

Going wireless and booth-less for hearing testing in industry



Deanna Meinke, PhD

Jesse Norris, PhD

Odile Clavier, PhD

Brendan Flynn, PhD

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SAN DIEGO, CA

MAKING **SOUNDWAVES**

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www.hearingconservation.org



Introduction

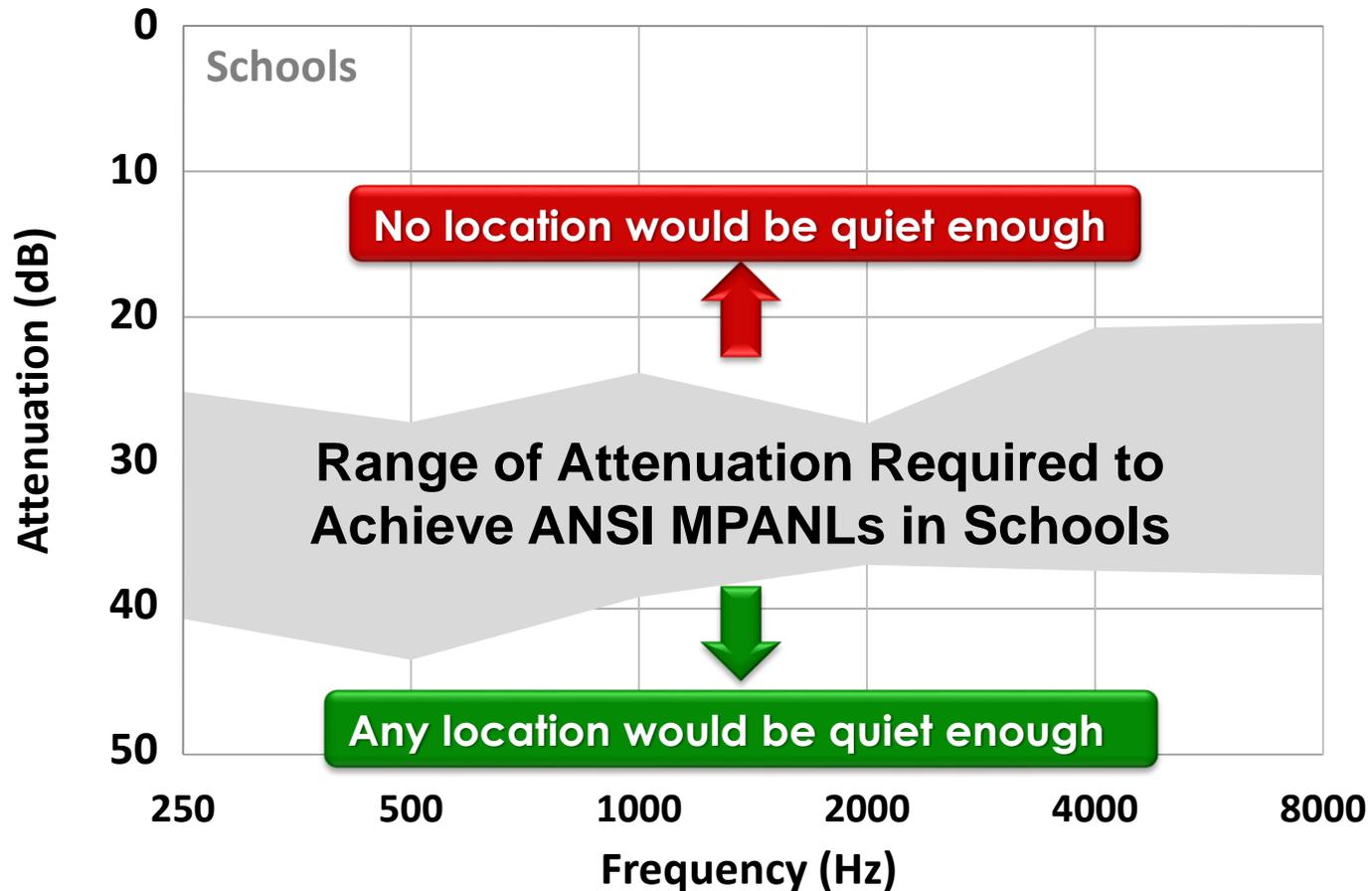
- New technologies offer opportunities to improve/expand our ability to provide audiometric testing services to workers.
- Traditional approaches are equipment and labor intensive.
- How can we bring audiometric monitoring for hearing conservation programs into the 21st century?



Headset Development

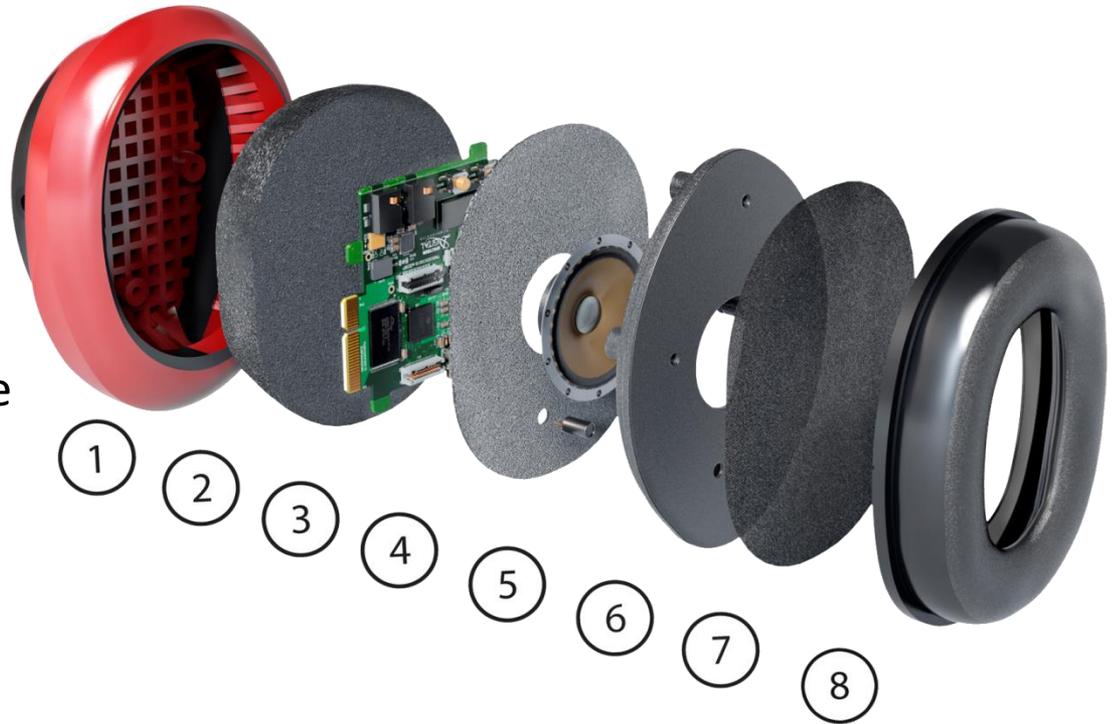
- Identified key features that could increase access to audiometric testing services:
 1. Attenuation,
 2. Validation against audiometry standards,
 3. Portability,
 4. Usability
- Tested prototypes
 - Bench top tests, sound chamber with acoustic test fixtures, and human subject testing (fit, attenuation, RetSPLs)
- Refined design for manufacturability
- Actively conducting human studies

