Phonak Field Study News.

Beyond wireless protocols: Roger's excellence in Remote microphone performance

Competitive benchmarking with three different remote microphones shows Roger™ systems outperform in estimators of speech intelligibility and audio quality while minimizing delay.

Roh M., Dubach M., Utiger M., & Harsh S. September, 2025

Introduction

Remote microphone (RM) technology for people with hearing loss is used to enhance speech, bypassing the detrimental effects of distance, noise and reverberation, and allowing a good Signal-to-Noise Ratio (SNR) to be perceived by the listener. A large body of evidence shows that RM technology helps to enhance the hearing ability of people with hearing loss when used in combination with hearing devices (HDs).

Roger is both a wireless protocol as well as a microphone system designed for people with hearing loss, developed to have the best balance between minimizing delay and power consumption while maximizing speech understanding and sound quality (Phonak, 2013). The ability for the protocol to not only transmit audio but to also transmit and receive control data, allows the capacity to have advanced features such as MultiTalker Networks with a primary talker mode, the ability to check connected receivers in the network, and adaptive gain on the transmitter and/or receiver.

For over 12 years, Roger has served as an advanced RM system that has continuously evolved to meet the needs of users. Recent advancements have focused specifically on optimizing its ease of use, further enhancing its practicality and accessibility (Roh, 2024). Over the years, a robust and consistent track record of peer-reviewed evidence has been established, showing the auditory and psychosocial benefits of Roger technology in various clinical populations (Huang & Guan, 2025).

Improving speech understanding in noise can be critical in various settings: in education where access to speech has a direct impact on language and academic outcomes, as well as workplace settings where reliable and good audio quality are highly valued for productivity and confidence. This is why Roger has strived to be agnostic to brand when it comes to compatibility to HDs, including access to cochlear implants and bone conduction hearing aids – via direct compatibility with RogerDirect™ HDs, or with Roger receivers that help relay the signal to other HDs.

In the future, there is an expectation of a universal broadcasting protocol, and work is currently being done to develop technologies with this protocol to stream directly to HDs as well as consumer earbuds. This open standard one-to-many broadcasting will slowly but eventually replace public accessibility solutions such as loop systems, as well as open new opportunities via high quality, low delay streaming.

With this in mind, there have been questions regarding the potential benefits of third-party RMs using this protocol, which will work with HDs in the future, as an alternative to native RMs (meaning that the HD is from the same manufacturer as the RM), and Roger. Given this growing availability of RM options, there is a need to compare different RM technologies, where performance is ultimately defined by the system as a whole, rather than the wireless protocol itself.

Previous studies have documented methods to investigate RM performance, both with setups that measured technical specifications of RM systems (e.g. Stone et al., 2023) as well as clinical validation protocols (e.g. Husstedt et al., 2021). To that end, this study investigated three technical, clinically relevant metrics of four different RM systems, to help characterize differences in technologies. By definition, RMs are a system that consist of a transmitter (microphone) and a compatible receiver (HD/earbud). The three metrics that were measured are outlined below.

Delay: This study specifically measured the transfer delay, defined as the elapsed time between a generated stimulus and when it is played back (aka end-to-end delay). Transfer delay is a combination of the transport delay (delay from wireless transmission) as well as any processing from the RM and/or receiver (Figure 1). In this regard, Roger was developed to maintain an end-to-end audio delay of below 25ms (Phonak, 2013).

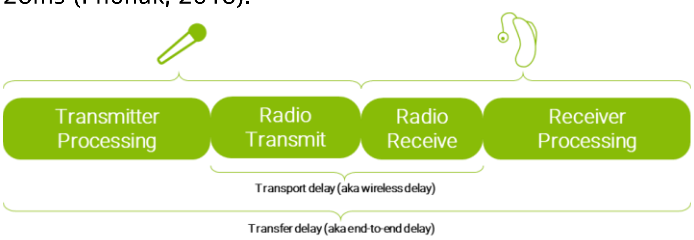

Figure 1. Schematic overview of the different definitions of delay.

