech enhancement system. DEEPSONIC was developed specifically to apply DNN-based signal processing on a hearing aid to enhance speech and suppress noise, overcoming the hardware limitations that have, until now, prevented a large-scale DNN-based noise reduction system from being applied in a hearing aid.

Spheric Speech Clarity, in combination with a fixed directional microphone, offers an unprecedented SNR improvement of 9 dB at default strength and up to 10.2 dB at maximum strength (Raufer et al., 2024).

Technical measures indicated promising results (Raufer et al., 2024) for the new Spheric Speech Clarity in terms of outperformance compared to three key competitors. Likewise, behavioral measures were obtained with experienced hearing aid users in a lab environment (Wright et al. 2024), which found that Sphere Infinio outperformed competitors for speech understanding in noise when the speech was off-axis, and the noise was co-located. Taken together, these data indicate the performance improvement clients can expect with Sphere Infinio, but they do not provide any indication about whether clients prefer the listening experience it provides.

Subjective ratings in a lab environment

As an additional task in the Wright et al. (2024) study, subjective information was gathered from twenty-seven adult experienced hearing aid users via a simulated speech in noise scene in a lab environment. In this task, the participants were seated in a 5-speaker array with diffuse food court noise presented at 72 dBA. A recorded dialogue with realistic vocal effort was presented at -3 dB SNR from the front hemisphere with a female talker positioned at -60 degrees azimuth and a male talker at +60 degrees. The participants listened to this dialogue three times, in randomized order. Once while wearing Sphere Infinio devices and again with each of the two competitors. The manufacturer's automatic listening program was used for all the tested devices. To ensure adaptation of the devices to the acoustic scene, one minute of a speech-in-noise stimulus was played before the dialogue began.

After wearing each set of devices, the participants rated the speech clarity, speech naturalness, speech and noise separation, loudness of speech, loudness of noise, and overall satisfaction using a 5-point scale. After all three devices were rated, the participant then indicated which device they preferred and ranked the three devices from most liked to least liked.

The results of the laboratory investigation for the subjective ratings were favorable for Sphere Infinio over both competitors, with Sphere Infinio consistently rated highly for speech clarity, speech naturalness, speech and noise separation, and overall satisfaction (Figure 1). With Sphere Infinio, speech loudness was consistently rated as the "right amount of loudness" and noise loudness was rated as "loud, but ok" (Figure 2). Additionally, Sphere Infinio was the most preferred device for 22 out of 27 participants (Figure 3).

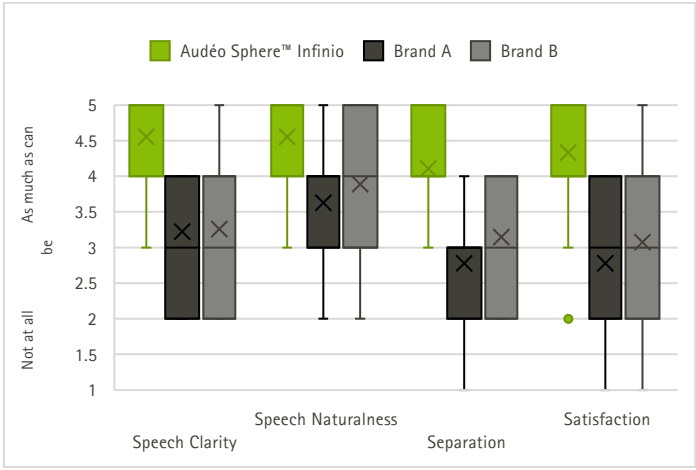

Figure 1. Subjective ratings for the three devices, with 1 as the least favorable rating and 5 as the most favorable (n=27).

