

Phonak

Field Study News

Digital Service Delivery with AudiogramDirect: being there for your clients when you can't be with them

Hearing care professionals can use AudiogramDirect, the in-situ audiometry feature from Phonak, to measure hearing thresholds during a Remote Support session. A new study shows thresholds obtained remotely are accurate, despite the imperfections of an in-home test environment.

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Key Highlights

- Results show that threshold measurements with AudiogramDirect are in good agreement with traditional audiometry across test frequencies, with the largest deviations at 250 and 500 Hz.
- Repeat testing with AudiogramDirect showed strong test-retest reliability.
- Clients were highly satisfied with the remote hearing assessment and fitting process. There were no significant differences in reports of sound quality when devices were fit to AudiogramDirect thresholds versus clinically obtained thresholds.

Considerations for practice

- AudiogramDirect is a viable option when offering remote initial fittings in situations when in-person fittings are not possible. Clients fit remotely using AudiogramDirect should be seen as soon as possible for a clinical audiogram, fine-tuning, and in-person counseling.
- If WhistleBlock is on, yet the client reports feedback, reducing high-frequency gain may alleviate the issue. A feedback test should be run at the first in-person appointment, held as soon as possible after the fitting.
- New clients may need extra time in advance of the initial fitting session to download and pair to the myPhonak app and set up and confirm their myPhonak account.

Introduction

Remote services in hearing healthcare first became available for Phonak products with the introduction of Audéo B-Direct. Since that time, clients fit with Audéo B-Direct or Marvel hearing aids have enjoyed the option of having their hearing aids adjusted from the comfort of their home. Previous investigations have found that both clients and providers appreciate the convenience that remote services provide (Angley et al., 2017).

Research has demonstrated the positive influence of the hearing care professional's (HCP) role on hearing aid satisfaction (Humes et al., 2017). The initial required closures, and subsequent restricted re-openings, of HCP practices due to the COVID-19 crisis in early 2020 revealed the value of remote service delivery of hearing care for purposes beyond fine-tuning adjustments, as a means of preserving HCP involvement in clients' hearing journeys. In response, Phonak has created guidelines and processes to empower and enable HCPs to blend remote and in-person care for all clients, new or established. In this way, the HCP can continue to provide personalized hearing care, even when physical togetherness is not possible.

Perhaps the most significant barrier to date to providing remote care to a new client has been the inability to complete conventional measures of hearing thresholds. Without reliable hearing thresholds, a fitting cannot proceed, and traditional audiometry requires equipment and facilities that are far from portable. AudiogramDirect provides a means to gather hearing thresholds using only Phonak Target fitting software and Phonak hearing devices as a starting point for a new remote fitting, until a conventional diagnostic hearing assessment can be completed.

AudiogramDirect has been available in Phonak Target since 2011. This feature has historically enabled HCPs to perform in-situ audiometry in the clinic. However, it has now been made available for use during Remote Support sessions, giving HCPs more flexibility in when and where they can obtain in-situ hearing thresholds.

In-situ audiometry refers to the process of measuring hearing thresholds directly with the hearing device. Although it cannot and is not intended to replace traditional audiometry, in-situ testing does offer some distinct advantages over traditional audiometry for the purposes of fitting hearing aids. For example, in-situ audiometry inherently accounts for effects of ear canal geometry, acoustic coupling, and receiver characteristics in the threshold estimation (Block, 2008). By its nature, traditional audiometry cannot. For this reason, some HCPs have chosen

to use in-situ audiometry in the clinic, even though a traditional audiogram may already have been completed.

Previous investigations have shown AudiogramDirect to be comparable to a traditional audiogram when used in a clinic environment (Vercammen, 2020; Omisore, 2011). While those studies both found good agreement between a traditional audiogram and AudiogramDirect thresholds, the latter measurements were obtained while the client and HCP were together in a clinic environment. The present study investigated whether similarly reliable thresholds could be obtained with the client located at home, where ambient noise, distractions, and technical difficulties are more likely to have an impact. It was expected that thresholds obtained via AudiogramDirect would be higher than those obtained via traditional audiometry at low audiometric frequencies, while thresholds at higher frequencies were expected to be lower when measured with AudiogramDirect compared to traditional audiometry, as observed in prior investigations (Vercammen, 2020; Kiessling, et al., 2015).

