

AUDITO: A web-based listening test system for auditory research with cochlear implant recipients

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Introduction

Experimental studies on cochlear implants (CIs) are difficult due to recruitment, time and cost. Research suffers from limited sample sizes and inclusion.

Web-based studies can allow more people with CIs to take part in research, saving cost and time.

Experimental stimuli can now be streamed directly to CI devices to deliver high sound quality.

AUDITO is a web-based test system for inclusive CI and auditory research, requiring no programming.

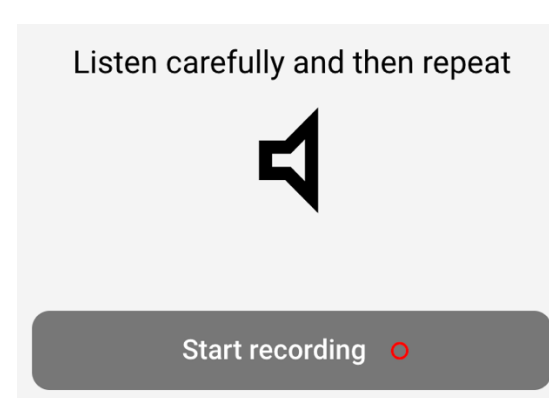
To validate AUDITO, we compared speech scores between direct and streamed stimuli presentation in the lab for a group of 10 CI listeners. We then compared the results to speech scores obtained remotely with AUDITO for 12 CI listeners.

Finally, we collected DIN and STRIPES scores with AUDITO remotely and performed a user survey.

Listening tests

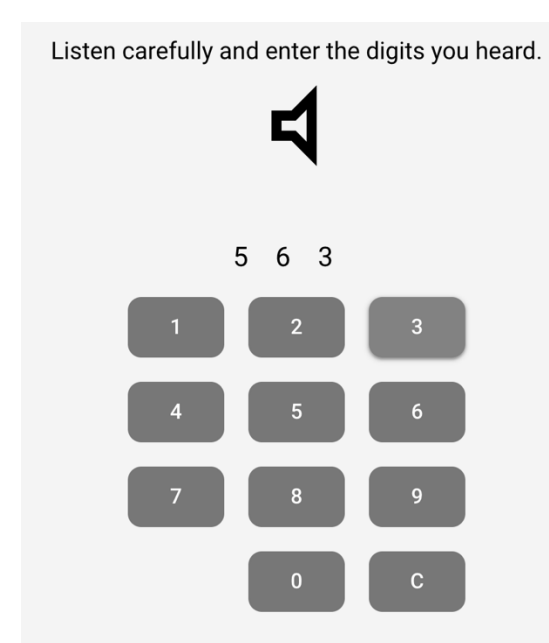
1) Speech: Sentences (SIN)

Male speaker in Babble at 5 dB SNR
Conditions: NOISY, PROC, CLEAN
PROC = after noise reduction
Responses: Vocal recordings



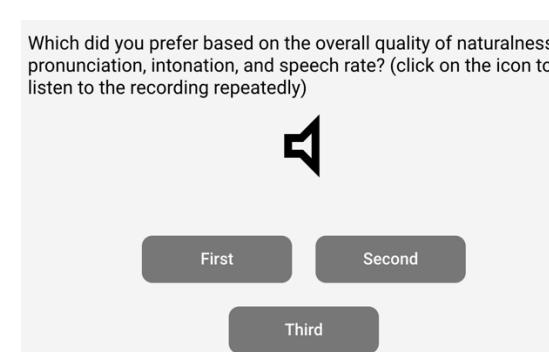
2) Speech: Digits in Noise (DIN)

Male speaker in Stationary noise
Adaptive speech test (SRT in dB)
Responses: Numpad



3) Sound: STRIPES²

Temporally overlapping sweeps
Adaptive spectro-temporal test
Responses: Choice (First/Last)



Results

Participants: Experienced CI users took part (Age: 23-80, med=64). N=10 for in-lab study, N=13 for remote study: 15 Advanced Bionics, 3 Cochlear, 3 MED-EL; 2 drop-out.