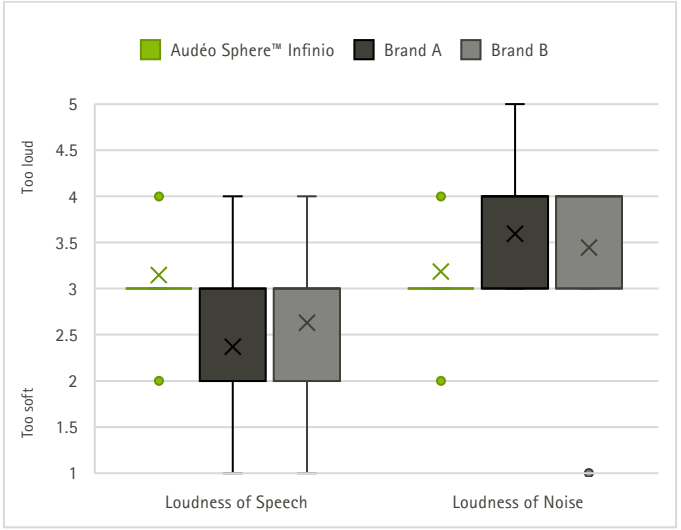

Figure 2. Loudness ratings for speech and noise for the three devices, with 3 as the ideal rating (n=27).

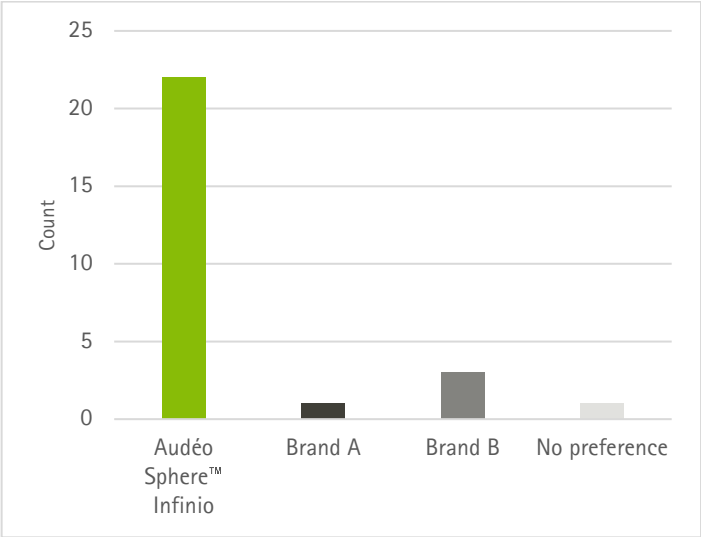

Figure 3. Subjective ratings of which device was preferred (n=27).

Can the lab translate to real-world experience?
It is well documented that there are discrepancies between results of speech testing in the lab and self-reported benefit. Specifically, Nilsson et al., (1994), found benefit from directional microphones measured in the laboratory was *not* predictive of perceived benefit outside the laboratory. Speech tests appear to be particularly prone to overestimating real-world outcomes, often showing better outcomes at rather low (negative) signal-to-noise (SNR) ratios (Cord et al., 2004; Walden and Walden, 2004). To improve quality of life for individuals with hearing impairment, it is vital for professionals to decide if a certain hearing aid intervention such as a new feature or fitting strategy, provides better outcome than an alternative intervention (Wu et al., 2018).

The discrepancy between laboratory and real-world hearing aid benefit motivated the present study. Even though the real world is uncontrollable and chaotic, such environments are representative of where clients form their first impressions of a new device when working with an HCP. This Field Study News reviews the real-world comparison of Phonak Spheric Speech in Loud Noise program to Phonak Speech in Loud Noise (with StereoZoom 2.0), and the Sphere Infinio compared to two key competitor products in the same noisy café environment.

Methodology

Cafe selection:
Out of three cafés investigated, the local café selected had steady noise levels on three different weekdays. Times tested included early morning, late morning, lunch, early afternoon, and late afternoon. On all days and times tested, the noise level was found to be at least at 72dBA. Additionally, this cafe was near the geographic center of our participant postal zip codes.

Participants
The same twenty-seven experienced adult hearing aid users with moderate to moderately severe bilateral hearing loss aged 58 to 93 years (m = 75.1 ± 8) that were recruited for the first arm of the study (Wright, et al., 2024) were invited back to this arm. Of those, twenty-six participated in this arm of the study. Due to illness, two of the twenty-six participants were only able to complete the first café condition. All participants had otoscopy and a hearing evaluation performed prior to the home trial hearing aid fitting.

