

EVALUATION OF THE TELE-TEST HANDSET AND CONSIDERATIONS FOR PHONE FEATURE VERIFICATION

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PURPOSE

To evaluate the Audioscan tele-test handset for telecoil based phone strategies including binaural streaming in forty hearing aid fittings on twenty-one adults measured on the Audioscan Verifit (VF2). Real ear measurements (REM) and simulated real ear measurements (SREM) were completed.

About the tele-test handset (Figure 1):

- Used as an accessory with the VF2 to verify T-coil programs
- Inductive signal equivalent to a 65 dB SPL acoustic stimulus (56.2 mA/m), for use according to the TMFS standard (ANSI, 2009)
- Can be used during real ear (REM) or simulated real ear (SREM) measures
- Can be used as a counselling tool for phone positioning and streaming
- Most effectively used in conjunction with monitoring headphones

Verification of telecoil responses is recommended practice (Valente, 2013). On-ear verification allows incorporation of placement and venting effects.

METHOD

An acoustic phone was calibrated in a B&K head and torso simulator (Figure 2: 4128C) with the phone positioned on a handset positioner (B&K 4606). A recording of the ISTS test signal (Holube et al., 2010) was played via a Train-On-Phone telephone trainer to the input jack of a Northern Telecom Harmony landline telephone. The sensitivity of the trainer was adjusted to produce an overall level of the ISTS of 65 dB SPL in the ear simulator (Figure 2).

Behind-the-ear (BTE), in-the-ear (ITE) and/or receiver-in-the-canal (RIC) style Unitron hearing aids were fitted to 21 adults (mean age 67, range: 19-78 y) with mild to severe hearing losses, using the DSL v5.0 target within the Audioscan VF2. Most participants were fitted with more than one hearing aid style, resulting in a total of forty binaural hearing aid fittings. The fine tuning adjustments in the primary program were applied to the telephone programs. Two t-coil programs were created:

- (1) monaural T-coil (T); and
- (2) binaural streaming of microphone and t-coil with microphone attenuation set at -30 dB (mT).

REM (Figure 3): Simultaneous binaural probe microphone measures of the ISTS test signal, at 65 dB SPL, were completed using the tele-test handset held to the hearing aid at ear level. Best positioning of the tele-test handset for t-coil pick up was determined with input from the participant, aided by the tester who wore the accompanying VF2 monitoring headphones.

SREM (Figure 4): Coupler measures of the telecoil (T) and streamed telecoil (mT) programs were also made, using tele-test handset positioning that maximized repeatability. This measure predicted REM from coupler measures using the Real Ear to Coupler Difference transform.

Tele-test REM was compared to Phone REM and tele-test SREM (Figure 5).

