Phonak
Field Study News

Roger Focus II in children with Unilateral Hearing Loss

Children with unilateral hearing loss (UHL) struggle with localization[1, 2] and speech intelligibility in background noise and at a distance.[3, 4] Classrooms are often noisy and reverberant[5], making it hard for children with UHL to listen and learn, and increasing risk of behavioral issues, fatigue, grade retention and academic issues.[6-10] Using Roger Focus II significantly improves listening ability for children with UHL both in background noise and at a distance.

J. Nelson & A. Dunn, May 2021

Key highlights

- Speech intelligibility in quiet and in noise improved significantly in children with UHL when wearing Roger Focus II regardless of where the child was seated in the simulated classroom.
- When using Roger Focus II, children with UHL outperformed normal hearing peers on speech intelligibility in noise and at a distance consistent with the middle and back of a classroom (3-5 m/10-16 ft).
- Default EasyGain was considered to be "Just right" for the majority of study participants with respect to loudness comfort.

Considerations for practice

- Recommend Roger Focus II for children with UHL to improve speech intelligibility inside and outside the classroom.
- Fit with the smallest appropriate dome to maximize the openness of the fitting and promote full access to peer speech and environmental sounds.
- Personalize loudness comfort by adjusting EasyGain while presenting conversational speech in quiet at a distance of 3 meters (10 ft).

Introduction

Phonak has been committed to creating hearing solutions for children and adults with unilateral hearing loss for decades, originating with FM technology and evolving to the Roger proprietary protocol using adaptive digital wireless transmission at 2.4 GHz. Roger Focus II is the next step in ear-level receivers, offering two form factors including rechargeable and zinc-air battery-powered (312) receiver options*. When paired with Roger microphones, Roger Focus II can dramatically improve signal-to-noise ratio (SNR) and enhance speech intelligibility in many environments.

** Roger Focus II will be used to describe both rechargeable and zinc-air receivers throughout this document.*

A study at Hearts for Hearing evaluated speech intelligibility in a simulated classroom with and without Roger Focus II in children with UHL and compared their performance to that of unaided normal hearing peers. The study also investigated loudness comfort via adjustments to the Roger Focus II EasyGain setting and the influence of acoustic coupling on real-ear measures, providing recommendations to maximize the openness of the fitting.

Methodology

Speech intelligibility

Speech intelligibility was evaluated in 16 children (ages 8 to 16 years) with UHL and 10 children with normal hearing sensitivity (NH). All children used English as their primary language.

Testing was completed in a realistic, simulated classroom environment. Children with UHL completed testing with and without the Roger Focus II whereas listeners with normal hearing only completed the task unaided. Each participant with UHL was fit with a Roger Focus II-312 in their normal hearing ear coupled to an appropriately sized SDS 4.0 SlimTube and either a small open or cap dome, based on feedback and observation of comfort and retention.

Target speech was comprised of AZ Bio sentences. It was calibrated for average (65 dB A) and loud (72 dB A) speech levels at a distance of 1 m (3ft) from the speaker. A Phonak Roger Touchscreen Mic (TSM) was suspended 15 cm (0.5 feet) below a speaker located in front of the participant (0° azimuth). Participants' speech intelligibility was measured at a distance of 1.5, 3 and 5 meters (5, 10 and 16 ft) from the front speaker to different seat locations in the classroom (i.e., front, middle, back) (Figure 1).