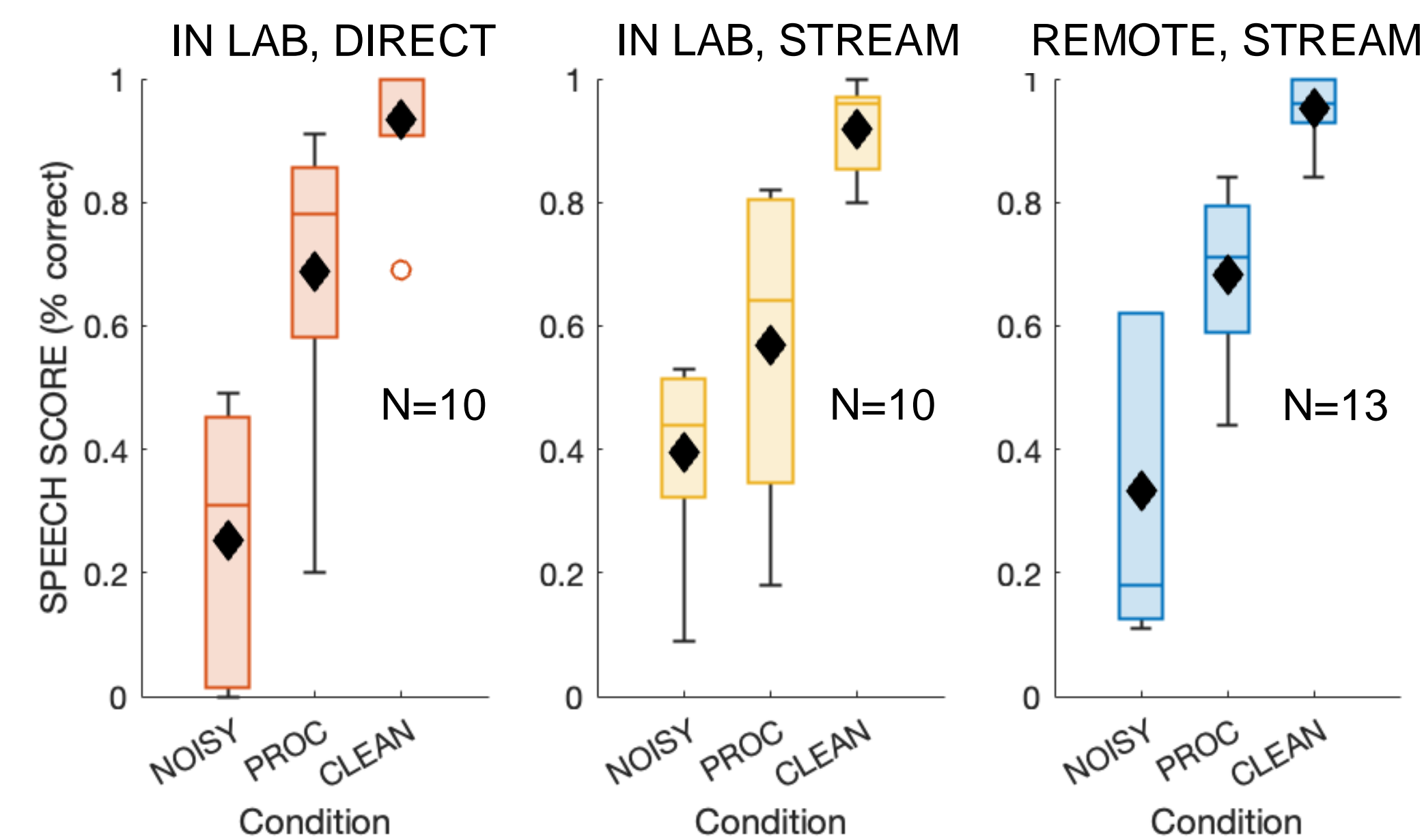
1) SIN: Sentences (N=10, N=13)

Response recordings were evaluated manually for keywords.

