

Not all remote microphones are created equal

A comparison of remote microphone technologies for pediatric hearing aid users

Sara Neumann¹, Sabrina Calise¹, Hannah Hill¹, Lisa Standaert², Jean Anne Schnittker², **Min Roh**², Johanna Nelson², Xiuming Zhu²
¹Hearts For Hearing, ²Sonova AG min.roh@phonak.com



Background

Classroom noise levels can vary significantly, ranging from -7 dB to +15dB SNR, with a significant amount of a child's day being spent in the presence of noise (Crukley et al, 2011).

Roger systems have multiple clinical benefits such as better speech intelligibility in noise (Wolfe et al., 2021), better receptive discourse skills (Curran et al., 2018), and more child-directed speech (Benitez-Barrera et al., 2019) compared to hearing aids alone.

Studies comparing Roger against FM systems (Thibodeau, 2014) as well as other fixed gain remote microphone systems (Wolfe et al., 2015) have been done in the past, with Roger outperforming both solutions in adults. No studies have compared these alternatives for the pediatric population.

Aim

Compare speech intelligibility in noise performance for school age children with hearing loss using **Roger Touchscreen Mic (TSM)** against a **traditional fixed directional remote microphone (RM)**, in a simulated teaching setting and small group setting.

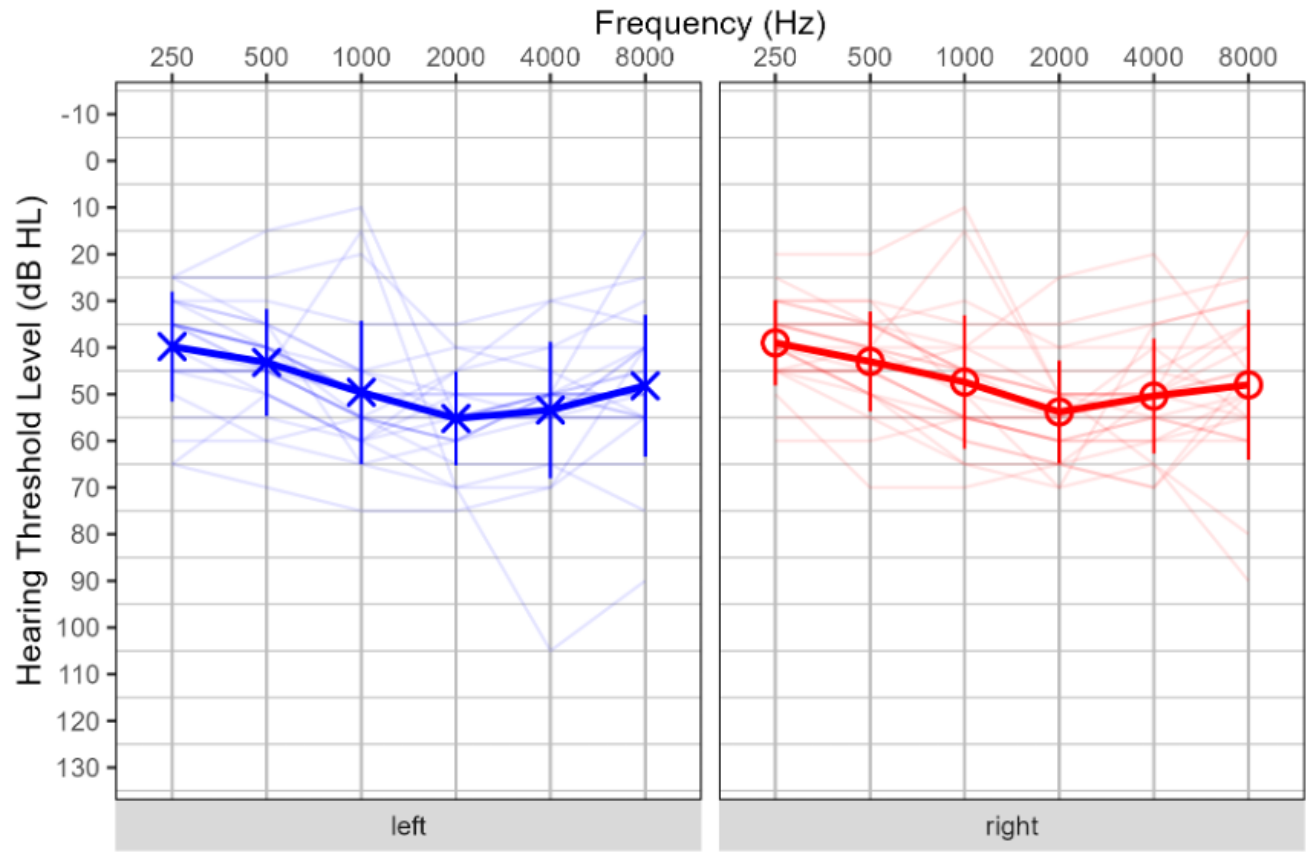
Participants & Devices

Participants

- Sample size: 25 children
- Age: 8-12 years old
- Inclusion: aided score of >70% AZ-Bio recognition
- Average PTA = 50dB HL (Moderate HL)

Devices

- Hearing aid: Sky/Audéo L50 fit to DSL 5.0 targets
- Phonak Partner Mic
- Phonak Roger Touchscreen Mic, dual adaptive mode



Experiment 1: Teaching

Methods

- **Single target 0°** in **diffuse classroom noise**
- **No RM** vs **fixed directional RM** vs **Roger**
- **Participant** response scored (%)
- Tested at various presentation levels

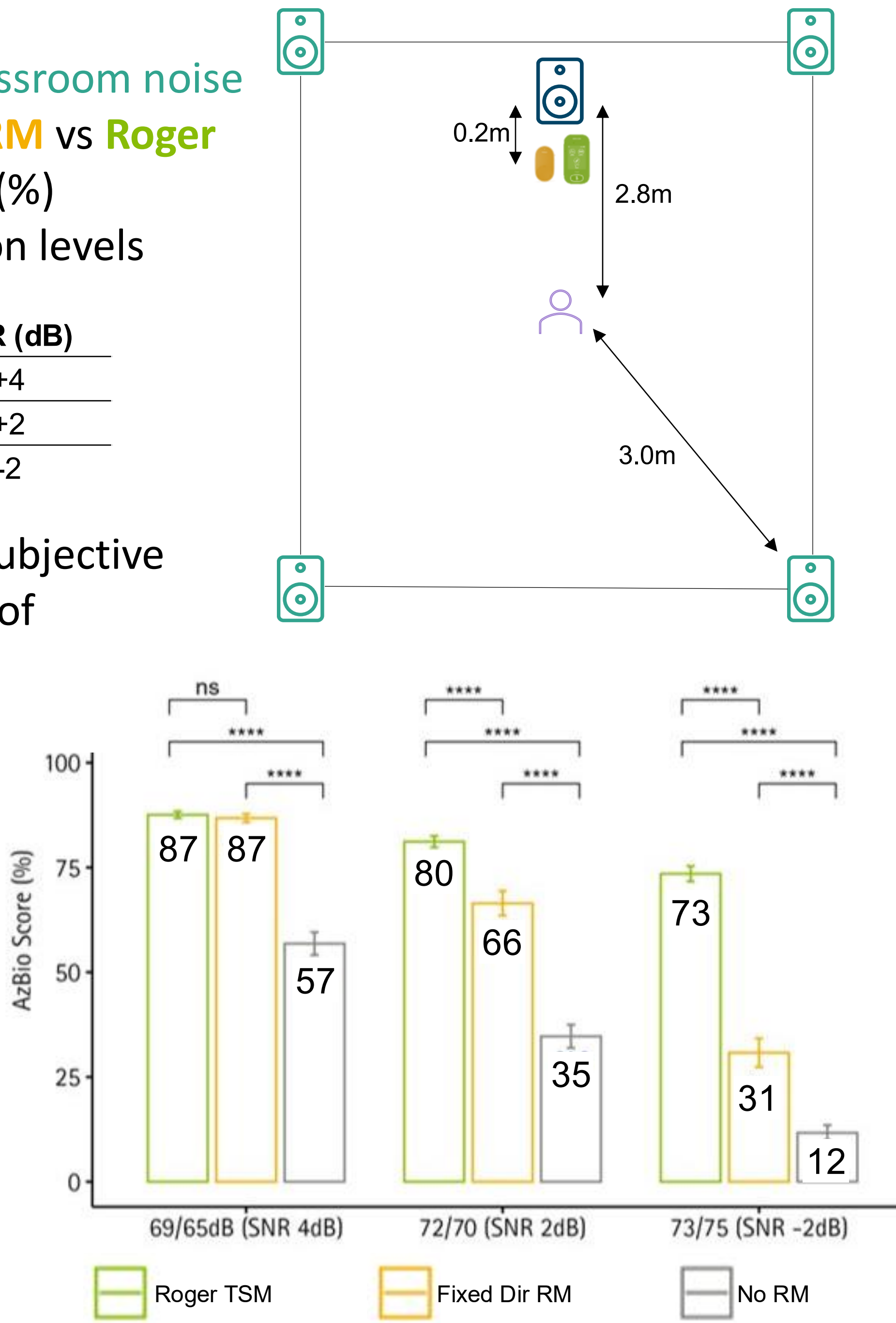
Signal (dBA)	Noise (dBA)	SNR (dB)
69	65	+4
72	70	+2
73	75	-2

