Introducing REM Target Match

Eric J. McCabe, AuD | **Tracie L. Tuss, AuD**

Introduction

Starkey's new REM Target Match is an automatic real ear measurement (REM) tool that allows the hearing professional to quickly and automatically fit hearing aids, while providing their clients with a superior outcome. Using the unique acoustics of the client's ears, REM Target Match automatically measures the Real Ear Unaided Gain (REUG) and the Real Ear Aided Response (REAR). With these measurements, Inspire X automatically adjusts the gain to match target, and measures the REAR again to ensure an optimal fitting. REM Target Match facilitates direct communication between Inspire X and the Otometrics Aurical Free Fit, the MedRx Avant, the MedRx Avant REM+ and the Inventis Trumpet systems. REM Target Match can be used with any fitting formula supported by Inspire X, including Starkey's proprietary e-Stat targets.

Audiology best practice guidelines recommend using REM as part of the hearing aid fitting verification procedure[1]. Research has shown that real ear verification measures are consistent with better overall patient satisfaction with their hearing professional, with their hearing aids and an improved client experience[2]. Unfortunately, numerous studies have shown more than half of hearing professionals do not routinely complete real ear measurements[3,4,5]. One reason often cited for not completing real ear measurements is because it takes too much time to complete the process manually. When manually matching to targets, the hearing professional must switch between the hearing aid fitting software and REM software multiple times. This can take considerable time—time that could be used to counsel and educate the patient about the functionality of their hearing aids. In contrast, by automatically verifying and adjusting the hearing aid responses with REM Target Match, the whole process can be completed with a high degree of accuracy in approximately 5 minutes. Additionally, the easy-to-follow instructions within the REM Target Match feature simplify what can be a frustrating procedure. This provides more time for the hearing professional to devote to each patient and increase productivity.

Clinical Validation

A study was completed to compare REM Target Match to Traditional real ear measures (REM). Traditional REM has been defined here as manual gain adjustments in the fitting software by the hearing professional. It is practical and important to compare this new automated REM Target Match to Traditional REM to show both accuracy and reliability of the feature.

Ten normal-hearing participants recruited at Starkey (7 females, 3 males) were fit binaurally with Livio Edge AI 2400 hearing aids. All 10 participants were fit with rechargeable RIC hearing aids with open comfort buds and occluded comfort ear buds. Five participants were additionally fit with custom rechargeable in-the-ear (ITE /ITC) hearing aids. As proposed by Bisgaard, et al (2010), standard

audiograms N2, N3 and S1 were chosen for the study. N2 corresponds to a mild flat hearing loss, N3 corresponds to a moderate flat sensorineural hearing loss, and S1 corresponds to a normal sloping to moderately severe high frequency sensorineural hearing loss. See figure below.

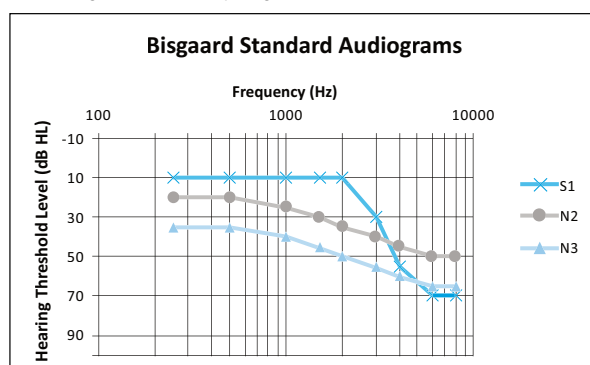Hearing aids were programmed initially to NAL-

Figure 1. Standard Audiograms as proposed by Bisgaard, et al, (2010) selected for the study

NL2 fitting prescription and appropriate venting was chosen based on the audiogram configuration as suggested by the Inspire X fitting software (N2 fit with custom hearing aids, N3 fit with occluded buds, and S1 fit with open buds). All hearing aids used were configured with 50-gain receivers. Participants were seated 0.5 meters away from each real ear system. NAL-NL2 targets were used by both REM Target Match and Traditional REM. All noise management features were disabled, and the hearing aid microphones were set to omnidirectional mode. This was done manually for Traditional REM and is automated when completing REM Target Match.