Methods

Twenty-four adult participants with mild to moderately-severe sensorineural hearing loss were recruited to participate in the study. All participants were current smartphone users and had had a traditional audiogram completed at the Phonak Audiology Research Center within the past twelve months, which was used as the reference condition. The average age of the participants was 74 years, and twelve of the participants were female. All but one of the participants completed at least one AudiogramDirect (AD) test. One participant was not able to complete the full home trial or the second AD test due to a broken receiver. One participant experienced excessive feedback during initial fit and was not able to wear hearing aids comfortably for the home trial, though AD test and retest measures were able to be completed. Two participants initially had difficulty connecting to Remote Support but were able to complete AD testing at a later time. However, this did not allow enough time for these participants to complete home trials. Due to these constraints, twenty participants completed all portions of the study, and three additional participants completed the AudiogramDirect measures without home trials.

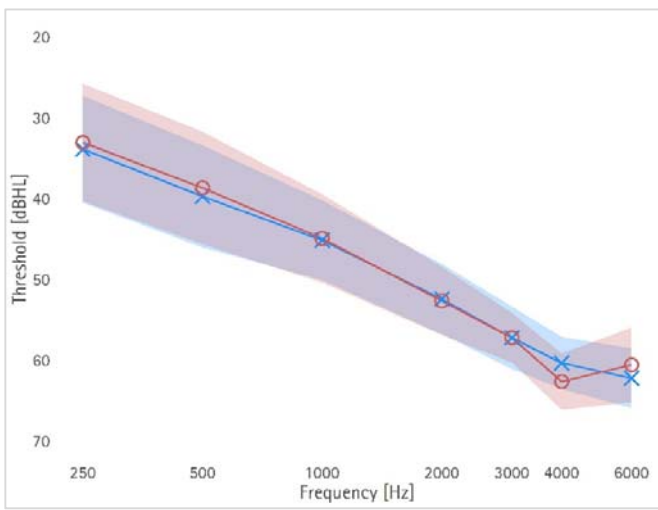


Figure 1. Average (traditional) audiogram for all participants in the study. The solid lines show the mean value across all participants, and the shaded regions give the 95% confidence interval of the mean.

Participants were shipped Phonak Audéo M90-R RIC hearing aids, preprogrammed to “first fit” settings based on their traditional audiogram, along with a copy of the “Getting Started with Phonak Remote Support” guide. Participants were asked to download and install the myPhonak application from the App Store (iOS users) or the Google Play Store (Android users). Once installed, participants were asked to connect the hearing aids to their smartphone.

Each participant completed three study sessions, which were conducted remotely, and two home trials (see table 1). During the first session, thresholds were measured with AudiogramDirect (AD1) at 250, 500, 1000, 2000, 3000, 4000, and 6000 Hz (AudiogramDirect cannot measure beyond 6000 Hz). The experimenter then programmed the hearing aids to the traditional audiogram thresholds for one half of the participants, and to the AD1 thresholds for the other half. All participants were given the opportunity for fine tuning via Remote Support, regardless of which thresholds were used in the programming. In the second session, a repeat AudiogramDirect measurement (AD2) was conducted to assess test-retest reliability; however, AD2 thresholds were not used for hearing aid programming. Instead, the hearing aids were reprogrammed to either a) AD1 (for those initially programmed to their traditional audiogram) or b) the traditional audiogram (for those initially programmed to AD1). Again, fine tuning was allowed for all participants. Additionally, each participant responded to a sound quality interview regarding the device settings for the home trial. At the third and final session, a final sound quality interview was conducted with each participant regarding the device settings from the second home trial, and the participants were given instructions to return the devices.

All home trial participants (N = 20)		
	Group 1 (n = 9)	Group 2 (n = 11)
Session 1	AudiogramDirect (AD1)	
Home trial 1 (2–3 days)	Gains set to traditional audiogram	Gains set to AD1
Session 2	Repeat AudiogramDirect (AD2); sound quality interview	
Home trial 2 (2–3 days)	Gains set to AD1	Gains set to traditional audiogram
Session 3	Final interview	

Table 1. Summary of the participants' progression through study sessions and home trials. Three additional participants completed AudiogramDirect measures but did not complete home trials.