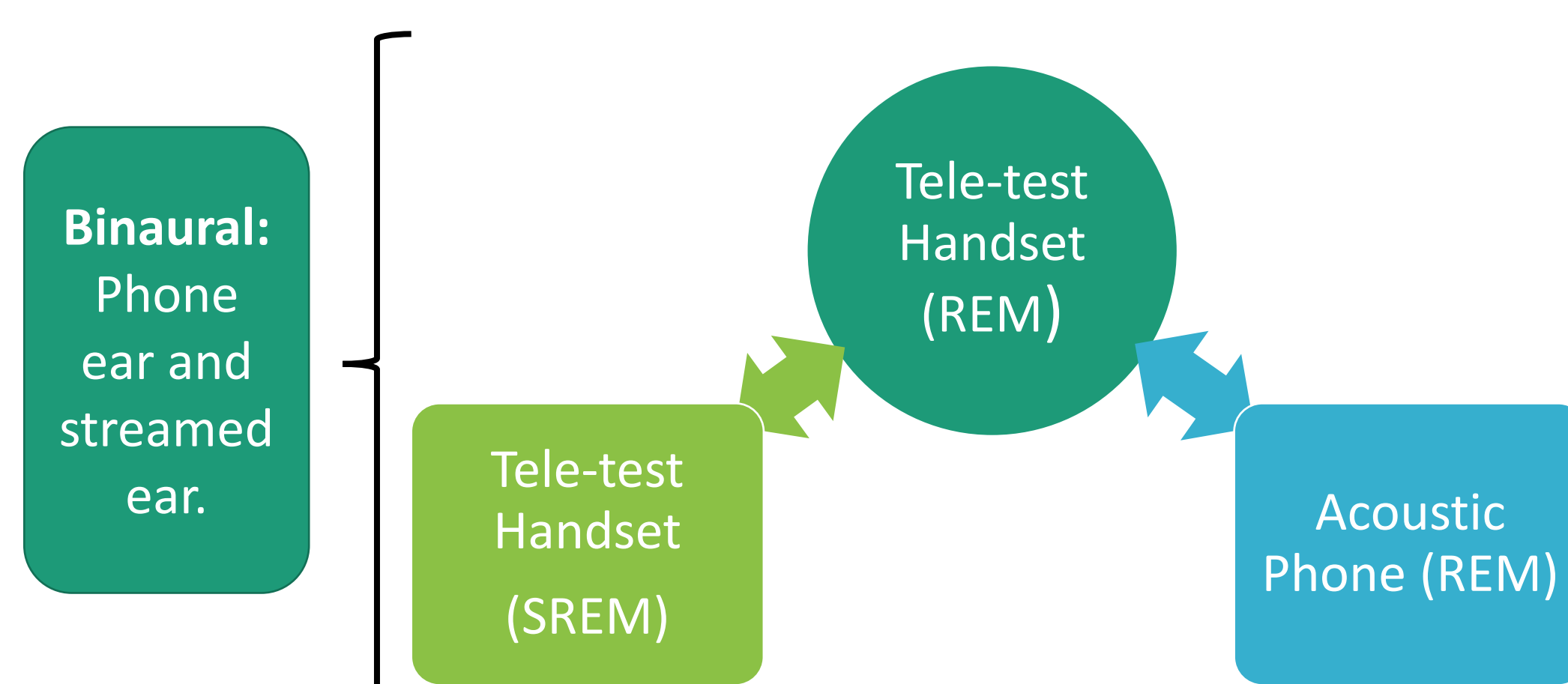


Figure 5. Conceptual illustration of comparisons made in this project. Each comparison was made for phone and non-phone (streamed) ears of BTE, ITE, and RIC hearing aid styles.

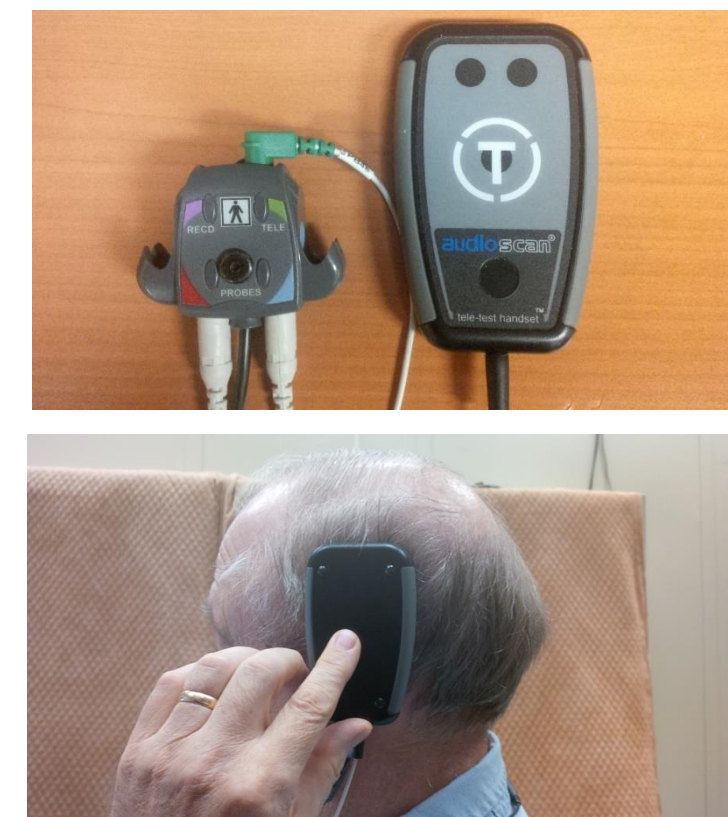


Figure 1. Tele-test handset device, shown in isolation and in correct use position for on-ear verification.



Figure 2. Calibration of the acoustic phone apparatus used in this study.



Figure 3. Use of headphones and tele-test handset during on-ear verification of a binaurally streamed telecoil program.



Figure 4. Positioning of the tele-test handset during coupler-based telecoil verification.

RESULTS

Repeated measures analysis of variance was used to compare aided responses (TT-REM to TT-SREM and AP-REM) across the full 200 to 8000 Hz range. Results indicated a significant frequency by measurement type interaction in the phone ear for ITEs ($F(5.5, 49.6)=2.5, p<.05, \eta^2=0.21$), BTEs ($F(7.2, 86.42)=28.8, p<.01, \eta^2=0.71$), and RICs ($F(7.2, 86.42)=28.8, p<.01, \eta^2=0.71$) and in the non-phone ear for ITEs ($F(5.6, 50.1)=3.1, p<.05, \eta^2=0.25$), BTEs ($F(5.8, 104.5)=4.8, p<.01, \eta^2=0.21$), and RICs ($F(6.4, 48.5)=30.9, p<.01, \eta^2=0.72$). Post-hoc comparisons were used with Bonferroni correction to locate the frequencies at which measures differed between measurement types. Frequencies at which measures differed significantly are marked in Figures 6 and 7 if the differences were significant and exceeded 3 dB.