Greater Attenuation Means Testing in More Locations



Integrated Microphones Measure Noise at the Ear

1. Deep earcup
2. Foam
3. Electronics
4. Speaker plate
5. Speaker and microphone
6. Grill
7. Fabric cover
8. Earseal and spacer



Designed for mobile platforms to enable portability



**Easily administer hearing
exams on a tablet**



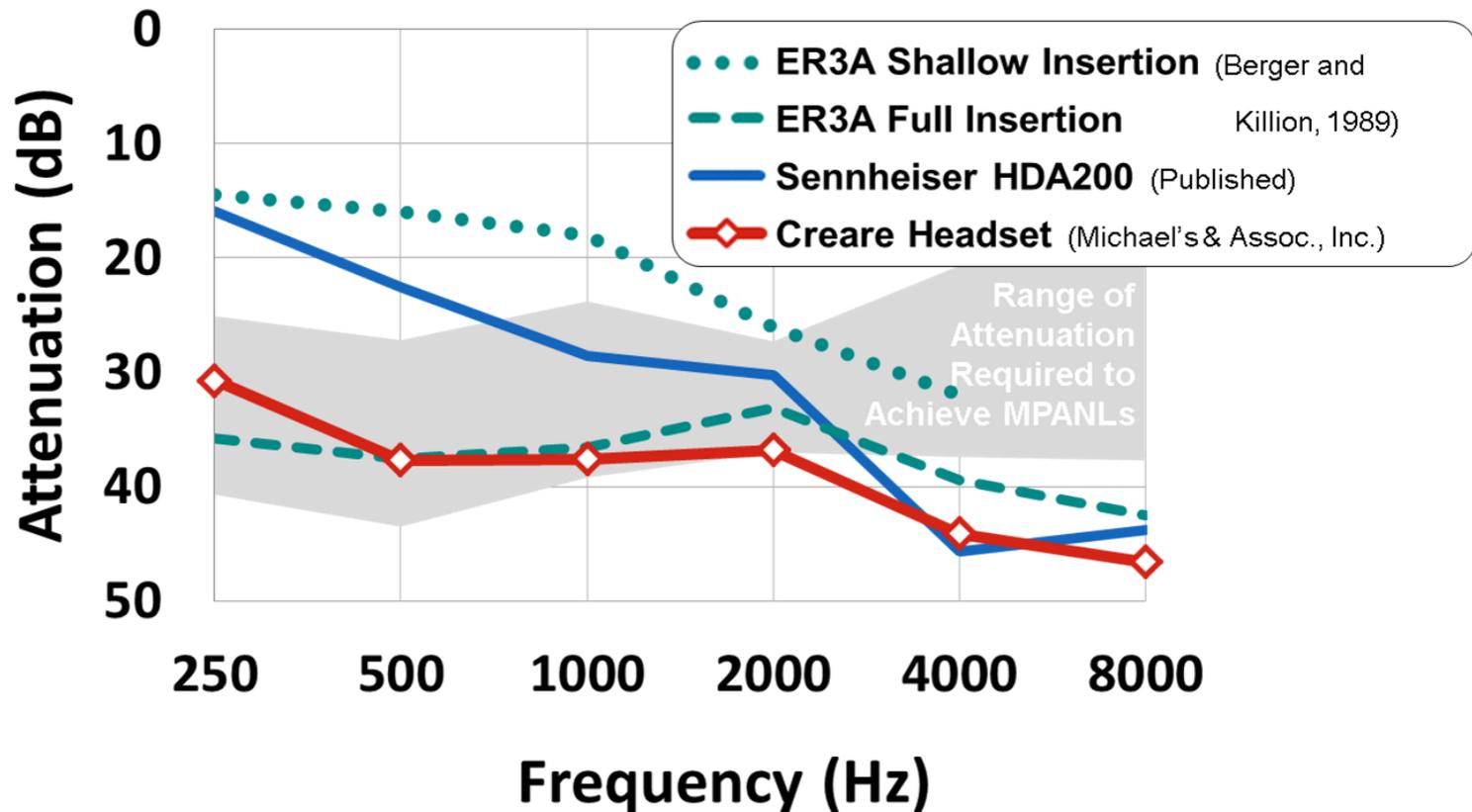
**Gather data from
multiple sites**



**Track in database or use
printouts**

Preliminary Studies

- Attenuation (ANSI S12.6-2008 Method A)



- Ref. Equivalent Sound Pressure Levels (ISO 389)
 - Performed by collaborators at House Clinic

