



In-Situ Electroacoustic Data Drives Accurate, Efficient Hearing Aid Fittings

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INTRODUCTION

Achieving accurate hearing aid fittings requires consideration of individual ear canal acoustics and coupling effects. Traditional first-fit algorithms rely on average models which may result in large deviations from prescriptive targets. An individualized acoustic model can reduce these deviations by updating the fitting software's acoustic model using in-situ electroacoustic measurements collected during feedback canceller initialization and applying an individualized correction.

This study aims to evaluate the performance of the updated individualized acoustic model feature, which incorporates broader acoustic coupling parameters than its predecessor, 1) using simulations on a Head and Torso Simulator (HATS) and 2) using real-ear aided response (REAR) measurements and in-situ audiometry on a group of hearing aid users.

METHODS

Laboratory Evaluation

- A HATS was fitted with Starkey Omega AI receiver-in-canal (RIC) hearing aids programmed using a flat 40 audiogram.
- HATS avoids potential measurement errors that may occur with REAR due to improper placement or excessive constriction of the probe tube^{1,2}.
- The International Speech Test Signal (ISTS) was played at 65 dB SPL via a loudspeaker placed 1m from the center of HATS.
- First-Fit accuracy was assessed with and without the updated acoustic model optimization (AMO 2.0) feature using both mismatched and matched acoustic conditions by assessing deviations between target and measured REARs. The mismatched condition simulated discrepancies between the acoustic option as worn on-ear and the acoustic option selected in the fitting software.

Clinical Evaluation

- 54 participants tested with Omega AI (AMO 2.0) and 53 participants tested with Edge AI (AMO 1.0) using either RIC or custom devices.
- Hearing thresholds were measured in-situ as well as with ER-3A insert earphones.
- Absolute deviations between in-situ and insert earphone thresholds were calculated.
- REAR measurements were collected with RIC or custom devices using an Audioscan Verifit 2 in 62 participants fitted with Omega AI and in 48 participants fitted with Edge AI, and median deviation of REARs from e-STAT 2.0 targets were calculated at third-octave frequencies (.25 – 6.3 kHz).

RESULTS

Individualized Acoustic Models Correct for Deviations

Omega AI RIC RT hearing aids coupled to occluded domes were fitted in an artificial ear on HATS (Figure 1). Results in Figure 2 indicate 1) the open dome mismatched condition shows large deviations without AMO 2.0, which is corrected with AMO 2.0. 2) The no-vent mold mismatched condition is within 5 dB of target without AMO 2.0, which might have been due to the occluded dome providing more occlusion in HATS than is realized in human ears; therefore, the improvement seen with AMO 2.0 is minimal. 3) The matched occluded dome condition shows improved accuracy when using AMO 2.0, especially from 250-1000 Hz.

