



Evaluation of Radioear DD450 Earphone

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Introduction

We compared the performance of two circumaural earphones, the Sennheiser HDA 200, which has been used in audiometry for many years and is no longer manufactured, and the Radioear DD450 which is designed to replicate the characteristics of the HDA 200. Reference equivalent threshold sound pressure levels (RETSPLs) for the HDA 200 earphone are published in American and international audiometer standards (ANSI S3.6-2010 and ISO 389-8-2004). Audiometric thresholds of normal-hearing adults were measured with both earphones and corrected RETSPLs were derived for the DD450. Ambient noise attenuation was measured so that Maximum Permissible Ambient Noise Levels could be calculated and the need for a sound booth could be examined. Occlusion effect was measured to determine the potential effect of the earphone on bone-conduction thresholds.

Methods



HDA 200



DD450

Subjects:

- 10 normal-hearing adults were tested with HDA 200 and DD450 earphones
- Inclusion Criteria:
 - Pure-tone thresholds within normal limits (octave and inter-octave frequencies 125 Hz to 16000 Hz)
 - No known otologic disorders
 - Normal tympanogram
 - Age 24-32 Yrs

Procedures:

Psychoacoustic Determination of RETSPLs:

- Subjects were tested with one HDA 200 headset (two earphones) and two DD450 headsets (four earphones)
- Manual pure-tone thresholds for octave and inter-octave frequencies (125 – 8000 Hz) and six extended high frequencies (9 – 16 kHz)
- Hughson Westlake procedure
- AudioStar Audiometer
- All earphones calibrated to standard HDA 200 RETSPLs

Ambient Noise Attenuation:

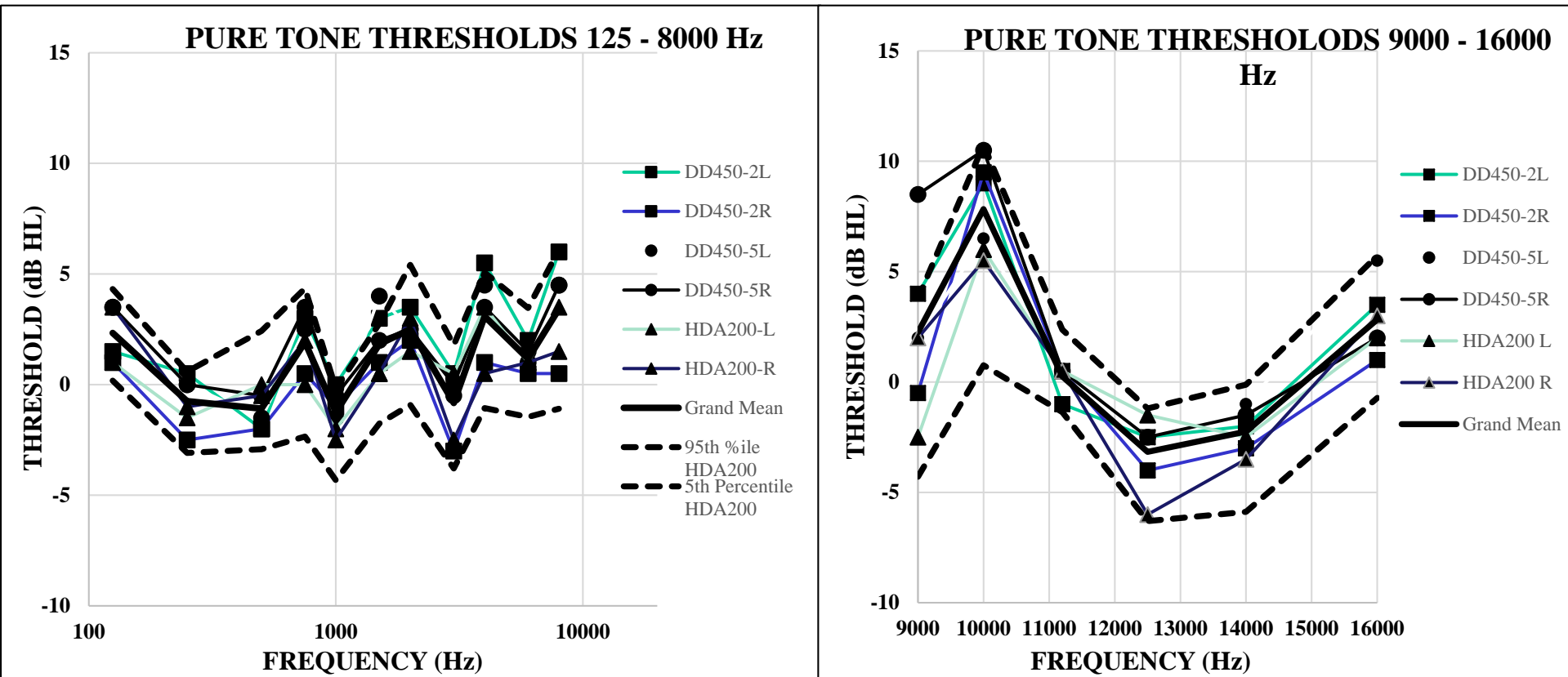
- Subjects were tested with one HDA 200 earphone and two DD450 earphones.
- Stimulus: pink noise (approx. 75-dB SPL) presented by Audioscan Verifit external speaker, with subject seated approx. 1.5 feet from speaker with test ear facing the speaker.
- Probe microphone measurements were made in the ear canal with ear unoccluded and occluded with each earphone. Attenuation = difference between unoccluded and occluded conditions.