Real ear aided responses (REAR) were measured for both ears of each participant. For Traditional REM, REAR was measured using International Speech Test Signal (ISTS) passage played at 65 dB SPL with probe tubes and hearing aids in the ears. After the initial measurement of the Traditional protocol, gain was adjusted in Inspire X by the

researcher to match 65 dB SPL targets between 250 and 8000 Hz. Real ear measurement data was considered complete when the gain was as close to NAL-NL2 targets as possible. When matching to targets using Traditional REM, targets were matched within +/- 5 dB SPL for frequencies 250-8000 Hz. These tolerances where chosen based on work by Bentler et al (2006)[6].

Hearing aids and probe tubes were removed from the participants' ears and the procedure was completed again using the REM Target Match tool in Inspire X. The probe tubes were calibrated, real ear unaided gain (REUG) was measured as part of the REM Target Match workflow, and the REAR was measured using the ISTS passage played at 65 dB SPL. During REM Target Match protocol, the initial measurement is taken, then a second measurement is completed after gain adjustments have been automatically applied to reach prescriptive targets for that patient. Once REM Target Match is complete, gain adjustments are saved to hearing aids.

Real ear measures were performed twice, once each with the Otometrics Aurical Free Fit system and another with the Med Rx Avant REM+ system. The process was repeated for each system with each device configuration until all measurements were obtained.

Accuracy was assessed by comparing the difference between REAR measurements made using REM Target Match and Traditional REM across frequencies. Reliability of REM Target Match was assessed by comparing REAR measurements obtained using REM Target Match and Traditional REM for different hearing aid styles and hearing loss configurations. Additionally, differences between real ear equipment were assessed.

Results

There was no significant difference in trends across the different hearing aid styles, real ear systems, and/or hearing loss configurations tested during this study, therefore all data shown is averaged across the conditions.

As described above, REAR measurements were obtained for each participant using REM Target Match and Traditional REM. The difference between the two measurements was obtained for each participant by subtracting the REM Target Match measurements from the Traditional REM for all ears to look at accuracy of REM Target Match compared to Traditional REM. The difference measures were then averaged across all participants.

Figure 2 shows the difference for REAR measurements using the Aurical Free Fit and MedRx AvantREM+ systems. The difference in REAR between REM Target match and Traditional REM demonstrates acceptable accuracy with differences of 4.5 dB or less from 250-6000 Hz. Measured REAR differences at 8000 Hz were 5.3 dB for the Free Fit, and 6.5 dB for the Avant REM+, slightly outside of the +/- 5 dB acceptability range. This can
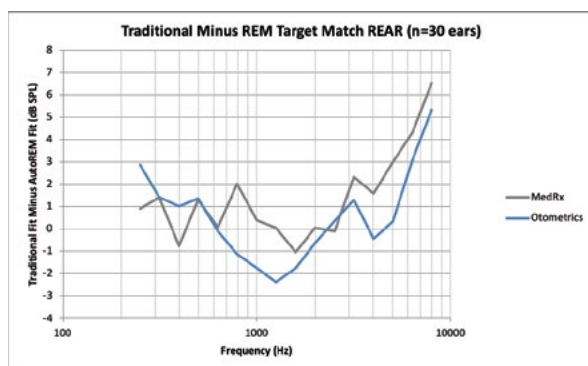
Figure 2. Difference of averaged Traditional REM and REM Target Match REAR measurements in dB