The lower the delay the better, with prior studies showing that for own voice a delay of 20ms, and for external voices a delay of 30ms is considered acceptable. Any delay beyond these risks an uncomfortable own voice experience as well as lip sync issues affecting speech understanding (Goehring et al., 2018).

Performance in Noise: One of the main use cases for RM systems is to hear well in situations where noise, distance, and/or reverberation is too great for a hearing aid to provide ample audibility of speech. By having the RM physically closer to the source of the signal, this gives the listener the best chance at maintaining a good SNR (the so-called "10dB FM advantage"). Advanced RM systems could provide an even greater SNR advantage by adapting gain applied to the RM signal based on the ambient noise levels. All Roger RMs utilize this adaptive gain technology, and the performance boost compared to non-Roger products has been well documented in clinical studies in both adults and children (Thibodeau, 2014; Wolfe et al., 2015; Neumann et al., 2025). Behavioral measures remain the gold standard for speech intelligibility, but there have been developments in algorithms for estimation and prediction of speech intelligibility, with some models (e.g. HASPI) having already been used in RM studies (e.g. Salehi et al., 2018; Stone et al., 2023; Zanin et al., 2025).

Audio quality: this is a key consideration to HD acceptance, as well as acceptance to RM systems. Some aspects of audio quality include the overall quality of the transmitted signal, the intrusiveness/annoyance of unwanted noise, and the quality of the actual speech signal that is coming through. While audio quality is considered to be a subjective measure and therefore difficult to consistently measure, there have emerged estimators of audio quality in scientific literature, using algorithms to correlate ratings to that of humans (e.g. HASQI, STOI, PESQ). The key advantage of such a method is the ability to test hundreds of sound samples succinctly without extensive human subject testing, while one key disadvantage is that most of these tests are intrusive , meaning that a clean audio signal is often required to create a reference point for the estimators.

Beyond these three metrics, there are many other determinants of a good RM system that may relate to its technical specifications (such as total harmonic distortion, dynamic range of input signals, etc.), as well as measures of usability (use cases, automation, battery life, ease of use etc.) which, for purpose and scope, were not explored in this study.

The aim of this study was to assess remote microphone performance across three metrics of transfer latency, predicted speech intelligibility in noise, and estimated audio quality ratings across three sub-scales.

Methods

Devices

The following RM systems were used in this study:

1. Phonak Roger Touchscreen Mic (TSM) 3 was used as the transmitter, using the Roger protocol to stream to a RogerDirect Receiver-in-the-canal (RIC) HD.
2. Manufacturer A's RM uses a proprietary broadcast wireless protocol marketed towards education, that works with native HDs (as defined in the Introduction), including bone conduction hearing devices. The receiver was a native RIC HD.
3. Manufacturer B's RM uses a proprietary broadcast wireless protocol but also has an option to use the aforementioned open standard broadcast protocol (the latter was used throughout the study). It works with a variety of HDs including bone conduction HDs and cochlear implants. The receiver was a native RIC HD.
4. Manufacturer C's RM is from a third-party manufacturer and uses the aforementioned open standard broadcast protocol which allows audio to be sent to HDs or consumer earbuds that support this protocol. The receiver was a set of consumer earbuds that supports this broadcast protocol.

A summary of the devices used are shown below:

Transmitter (RM)	Wireless protocol	Receiver
Phonak Roger TSM	Proprietary Roger	Native RIC HD
Manufacturer A	Proprietary	Native RIC HD
Manufacturer B	Open standard broadcast	Native RIC HD
Manufacturer C	Open standard broadcast	Consumer earbud

Table 1. Investigational devices used in the study.

All transmitters offered direct connectivity to the receiver without the need for an intermediary device. HDs, when used, were set to a flat 20dB audiogram in first-fit settings, with small power domes (domes were removed when attached to the coupler).