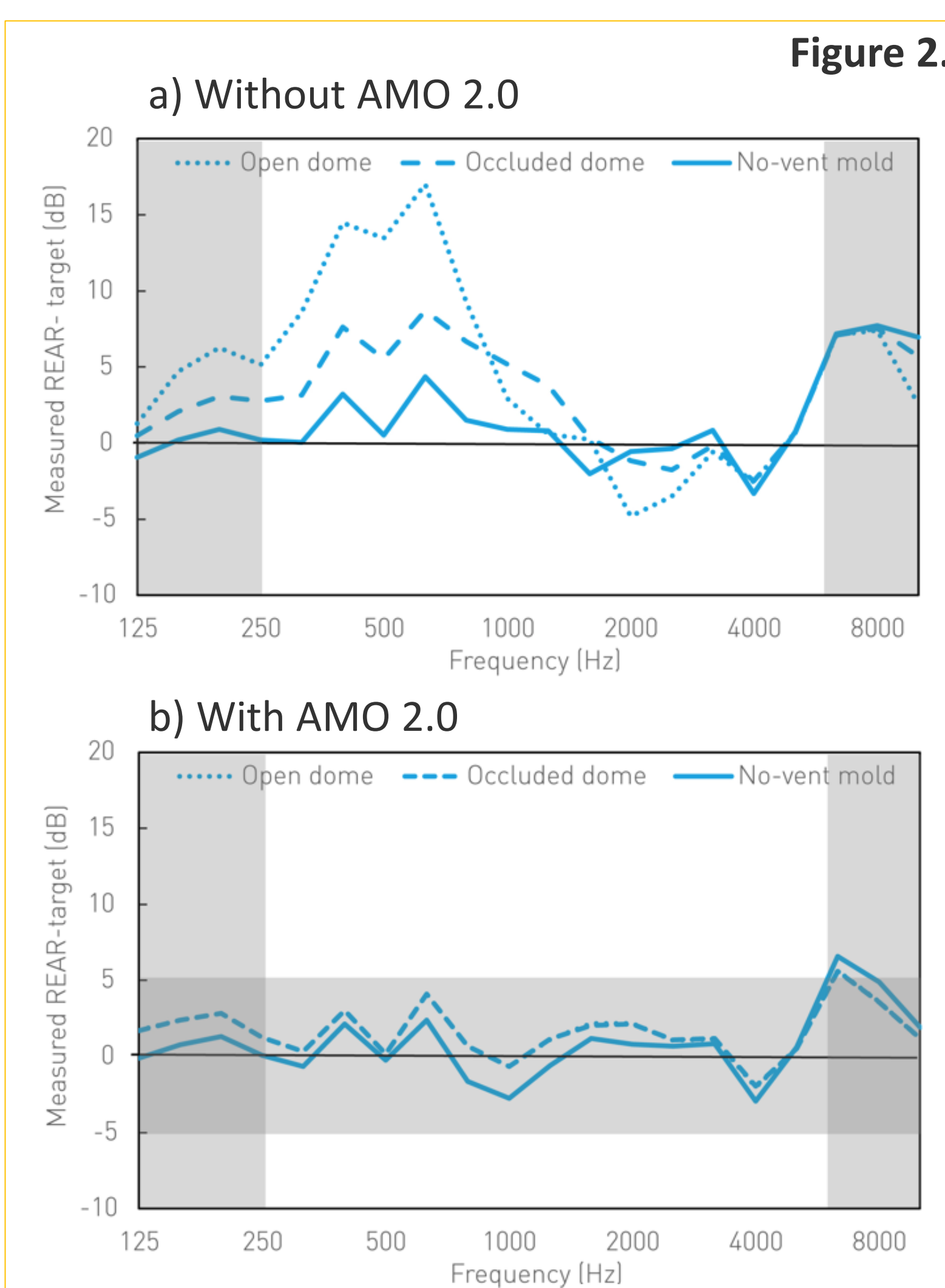


Figure 2.

Figure 1. HATS model used for this study (GRAS KEMAR 45BB) wearing an Omega AI RIC hearing aid

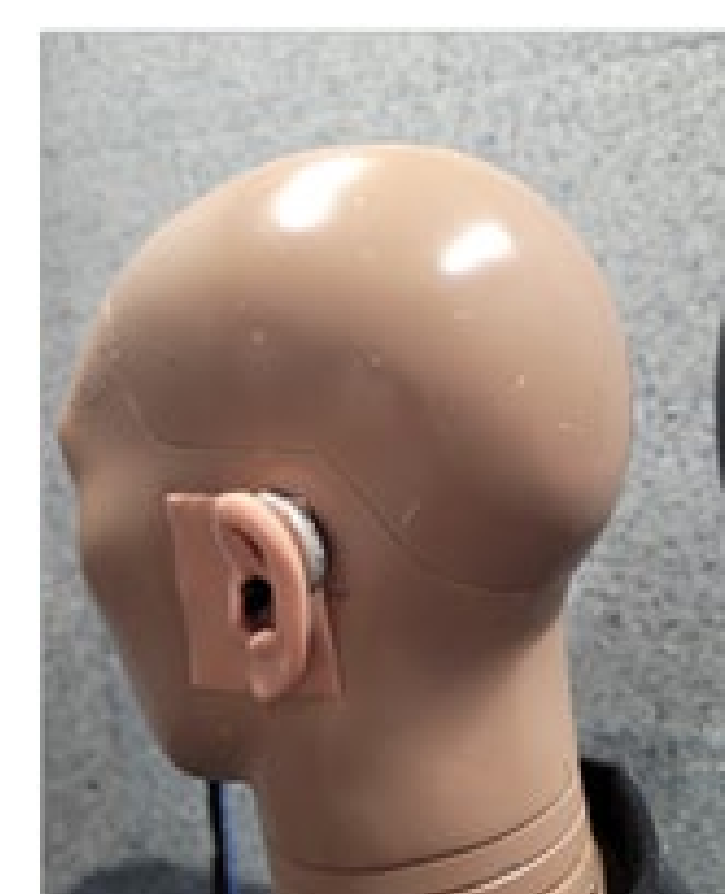


Figure 2. Individualized Acoustic Models Improve REAR Fit to Target when Deviations are Detected. Differences between e-STAT 2.0 targets and first fit REARs by frequency without AMO 2.0 (a) and with AMO 2.0 (b). The occluded dome (dashed line) condition indicates a matched condition between the coupling worn on-ear and the acoustic option selected in Pro Fit. The open dome (dotted line) and no-vent mold (solid line) conditions indicated a mismatch between coupling worn on-ear (occluded) and acoustic option selected in Pro Fit.