Visit one (conducted at PARC lab, Aurora IL)
One set of Sphere Infinio receiver-in-canal (RIC) hearing instruments were fit to each subject for a four-week home trial (HT). The HT devices were fit according to Target fitting software recommendations for gain (100% target gain), dome, and receiver power. A feedback test was run. For the HT, participants were allowed basic fine tuning if warranted. Hearing aids were paired to the participant's phone and connection was verified. All user controls were disabled, except for volume control and phone call answering via the multifunction button. Participants were instructed on use and care of the devices and were instructed on filling out a Battery Life Log. This Battery Log required the participant to enter the daily wearing time and to note whether a hearing aid needed to be recharged to make it through the day.
In addition to the fitting of the HT instruments, fitting sessions were created for the planned café visits. A single set of Sphere Infinio hearing aids were used for cafe testing for all participants. HT devices potentially could have had basic fine tuning performed at the fitting session, and the common devices instead were prepared in advance of each appointment.

The fittings for the first café test had Sphere Infinio receiver-in-canal (RIC) hearing instruments set to 100% target gain, using the recommended dome and receiver model. Feedback testing was completed. The only deviations from the default settings were adding manual program 1-Spheric Speech in Loud Noise (featuring Spheric Speech Clarity) and adding manual program 2-Speech in Loud Noise (featuring StereoZoom 2.0).

For the sessions to be used during the second café visit, in order to have the comparison be as equitable as possible between all manufacturers, the hearing aids were programmed following all the manufacturer's recommended default settings for a long-term user. This included: gain, receiver strength, feature settings, and acoustic dome

coupling. If the manufacturer did not recommend an acoustic coupling, the most comparable dome to the other two manufacturers was chosen. Feedback tests were run on all sets of devices. Hearing aids from all three manufacturers were programmed to have only the automatic startup program enabled. No other fine tuning was permitted, and manual controls were disabled.

First café appointment
Participants met the investigator individually for an appointment conducted at a local metropolitan café. The objective at this appointment was to compare Sphere Infinio with Spheric Speech Clarity to Sphere Infinio with StereoZoom 2.0. Noise levels (dBA weighting) were monitored with a sound level meter throughout the appointment.

The participants were randomly assigned and blinded to their starting condition and were put into devices programmed for either Spheric Speech in Loud Noise or Speech in Loud Noise.

They were then asked to listen to "The Grandfather Passage" (Darley et al., 1975) read by the investigator and answer six questions about their listening experience. They were then switched to the opposite condition and the process was repeated. Ultimately, they were asked to choose their preference.

The self-reported Battery Life Logs were collected, and HT hearing aids were connected to Target software to collect data logging information.

Second café appointment. This visit's objective was to compare Sphere Infinio to two leading competitors while in each manufacturer's default automatic program. The reader may recognize that a similar comparison was done in the lab (c.f., Figures 1-3). The comparison in the lab was done within each manufacturer's Speech in Loud Noise equivalent *manual* program, while this arm compared the hearing aids when running in their automatic programs in a natural (i.e., not simulated) environment. Participants were randomly assigned and blinded to their starting condition. Noise levels were monitored identically to the previous cafe visit. For each condition, after the aids were placed and noise levels documented, "The Rainbow Passage" (Fairbanks, 1960) was read to the participant. "The Rainbow Passage" is another commonly used, phonetically balanced speech passage. Identical to the first café visit, the participants were then asked to answer six questions about their listening experience. They were then switched to the next condition per the randomization schedule and the process was repeated twice. Ultimately, they were asked if they had a preference, and if so, to choose their preference between the three devices. A total of 24 participants were able to complete this appointment: two were ill and could not reschedule during the study duration.

Results

Sphere Infinio with Spheric Speech in Loud Noise was preferred more often than with Speech in Loud Noise with StereoZoom 2.0 in a loud, real-world café situation (Figure 4).