In the streaming program, the HD mics and all DSP features were disabled where possible. For Manufacturer A there was no option of disabling the HD microphone in the fitting software, so putty was used to cover the HD microphones to minimize external noise.

Procedures

Part 1 – Transfer Delay

The transfer delay of the various RM systems was measured using the set up below (Figure 2):

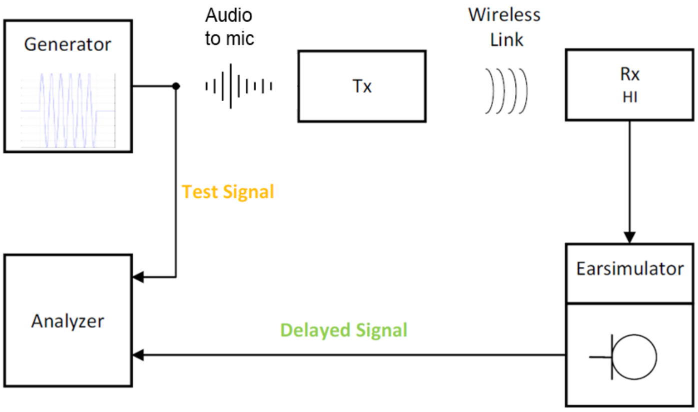

Figure 2. Simplified measurement set up for Part 1 – Transfer Delay.

The transmitter was placed flat in a test-box, and the receiver was attached to an ear simulator. An audio analyzer was used to generate and record a cycle of 1kHz pure-tone sine bursts as the stimulus.

The output of the receiver was recorded using the same audio analyzer, and the transfer delay was measured as the delay between the generated signal (yellow) and the hearing aid output response (green) (Figure 3).

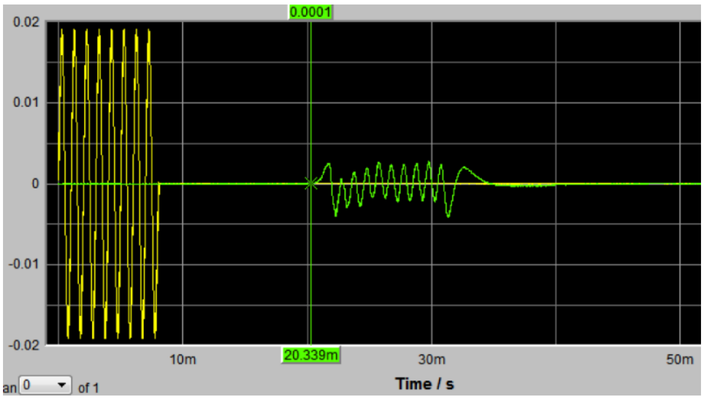

Figure 3. Example of measured transfer delay.

Part 2 –Speech Intelligibility Estimator

To estimate speech intelligibility of the RM signal, the Articulation Band Correlation Modified Rhyme Test 16 (ABC-MRT16) was used, an objective estimator of speech intelligibility that follows the paradigm of the Modified Rhyme Test (MRT) to estimate the rate of successful word identification based on articulation index band correlations and models of forced-choice word selection (Voran, 2017).

All testing was done in a small sound-treated chamber (2.75m x 3.75m) with a low RT_{60} (Figure 4).

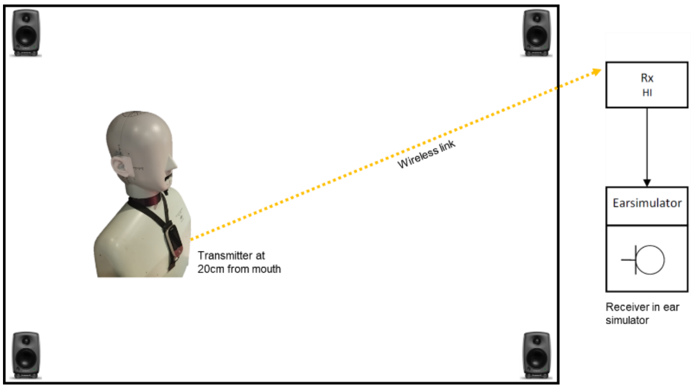

Figure 4. Room setup for Part 2 – Speech Intelligibility Estimator.