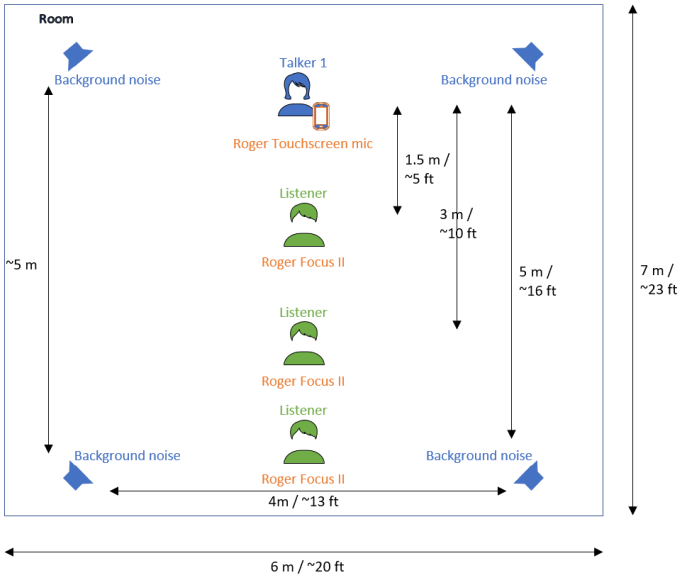

Figure 1. Simulated classroom configuration

For the "quiet" conditions, diffuse uncorrelated classroom noise was played at a low fixed-level of 50 dB(A) and target speech was presented at 65 dB(A). For the "noise" conditions, the classroom noise was played at 65 dB A and target speech level was increased to 72 dB A to simulate increased speaker vocal effort in noisy environments[5]. This resulted in SNRs at the listener's ear ranging from +12 to -2 dB SNR (Table 1).

Prior to testing, EasyGain was adjusted based on participant feedback (see below, Loudness Comfort). Condition order was randomized and counterbalanced. Open-set speech intelligibility was measured for each condition and a repeated measures ANOVA and paired comparisons were used to evaluate performance differences in children with UHL across conditions (distance, noise, device) and between groups (UHL, NH).

Condition	Distance	SNR
Quiet	1.5 m (5 ft)	+12 dB
	3 m (10 ft)	+10 dB
	5 m (16 ft)	+6 dB
Noise	1.5 m (5 ft)	+4 dB
	3 m (10 ft)	0 dB
	5 m (16 ft)	-2 dB

Table 1. SNR conditions as a function of distance from target speech (1.5, 3, 5 m / 5, 10, 16 ft) and noise condition (quiet, noise)

Loudness comfort

Loudness comfort was determined for all participants based on feedback elicited by playing target speech at an average level (65 dBA) in quiet. Participants were seated at 3m (Figure 1) and asked to judge the loudness of the overall signal using a rating scale varying from 1 = Much too Quiet to 5 = Much too Loud (Figure 2). For all participants who initially selected a rating of 1 or 5, the EasyGain loudness (aka volume) setting of the Roger Focus II was adjusted on

the Touchscreen Microphone (TSM) until a rating of 3 (i.e., Not too quiet or loud. "Just Right.") was achieved.

Figure 2. Loudness rating scale.

Insertion loss

Real-ear unaided responses (REUR, open ear) and real-ear occluded responses (REOR, Roger Focus II in-situ but turned off) were obtained for 10 of the participants with both the small Open dome and the Cap dome using an Audioscan Verifit 2. Each participant's REORs were visually compared to their REUR to identify any potential impact of acoustic coupling on the openness of each fitting.

Results

Speech intelligibility – UHL

Results from an individual participant whose data is consistent with group-average performance can be found in Figure 3. On average, unaided performance declined with increasing distance, especially in noise where speech understanding was significantly reduced at 3 and 5m (10 and 16 ft) compared to 1.5m (5 ft) ($p < .05$). The addition of Roger Focus II significantly improved speech understanding in all conditions, including quiet and noise for front, middle and rear locations. The largest improvement was seen in noise at 5m (i.e., -2 dB SNR) where the addition of the Roger Focus II device resulted in a dramatic 60 percentage-point increase in scores relative to unaided performance. With the Roger Focus II, speech intelligibility was maintained regardless of classroom position and noise level.

Speech intelligibility – UHL versus normal hearing

Comparison of performance across groups indicated that children with UHL performed as well as their peers with normal hearing at the most positive SNR (distance of 1.5 m / 5 ft in quiet) with no technology and slightly better when wearing Roger Focus II. At all other SNRs, using Roger Focus II allowed the children with UHL to outperform their peers with normal hearing resulting in an average of 53 percentage points better speech intelligibility for the children with UHL compared to their peers with normal hearing in the most challenging SNR. (See representative participant data in Figure 3).

Loudness comfort

Results of loudness comfort ratings indicated that the majority of participants were happy with the default EasyGain setting, and all participants achieved a comfortable level with EasyGain adjustment. Two participants achieved a "Just Right" level after decreasing EasyGain by 1 step; none of the participants requested an increase.