RM-ANOVA: Significant effect of Condition, but no Exp*Condition interaction was found ($p = 0.21$).

Similar group performances for all three experimental parts.

Average scores: 35%, 63%, 91% for NOISY, PROC, CLEAN.



2) DIN: Digits in Noise (N=16)

Similar range of performances to previous studies¹

Adaptive test for Speech Reception Threshold (SRT).

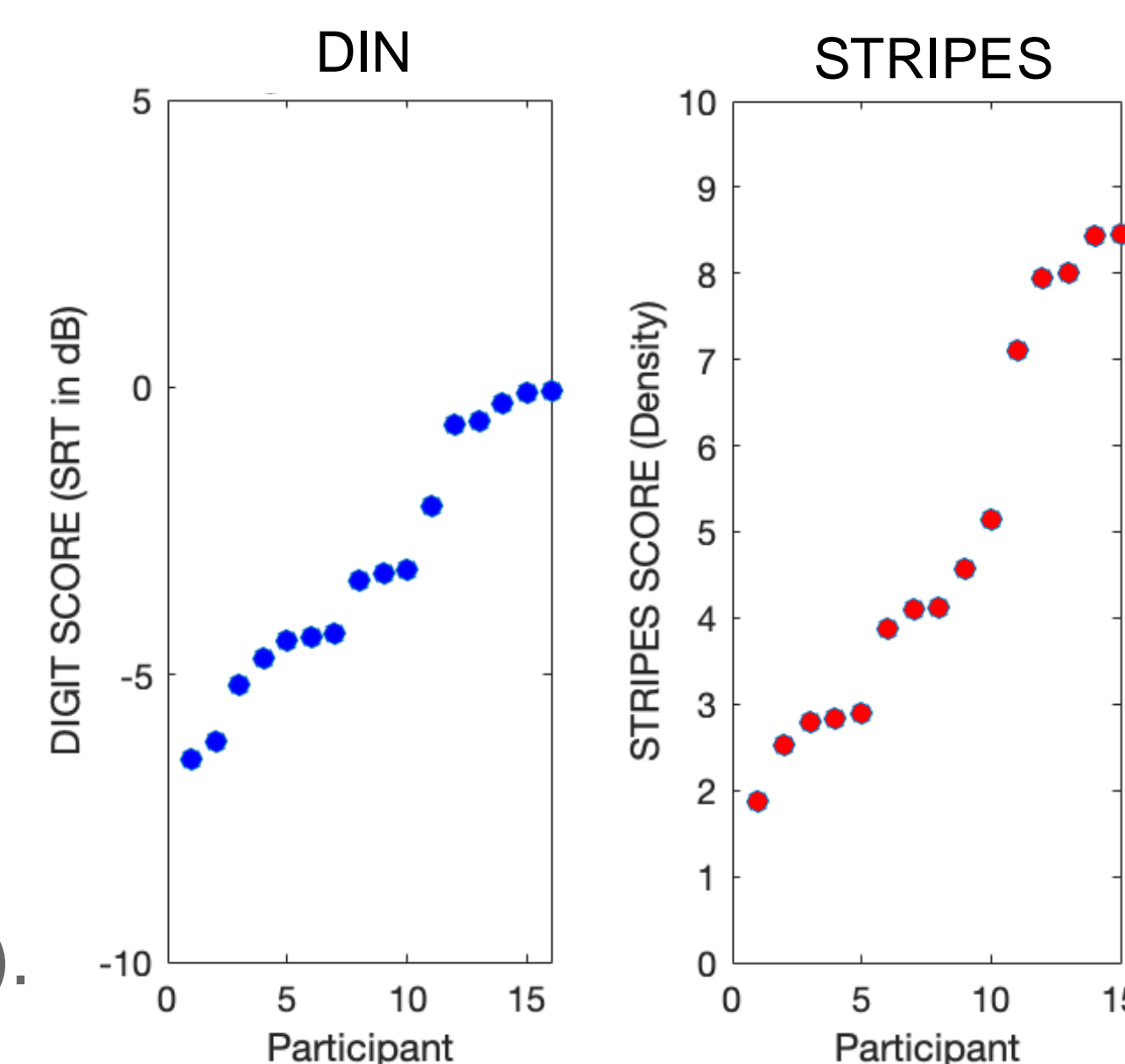
Details presented by Dang et al. (WCA2024, poster)