The stimulus was played using a B&K 4128C head and torso simulator (HATS) with a level of 74dBA (as measured 20cm from the mouth, 60dBA measured at 1m).

All transmitters were placed in lanyard mode, 20cm from the HATS. The receiver was placed outside the test chamber, attached to a GRAS RA0045 coupler microphone, so that the audio output recording only included the signal coming from the transmitter.

A quiet condition was recorded where no noise was being played, followed by conditions with diffuse classroom babble noise being played from four Genelec 1020C corner speakers. Noise levels were measured at the reference microphone 20cm from the HATS where the transmitter would be placed, at various levels: 50, 60, 70, and 80dBA.

Recordings of reference microphones placed 20cm and 1m from the HATS across all conditions were also measured, and these were used to simulate a listener at 20cm or 1m from the talker respectively, for comparison of the various RMs with these conditions.

Part 3 – Audio Quality Estimator

The Audatic Speech Quality Metric (ASQM) incorporates a Deep Neural Network (DNN) to evaluate audio files across three ITU P.835 categories: Overall quality, Sound Quality, and Noise. The networks are trained and tested on over 1 million crowd-sourced human sound ratings across the three ITU categories and is non-intrusive, meaning that it does not rely on a clean sound file as a reference (Figure 5). If interested, readers are directed to read the full article describing the development and validation of this metric in more detail (Diehl et al., 2022).

Sound files recorded from Part 2 were used for this section and the audio files were prepared to allow compatibility with the audio quality estimator.

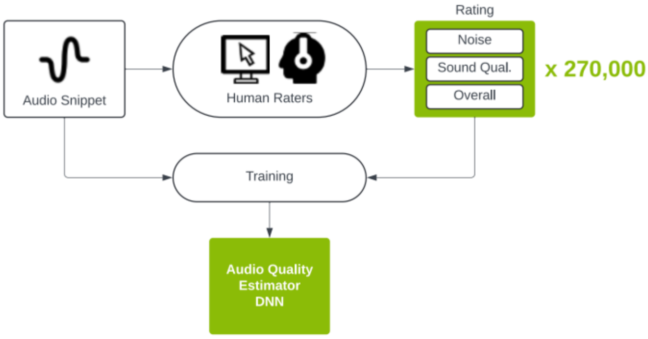

Figure 5. Training of the Audatic Speech Quality Metric (ASQM).

Results

Part 1 – Transfer Delay

Figure 6 shows the transfer delay measured across the four different RM systems.

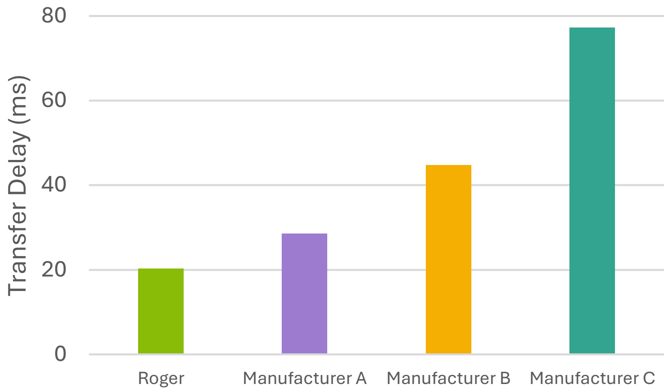

Figure 6. Transfer delay for various remote microphone (RM) systems.

Roger offered the lowest delay from the RM systems tested, with a total transfer delay of approximately 20ms. Manufacturer A which uses a proprietary protocol and only works with their HDs had a good delay of under 30ms.