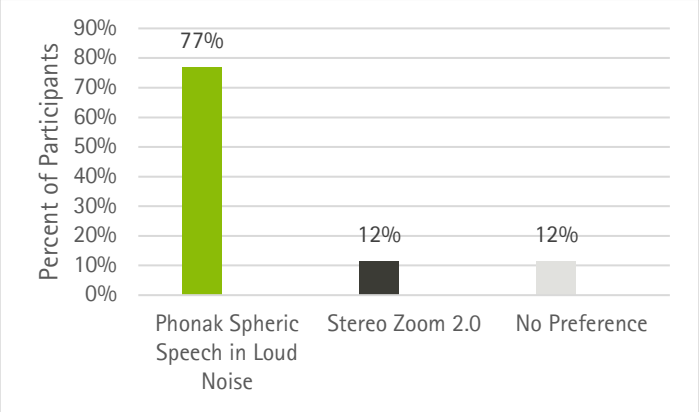

Figure 4. First café appointment overall preference: Spheric Speech in Loud Noise, StereoZoom 2.0, or no preference (n=26) Labels are rounded to the nearest whole number for readability.

Sphere Infinio was also preferred over two competitors in a loud, real-world café (Figure 5).

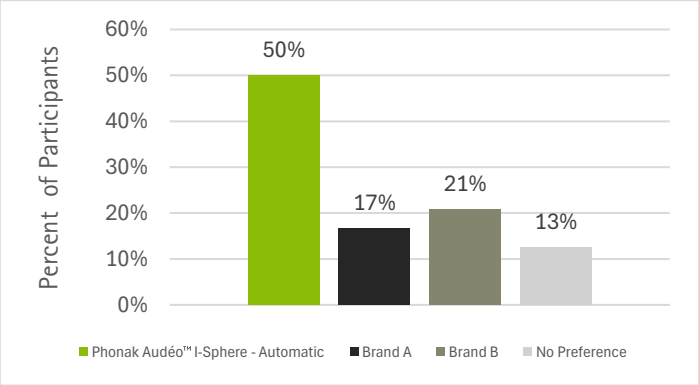

Figure 5. Second café appointment overall preference: Phonak Audéo I-Sphere, Brand A, Brand B, or no preference (n=24). More participants preferred Sphere Infinio than either of the other two brands combined, while only three participants had no preference at all. Labels are rounded to the nearest whole number for readability.

Speech was rated to be clearer with Sphere Infinio, as compared to two competitors (Figure 6), as well as being rated as more natural (Figure 7).

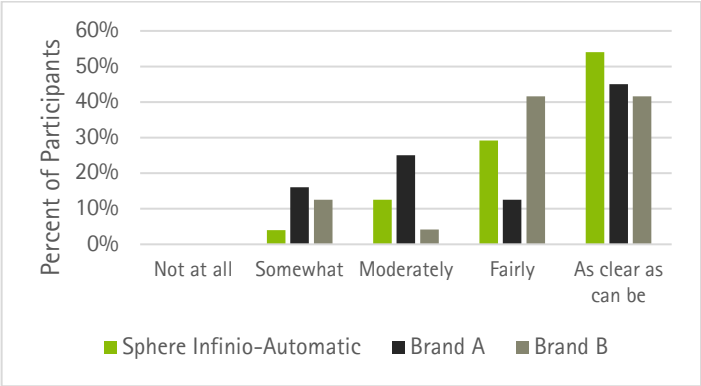

Figure 6. Subjective rating: How clear is the speech with the hearing aid? (n=24)

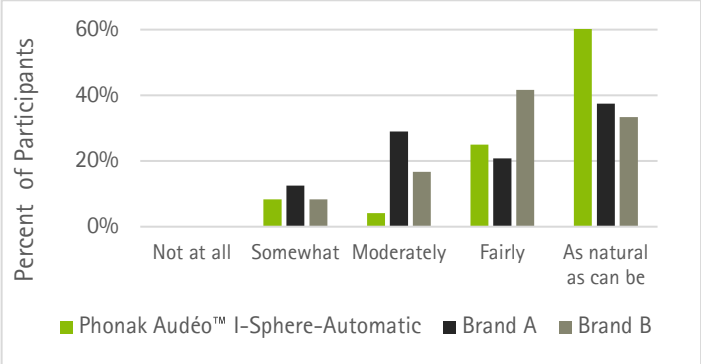

Figure 7. Subjective rating: With the hearing aids, how natural is the speech? (n=24)

Finally, loudness in the noisy café was rated more appropriately loud with Sphere Infinio, as compared to two competitors (Figure 8). Note that in this scale, the ideal rating is three, "Loud but OK".