be attributed to the researcher matching to targets from 250 to 8000 Hz, while the REM Target Match feature matches targets from 250 to 5000 Hz.
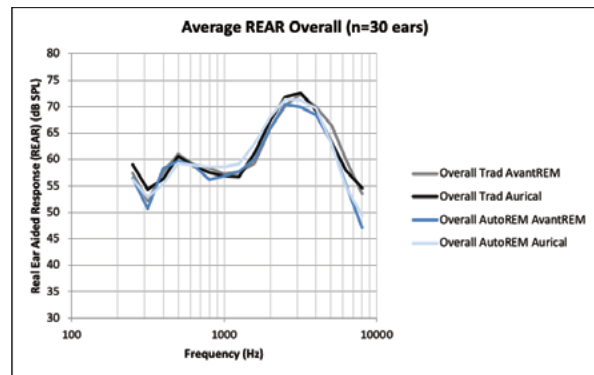
Figure 3. Average REAR for all hearing aid styles measured on each real ear system for REM Target Match and Traditional REM

Figure 3 shows this data in a different way by displaying the overall average REAR measurements in dB SPL plotted together across frequencies.

Reliability was assessed by comparing REAR measurements using REM Target Match and Traditional REM for different hearing losses and device configurations. An open RIC fit was assessed using the Bisgaard S1 audiogram and the appropriate size open ear bud for each participant. An occluded RIC fit was assessed using the Bisgaard N3 audiogram and the appropriate occluded ear bud for each participant. A custom fit was assessed by using the Bisgaard N2 audiogram and a custom hearing aid with appropriate venting.
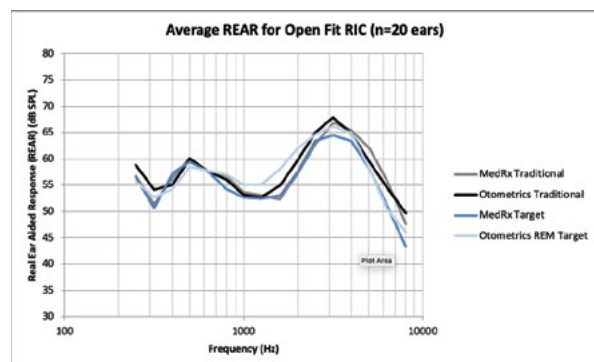
Figure 4. Average REAR for open fit RIC hearing aids on each real ear system for REM Target Match and Traditional REM

Figure 4 shows the average REAR across participants for an open fit. Although there is some variability between REM Target Match

and Traditional REM as seen here, average measurements are all within 5 dB across frequencies and between real ear systems. Figure 5 shows the average REAR measurements for custom hearing aids, which indicate differences of 3 dB or less across frequencies from 250-6000 Hz, with greater variability at 8000 Hz. A similar pattern can be observed in Figure 6 for occluded fit RIC hearing aids, which has even less variability between REAR measurements from 250-6000 Hz.
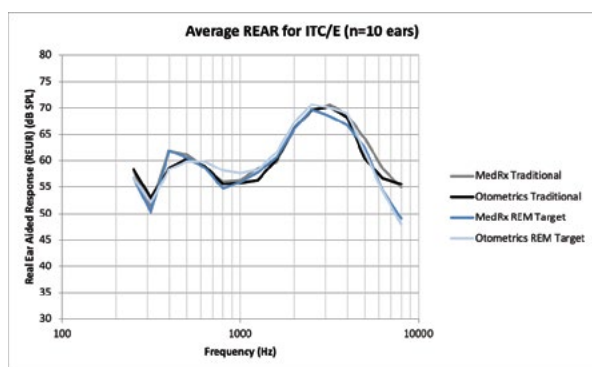

