Real-Ear Measurements Improve Subjective Performance of Hearing Aid Fittings

ABSTRACT

This article documents the real-world benefits of incorporating real-ear measurements into clinical practice. Data collected from clinical sites using real-ear measurements were compared to data from sites that did not complete real-ear measurements. Fittings optimized using real-ear verification resulted in increased high-frequency output relative to fittings that did not utilize real-ear verification. Data from the Device-Oriented Subjective Outcome (DOSO) Scale indicate that the fittings optimized with real-ear measurements delivered significantly greater benefit than fittings that were not optimized through real-ear measurements.

INTRODUCTION

Despite compelling evidence that the use of real-ear measurements (REM) improves the and audibility of a hearing aid fitting, the adoption rate of REM for fitting verification is remarkably low.[1] One reason cited for the limited adoption of REM is a supposed lack of correlation to real-world performance. In this article we explore the relationship that REM-optimized fittings have to a subjective scale of real-world hearing aid performance compared to fittings that were not verified or optimized using REM.

This article examines a subset of data from a larger study conducted across several clinical sites. Clinics participating in a large-scale field study were divided into two categories, those that verified fittings through the use of REM and those that did not use a standardized means of verification. Hearing aid fittings completed at the clinics using REM were optimized to meet NAL-NL1 targets. Clinics that did not perform REM adjusted the hearing aid response to meet patients' verbal requests for changes in sound quality and comfort.

METHODS

Participants: Thirteen adult participants were divided into two groups; those who received REM-based fitting adjustments and those who did not. The non-REM group consisted of six participants, five male and one female, ranging in age from 66 to 82 years (mean age = 72 years). The REM group was comprised of seven participants, four male and three female, ranging in age from 24 to 81 years (mean age = 67 years).

Mean right and left audiometric thresholds for the two groups are shown in **Figure 1**. Of note is that the non-REM group demonstrated elevated thresholds at all test frequencies relative to the REM group. This suggests that, in order to meet prescribed targets, hearing aid fittings for the non-REM group would require more output.

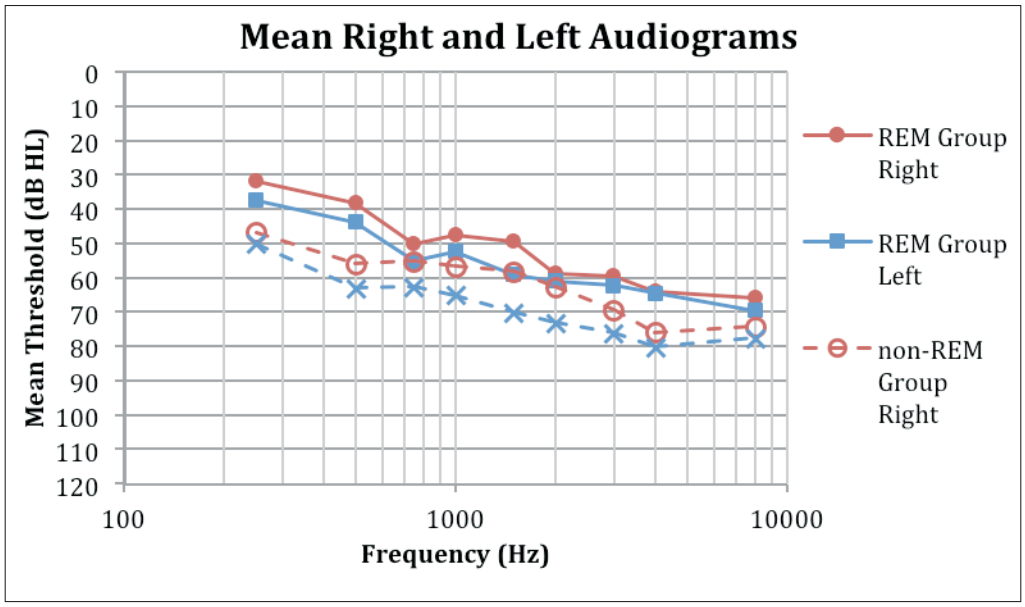

Figure 1: *Mean right and left audiometric thresholds for the REM group (n = 14 ears) and the non-REM group (n = 11 ears).*