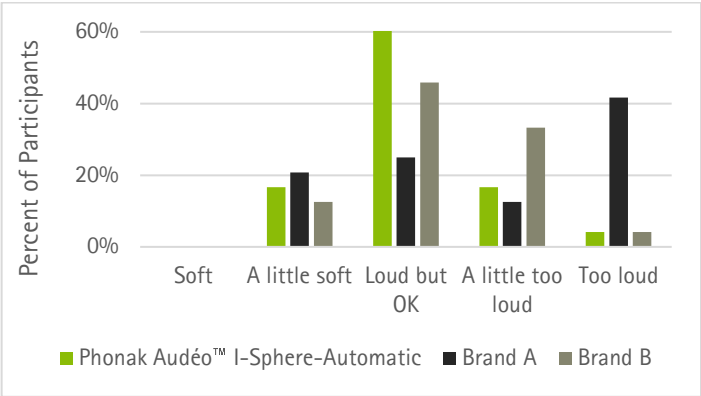

Figure 8. With the hearing aids, how loud is the noise? (n=24) In this measure, the ideal rating is three: Loud but OK.

Regarding information obtained through datalogging, it was found that on average, the average daily wearing time was 12.9 hours. The breakdown of the individual test subject average wearing time can be found in Figure 9. There were zero reports of hearing aids needing to be recharged to make it through the day. The amount of time spent in Spheric Speech in Loud noise varied between 1 and 7%. As an example, assuming an average wear time of 12.9 hours, three percent of the time in Spheric Speech in Loud Noise would be the equivalent to spending two and a half hours in a challenging speech in noise environment once per week, consistent with the expectation from the subject group.

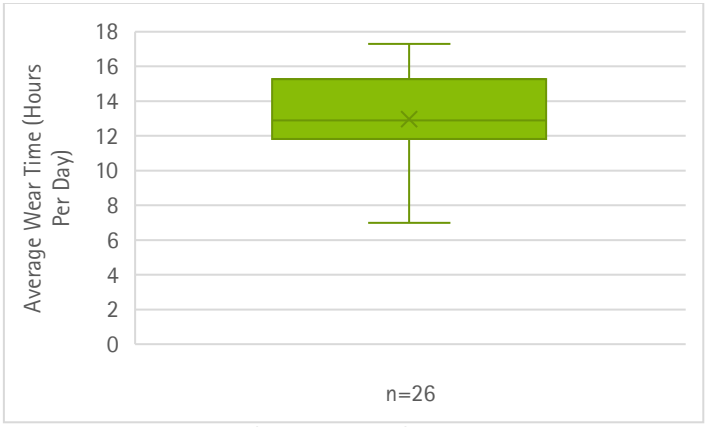

Figure 9. Average number of hours per day of wear-time during HT days 1-14. Mean=12.9, Error bars represent the minimum and maximum values. (n=26)

The average noise level during the café appointments was 79 dBA, with the minimum average level during a passage-reading condition at 76 dBA and the maximum at 81.5 dBA. The noise level throughout testing at this café was always higher than the level applied in the lab, making this an even more challenging environment. See figure 10 below for the distribution of noise levels during the café visits. Despite the increased and variable noise levels in the café, results match the subjective results from within the PARC lab. Since comparison of real-life judgements do not always match those from within the lab environment (Fillion et al., 1992), it is gratifying to see such analogous responses.