Manufacturer B and C measured transfer delays greater than 30ms, with the RM system from Manufacturer C having a transfer delay greater than three times that of Roger.

Part 2 –Speech Intelligibility Estimator

Figure 7 summarizes the predicted speech intelligibility scores using ABC-MRT16 for the different RM systems across the various noise conditions.

For an RM system, scores above the reference mic at 20cm are desired, which suggests the RM performance is giving benefit compared to having the signal 20cm from the ears. In contrast, scores below the reference mic at 1m suggest that listening at a distance of 1m is better without an RM. Scores between the two reference microphone values suggest that there is some benefit over listening from 1m, but not as good as having the talker 20cm from the listener.

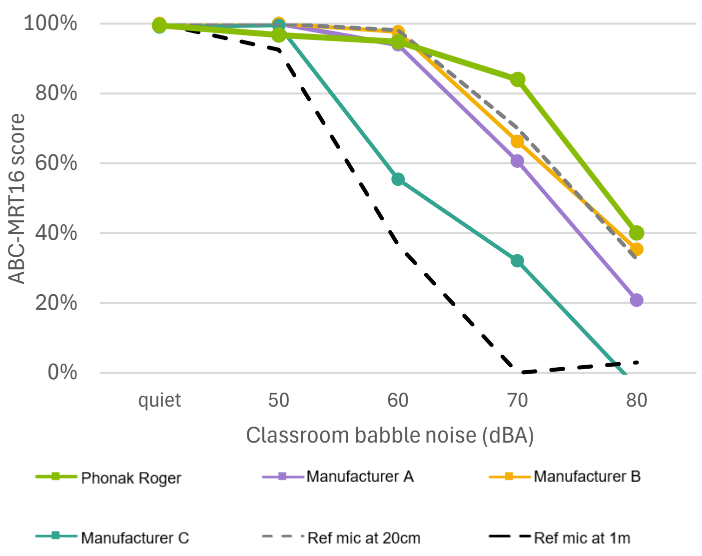

Figure 7. Summary of speech intelligibility estimator findings across various background noise levels.

In quiet and low noise levels (50dBA), all RMs perform similar to one another, and are only marginally better than listening from 1m. At higher noise levels (60dBA onwards), all RMs display a degradation of performance as expected, but continue to perform better than the reference mic at 1m, suggesting all RMs provide speech intelligibility benefit in higher levels of noise compared to listening at 1m.

Only Roger gave scores above the reference mic at 20cm across higher noise levels, suggesting that better speech intelligibility was estimated with Roger than when the listener is 20cm from the talker. This is explained by Roger's adaptive gain that estimates the noise floor and adjusts its own gain to keep speech above the noise even when the SNR was poor.

Manufacturer A & B showed similar performance to the reference mic at 20cm, suggesting the speech intelligibility benefit provided is as good as, but no better than, having the listener 20cm from the talker.

In contrast, Manufacturer C had the sharpest decline in performance for speech intelligibility in noise, giving 0% intelligibility at 80dBA. This is somewhat unsurprising given that this RM system is from a third-party manufacturer, and the signal being received by consumer-grade earbuds.

Part 3 – Sound Quality Estimator

Figure 8 shows the output of the ASQM on three sub-scales (Overall, Sound Quality, Noise) for the different RM systems across various noise conditions. Scores were given on a scale ranging from 1 (Bad) to 5 (Excellent).

The **Overall** rating (Figure 8A) captures the overall impression of the audio, and here both Roger and Manufacturer B give slightly better scores than the reference mic at 20 cm in higher noise levels. Manufacturer A had the poorest performance here but all RMs were better than reference mic at 1m.