Table 2, below, summarizes the fine tuning requested by participants for each fitting. It is important to note that not all participants required fine tuning. Six participants did not request any changes to the fitting based on traditional audiometry, and seven participants requested no fine tuning for the AudiogramDirect fitting. All participants requesting fine tuning for the AudiogramDirect fitting also requested adjustments to the fitting based on a traditional audiogram.

Frequency region	Direction of change	Number of fine tuning adjustments	
		Traditional audiometry	Audiogram Direct
Overall gain	Increase	1	0
	Decrease	4	3
Lows	Decrease	0	2
Mids	Increase	2	1
Highs	Decrease	5	3

Table 2. Summary of fine tuning adjustments made for fittings based on traditional audiometry and AudiogramDirect. No participants requested increases to low or high frequency gain or decreases to mid frequency gain.

To test whether AudiogramDirect via Remote Support provides an accurate threshold measure compared to traditional audiometry, analyses of variance (ANOVA) were used to examine threshold differences across measurement approach (traditional audiometry, AudiogramDirect) for each audiometric frequency. Chi-square tests were used to determine whether hearing aid gain settings resulting from each threshold measurement approach significantly impacted ratings of sound quality. ANOVAs were conducted in SPSS, and chi-square tests were conducted in R (R Core Team, 2020).

Results

To assess the test-retest reliability of AudiogramDirect, a one-way ANOVA was used to examine threshold differences across test session (AD1, AD2). There were no statistically significant differences at any test frequency, suggesting

good test-retest reliability for remote AudiogramDirect (see figure 2, below). Due to the strong correspondence between AD1 and AD2, statistical analysis comparing traditional audiometry to AD2 was not expected to yield different results than analysis of traditional audiometry and AD1. For this reason, only traditional audiometry and AD1 were subjected to statistical analysis.

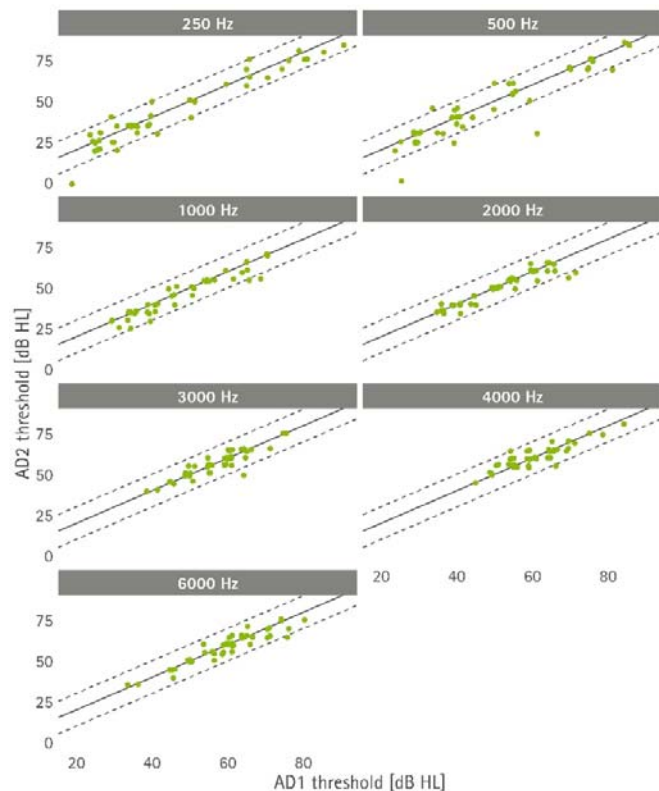


Figure 2¹. AD2 thresholds plotted as a function of AD1 thresholds for all participant-ears ($n = 45$ ears). The solid line shows perfect correspondence, and the dashed lines show a ± 10 dB HL region relative to AD1. Only 2% of datapoints fall outside this ± 10 dB HL range. An odd number of ears is included due to a single broken receiver occurring before the AD2 session for one participant.

