Pro Fit Acoustic Model Optimization: A Better, Faster Fit

Christophe Micheyl, Ph.D., Jumana Harianawala, Au.D., Henning Schepker, Ph.D., Laura Woodworth, Au.D., Meg Introwitz-Williams, B.A., BSc., Maddie Olson, Au.D., Sarah Iverson, Au.D.

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INTRODUCTION

- A desirable goal for hearing care professionals and their patients is to obtain an optimized, custom fit with as little time and effort as possible.
- The first step in obtaining a custom fitting is a *prescriptive formula*, developed to compensate for a patient's unique hearing loss. However, what the prescriptive fitting formula cannot account for is the variability of the individual ear being fitted (**Figure 1**).
- Most models rely on average real-ear parameters, thus necessitating the use of real-ear measurements to account for the unique in-situ acoustics of the individual ear.
- If the initial fitting were more accurate, the fitting and verification process could be expedited by reducing the number or magnitude of needed gain adjustments. Thus, this algorithm poses a potential for a better, faster fit.
- The **Acoustic Model Optimization (AMO)** feature in Pro Fit software leverages the in-situ acoustic measurements taken during the feedback cancellation process to estimate the acoustic-model parameters, mainly vent leakage, and update the parameters to better match the fitting targets, when appropriate.

METHODS

- A group of 73 participants with mild-to-moderately severe symmetric hearing loss were fit with hearing aids, utilizing a variety of couplings (open earbuds, occluded earbuds, small, medium, and large vent earmolds or custom devices) to evaluate the AMO feature:
  - 32 were fit with Starkey Genesis AI RIC hearing aids (RIC RT, mRIC R)
  - 40 were fit with Starkey Genesis AI custom hearing aids (ITE R, ITC R, CIC NW, IIC NW)
- Feedback Canceller (FBC) initialization was performed on all fittings, with AMO active
- Insert earphone audiometry and in-situ hearing thresholds were obtained on all participants. Insert earphone audiometry is considered the 'gold standard' and is used as the reference threshold which will be used to compare to the in-situ threshold with and without AMO active.
  - As thresholds ≤ 20 dB HL cannot be measured using in-situ, participants whose insert thresholds were ≤ 20 dB HL were excluded at the applicable frequencies, resulting in a variable sample size (40 to 74 ears) depending on the frequency.

- **Hypothesis: In-situ threshold measurements will be more accurate (i.e., closer to reference, insert earphone, thresholds), on average, when AMO is turned on than when it is turned off**

RESULTS

Accounting for Individual Ear Variability is Critical in Achieving a Better, Faster Fit

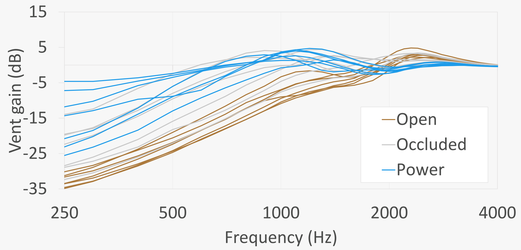

Figure 1. Measured outward sound leakage for 3 dome types, in different ears

Participant Group	AMO Recommendation Received
All (n=73)	**35/73 (47.9%)**
RIC (n=32)	10/32 (31.25%)
Custom (n=41)	25/41 (60.98%)

Table 1. Percentage of participants who received an updated AMO recommendation upon initializing Feedback Canceller

- For participants who did not receive an AMO recommendation, the comparison between thresholds with AMO turned on vs. off cannot be completed.
- For participants who did receive an AMO recommendation, the AMO off condition was estimated by subtracting the acoustic-model change applied by AMO from the measured in-situ thresholds, effectively 'undoing' the impact of AMO.

For Fittings Where an AMO Recommendation was Made, the Correction Applied Significantly Improved In-Situ Thresholds from 250-750 Hz

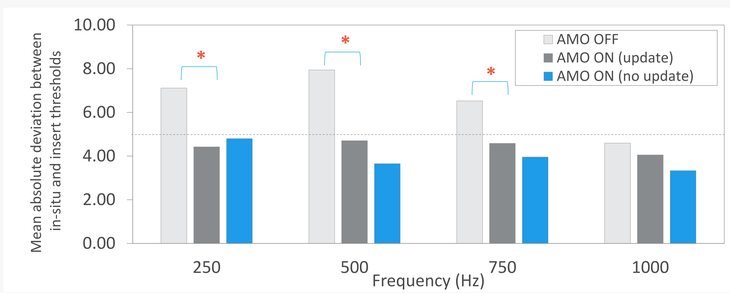

Figure 2. Mean absolute deviations between in-situ and insert thresholds with AMO OFF vs ON. AMO ON (update) indicates an AMO recommendation was made and AMO ON (no update) indicates no AMO recommendation was made. The dashed line at 5 dB corresponds approximately to the mean test-retest standard deviation for hearing thresholds across 250-750 Hz (Pugsley et al., 1993). Asterisks indicate a significant improvement (Wilcoxon Signed-Rank test, $p < 0.05$)

RESULTS (CONT.)

Clinically Meaningful Differences in Threshold were Significantly Lessened with AMO at 250 and 500 Hz

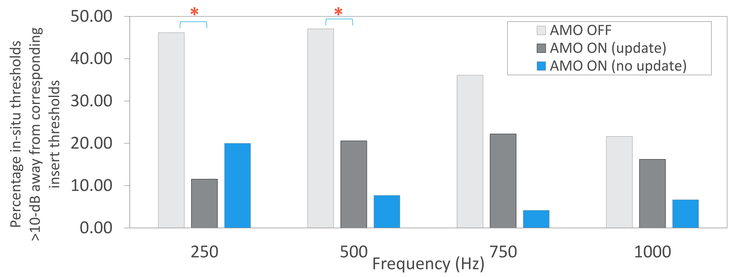

Figure 3. Percentage of in-situ measurements that deviated by more than 10 dB, from the corresponding insert thresholds, with AMO OFF vs. ON. The 10 dB criterion is commonly used in clinical audiology for declaring a significant difference in hearing thresholds (ASHA, 2015). Asterisks indicate significant improvements (Wilcoxon Signed-Rank Test, $p < 0.05$).

CONCLUSIONS

- AMO recommendations were provided for 31.25% of RIC fittings and 60.98% of custom fittings (see **Table 1**).
- AMO recommendations are less likely to occur with more open fittings, as vent effects are least variable with open fittings (see **Figure 1**)
- In-situ thresholds were more accurate with AMO ON vs. AMO OFF at 250, 500, and 750 Hz for those participants who received a recommendation (see **Figure 2**), and clinically meaningful differences in threshold (> 10 dB) were significantly lessened at 250 and 500 Hz when comparing the AMO ON vs. AMO OFF conditions (see **Figure 3**)
- These findings indicate that accounting for the in-situ acoustics of the ear can improve the accuracy of the fitting in the software, and consequently improve the accuracy of in-situ threshold measurement at the lower frequencies most susceptible to vent leakage.

REFERENCES

American Speech-Language-Hearing Association. (2005). Guidelines for manual pure-tone threshold audiometry (Guidelines). Retrieved from www.asha.org/policy

Pugsley, S., Stuart, A., Kalinowski, J., & Armson, J. (1993). Changes in hearing sensitivity following portable stereo system use. *American Journal of Audiology.*

2023