Sound quality (Figure 8B) rating relates to the speech signal containing artifacts, distortions, or anything that would suggest poor quality of the recording/transmitter. Manufacturer A was rated best, followed by Roger, with both having ratings above the reference mic at 20cm across most conditions. Manufacturer B performed similar to the reference mic at 20cm while Manufacturer C's performance was deemed to be poor, similar to the reference mic at 1m.

Noise (Figure 8C) is a rating of how intrusive the recorded background noise is. At higher noise levels, Roger is the best performing, maintaining ratings better than the reference mic at 20cm. Manufacturer A and B perform similar to each other, while Manufacturer C's performance was considered very poor performing, with the only set of results that were worse than the reference mic at 1m across all quiet and noise conditions.

Of note, the reference microphone samples had ratings ranging from 1.3 to 4.2 across all three metrics, from a rating scale that ranges from 1 to 5, suggesting that the reference and anchor audio recordings may not have been optimized for a full distribution of scores. Given the narrow range of reference and anchor scores, it seemed fitting to interpret these results in a relative sense rather than with absolute ratings.

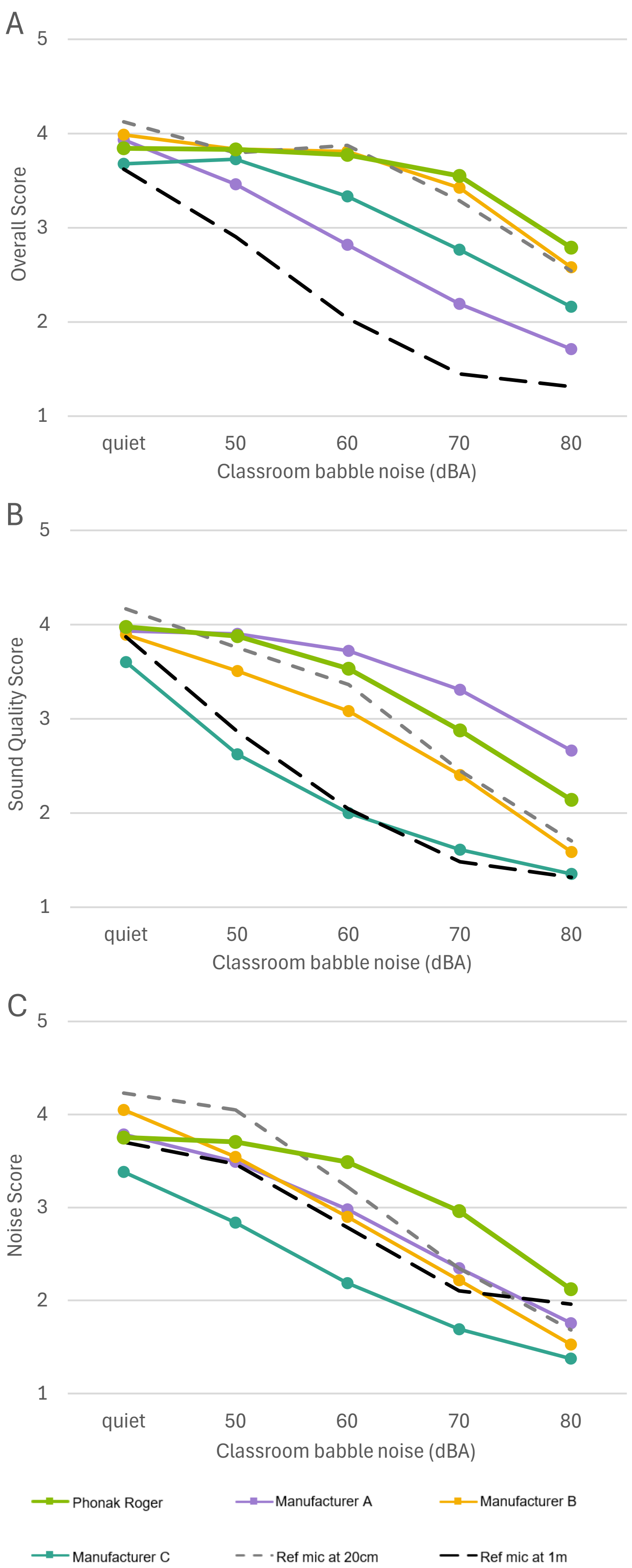

Figure 8A-C. Summary of ASQM ratings for the three different sub-scales (Overall, Sound Quality, Noise).