All of the participants were experienced hearing aid users and were fit binaurally with the exception of one participant in the non-REM group who was fit monaurally. Hearing aid fittings were accomplished with Starkey S Series™ 11 BTEs using #13 tubing, conventional earmolds, and venting appropriate to the hearing loss. All adaptive features were left at default settings and the participants wore the hearing aids over an eight-week period.

Materials and Equipment: Fittings for the REM group were verified and adjusted to NAL-NL1 targets using either composite noise on a Frye Electronics Fonix 6500 system, or via speech mapping using 'the carrot passage' on an Audioscan Verifit system. Fittings for the non-REM group were not objectively verified. Adjustments made to non-REM fittings were based on verbal feedback from the individual wearers.

The instrument used to collect subjective ratings of real-world performance was the Device-Oriented Subjective Outcome (DOSO) Scale.[2] The DOSO Scale consists of 25 questions separated into six subscales. Four of the six subscales relate directly to the listening performance of the wearer's hearing aid: Speech Cues, Listening Effort, Pleasantness, and Quietness. Ratings on the DOSO Scale are made on a seven-point scale where higher is better.

Procedures: By definition, there was no actual real-ear data available for the non-REM fittings. In order to ensure a comparison of like data sets, the simulated Real-Ear Aided Response (sREAR) values from the final fitting record of each fitting in both groups were obtained from Inspire® programming software. These values represent the predicted real-ear output that would be expected from each fitting, normalized to an average ear. Adjustments to the fittings represent a departure from the initial fitting values predicted by the software algorithm. Adjusted sREAR values were averaged together within each group.

The DOSO Scale was administered once at the outset of the study and again at the end of the eight-week evaluation period. The DOSO Scale data evaluated for this article are those obtained at the end of the study, after the participants had worn the new fittings for a time sufficient for them to make meaningful observations about the performance of the hearing aids.

RESULTS

Figure 2 demonstrates the differences between fittings that were optimized to meet NAL-NL1 targets using real-ear measurements versus those that were not adjusted, or perhaps adjusted based solely on verbal feedback from the wearers about sound quality and hearing ability. As expected, the non-REM group reveals additional mid-frequency output (between 0.4 kHz and 2 kHz) dictated by the more elevated thresholds; yet there is less high-frequency output in this group than the REM group. Of particular note is the difference between REM and non-REM fittings between 3.0 and 5.0 kHz. Patients in the non-REM group — the group with poorer thresholds — were prescribed approximately 10 dB less output in this frequency range, than the REM group. At these important frequencies for speech intelligibility, it may be expected that insufficient audibility would impact subjective outcomes.