Study Aims

- To assess the test/retest variability of the device when testing industrial workers at a worksite as compared to automated hearing thresholds obtained in a mobile van test setting.
- To subjectively assess the usability of the Creare headset automated hearing testing device by adults who do not routinely deliver hearing tests in the course of their work (EH&S, HR, Management personnel)



Study Design

- **Participants:** 20 pairs of listeners (workers) and untrained testers (EH&S/Administrative staff) recruited from a large local craft brewery.
- **Test/Retest of Creare Headset:** 2 sequential tests with headset removed and replaced between each hearing test.
 - 500 Hz
 - 1000 Hz
 - 2000 Hz
 - 3000 Hz
 - 4000 Hz
 - 6000 Hz
 - 8000 Hz



Study Design

- **Benchmark Test:** Mobile trailer audiometry conducted with Benson CCA-200m audiometer (TDH 39 earphones) with in-line sound level meter monitoring for OSHA compliance. Single-walled test booth.



Study Design

- **Test Operators:** No experience in hearing testing. Testers only followed on-screen instructions from iPad. Listener was allowed to adjust headset without removing (no instructions given).



Test Environments

- **Rooms at Plant:** 6 rooms were utilized at the brewery site for the Creare headset testing. The rooms were selected by the EH&S staff with regard to available plant space that could be used for hearing tests if on-site testing were feasible.
- **Ambient Noise Levels:** octave-band sound pressure levels were measured during each hearing test with Quest 2900 SLM with OB-300 filter set.



BLUE Room



Drilling for water on Indian land

Kin bottling in basement
122 Frey Ave. 1991

...