3) STRIPES (N=15)

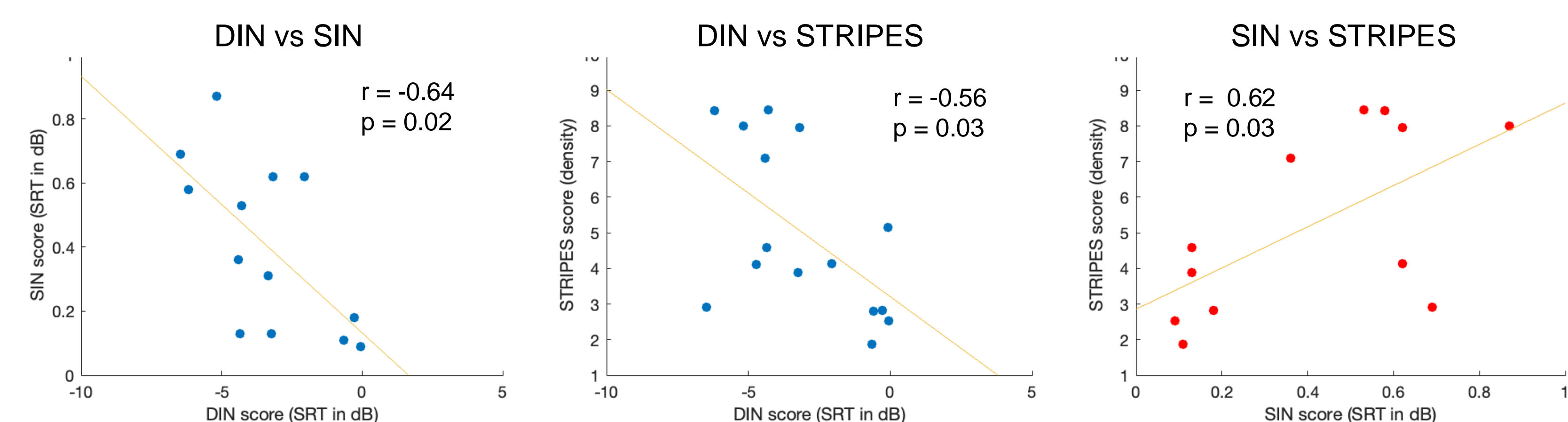
Similar range of performances to previous studies^{2,3}

Correlation to in-lab studies: $r = 0.91$, $r = 0.92$ (N=7).

Reliable MAD between runs: 0.99 density (max=1.15).



4) Correlations between the 3 listening tests (SIN scores for NOISY):