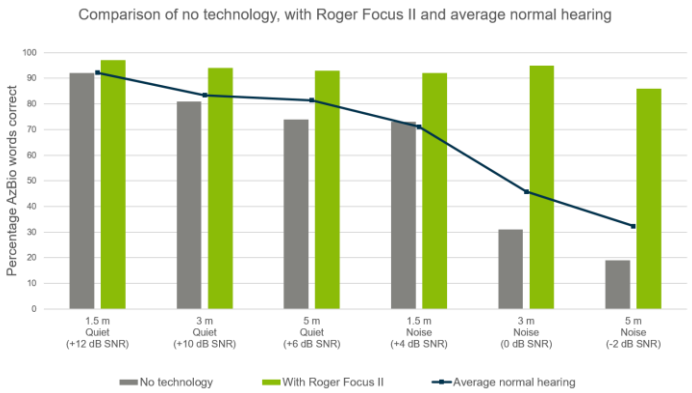

Figure 3: AZ Bio Sentence speech intelligibility UHL without Roger Focus II (gray bars), UHL with Roger Focus II (green bars), normal hearing (dark line) across all SNRs in participants with UHL.

Insertion loss

Visual inspection of individual real-ear tracings revealed an influence of acoustic coupling on the openness of the fitting in some participants. Sample findings from two participants are provided, which depict the variable results observed (Figure 4). Example A shows results from an ear with no insertion loss regardless of acoustic coupling. In contrast, Example B shows an insertion loss with the small open dome which was eliminated with the cap dome. In the majority of patients who exhibited insertion loss, an open fitting was achieved when switching to the cap dome.

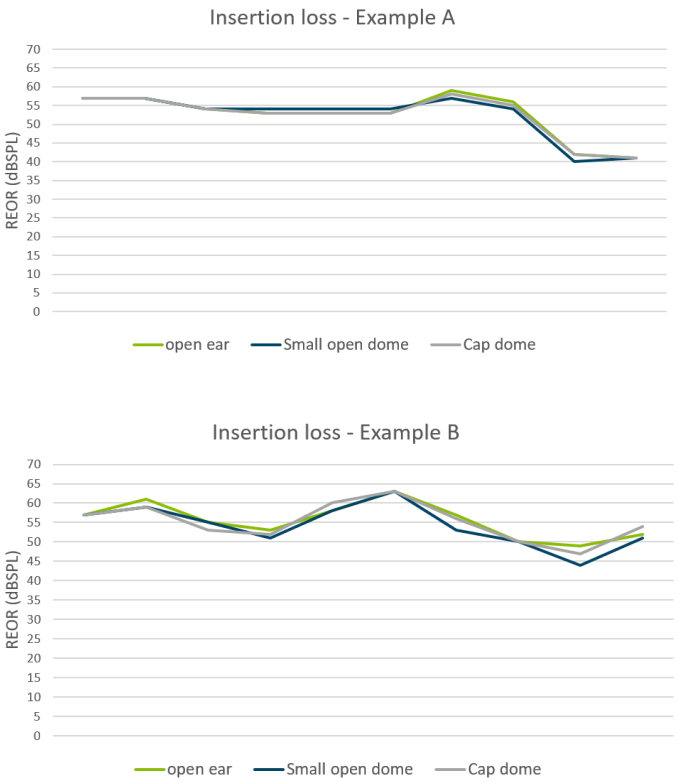

Figure 4: Measured real ear responses unaided (green) and occluded with a small open dome (blue) and cap dome (gray)

Discussion and implications for practice

Roger Focus II helps children with unilateral hearing loss overcome the impact of noise and distance in the classroom. This is very beneficial in today's classroom where the teacher often speaks from different locations in the room rather than always being at the front of the class. When using the device, they outperformed their peers with normal hearing when seated in the middle or back of the simulated classroom (i.e., 3m and 5m / 10 and 16 ft). By improving access to speech, Roger Focus II has the potential to positively influence learning, behavior and fatigue, and lower the likelihood of grade repetition.

Roger Focus II is designed to be 'plug and play'. A one-click connection to the Roger microphone means that each time the Roger microphone is on and the Roger Focus II is in range, the speaker's voice will stream seamlessly to the child's normal hearing ear.

The speaker's voice was generally reported as comfortable at default settings, but subjective loudness comfort ratings can also be used to determine the most suitable EasyGain setting for each child using the method described above. EasyGain settings can be adjusted either on the Touchscreen Mic or, if a child is capable, they can independently adjust the level on the Roger Focus II via the multi-function button. Once the EasyGain has been set, the Roger Focus II will always turn on at that setting and you have the option to lock the control. After the child has experience using the device in various settings, consider instructing on using the multi-function button to adjust to comfort or turn the EasyGain down 2 dB (1 step) if they complain it is too loud in some environments.