As shown in Figure 3, thresholds obtained via traditional audiometry and AD1 generally showed strong agreement, in line with previous findings (Vercammen, 2020; Omisore, 2011). A one-way ANOVAs revealed that AD1 thresholds were significantly higher (poorer) than traditional audiometry thresholds at 250 Hz ($F[1, 90] = 6.78, p = 0.01, \eta^2=0.07$) and 500 Hz ($F[1, 90] = 5.68, p = 0.02, \eta^2=0.06$). No significant differences were observed at any of the other test frequencies. These results indicate that, for most clients, an audiogram obtained via remote AudiogramDirect will correspond well to a traditional audiogram, though some variation may be expected in the lowest audiometric frequencies.

¹ Because thresholds are measured in 5 dB steps, many points in Figures 2 and 3 would naturally overlap. To ensure all datapoints

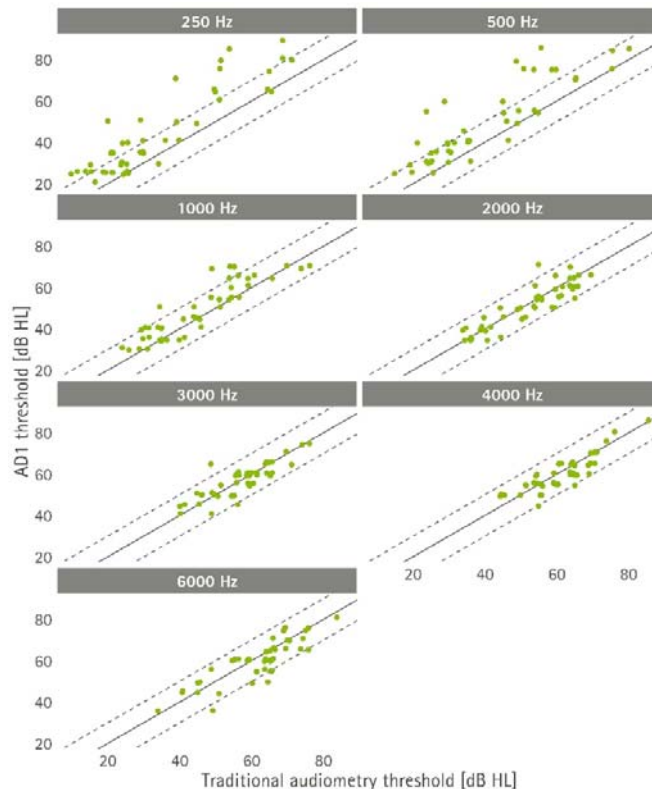


Figure 3. AD1 thresholds plotted as a function of traditional audiometry thresholds for all participant-ears ($n = 46$). The solid line shows perfect correspondence, and the dashed lines show the ± 10 dB HL region relative to traditional audiometry. The majority of data points across all frequencies fall within this ± 10 dB HL region.

Figures 4, 5, and 6 show participants' subjective ratings of sound quality, speech intelligibility, and overall satisfaction, respectively, for hearing aid settings programmed per traditional audiometry and AudiogramDirect. Although some participants' low frequency thresholds were overestimated by remote AudiogramDirect, there were no statistically significant differences in subjective ratings of sound quality ($\chi^2[2] = 0.74, p = 0.69$), speech intelligibility ($\chi^2[4] = 1.80, p = 0.77$), or overall satisfaction ($\chi^2[9] = 8.68, p = 0.47$) with devices fit to AD1 versus the traditional audiogram.

were visible, the data were jittered by adding up to 1 dB of random noise in either the vertical or horizontal direction.

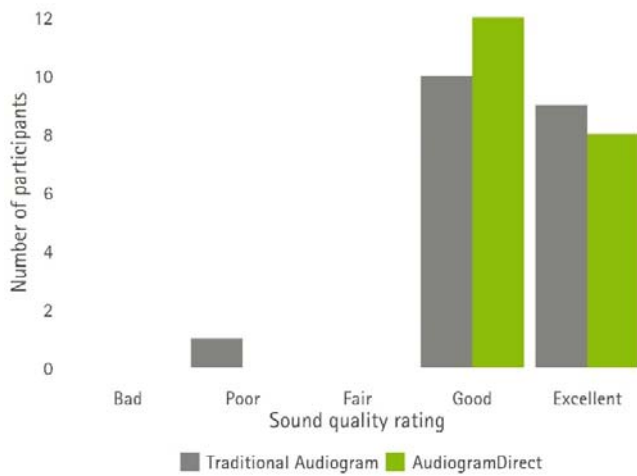


Figure 4. Subjective sound quality ratings for all participants completing home trials (n = 20). No significant difference in the rating between the AD1 and traditional audiogram fittings was observed.