GREEN Room





BAMBOO Room

CONCRETE Room



BROWN Room



SECURITY TRAILER











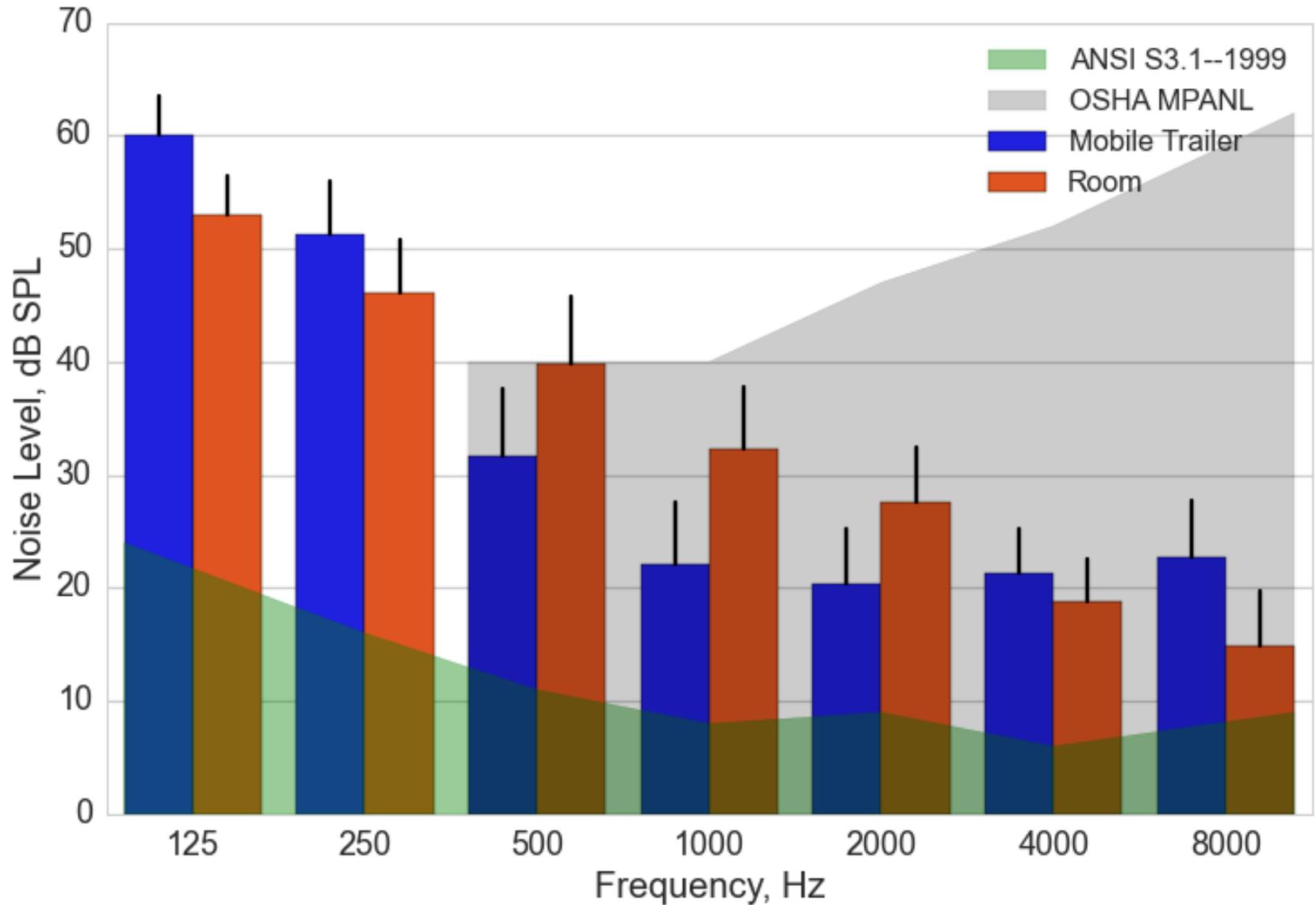