Children were asked several subjective preference ratings at the end of session

Results

Category	Roger	Both equal	Fixed Dir RM
Best sound	16	3	6
Comfort in Noise	14	1	10
Speech clarity	18	1	6
Overall	15	1	9

Table 1. Subjective questionnaire results asking participant to rate preferences of various quality ratings of the two remote microphone conditions in the simulated teaching condition.



- **Speech recognition with Roger and the fixed directional RM was significantly better than hearing aid alone**
- **Speech recognition with Roger was significantly better than fixed directional RM**
- **Roger was consistently preferred over the fixed directional RM**

Experiment 2: Small Group

Methods

- **Multiple target 0°, 90°, 270°** in **diffuse classroom noise**
- **No RM** vs **fixed directional RM** vs **Roger**
- **Participant** response scored (%)
- Tested at various presentation levels

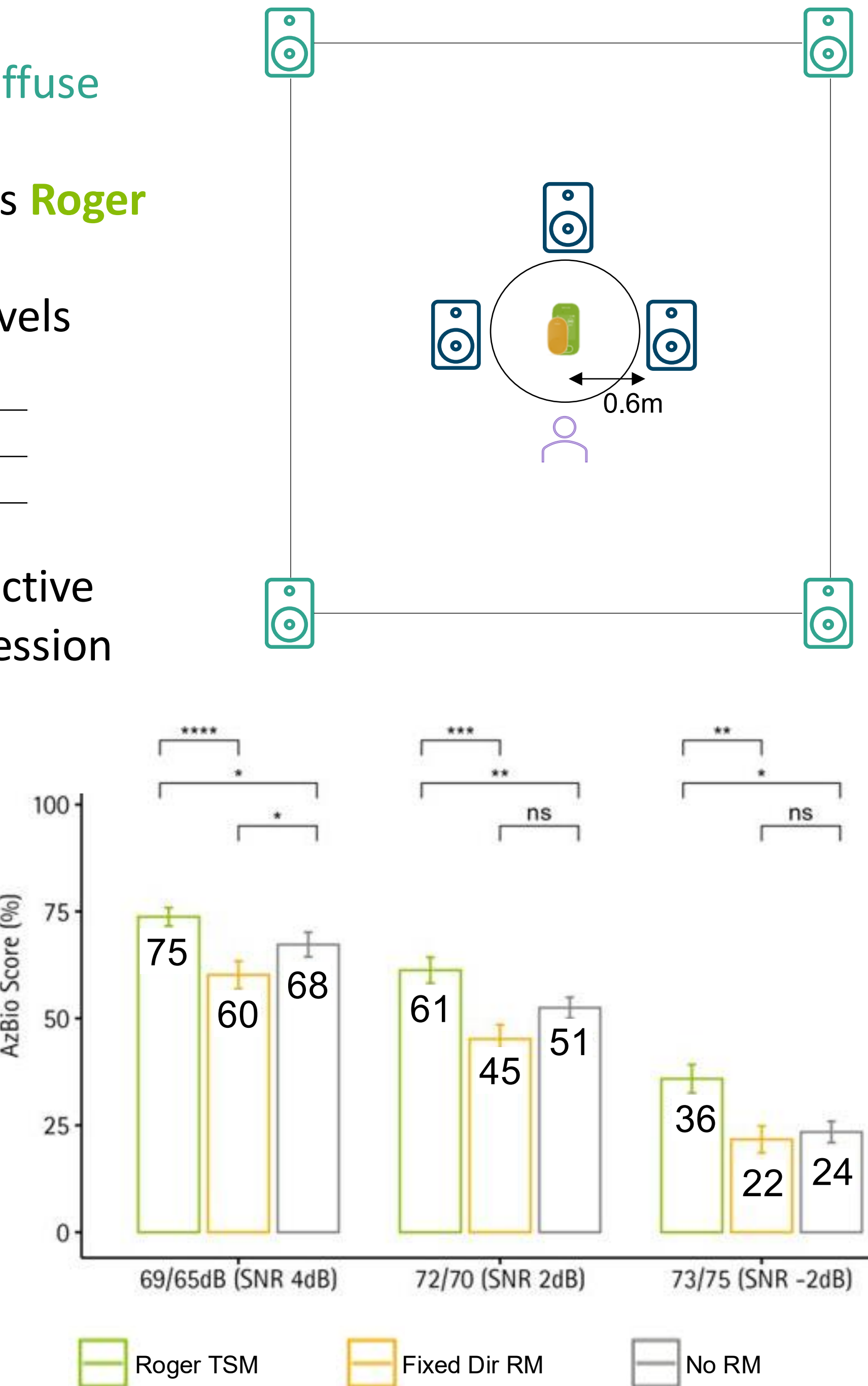
Signal (dBA)	Noise (dBA)	SNR (dB)
69	65	+4
72	70	+2
73	75	-2