Test-retest reliability: Measures of the phone ear response for the tele-test handset used the same settings in streamed and non-streamed hearing aid modes, and were therefore used to assess test-retest reliability. Across hearing aid styles, the overall levels of REM measures made with the tele-test handset responses did not differ at test and re-test ($p=.51$) and were similar in level (mean difference: 0.35 dB, standard deviation: 3.4 dB).

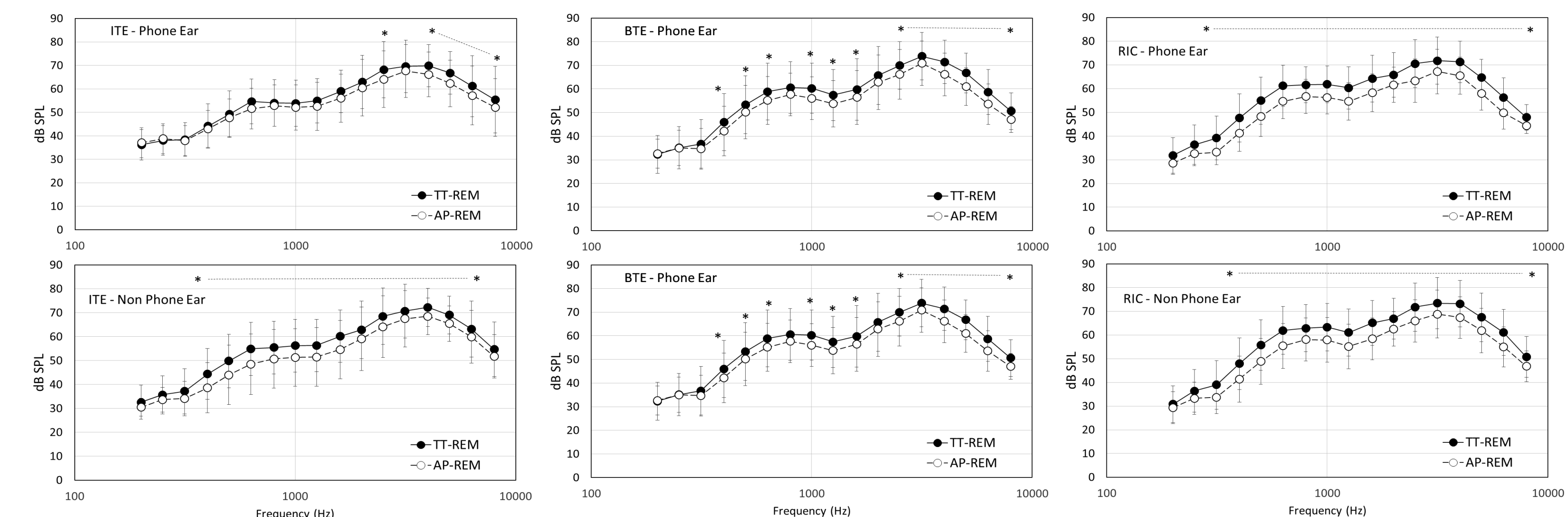


Figure 6. Mean real ear aided responses measured from hearing aids using stimuli from the tele-test handset (TT) and an acoustic phone (AP). Bars show one standard deviation.