E VINE ST

DO NOT STOP ON TRACKS

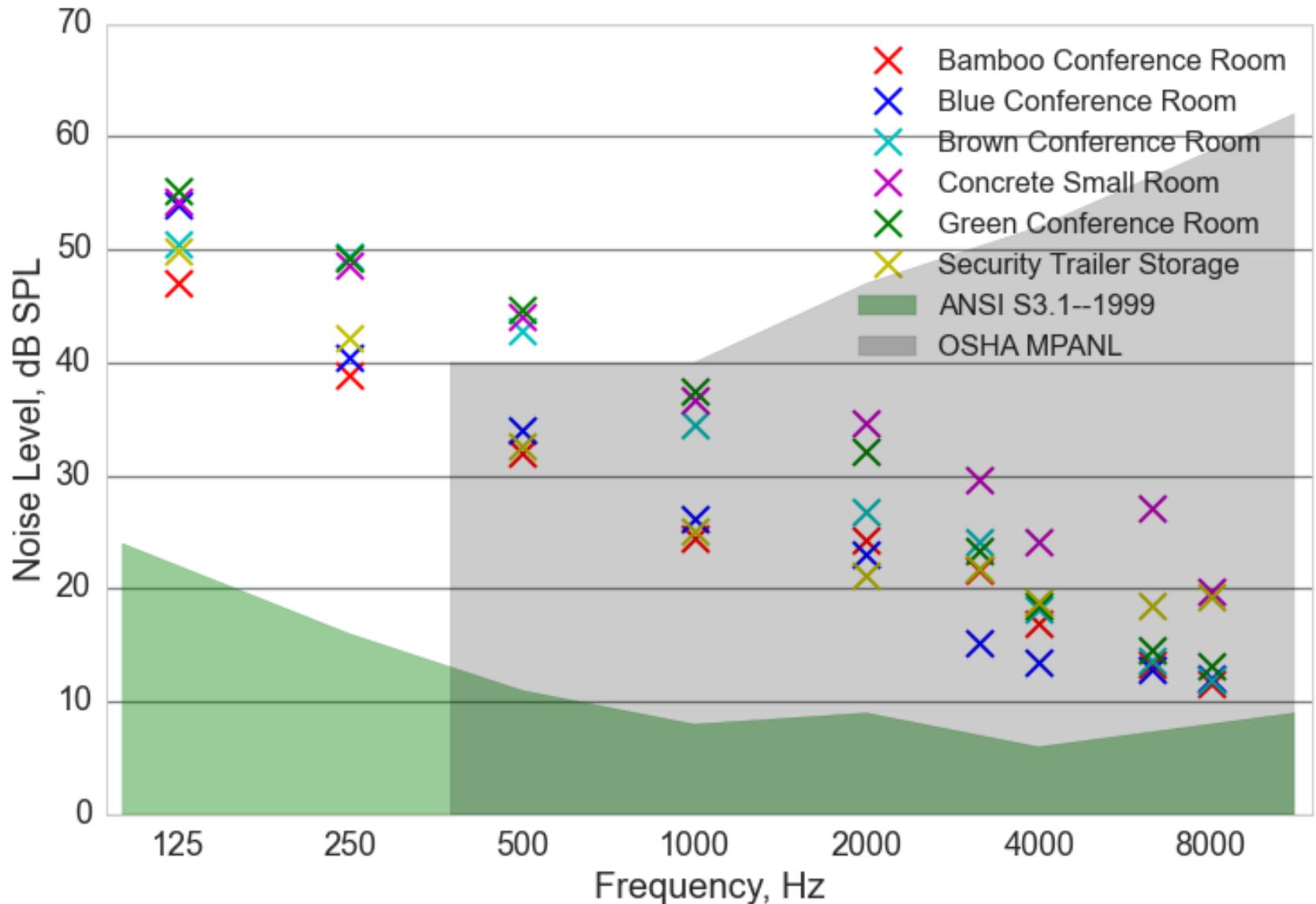
STOP

RAILROAD CROSSING

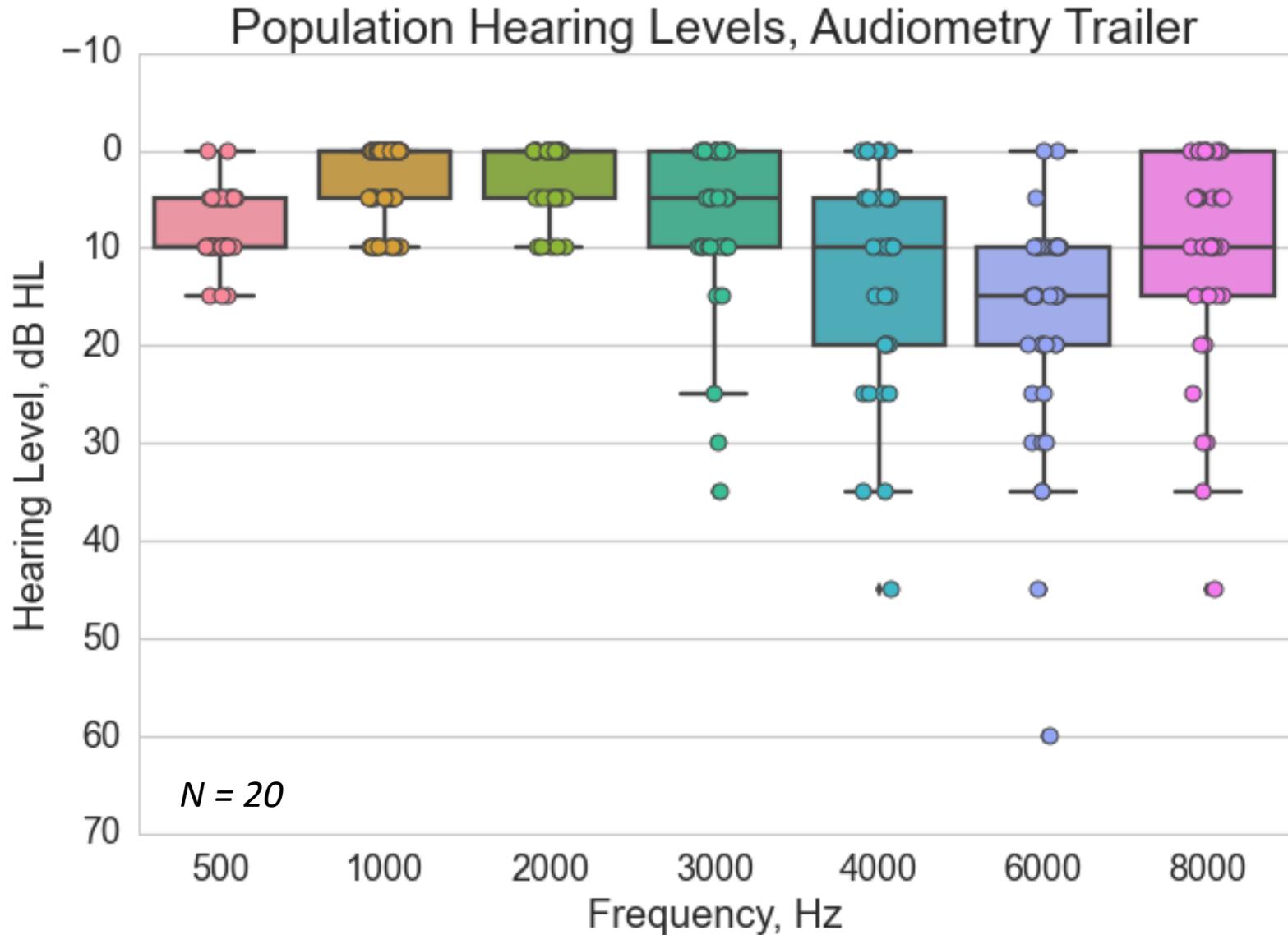