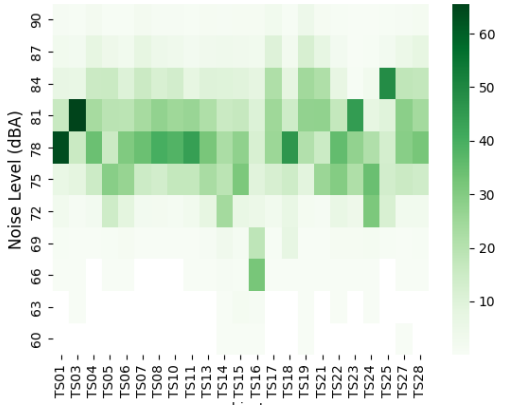

Figure 10. Distribution of noise levels per subject. The y-axis shows the dBA value range throughout the café visits; the deeper the shade, the longer amount of time spent at that dB level. (n=23)

Discussion

When participants compared the new Spheric Speech in Loud Noise program (with Spheric Speech Clarity) to Speech in Loud Noise (with StereoZoom 2.0), participants overwhelmingly chose Spheric Speech Clarity, the new DNN-based noise reduction system.

Additionally, Sphere Infinio was chosen more often over two key competitors in a comparison at a live, non-simulated, noisy café environment. Importantly, in addition to being chosen overall, speech clarity, naturalness, and loudness of noise were all favorable toward Sphere Infinio.

During the 4-week home trial of Sphere Infinio, with default AutoSense activation of Spheric Speech in Loud Noise, results from the log indicated that the devices provided sufficient battery life to make it through a typical day without requiring a recharge. Several participants indicated that they usually would avoid such noisy places as the café we chose for testing due to the typical conversation difficulty, but with the new DNN-based hearing aids they were able to communicate. With the introduction of Sphere Infinio, it is critical to encourage the hearing aid wearer to re-explore environments with challenging sound architectures.

This study reflects subjective data obtained both in a loud lab situation, and inside a real-world noisy café environment. It may be interesting to see how using the Spheric Speech in Loud Noise program in other types of sound architectures would affect subjective responses. Not only does the data obtained in this real-world arm closely resemble the data obtained in the more controllable lab setting, the data support two processors working in parallel indeed enhance speech and suppress noise, achieving outstanding results on real people in a real-world noisy café, even as compared to other premium level hearing instruments from competitor manufacturers.

Conclusion

The motivation for this study was to confirm the objective laboratory measures, both technical and perceptual, of Sphere Infinio translates also into real-world hearing aid benefit.

Technical measures of the Spheric Speech in Loud Noise program showed an unprecedented 10dB SNR benefit (max strength compared to Omni). This SNR benefit also outperformed three key competitors by up to 3.7dB (compared to unaided) (Raufer et al., 2024). In the Wright et al. (2024) study, results confirmed that the measured SNR benefit translated into significant improvement in speech understanding and reduced listening effort.

Subjective results from inside the PARC lab match responses from participants when inside a live, noisy café. Participants overwhelmingly chose Spheric Speech in Loud noise over StereoZoom 2.0, indicating better performance of the novel large DNN-based denoising strategy over the predecessor. In addition, the Sphere Infinio was chosen more often than two top competitors in the same live, noisy café.