In-Situ Audiometry Accuracy is Improved with AMO 2.0

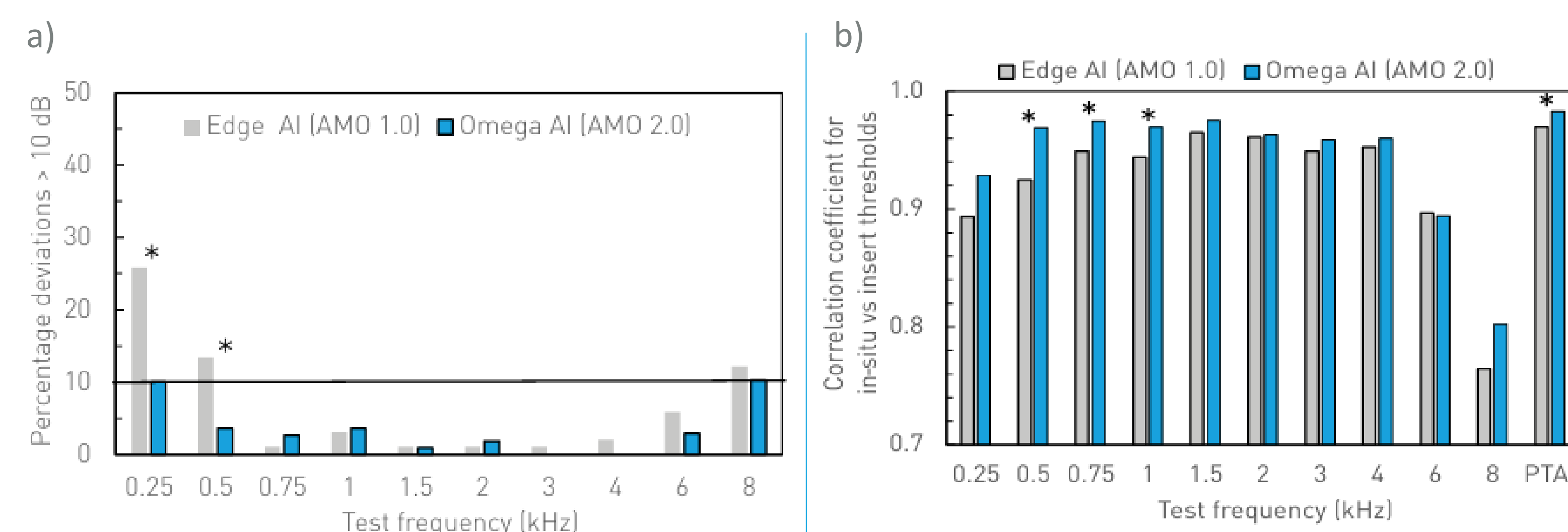


Figure 3. AMO 2.0 results in significantly fewer instances where in-situ/insert earphone audiometry deviate by >10dB at 250 and 500 Hz (a) and results in significantly higher correlation coefficients from 500-1000 Hz (b) compared to AMO 1.0. Asterisks indicate statistically significant differences (p < 0.05).

RESULTS (CONT.)

REAR Accuracy is Improved with AMO 2.0

Figure 4. AMO 2.0 is significantly more accurate vs. AMO 1.0 from 4-5 kHz, and median differences are well within clinical tolerances of +/- 5 dB. Median deviations of measured first fit REARs from e-STAT 2.0 targets at third-octave frequencies (.25-6.3 kHz). Asterisks indicate statistically significant differences (p < 0.05).