Occlusion Effect:

- Subjects were tested with one HDA 200 earphone and two DD450 earphones.
- Stimulus: Uncalibrated sweep-frequency pure-tone (~50 dB HL) produced by Audioscan Verifit presented via Radioear B-81 bone vibrator placed on the mastoid. Probe microphone measurements were made in the ear canal contralateral to the bone vibrator with the test ear unoccluded and occluded with each earphone. Occlusion effect = difference between unoccluded and occluded conditions.

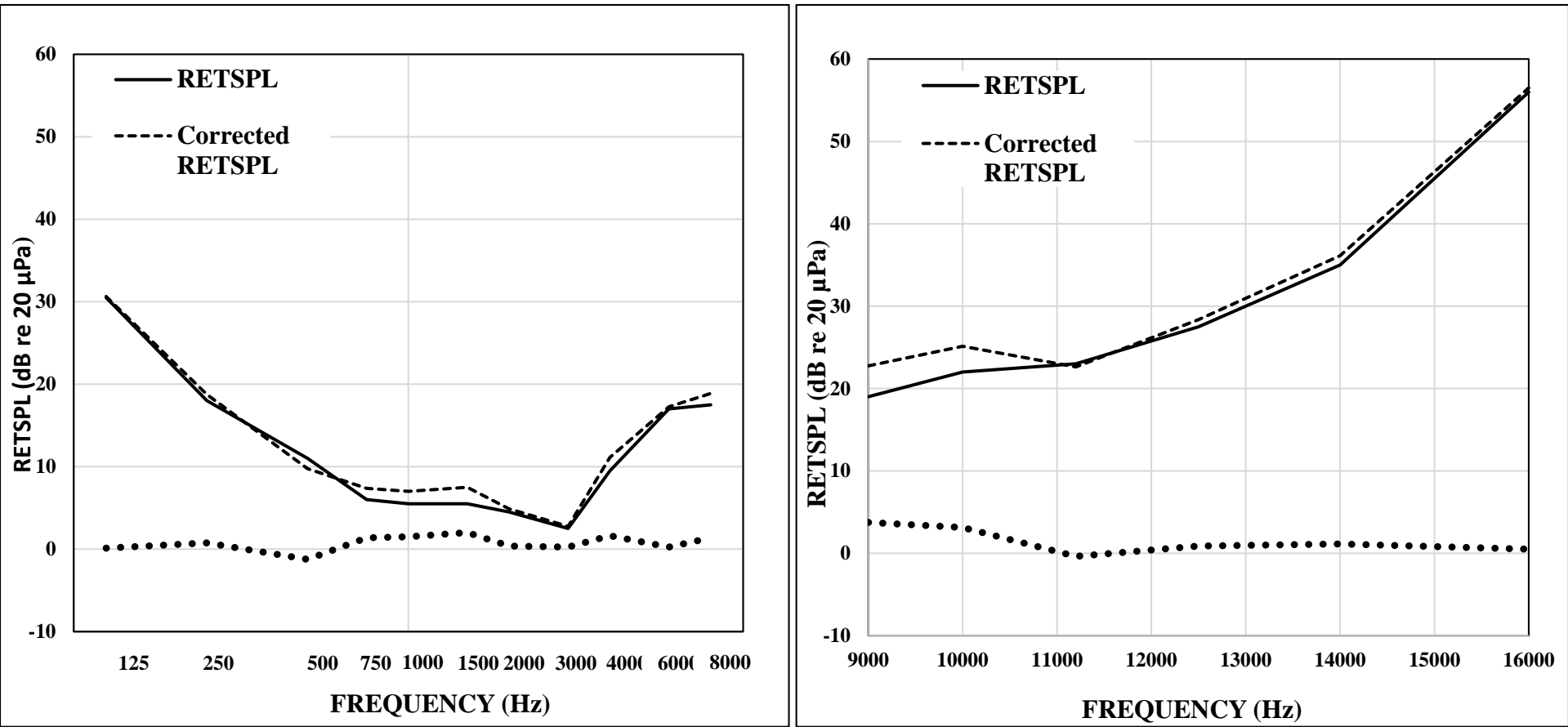
Results

Thresholds



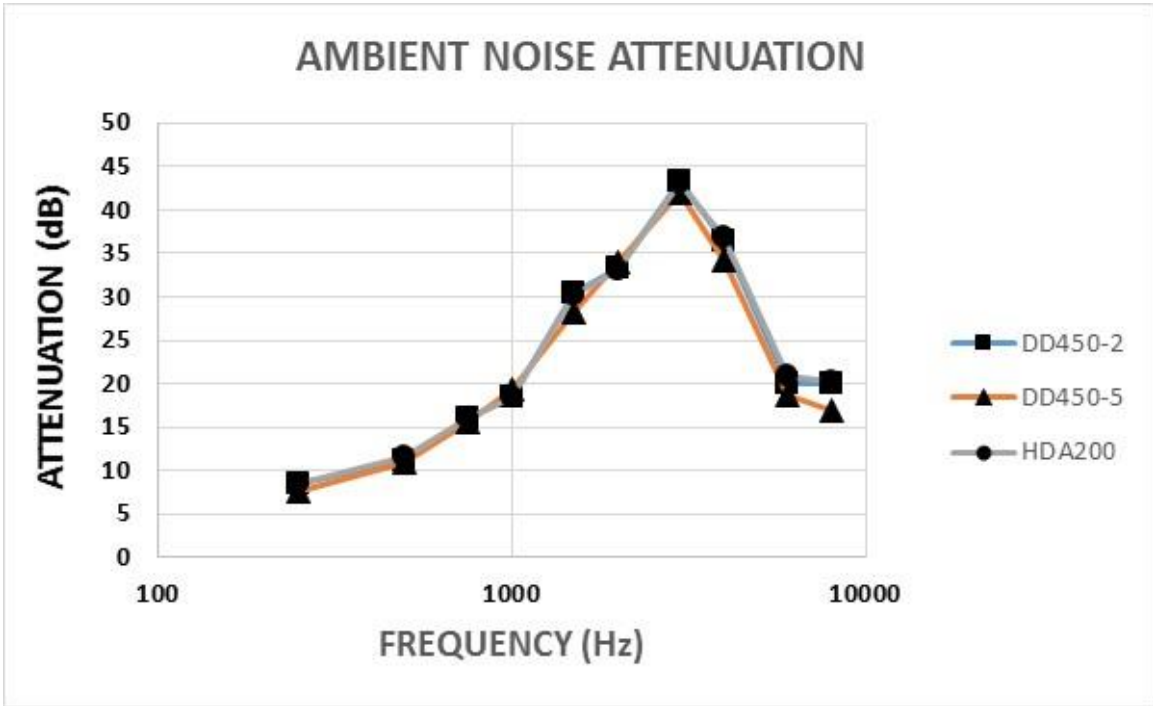
- Mean thresholds for all DD450 earphones were within the 90% confidence interval (dashed lines) of the HDA 200 threshold measurements, with the exception of a few outliers which fell just outside the confidence interval.
- Mean thresholds are close to 0-dB HL except at 10 kHz, indicating that RETSPLs closely approximate normal thresholds.