Ambient Noise Measurements



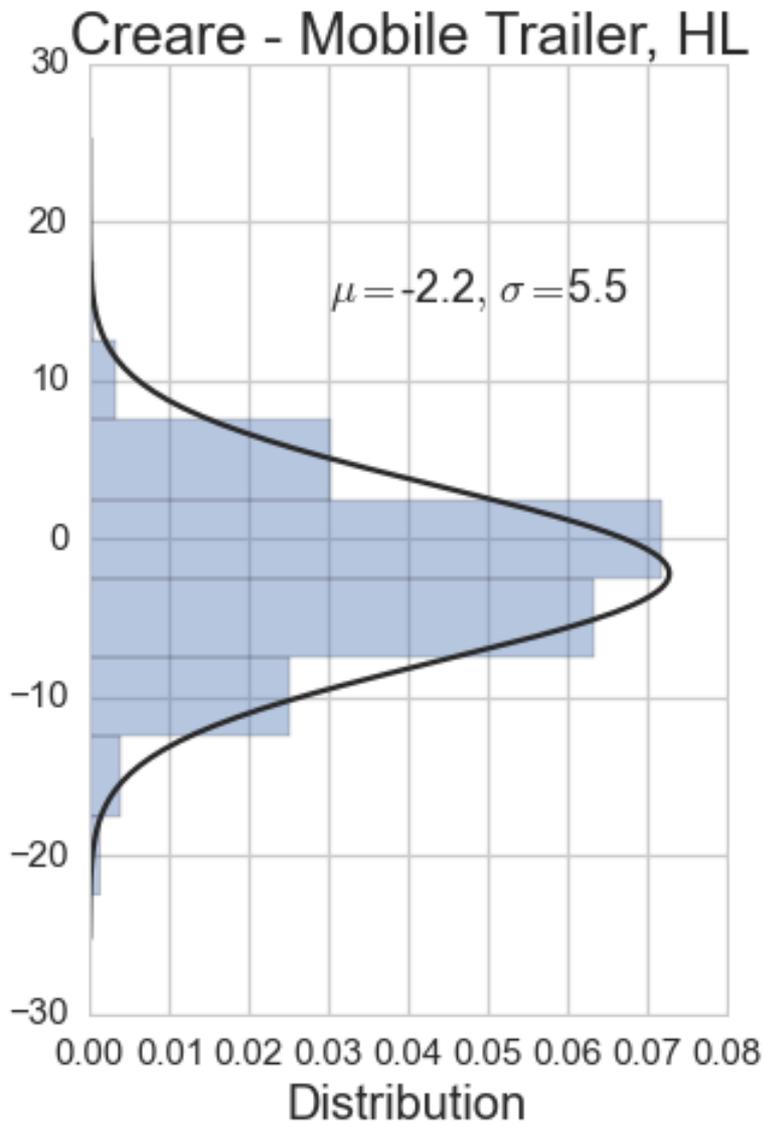
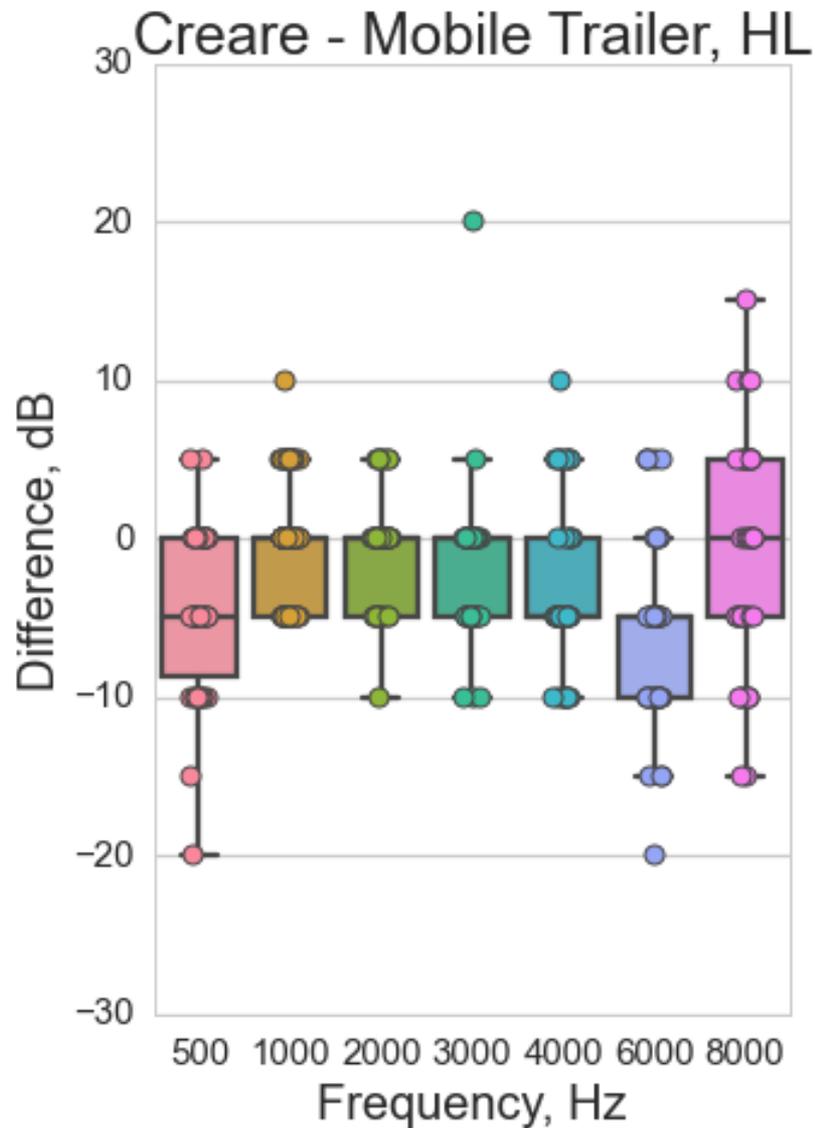
Room Noise Levels