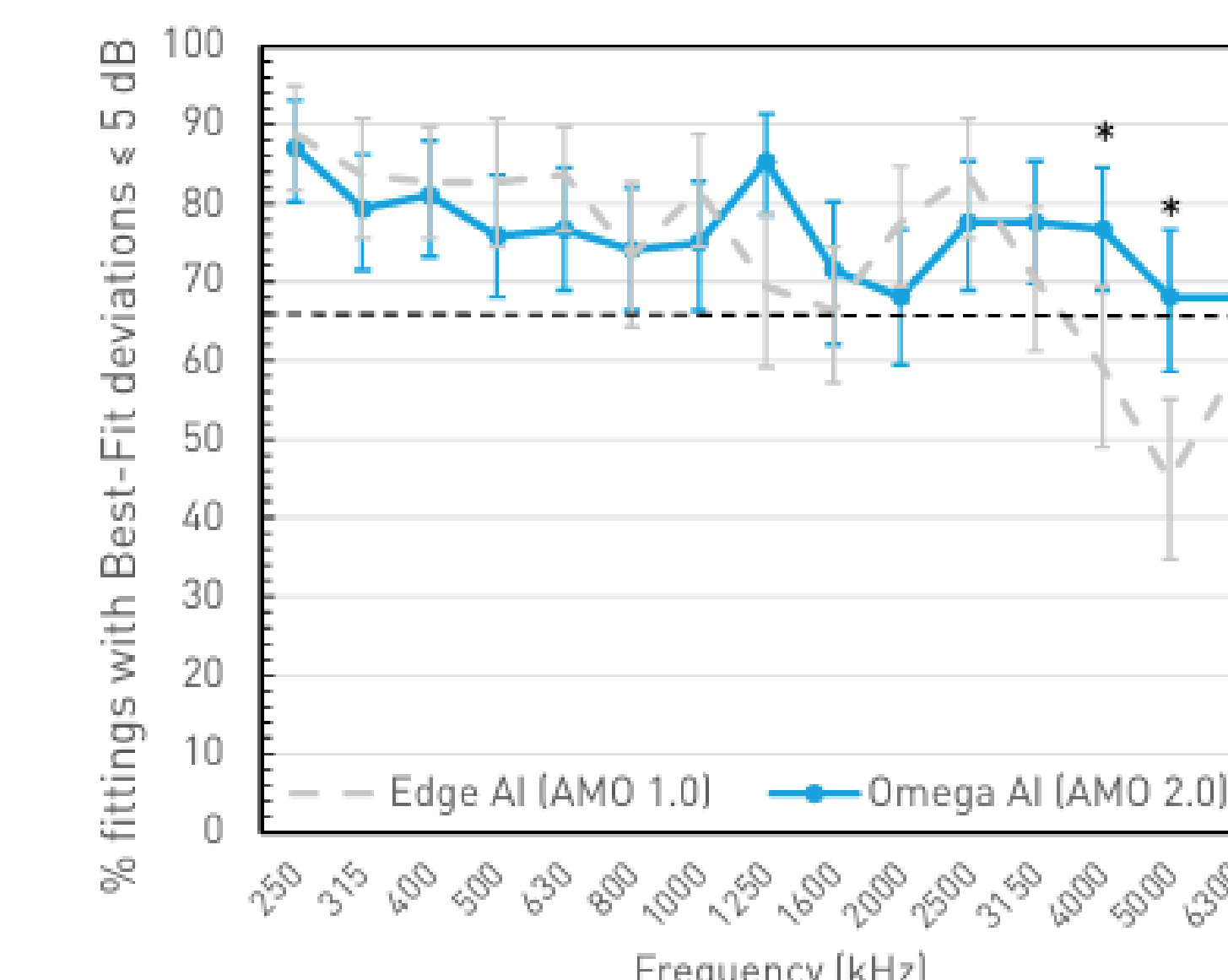
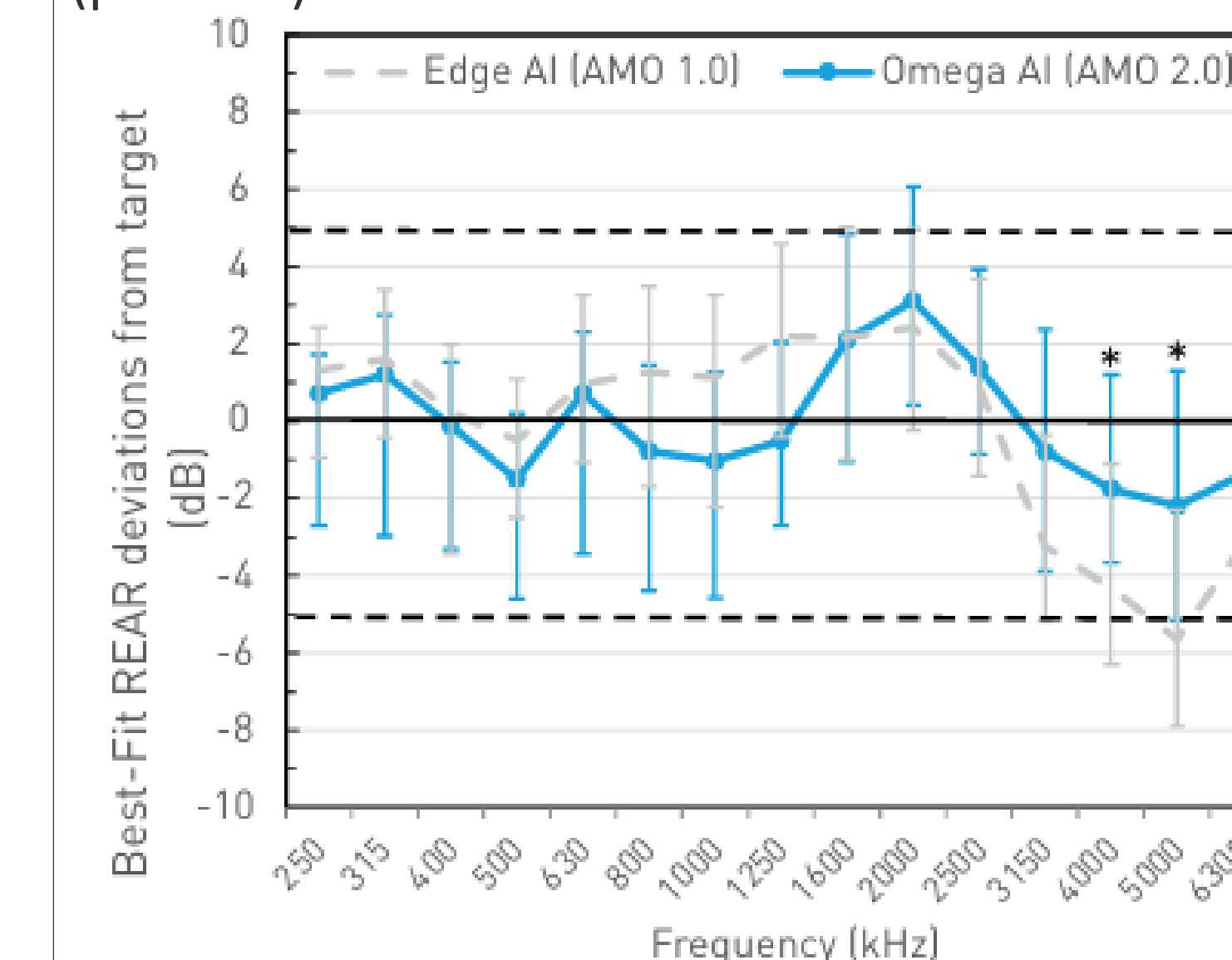