Children were asked several subjective preference ratings at the end of session

Results

Category	Roger	Both equal	Fixed Dir RM
Best sound	17	2	6
Comfort in Noise	9	2	14
Speech clarity	15	0	10
Overall	18	0	7

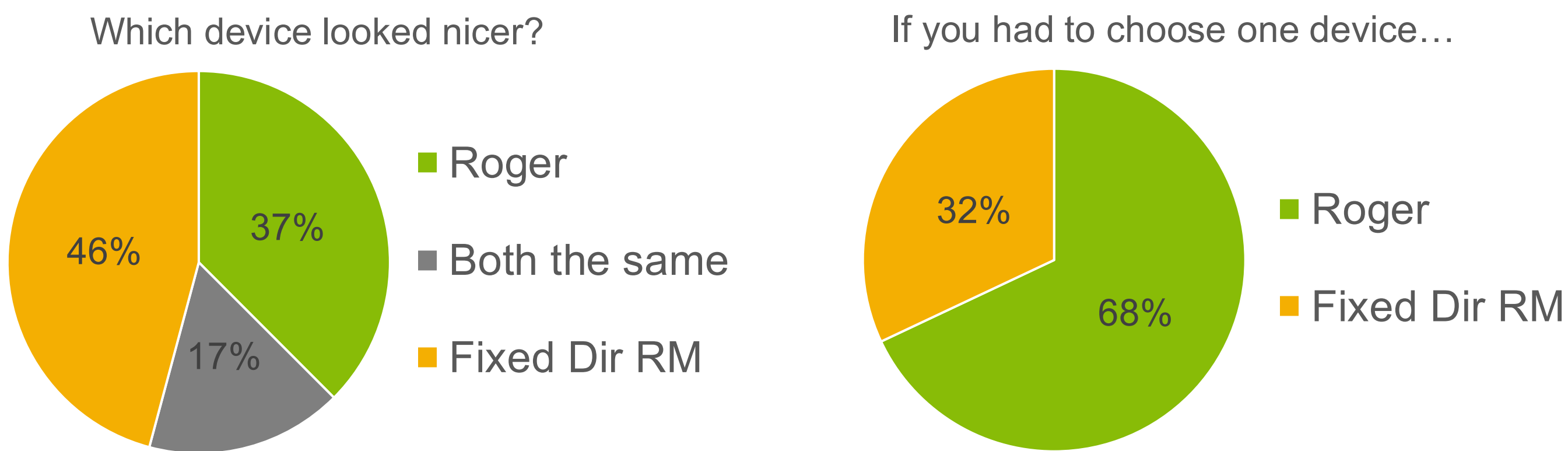
Table 2. Subjective questionnaire results asking participant to rate preferences of various quality ratings of the two remote microphone conditions in the simulated small group condition.