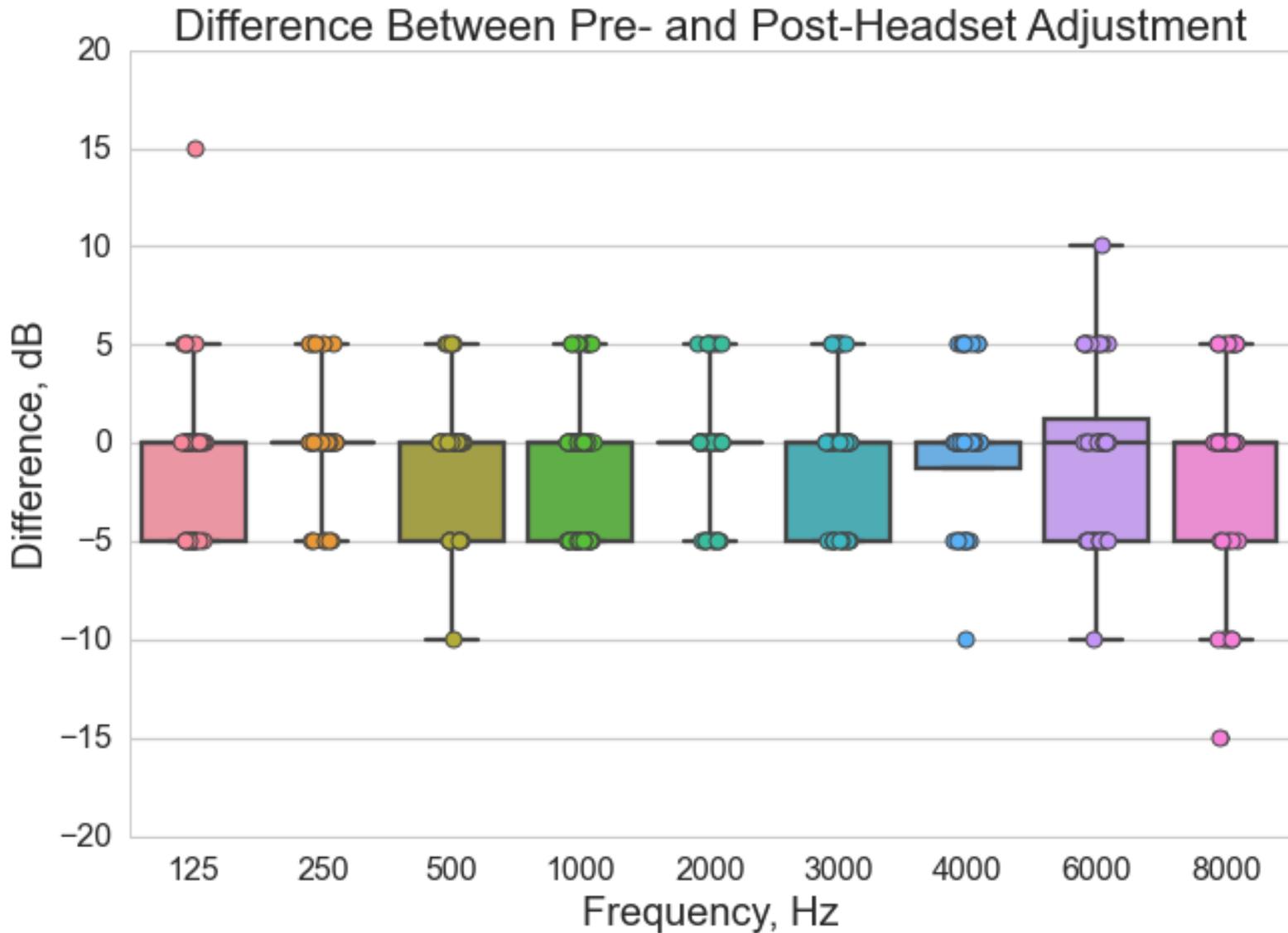
Subject Population



Comparison Between Systems

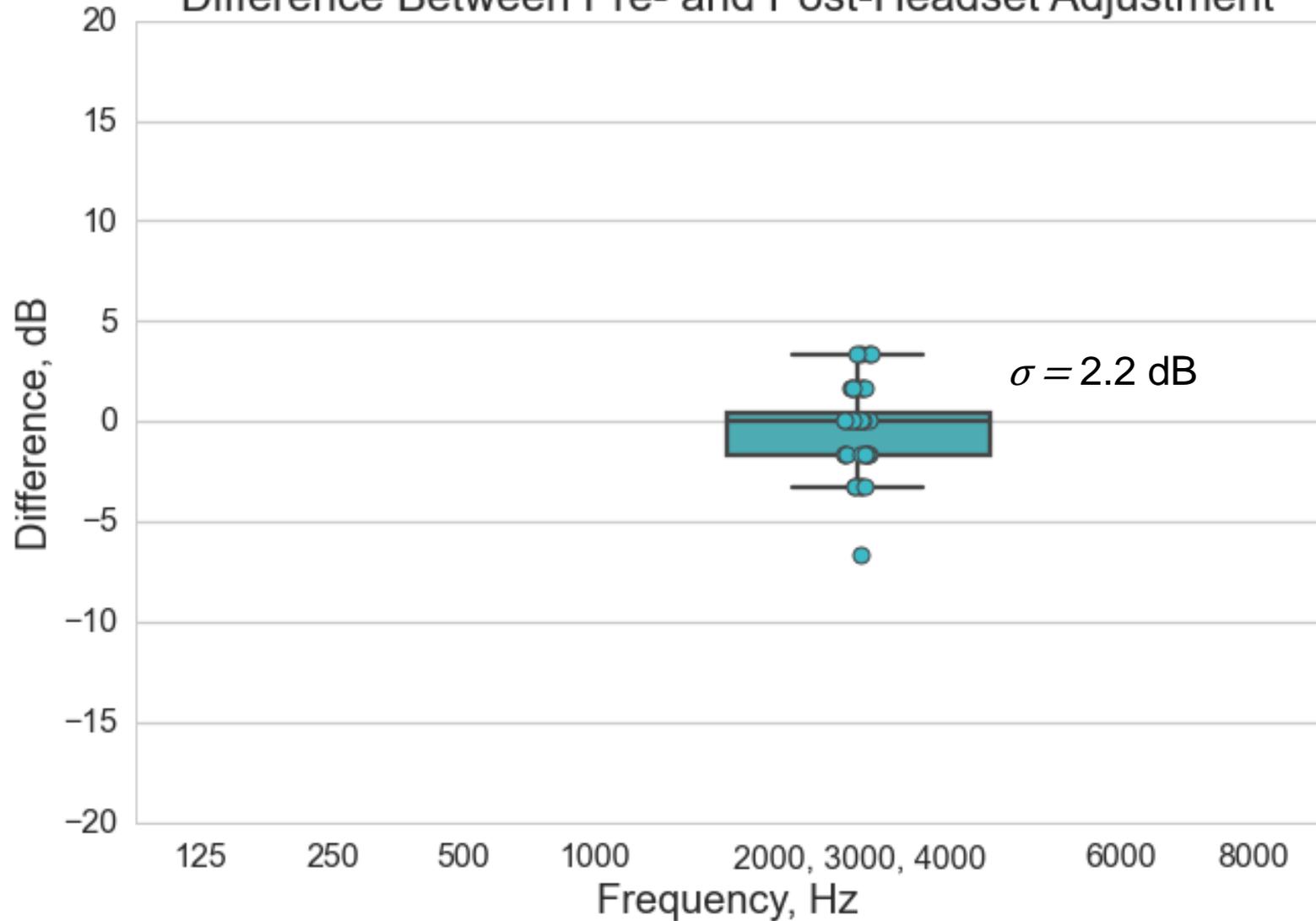


Repeatability

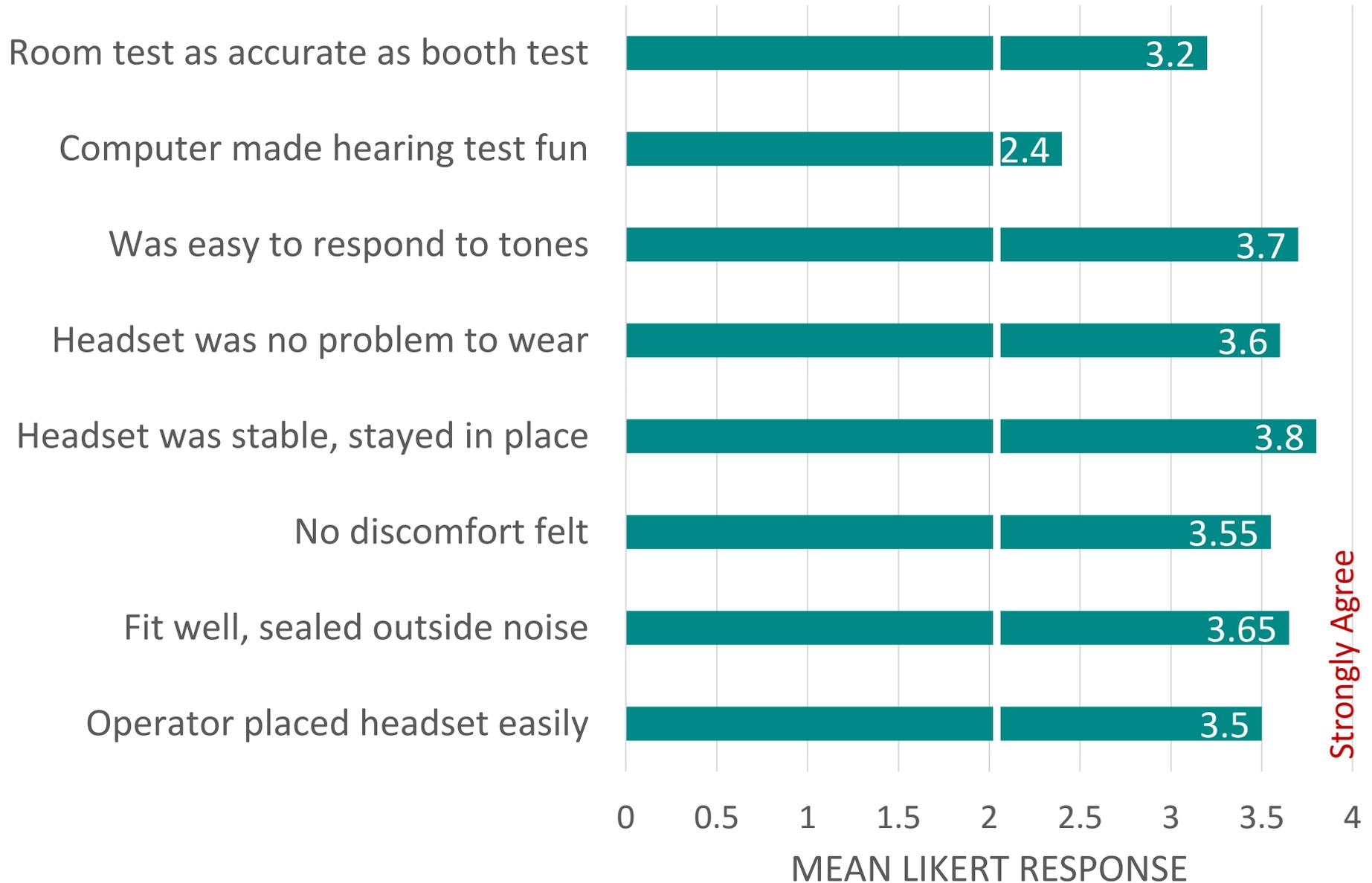


Repeatability: 2-4 kHz

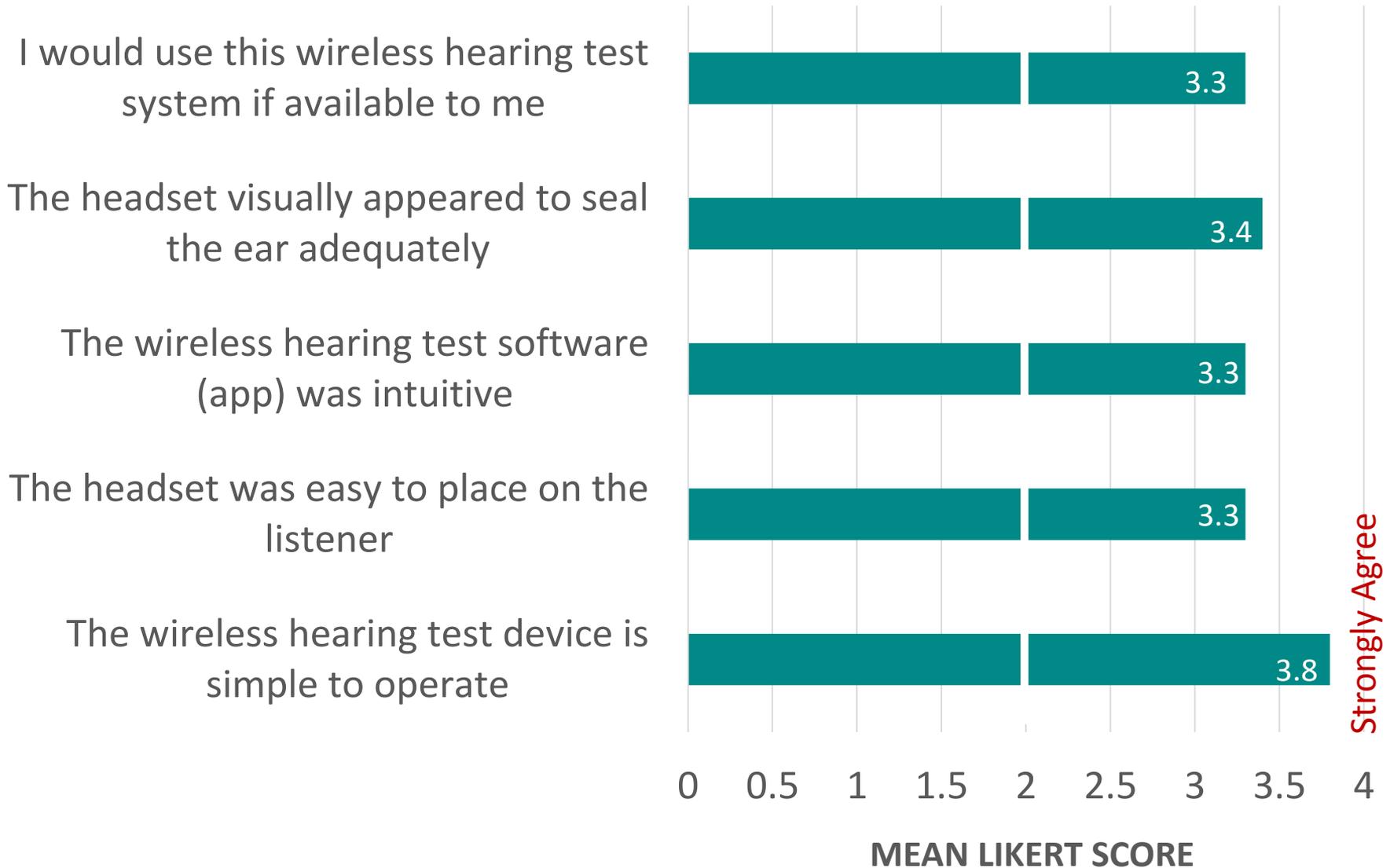
Difference Between Pre- and Post-Headset Adjustment



Listener Survey



Operator Survey



Conclusions

- This innovative noise attenuating wireless headset is reliable, and results are comparable to other audiometric earphones or headphones used for audiometric monitoring in the occupational setting.
- The noise attenuating wireless headset enables valid hearing threshold measurement outside of a sound booth in an industrial work environment.
- The noise attenuating wireless headset is easily operated and well received by both untrained testers and hearing test takers.

Acknowledgements



Dania Fiorito

UNC Research Assistant



Create Engineering

Crew

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Attenuation

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