Although Roger Focus II does not provide amplification, some providers may want to verify that the device meets prescriptive audibility and loudness targets for a child with normal hearing. For more information on real-ear verification of remote microphone systems for normal hearing listeners please see Schafer, et al., 2014.[11]

Providers also need to ensure the openness of the fitting. by selecting the smallest dome possible such that it holds the Roger Focus II securely in the ear and is comfortable for the child to wear. At follow-up, if the child complains of difficulty hearing their peers, consider running real ear measures to check for insertion loss. If possible, reduce dome size, or consider a custom, IROS type earmold option to achieve an open fitting.

Roger Focus II gives children with UHL greater access to speech both in noise and over distance. Dramatic increases in speech intelligibility were observed compared to unaided performance and relative to normal hearing peers in harder listening conditions. Findings have important implications for children with UHL, affording them more opportunity to move throughout the classroom without sacrificing audibility and putting them in a better position to hear and learn.

References

1. Humes, L. E., Allen, S.K. & Bess, F.H. (1980). Horizontal sound localization skills of unilaterally hearing-impaired children. *International Journal of Audiology 19,*(6), 508-518. doi:10.3109/00206098009070082.

2. Johnstone, P. M., Nabelek, A.K., & Robertson, V.S. (2010). Sound localization acuity in children with unilateral hearing loss who wear a hearing aid in the impaired ear. *Journal of the American Academy of Audiology, 218*, 522–534.doi:10.3766/jaaa.21.8.4.

3. Bess, F. H., Tharpe, A.M., & Gibler, M. (1986). Auditory performance of children with unilateral sensorineural hearing loss. *Ear and Hearing* 7(1), 20–26. Doi:10.1097/00003446-198602000-00005.

4. Ruscetta, M.N., E.M. Arjmand, & Pratt, S.R.(2005). Speech recognition abilities in noise for children with severe-to-profound unilateral hearing impairment. *International Journal of Pediatric Otorhinolaryngology, 69* (6), 771–779. doi:10.1016/j.ijporl.2005.01.010

5. Crukley, J., Scollie, S., Parsay, V. (2011). An exploration of non-quiet listening at school. *Journal of Educational Audiology, 17,* 23-35.

6. Bess, F., & Tharpe, A.M. (1986). Case history data on unilaterally hearing-impaired children. *Ear and Hearing, 7(1*), 14-19.

7. Lieu, J. E. (2004). Speech-language and educational consequences of unilateral hearing loss in children. *Archives of Otolaryngology–Head & Neck Surgery 130* (5), 524–530. doi:10.1001/archotol.130.5.524.

8. Lieu, J. E. (2013). Unilateral hearing loss in children: Speech-language and school performance. B-Ent Supplement (21),107–115.

9. Oyler, R.F., Oyler, A.L., & Matkin, N.D. (1988). Unilateral hearing loss: demographics and educational impact. *Language, Speech, and Hearing Services in Schools, 19*(2), 201-210.

10. Bess FH, Tharpe AM. Unilateral hearing impairment in children. *Pediatrics*. 1984 Aug;74(2):206-16.

11. Schafer EC, Bryant D, Sanders K, Baldus N, Algier K, Lewis A, Traber J, Layden P, Amin A. Fitting and verification of frequency modulation systems on children with normal hearing. J Am Acad Audiol. 2014 Jun;25(6):529-40. doi: 10.3766/jaaa.25.6.3.

Authors

Jodie Nelson is the Phonak Pediatric Audiology Manager based at Phonak headquarters in Switzerland. In her role she ensures that Phonak offers the highest quality pediatric hearing solutions for children with all degrees and types of hearing loss. She works by the motto 'every child matters'. Her knowledge is based on years of clinical experiences while working as a Pediatric Audiologist and Clinical leader in Australia.

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Researchers

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Jace Wolfe, Ph.D., is the Chief Audiology and Research Officer at the Hearts for Hearing Foundation in Oklahoma City, OK. His areas of interests are pediatric amplification and cochlear implantation, personal remote microphone technology, and signal processing for children. He provides clinical services for children and adults with hearing loss and is also actively engaged in research in several areas pertaining to hearing aids, cochlear implants, hybrid cochlear implants, and personal remote microphone systems.

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