Figure 5. Average REAR for custom hearing aids on each system for REM Target Match and Traditional REM
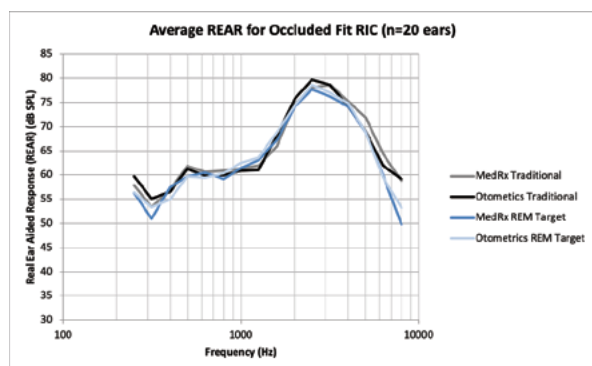

Figure 6. Average REAR for occluded fit RIC hearing aids on each real ear system for REM Target Match and Traditional REM

Conclusion

Incorporating REM Target Match into hearing professionals' hearing aid fitting routine allows for verification of the accuracy of prescription target match faster than traditional manual adjustment methods. Hearing professionals no longer need to control two separate systems and make manual adjustments to match hearing aid responses to target because the workflow is fully integrated into Inspire X. This seamless integration makes the fitting more efficient and ensures an accurate fitting. Results from this clinical study demonstrate that REM Target Match provides a fitting that is equivalent in accuracy to manually matching to targets—thus encouraging hearing professionals to engage in hearing care best practices without sacrificing the time that it would take to do REM in the traditional manner.

By using REM Target Match, real ear measurements can be completed in just a few minutes. This reduces the amount of time spent during a fitting manually matching to targets. Used in conjunction with Starkey's Initial Fit, fittings can happen quickly and efficiently, thus allowing for more time to counsel and educate clients. Additionally, by encouraging more standard-of-care fittings with Real Ear measures, REM Target Match may reduce the number of follow-up visits with clients by providing optimal hearing aid benefit from the initial fitting[11], and improving the overall patient experience.

References

[1]Valente, M., Abrams, H., et al. (2006). Guidelines for the Audiological Management of Adult Hearing Impairment. *Audiology Today*, 18(5), 1-44.

[2]Amlani, A.M., Pumford, J., Gessling, E. Improving patient perception of clinical services through real-ear measurements.(2016). *Hearing Review*, 23(12),12-21.

[3]Kirkwood, D.H. Survey: Dispensers fitted more hearing aids in 2005 at higher prices.(2006). *Hear Jour*, 59(4),40-50. Doi: 10.1097/01.HJ0000286695.28587.f5

[4]Mueller, G.H. (2005). Probe-mic measures: Hearing aid fitting's most neglected element. *Hear Jour*, 58(10),21-30. Doi: 10.1097/01.HJ.0000285782.37749.fc

[5]Mueller, H.G., Picou, E.M. (2010). Survey examines popularity of real-ear probe-microphone measures. *Hear Jour*, 63(5),27-32.doi: 10.1097/01.HJ.0000373447.52956.25

[6]Bentler, R., Mueller, H.G., Ricketts, T.A. (2016). *Modern Hearing Aids: Verification, Outcome Measures, and Follow-up*. Plural Publishing.

[7]Bisgaard, N., Vlaming, M. S., & Dahlquist, M. (2010). Standard audiograms for the IEC 60118-15 measurement procedure. *Trends in Amplification*, 14, 113-20.

[8]Ricketts, T. A., and Mueller, H. G. (2009). Whose NAL-NL fitting method are you using? T*he Hearing Journal*, 62(8), 10.

[9]Kochkin, S. (2011). MarkeTrak VIII: Reducing patient visits through verification and validation. *Hearing Review*, 18(6), 10-12.

[10]Kochkin, S., Beck, D.L., Christensen, L. et al. (2010). MarkeTrak VIII: The impact of the hearing healthcare professional on hearing aid user success. *Hearing Review*, 17(4), 12-34.

[11]Abrams, H.B., Chisolm, T.H., McManus, M., McArdle, R. (2012). Initial-fit approach versus verified prescription: Comparing self-perceived hearing aid benefit. *Journal of the American Academy of Audiology*, 23(10),768-778.