When looking at the relative scores (ranking), as summarized in Table 2, the combined results suggest that Roger is the best performing RM system as rated by the ASQM, being the only RM to have ratings consistently above the reference microphone at 20 cm. Performance ranking is then followed by Manufacturer A and B, with Manufacturer C being the poorest performing RM system overall.

Transmitter (RM)	Overall	Sound Quality	Noise
Phonak Roger TSM	1st	2nd	1st
Manufacturer A	4th	1st	2nd
Manufacturer B	2nd	3rd	3rd
Manufacturer C	3rd	4th	4th

Table 2. Summary of ASQM rankings.

Discussion & conclusion

The findings across the three technical but clinically relevant metrics suggest that Roger is the best performing RM in all three categories measured: transfer delay, estimated speech intelligibility, and estimated audio quality.

The transfer delay of the Roger system is superior compared to the investigated solutions of Manufacturers A, B and C, while clearly falling below of 30ms acceptable delay to external voices for people with hearing loss (Goehring et al., 2018). This implies that the resulting audio remains in sync with the external speaker's lip-movements, allowing for more natural audio to be perceived by the listener.
The low delay obtained with Roger is due to both the Roger wireless protocol prioritizing low transport delay, as well as minimizing any signal processing at the microphone without compromising on clinical benefit (as seen by the speech intelligibility and audio quality results). The combination of these features allows Roger to minimize delay whilst maximising speech intelligibility and audio quality. Manufacturer B and C uses the same open standard broadcast protocol that is expected to be implemented in HDs in the future, and so it was surprising to see the large differences in delay. This may suggest differences arising from processing delays of the transmitter/receiver, rather than the delay of the wireless protocol (transport delay) itself, given that consumer grade earbuds were used for Manufacturer C's measurements.

For estimated speech intelligibility, the Roger difference was apparent at higher noise levels (70dB, 80dB), performing superior compared to other RMs in this study. These results demonstrate the benefits of Roger technology in these loud noise situations, precisely where RM technology would be clinically indicated and recommended, and are consistent with previous clinical studies in both adults and children (Thibodeau, 2014; Neumann et al., 2025). This highlights the value of adaptive gain technology, whilst adding weight and validity into this estimator and experimental set-up.

Differences in transfer delay (Part 1) are unlikely to have played a role here, as the ABC-MRT16 recordings did not have access to any indirect sound from the HD mics.

Results from the ASQM showed Roger had the best overall ranking, rating best in two of three sub-scales of estimated audio quality (Overall, Noise). This is consistent with other literature that used two different audio quality estimators (HASQI, SRMR-HA), which showed better speech quality in noise with RMs that have an automatic gain control, like Roger (Salehi et al., 2018).
These ASQM results may explain the results from the ABC-MRT16, as it is known that ratings of audio quality and speech intelligibility are highly correlated with one another (Arehart et al., 2018), where excellent performance of Roger across both metrics was seen in this study, while on the other hand, saw the poorest performance on both metrics with Manufacturer C.

Overall, the combined results of this study help illustrate how a wireless protocol plays only a small part in determining the performance of RM systems. Even with a relatively new broadcasting protocol, the performance of Manufacturer C's RM was the poorest across all three metrics measured and more work will need to be done to optimize this system for use in people with hearing loss, where delay, speech intelligibility and audio quality play key roles in the benefit of RMs.