References

1. Appleton-Huber, J. (2022). What is important to your hearing aid clients…and are they satisfied? *The Hearing Review.* https://hearingreview.com/hearing-loss/patient-care/counseling-education/what-important-to-your-hearing-aid-clients-are-they-satisfied.
2. Cox, Robyn M.; Johnson, Jani A.; Xu, Jingjing. Impact of Hearing Aid Technology on Outcomes in Daily Life I: The Patients' Perspective. Ear and Hearing 37(4): p e224-e237, July/August 2016. | DOI: 10.1097/AUD.0000000000000277
3. Darley, F. L., Aronson, A. E., & Brown, J. R. (1975). Motor speech disorders (3rd ed.). Philadelphia, PA: W.B. Saunders Company
4. Coolexp (2024). *dB Sound* (App version 2.4) [Mobile App] Google Play Store. https://play.google.com/store/apps/details?id=com.noise.sound.meter.decibel
5. Cord M. T., Surr R. K., Walden B. E., Dyrlund O. (2004). Relationship between laboratory measures of directional advantage and everyday success with directional microphone hearing aids. *J. Am. Acad. Audiol.* 15 353–364. 10.3766/jaaa.15.5.3
6. Fairbanks, G. (1960). Voice and Articulation Drillbook, 2nd ed., New York: Harper & Row. Pp 124-139.
7. Filion, P.R., &tMargolis, R.H. (1992). Comparison of clinical and real-life judgments of loudness discomfort. *Journal of the American Academy of Audiology, 3*(3),193-199.
8. Lelic, D., Nielsen, J., Parker, D., & Marchman Rønne, F. (2021). Critical hearing experiences manifest differently across individuals: insights from hearing aid data captured in real-life moments. *International Journal of Audiology*, *61*(5), 428–436. https://doi.org/10.1080/14992027.2021.1933621
9. Miles, K., Beechey, T., Best, V., & Buchholz, J. (2022). Measuring Speech Intelligibility and Hearing-Aid Benefit Using Everyday Conversational Sentences in Real-World Environments. *Frontiers in neuroscience*, *16*, 789565. https://doi.org/10.3389/fnins.2022.789565

10. Nilsson M., Soli S. D., Sullivan J. A. (1994). Development of the Hearing in Noise Test for the measurement of speech reception thresholds in quiet and in noise. *J. Acoust. Soc. Am.* 95 1085–1099. 10.1121/1.408469
11. Raufer, S., Kohlhauer, P., Jehle, F., Kühnel, V., Preuss, M., Hobi, S. (2024). Spheric Speech Clarity proven to outperform three key competitors for clear speech in noise. Phonak Field Study News retrieved from https://www.phonak.com/evidence
12. Walden T. C., Walden B. E. (2004). Predicting success with hearing aids in everyday living. *J. Am. Acad. Audiol.* 15 342–352. 10.3766/jaaa.15.5.2
13. Wright, A., Keller, M., Kuehnel, V.M., Seitz-Paquette, K. (2024). Spheric Speech Clarity applies DNN signal processing to significantly improve speech understanding from any direction and reduce the listening effort. *Phonak Field Study.*
14. Wu, Y. H., Stangl, E., Chipara, O., Hasan, S. S., Welhaven, A., & Oleson, J. (2018). Characteristics of Real-World Signal to Noise Ratios and Speech Listening Situations of Older Adults With Mild to Moderate Hearing Loss. *Ear and hearing*, *39*(2), 293–304. https://doi.org/10.1097/AUD.0000000000000486

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Volker Kühnel, PhD, holds a doctorate in physics and completed his studies in 1995. From 1995 to 1997 he worked in Oldenburg as a research assistant in the Medical Physics group of Prof. Dr. Dr. B. Kollmeier. Since 1998, he has been working at Phonak/Sonova in product development on the audiological design at the interface between hearing aid algorithms and fitting software. His work focuses on the audiological quality of hearing systems to achieve maximum customer benefit.

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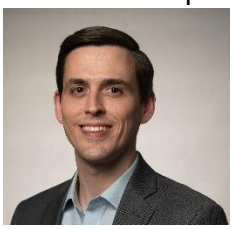
Kevin Seitz-Paquette, Au.D., Director PARC



Kevin is the director of the Phonak Audiology Research Center (PARC), located in Aurora, IL. Kevin earned his Au.D. at Northwestern University, and a master's degree in Linguistics from Indiana University. His team evaluates both emerging and released products to demonstrate the benefits of Phonak technology for the patient and professional.

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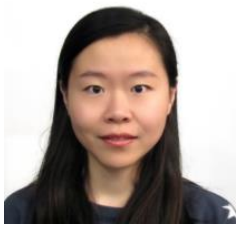

Xiuming joined Phonak Audiology Research Center (PARC) in 2024 and works on clinical data management and analysis. She joined Sonova in 2018 and worked as research and development engineer, contributing to development of various innovative hearing aid products. She completed her MSc at University of California, Los Angeles.