RETSPLs



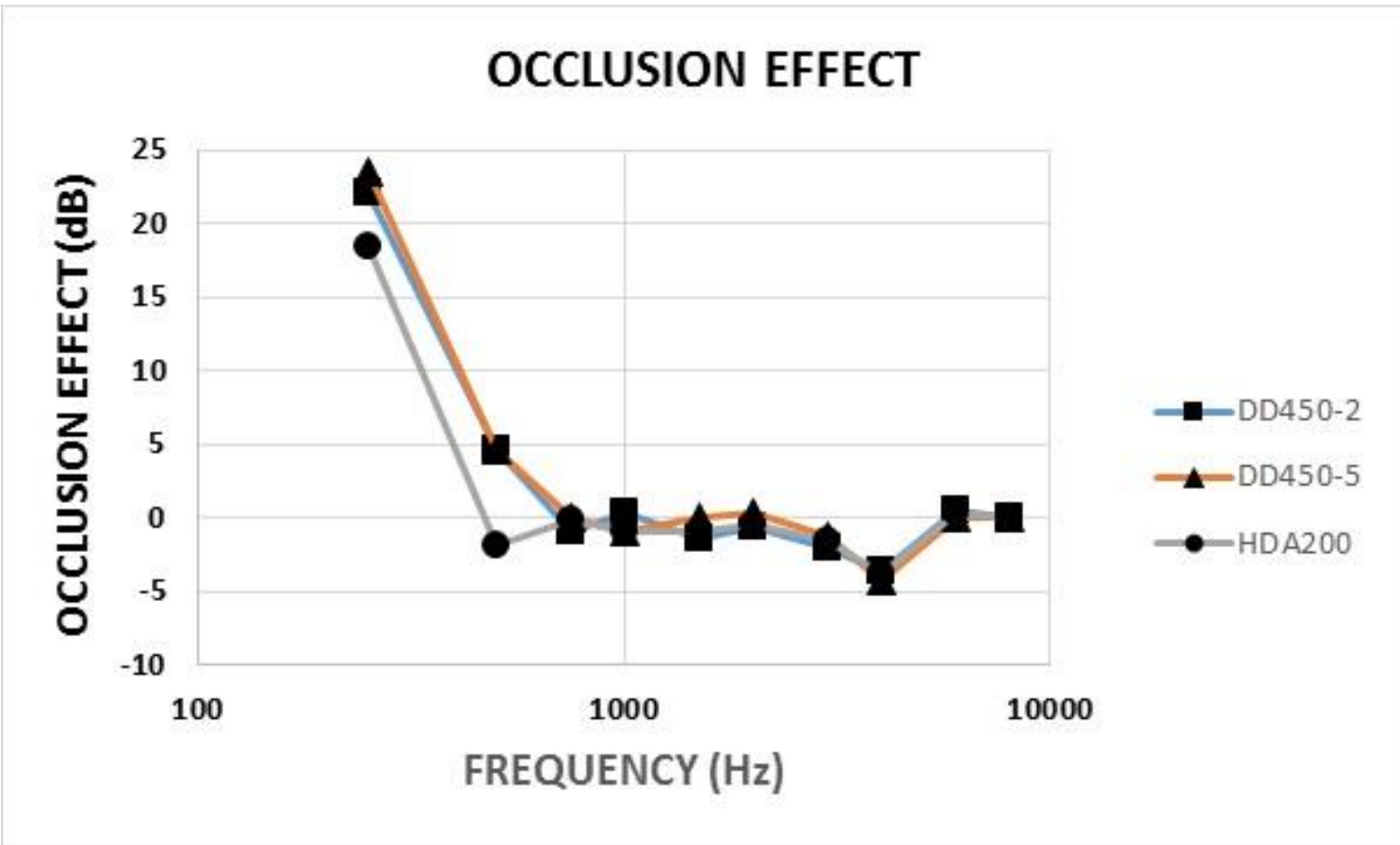
- RETSPLs for the HDA 200 (solid line), and corrected RETSPLs for the DD450 (dashed line) are similar. Differences (dotted lines) are substantially smaller than standard deviations associated with threshold measurements and do not warrant modifying the RETSPLs for the DD450.

Ambient Noise Attenuation



- Ambient noise attenuation is almost identical for the two earphones.

Occlusion Effect



- Occlusion effects for the two earphones were nearly identical from 750-8000 Hz.
- At 250 and 500 Hz, the occlusion effect was about 5 dB higher for the DD450 earphone compared to the HDA 200.

Discussion, and Conclusions

- **Thresholds:** Mean thresholds for the DD450 earphone fell within the 90% confidence interval of HDA 200 measurements, and were close to 0 dB HL, indicating that the current RETSPLs accurately estimate normal thresholds (except at 10 kHz).
 - **RETSPLs:** Differences between corrected RETSPL values for the DD450 earphone and the current HDA 200 RETSPLs were so minimal that updating the RETSPLs for the DD450 is not warranted. The same RETSPL values can be used to calibrate both earphones for audiometric testing.
 - **Ambient noise attenuation:** Ambient noise attenuation measurements for the two earphones were nearly identical, indicating that the DD450 provides the same amount of benefit in testing environments with background noise. Published Maximum Permissible Ambient Noise Levels for the HDA 200 earphone (Margolis & Madsen, 2015) are applicable to the DD450 earphone.
 - **Occlusion effect:** For mid to high frequencies (750 – 8000 Hz), the occlusion effect was negligible for both earphones. The DD450 earphone produced slightly higher occlusion effects at lower frequencies. The DD450 may produce small air-bone gaps at 500 Hz in listeners with normal middle ear function, when testing with both ears covered by the earphones.
- Conclusion:**
The DD450 earphone has very similar characteristics to the HDA 200. No clinically important differences are expected in test results obtained with the two earphones.

References

- ANSI S3.6-2010. Specification for audiometers. New York: American National Standards Institute.
- ISO 389-8-2004. Acoustics. Reference zero for the calibration of audiometric equipment. Part 8: Reference equivalent threshold sound pressure levels for pure tones and circumaural earphones. Geneva: International Organization for Standardization.
- Margolis, R.H., Madsen, B. Acoustic Environment for Hearing Testing. *J. Amer. Acad. Audiol.*, 26,784-791, 2015.

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