Figure 5. With AMO 2.0, 2/3 of fittings are within 5 dB of target at first fit, and when compared to AMO 1.0, significantly more fittings are within this tolerance from 4-5 kHz. Percentage of first fit REAR deviations from e-STAT 2.0 targets ≤5 dB at third-octave frequencies (.25-6.3 kHz). Asterisks indicate statistically significant differences (p < 0.05).

CONCLUSIONS

- AMO 2.0 improves REAR accuracy (compared to without AMO 2.0) when deviations from the selected acoustic option in the fitting software are detected as measured on HATS (see Figure 2).
- In-situ audiometry results deviate >10 dB from insert earphone audiometry less frequently with AMO 2.0 compared to the legacy AMO 1.0 at 250-500 Hz (see Figure 3a), and in-situ results better correlate with insert earphone audiometry from 500-1000 Hz (see Figure 3b). The in-situ audiometer leverages the acoustic model to determine the in-situ test tone SPL; the improved accuracy of in-situ is indicative of acoustic model accuracy.
- REAR measurements completed with RIC and custom hearing aid users are significantly closer to e-STAT 2.0 target from 4-5 kHz when using AMO 2.0 compared to the legacy AMO 1.0 (see Figure 4 and Figure 5).
- While real-ear measures remain the gold standard for verification, individualized acoustic models offer a clinically relevant tool for streamlining fittings.

REFERENCES

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2. Van Noort, F., Atoniuk, O., & Kilic, Y. (2023). Is the “Observer Effect” present in real ear measurement practice? *The Hearing Review*.