Survey results

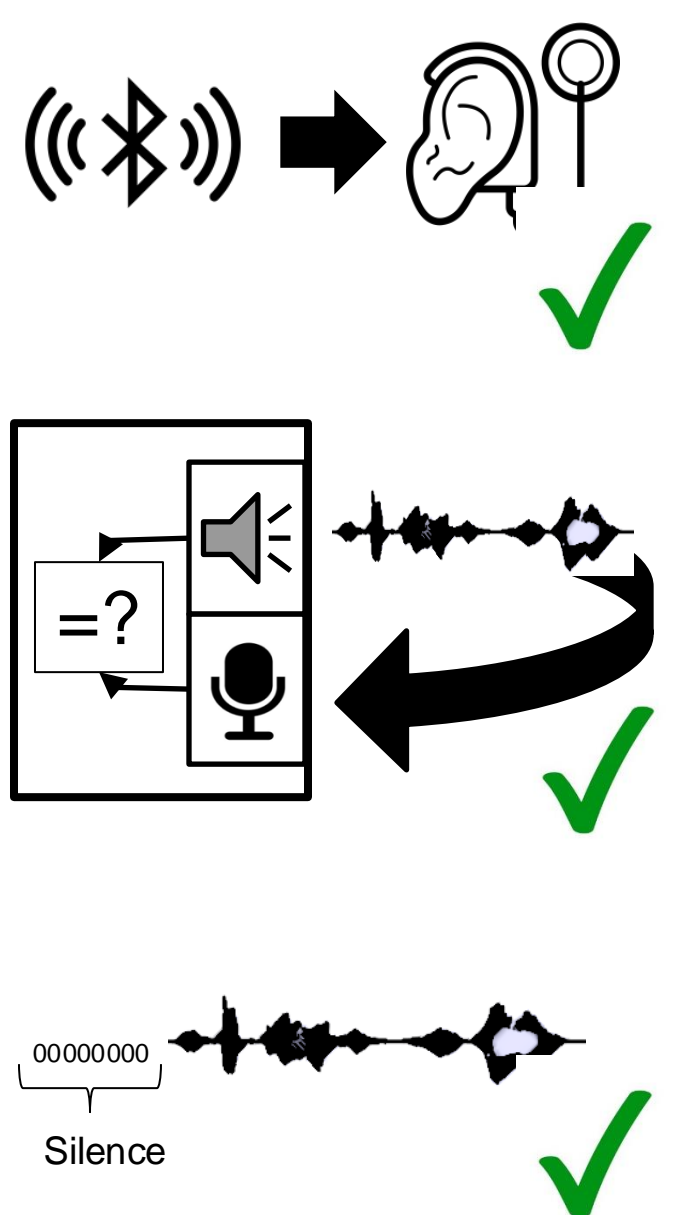
Questionnaire results: N = 16, MOS scale 1-7 (1-3: Bad, 5-7: Good)

Question topic	Response distribution	Mean score
Sign-up process	Bad: 3, Good: 13	5.3
User interface	Bad: 2, Good: 12.5	5.5
Technical setup	Bad: 5, Good: 11	4.8
Conn. & Mic. check	Bad: 2, Good: 13.5	5.5
"Happy to use again"	Bad: 6, Good: 10	4.8
"Prefer over in-person"	Bad: 4, Good: 5	4.0
"Prefer over clinics"	Bad: 8, Good: 5	3.7
Average score		5.0 of 7.0

- Technical issues occurred with Vocal response recordings for some devices
- Most participants positive about the sign-up process, user interface and technical setup with AUDITO, and 10/16 were happy to use it again
- 1/3 prefers in-person studies, 1/3 is neutral and 1/3 prefers AUDITO
- 1/3 of participants would prefer AUDITO also for clinical hearing checks

Conclusion

- AUDITO test system provided reliable and comparable results to in-lab testing with CI listeners.
- Sound presentation via streaming produced similar results as for direct connection using audio cable.
- Most participants positive about using AUDITO, while about 1/3 of CI listeners preferred in-person research.
- Technical difficulties affected some participants (for the vocal recordings), but overall good scores for usability.
- AUDITO update: Anonymous logins, text responses and improved experimental interface.
- AUDITO can now facilitate collaborative studies.



References:

- Wasmann et al (2024). *Ear and Hearing*.
- Archer-Boyd et al (2023). *JASA-EL*.
- Goehring et al (2020). *JARO*.

Acknowledgements:

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Want to use AUDITO in your CI research? Let us know!