- **The fixed directional RM performed worse than hearing aid alone.**
- **Speech recognition with Roger was significantly better than both the fixed directional RM and hearing aid alone**
- **Roger was predominantly preferred over the fixed directional RM**

Subjective Preference Questions

At the end of both experiments, participants were asked two questions:



When participants were asked about design and aesthetics, there was an even split, with a slight preference towards the fixed directional RM. However, when they were asked to choose only one microphone overall the majority of children (68%) chose Roger.

Conclusion

Speech recognition with the Roger TSM was significantly better than the fixed directional RM in loud noise situations. This may be attributed to Roger's adaptive gain.

In small group situations, the fixed directional RM compromised audibility of the off-axis talkers. This disadvantage was overcome by the Roger TSM's adaptive behavior.

Subjective ratings showed a slight preference for smaller remote microphone; however, when asked to directly select between devices, the Roger TSM was the preferred option.

This study reinforces the significant benefits provided by remote microphones while also demonstrating that the adaptive behaviors of the Roger TSM also provide benefits over traditional remote microphones.

Benitez-Barrera CB, Thompson EC, Angley GP, Woytowicz T, & Thorpe AM. (2019). Remote microphone system use at home: impact on child-directed speech. JSLHR, 62.
Curran M, Walker EA, Roush P, & Spatzford M. (2019). Using Propensity Score Matching to Address Clinical Questions: The Impact of Remote Microphone Systems on Language Outcomes in Children Who Are Hard of Hearing. JSLHR, 62.
Crukley J, Scollie S, & Pisoni V. (2011). An Exploration of Non-Quest Listening at School. JEPHA, 16.
Thibodeau L. (2014). Comparison of speech recognition with adaptive digital and FM remote microphone hearing assistance technology by listeners who use hearing aids. AIA, 23.
Wolfe J, Morais Duke M, Scholer E, Jones C, Mulder HE, John A, & Hudson M. (2015). Evaluation of performance with an adaptive digital remote microphone system and a digital remote microphone audio-streaming accessory system. AIA, 24.
Wolfe J, Neumann S, Scholer E, Towler W, Miller S, Dunn A, Jones C, Nelson J. (2021). Evaluation of a Dual-Adaptive Remote Microphone System. JEPHA, 26.

Not all remote microphones are created equal

A comparison of remote microphone technologies for pediatric hearing aid users

Sara Neumann¹, Sabrina Calise¹, Hannah Hill¹, Lisa Standaert², Jean Anne Schnittker², Min Roh², Johanna Nelson², Xiuming Zhu²

¹Hearts For Hearing, ²Sonova AG

Background

Classroom noise levels can vary significantly, ranging from -7 dB to +15dB SNR, with a significant amount of a child's day being spent in the presence of noise (Crukley et al, 2011).

Roger systems have multiple clinical benefits such as better speech intelligibility in noise (Wolfe et al., 2021), better receptive discourse skills (Curran et al., 2018), and more child-directed speech (Benitez-Barrera et al., 2019) compared to hearing aids alone.

Studies comparing Roger against FM systems (Thibodeau, 2014) as well as other fixed gain remote microphone systems (Wolfe et al., 2015) have been done in the past, with Roger outperforming both solutions in adults. No studies have compared these alternatives for the pediatric population.

Aim

Compare speech intelligibility in noise performance for school age children with hearing loss using **Roger Touchscreen Mic (TSM)** against a **traditional fixed directional remote microphone (RM)**, in a simulated teaching setting and small group setting.