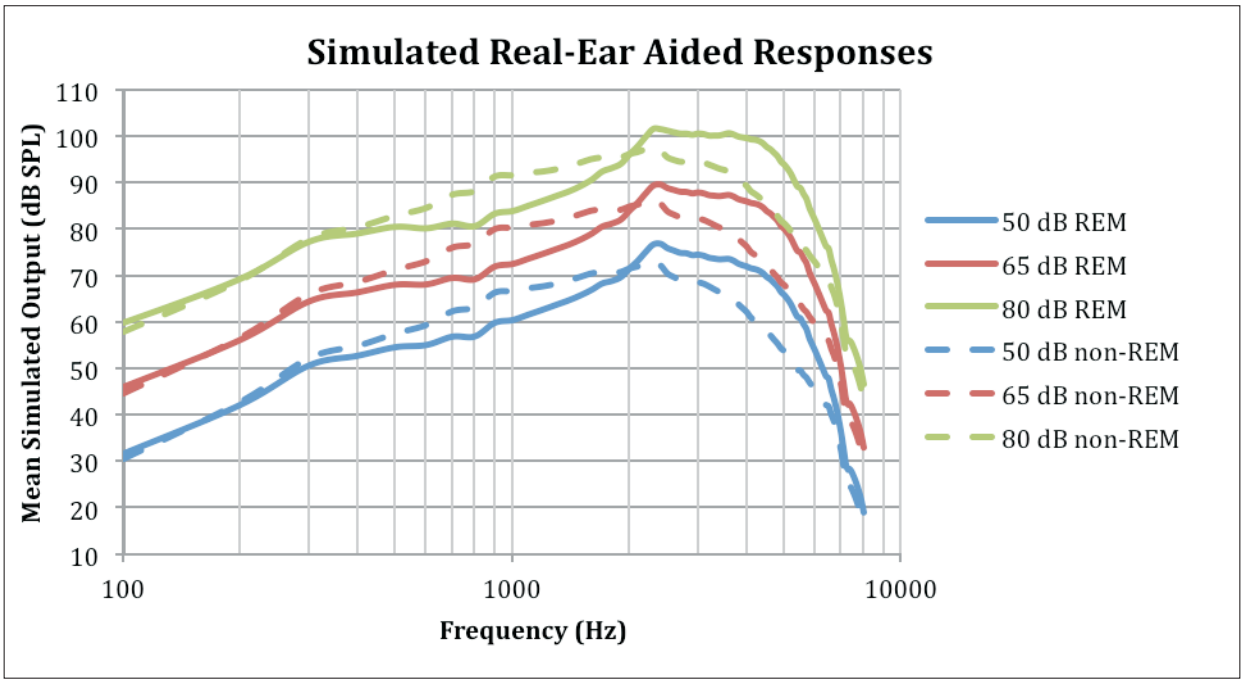

Figure 2: *Mean simulated REAR curves for the REM group (n = 14 ears) and non-REM group (n = 11 ears) at three input levels.*

High-frequency output is required for speech clarity, but can often result in undesirable effects such as harshness or increased propensity for feedback. In order to assess the expected benefit of the additional high-frequency output relative to any potential drawbacks, the DOSO Scale scores were analyzed.

Separate t-tests were used to compare the mean scores between the two groups within subscales of the DOSO Scale. Scores on the Speech Cues subscale were significantly higher for the REM group than for the non-REM group ($t[73] = 5.067$, $p < .001$), as were the scores on the Listening Effort subscale ($t[50] = 4.230$, $p < .001$).
As these two subscales assess the ability of the hearing aids to improve the understanding of speech, it is likely that the increased high-frequency output of the fittings in the REM group contributed to these significantly improved outcomes.

The Pleasantness and Quietness subscales assess any negative sound experience associated with wearing hearing aids. Pleasantness was scored significantly better for the REM group than for the non-REM group ($t[40] = 5.497$, $p < .001$), and Quietness was judged to be significantly better for the REM group as well ($t[44] = 5.136$, $p < .001$). These findings suggest that the increased high-frequency output did not result in objectionable sound quality. Taken together with the Speech Cues and Listening Effort results, the REM-adjusted fittings delivered significantly better results than the non-REM-adjusted fittings.

CONCLUSION

The outcomes presented here demonstrate real-world advantages of using real-ear measurements for optimizing hearing aid fittings. For these patients, real-ear verification of hearing aid output ensured that patients received prescriptively appropriate amplification. The results of meeting these needs are significantly improved speech understanding and reduced listening effort while maintaining a pleasant listening experience.

Clinical Implications: Many hearing care professionals have expressed the opinion that real-ear measurements do not improve clinical outcomes with amplification. This study shows that allowing patients to dictate hearing aid settings will yield poorer results than a hearing aid fitting that is controlled by the hearing care professional, during which the audibility of average speech is verified through real-ear measurements.

REFERENCES

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