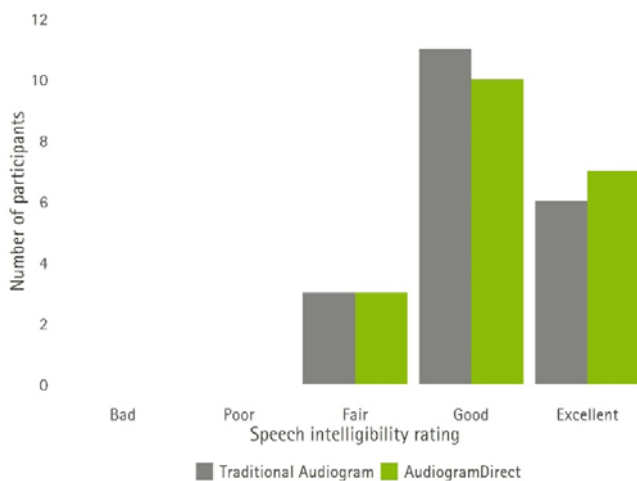


Figure 5. Subjective speech intelligibility ratings for all participants completing home trials (n = 20). Participants were asked to judge how well they felt they could understand speech with the AD1 and traditional audiogram fittings. No significant differences between the two treatment conditions were observed.

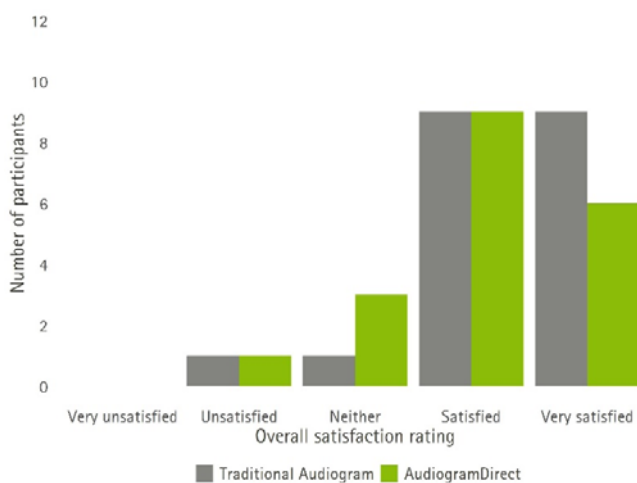


Figure 6. Overall satisfaction ratings for all participants completing home trials (n = 20). No significant differences between overall satisfaction with an AD1 fitting versus a traditional audiogram fitting were observed.

The subjective ratings shown in figures 4-6 provide an important check against the differences observed in the low frequencies between AD1 and a traditional audiogram. In general, AD1 and the traditional audiogram were in close agreement, with differences between testing approaches ranging from 1 to 2 dB, on average, in the mid to high frequencies to about 10 dB, on average, at the lowest frequency. Thus, AudiogramDirect may overestimate thresholds compared to traditional audiometry at the low frequencies. However, in a clinical scenario, when additional fine tuning is available, subjective assessments of sound quality, speech intelligibility, and overall satisfaction are equivalent between the two fittings.

Discussion

AudiogramDirect is not a substitute for a comprehensive diagnostic audiogram done in a clinical setting. However, the results of the present study suggest that when circumstances arise that prevent clients from being able to visit their hearing care professional, AudiogramDirect can be used with confidence as a reliable tool to fit and fine tune hearing aids .

While AudiogramDirect has been available to HCPs since 2011, it has not been included in the remote support toolkit until now. The previous validations of AD were done in a clinical setting, with minimal distractions, and yielded reliable results. It was unknown whether performing AD remotely, while participants were in their own homes, would return as accurate and/or reliable results. Even though participants were instructed to complete the testing in a quiet room with no other noise sources, there was always the possibility of unexpected noises and visual or mental distractions. However, results from this study confirm that AD-obtained thresholds are generally comparable to a clinical audiogram and have strong test-retest reliability.