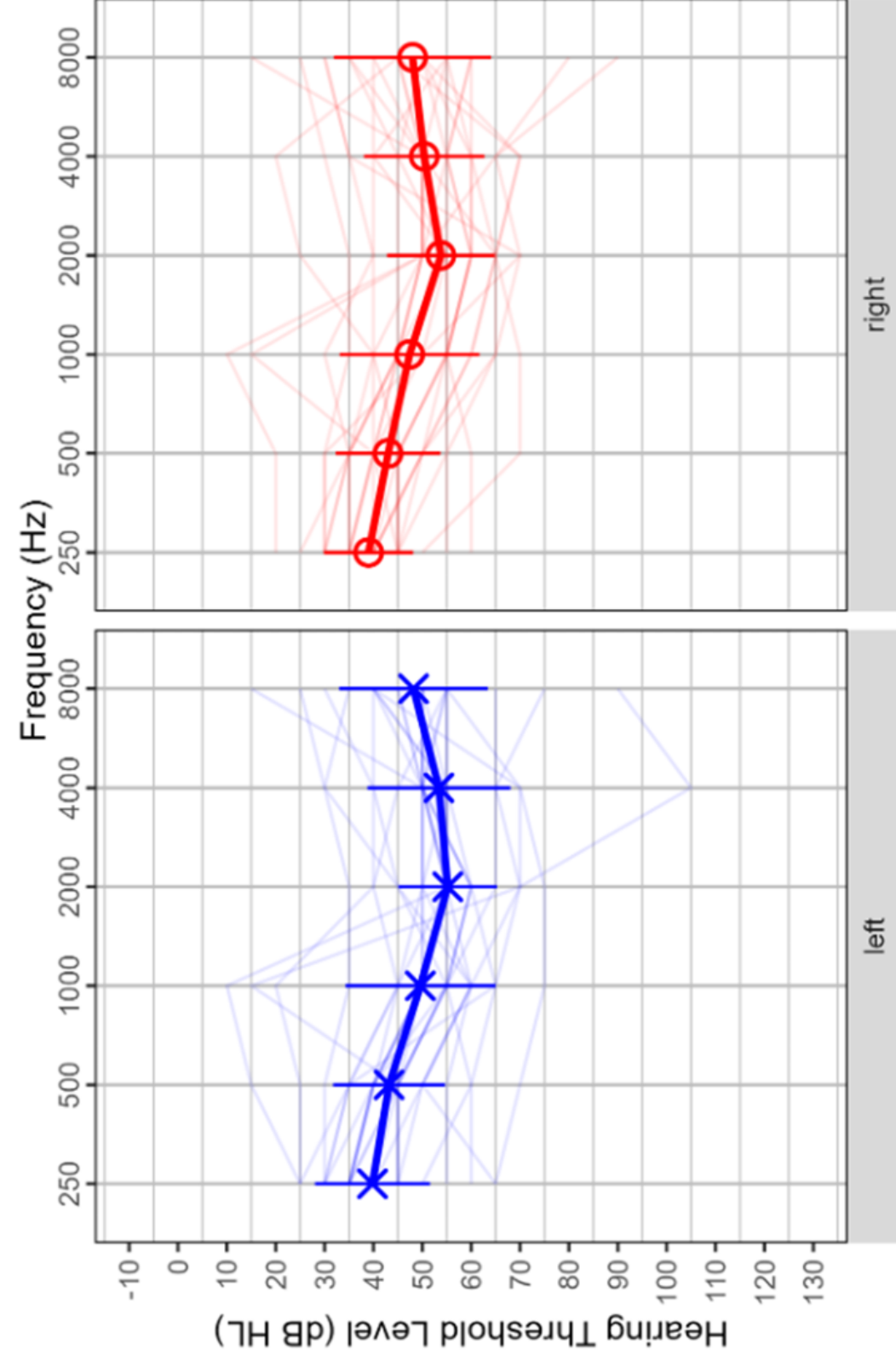
Participants & Devices

Participants

- Sample size: 25 children
- Age: 8-12 years old
- Inclusion: aided score of >70% AZ-Bio recognition
- Average PTA = 50dB HL (Moderate HL)

Devices

- Hearing aid: Sky/Audéo L50 fit to DSL 5.0 targets
- Phonak Partner Mic
- Phonak Roger Touchscreen Mic, dual adaptive mode



Experiment 1: Teaching

Methods

- Single speaker played at 0° in **diffuse classroom noise**
- No RM vs **fixed directional RM** vs **Roger**
- **Participant** response scored (%)
- Tested at various presentation levels