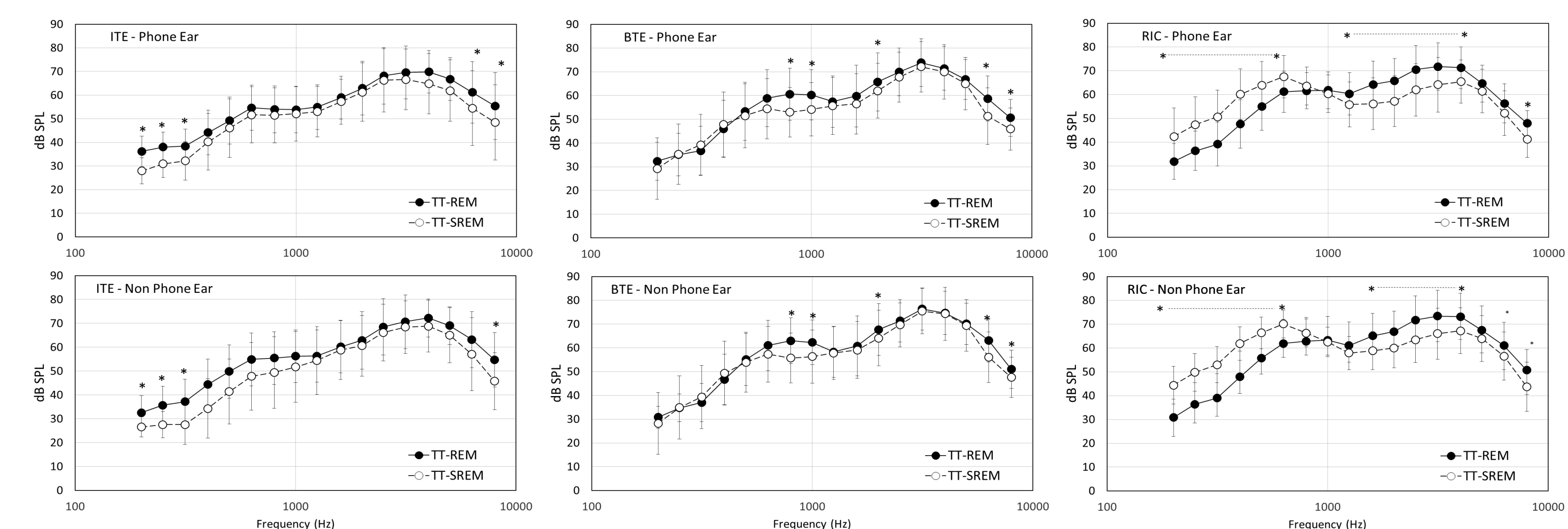


Figure 7. Mean aided responses measured from hearing aids using stimuli from the tele-test handset (TT) measured with real ear measurement (REM) and simulated real ear measurement (REM). Bars show one standard deviation.

SUMMARY

For predicting the real ear telecoil response from coupler measures (REM to SREM):

Unvented ITEs were predicted within ± 3 dB from 500-5000 Hz in both phone ears and streamed non-phone ears. Outside this frequency range, the SREM under-predicted the REM, although this frequency range is outside the passband of typical phone responses.

For BTEs, telecoil responses had similar spectral shapes when measured with REM and SREM in both the phone ear and the non-phone streamed ear, although the SREM under-predicted by 7 to 8 dB in the 800 Hz region. At most measurement frequencies, the match between REM and SREM was within ± 3 dB.

For RICs (most of which had significant venting), the overall level of the response was similar, but the spectral shape was dissimilar at some frequencies, with SREM over-predicting the REM by up to 10 dB in the low frequencies, indicating that for highly vented fittings, the telecoil response is best measured on the ear.

For predicting the real ear telecoil response from an acoustic phone from the teletest handset (TT-REM to AP-REM):

Unvented ITE telecoil responses were predicted within ± 3 dB across frequencies within the phone passband in the phone ear, with a 4 dB difference observed at 2500 Hz and above the passband of the phone. In the streamed non-phone ears, the tele-test handset slightly over-predicted the 65 dB SPL phone response, but the spectral shape was similar for both. These results indicate that the telecoil response of the phone was well predicted by the response from the tele-test handset, particularly in the phone ear.

For BTEs (some of which had significant venting), tele-test handset responses had similar spectral shapes to that of the acoustic phone, with over-prediction of about 3 to 5 dB across frequencies in both the phone ear and the non-phone streamed ear. This indicates that the tele-test REM measures reflected the spectral shape of the acoustic phone used in this study, but over-predict the response of the experimental phone, which was calibrated to provide a 65 dB SPL output level.

For RICs (most of which had significant venting), tele-test handset responses had similar spectral shapes to that of the acoustic phone, with over-prediction of about 4 to 7 dB across frequencies in both the phone ear and the non-phone streamed ear.

Overall, these results indicate that tele-test handset REM measures represent the spectral shape of phone telecoil responses but slightly over-predict standardized phone responses, which are calibrated to 65 dB SPL. However, typical phones produce output levels in excess of the standard 65 dB SPL signal level, and **typically produce about 76 dB SPL** (Baum, 2010). Verification using the tele-test handset can therefore ensure that weaker phone telefield responses receive appropriate shaping, gain, and streaming. Clinicians can expect that a user's actual phone, if it emits an average telecoil response, is likely to produce a stronger response than is shown on standard verification measures. When incorporated into an appropriate fitting and counselling regime, telecoil verification can help to ensure device functionality (including evaluation of binaural streaming) and appropriate frequency response shaping. This tool, paired with monitoring and follow-up, can help with troubleshooting and may contribute to patient use of telecoils in their own environments.

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