As expected, based on previous exploration (Vercammen, 2020; Kiessling, et al., 2015), thresholds obtained for the lower frequencies (i.e., 250 Hz and 500 Hz) were significantly higher (poorer) than thresholds obtained during traditional audiometry. On average, AD thresholds at these frequencies were still within +/- 10 dB of the traditional audiogram; however, differences of up to 30 dB were observed in a few participants. Minor fine-tuning adjustments were able to mitigate the clinical impact of threshold error with remote AudiogramDirect, as demonstrated by the subjective ratings.

The mid- and high-frequency thresholds obtained via AD fell within +/- 10 dB of the traditional audiometry thresholds, with very few exceptions. Fine tuning of high frequency gain was required to reduce feedback in some cases, as the

feedback test cannot be run during a remote session. It is worth noting that no participants required fine tuning only for the AudiogramDirect fitting. That is, the fine-tuning adjustments that were done with the traditional audiometry fitting were also needed for the AD fitting, and vice-versa. It is not surprising that participants did not notice differences in the fittings given the fidelity of the AD thresholds to the traditional audiometry thresholds. Most participants felt the sound quality was either good or excellent and were satisfied or very satisfied with both fittings.

During the study, participants were asked about the benefits and perceived obstacles of completing a hearing test remotely with the audiologist. All participants felt the process was convenient, and several participants mentioned that the process was easy and still felt personal. Among the perceived obstacles, participants mentioned the newness of the process ("I was nervous") and some questioned the accuracy of the test results given the fact that they were not in a sound booth. However, at the conclusion of the study, participants felt it was overall a positive experience, and the test results confirm that AudiogramDirect is an appropriate alternative when an in-office audiogram cannot be completed.

Conclusion

AudiogramDirect does not replace a clinical audiogram, but if clients are properly instructed, it can be done remotely with confidence when the HCP chooses to fit or fine-tune hearing aids. Minor adjustments may be needed, but no more so than a typical initial fitting may require.

Participants in this study reported no detriment to sound quality or satisfaction when the hearing aids were programmed to the AD data, compared to programming based on the traditional audiogram. Furthermore, participants enjoyed the personal process and the convenience of Remote Support. Hearing care professionals now have access to a complete toolkit, which allows them to successfully interact with their clients remotely without compromising quality of care.

References

Anglely G., Schnittker, J.A., Tharpe, A.M. (2017). Remote Hearing Aid Support: The Next Frontier. *Journal of the American Academy of Audiology*, 28(10), 893-900.

Block, M. (2008). Adding Precision to the Initial Hearing Aid Fitting. *The Hearing Professional*, 57(4), 7-10.

Humes, L., Rogers, S., Quigley, T., Main, A., Kinney, D., and Herring, C. (2017). The Effects of Service-Delivery Model and Purchase Price on Hearing-Aid Outcomes in Older Adults: A

Randomized Double-Blind Placebo-Controlled Clinical Trial. *American Journal of Audiology*, 26, 53-79.

Kiessling, J., Leifholz, M., Unkel, S., Pons-Kühnemann, J., Jespersen, C. T., & Pedersen, J. N. (2015). A comparison of conventional and in-situ audiometry on participants with varying levels of sensorineural hearing loss. *Journal of the American Academy of Audiology*, 26(1), 68-79.

Omisore, D. (2011). AudiogramDirect: In-situ hearing tests at their best. *Phonak Field Study News*, July, 1-3. Retrieved from: www.phonakpro.com/evidence. Accessed May 29, 2020.

R Core Team (2020). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL <https://www.R-project.org/>.

Vercammen, C. (2020). Audiogram and AudiogramDirect: comparison of in-clinic assessments. *Phonak Field Study News*, June, 1-6. Retrieved from: www.phonakpro.com/evidence. Accessed May 29, 2020.

Wickham, H. (2016). *ggplot2: Elegant Graphics for Data Analysis*. Springer-Verlag New York.

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