Signal (dBA)	Noise (dBA)	SNR (dB)
69	65	+4
72	70	+2
73	75	-2

Children were asked several subjective preference ratings at the end of session

Results

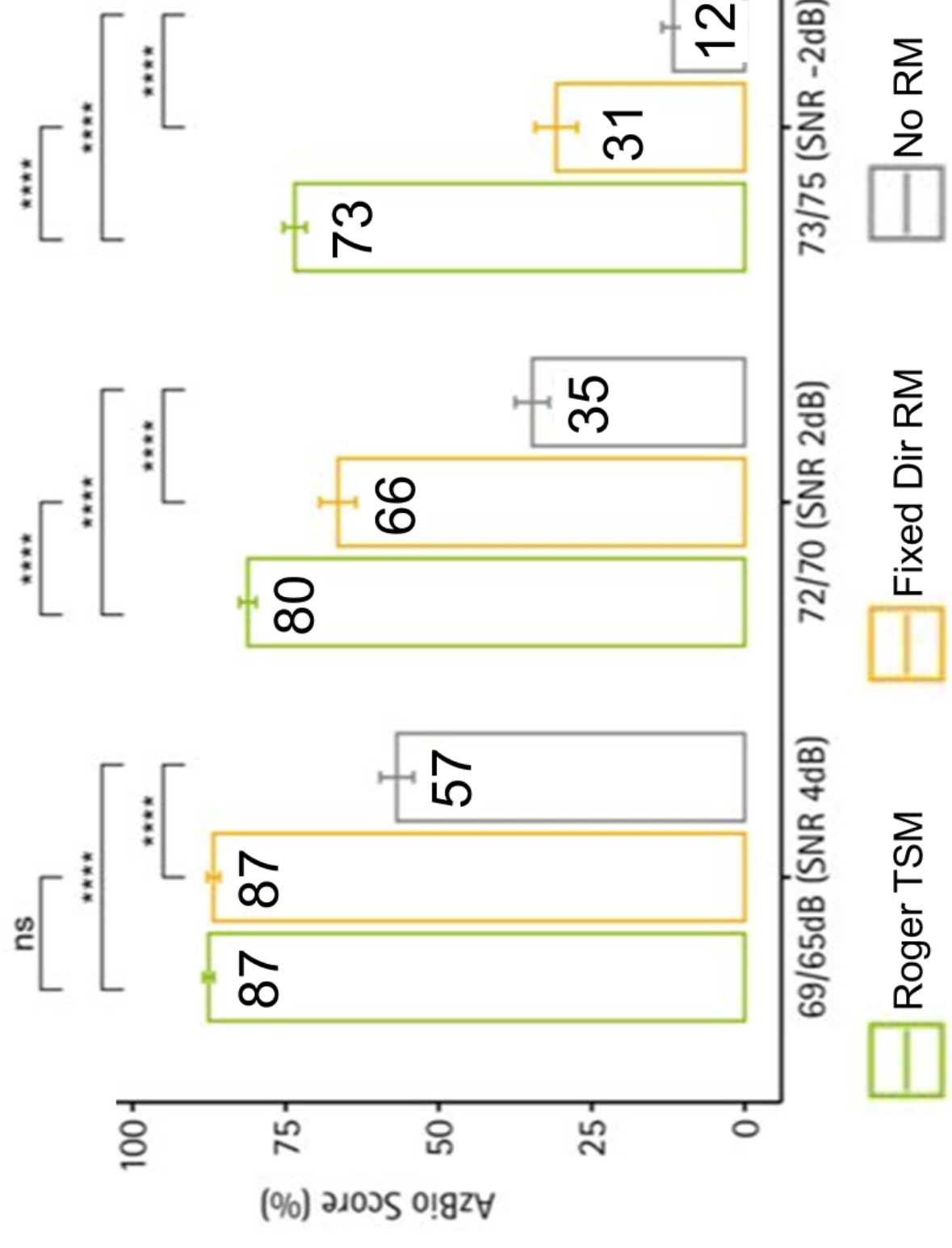


Table 1. Subjective questionnaire results asking participant to rate preferences of various quality ratings of the two remote microphone conditions in the simulated teaching condition.