Although these results show the superiority of Roger and confirm the results from prior studies, it is still important to remember that the results obtained here may not necessarily correlate to equivalent clinical benefits. Both the ABC-MRT16 and the ASQM used in this study are only computational estimators of performance and results may vary depending on factors such as the training algorithm/samples used for the model, the quality of the audio recording, real ear to coupler differences, and the specific parameters that are chosen to be extracted for analysis. This study demonstrates the potential time-saving benefits of using such models, but also reaffirms the fact that these metrics cannot replace the need to validate these objective results with clinical studies.

This study did not investigate the effects of reverberation, which is a key consideration when exploring signals affected by distance. These environments, where RMs are typically used, often have negative consequences compared to when testing in noise alone (Lewis et al., 2022). Future studies should consider exploring the use of signals processed with reverberation to replicate typical settings, or to perform tests in more realistic acoustic environments, the latter which may not be feasible in a laboratory or clinical setting.

The performance of the Roger On microphone was not explored in this study, but its results are expected to be similar to the performance of the Roger TSM in this study, given that both use the same Roger wireless protocol and adaptive gain, and similar DSP settings when used in lanyard mode. Equivalent measures could also have been done in table mode where the RM is placed flat, but because not all microphones tested supported this use case, it was not explored here.

Not all RMs are created equally – differences in technology exist, and these differences are measurable, as seen from this study. Roger outperformed other leading remote microphones across various technical but clinically relevant measures, and this is a result of both an optimized wireless protocol as well as the advanced digital signal processing of Roger microphones – namely adaptive gain technology.

A wireless protocol alone is insufficient to determine the performance of an RM system, and this study helps to inform clinicians should take these results into consideration when recommending a RM for their client who may be in louder noise situations – where Roger will provide the lowest delay, with best predictions of speech intelligibility and sound quality, compared to other remote microphones on the market today.

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Min obtained his Masters of Audiology at The University of Auckland, New Zealand in 2017. He has held various roles in diagnostic and rehabilitative audiology, tertiary education, professional bodies, and in the Sales & Audiology team at Phonak NZ, before joining as the Global Audiology Manager for Roger at Phonak HQ in 2024.

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Marco joined Sonova Communications in 2023 as electronics engineer and is engaged in the product development of our future Roger products. Marco has a background in electronic design and in electro-acoustics. He completed his Master of Science in Biomedical Engineering with a specialization in electronic implants at the University of Bern in 2018.

Internal investigator
Samuel Harsh, Acoustic Systems Engineer

Samuel holds a Federal Diploma of Higher Education as a Sound Technician. He joined Sonova Communications as an Acoustics Engineer in 2005. Over the years, he has been instrumental in developing Roger products that enhance sound quality and user experience.

External collaborator
Marc Utiger, Consultant

Marc joined Sonova as a consultant in 2022. He owns an engineering firm that provides services in the areas of hardware engineering and industrial audio analysis. Marc holds a degree in electrical engineering HTL with a specialization in analog signal processing. He also has experience in professional audio recording and reproduction.

Phonak Field Study News.

One-page summary

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Key highlights

- Roger had the lowest transfer delay, with the only remote microphone (RM) system to have an end-to-end delay below 25ms.
- Roger had the best performing estimation of speech intelligibility in noise, better than what would be obtained if the talker was 20cm from the listener.
- Roger had the best ratings across two of three audio quality estimator sub-scales (overall audio quality, noise intrusiveness).
- Roger maintains excellence in RM performance across delay, predicted speech intelligibility in noise, and estimated audio quality compared to three key competitors.

Considerations for practice

- Even with new and upcoming wireless broadcasting technology, it is important to consider the RM as a whole when assessing its benefits and performance.
- With the right study methodology, technical set-ups can be used to show differences in clinically relevant metrics where Roger outperforms three key competitors in the areas of delay, predicted speech intelligibility in noise, and estimated sound quality.
- Not all RM systems are created equal, and care should be taken by the clinician when recommending an RM solution that is best suited to their client's listening needs and realistic noise levels.