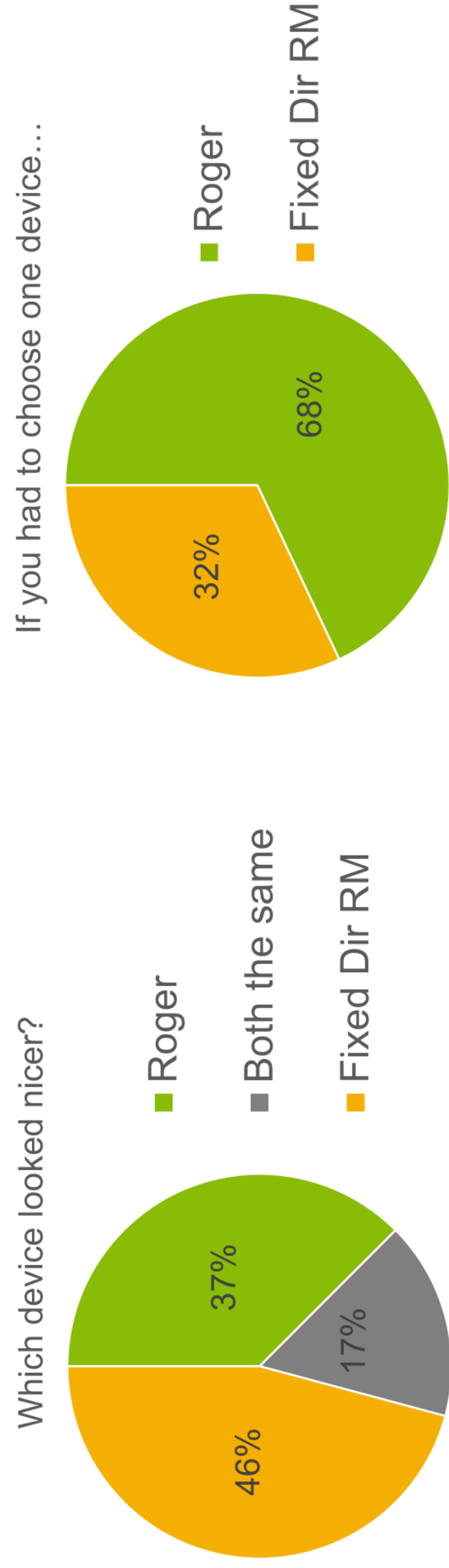
Question	Roger	Both equal	Fixed Dir RM
Best sound	16	3	6
Comfort in Noise	14	1	10
Speech clarity	18	1	6
Overall	15	1	9

- Speech recognition with Roger and the fixed directional RM was significantly better than hearing aid alone
- Speech recognition with Roger was significantly better than fixed directional RM
- Roger was consistently preferred over the fixed directional RM

Subjective Preference Questions

At the end of both experiments, participants were asked two questions:

If you had to choose one device...



When participants were asked about design and aesthetics, there was an even split, with a slight preference towards the fixed directional RM.

However, when they were asked to choose only one microphone overall the majority of children (68%) chose Roger.

Experiment 2: Small Group

Methods

- Multiple speakers played random 0°, 90°, 270° in **diffuse classroom noise**
- No RM vs **fixed directional RM** vs **Roger**
- **Participant** response scored (%)
- Tested at various presentation levels

Signal (dBA)	Noise (dBA)	SNR (dB)
69	65	+4
72	70	+2
73	75	-2

Children were asked several subjective preference ratings at the end of session

Results



Table 2. Subjective questionnaire results asking participant to rate preferences of various quality ratings of the two remote microphone conditions in the simulated small group condition.

Question	Roger	Both equal	Fixed Dir RM
Best sound	17	2	6
Comfort in Noise	9	2	14
Speech clarity	15	0	10
Overall	18	0	7

- The fixed directional RM performed worse than hearing aid alone.
- Speech recognition with Roger was significantly better than both the fixed directional RM and hearing aid alone
- Roger was predominantly preferred over the fixed directional RM

Conclusion

Speech recognition with the Roger TSM was significantly better than the fixed directional RM in loud noise situations. This may be attributed to Roger's adaptive gain.

In small group situations, the fixed directional RM compromised audibility of the off-axis talkers. This disadvantage was overcome by the Roger TSM's adaptive behavior.

Subjective ratings showed a slight preference for smaller remote microphone; however, when ask to directly select between devices, the Roger TSM was the preferred option.

This study reinforces the significant benefits provided by remote microphones while also demonstrating that the adaptive behaviors of the Roger TSM also provide benefits over traditional remote microphones.