STAY ON TARGET?

BY JASON A. GALSTER

The focus on gain and targets has obscured the most important part of the real-ear measurement—audibility. The topic of audibility is familiar; after all, a primary goal of fitting hearing aids is restoring the audibility of average speech. Yet audibility is not a commonly observed metric in many clinics today.

Recently, the results of multiple surveys have suggested that the use of real-ear probe-microphone measures in the United States may be growing, if only slightly (Kirkwood, 2010; Mueller and Picou, 2010). However, when talking with audiologists, there continues to be some confusion related to the need for routine-real-ear measurement. Take Australia, for instance. For an audiologist to be reimbursed by the government for the sale of hearing aids, that audiologist must document the fitting with a real-ear measurement. This means that it is routine practice for Australian audiologists to do real-ear measures. Yet on a recent trip to Australia, I spoke with audiologists who are not doing real-ear measures with private-pay patients. These audiologists choose only to do real-ear measures when the government requires the documentation. So I began to ask questions, and my anecdotal experience from these and other discussions suggests that if you ask some audiologists why they do a real-ear measurement, they will respond in one of two ways:

1. Real-ear measures are done as a means of matching prescribed targets.

2. Real-ear measures help to verify that hearing aid gain is appropriate for the patient.

While both statements are correct, they are highly reflective of the methods we have used to teach real-ear measurement for years. The focus on gain and targets has obscured the most important goal of the real-ear measurement—ensuring audibility.

Starting with the topic of prescriptive targets, audiologists have been provided with a number of independently derived prescriptive formulae, such as the desired senation level (DSL i/o) and a non-linear formula from Australia's National Acoustics Laboratory (NAL-NL1). Their successors, DSL 5.0 and NAL-NL2, are being made publicly available. Both are steps forward in the evolutionary process of understanding the needs of the impaired auditory system and will bring with them supporting evidence for clinical application (Polonenko et al, 2010). The targets generated by these formulae are a statistical generation—a method of quantifying the relationship between an appropriate amount of amplified sound and the patient's audiometric data. By matching prescribed targets at the start of a fitting, the amplified sound will be audible and comfortable, keeping a wide range of inputs within the patient's residual dynamic range. However, not all patients will tolerate the sound quality or loudness of a prescriptively appropriate fitting—and that's not a problem. Adjusting a hearing aid to optimize subjective sound quality after meeting prescribed targets is not heresy. Part of an audiologist's role is to ensure that patients wear their hearing aids. However, when adjusting a hearing aid's response, maintenance of audibility *must* be a concern.

A common question from clinical practitioners is "Where is the evidence that real-ear is beneficial?" The process of doing real-ear measures is not a magical formula that yields success. The question that should be asked regarding real-ear measurement is "Are patients successful when audibility is ensured?" This is a much different question—one supported by years of robust research—and the answer is an overwhelming *yes*. Audibility is a crucial component of success. In fact, the Speech Intelligibility Index can be used to predict speech recognition ability based on measures of audibility (ANSI S3.5-1997; ANSI, 1997). If a hearing aid fitting isn't providing an audible response, patients will not have access to the many acoustic cues that improve speech understanding (Moore et al, 2008), improve awareness of environmental sounds, and improve spatial awareness of sounds (Ahlstrom et al, 2009; Best et al, 2010). All of these are factors that combine to yield success and are contingent upon audibility.

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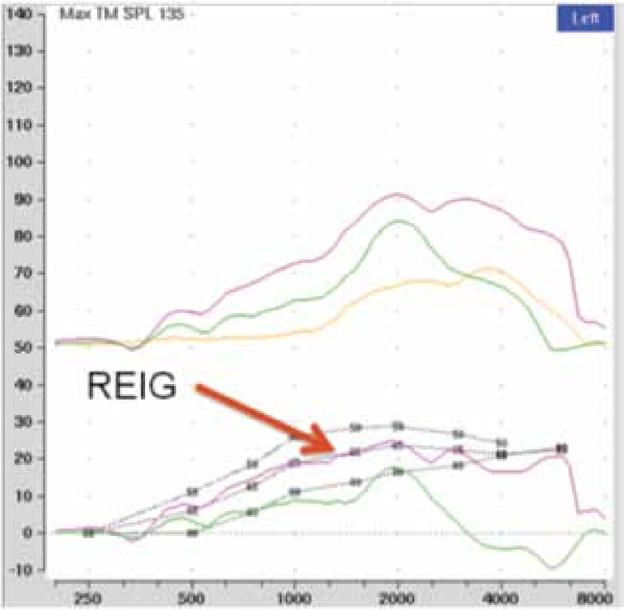

FIGURE 1. Real-ear insertion gain (dB) as a function of frequency (Hz). The magenta response below the red arrow shows insertion gain after manual matching to NAL-NL1 targets. The green response curve, below the red arrow, shows the default fitting.

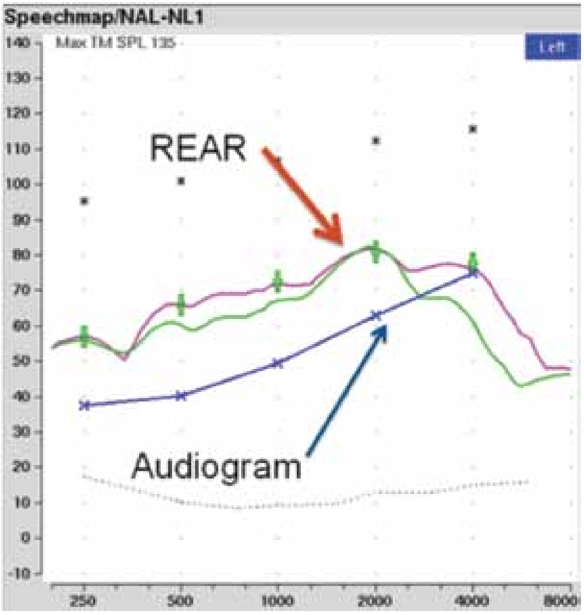

FIGURE 2. Real-ear aided response (dB) as a function of frequency (Hz). The magenta response shows the aided response after manual matching to NAL-NL1 targets. The green response curve, below the magenta, shows the default fitting. The blue line shows the patient audiogram in dB SPL.

conversational speech. Yet audibility is not a commonly quantified metric in many clinics today. In fact, any measure of gain (e.g., real-ear insertion gain [REIG] or real-ear aided gain [REAG]) will not be displayed with a reference to audibility. In other words, the on-screen display will show the prescribed targets, but there is no reference to the patient's thresholds. This means that if the hearing aid is turned down, or the frequency response rolls off in the high frequencies, there is no method for quantifying when that hearing aid response drops below the threshold of audibility for that patient.

In today's real-ear measurement equipment and manufacturers' programming software, the default view and the data collected must reference an SPL value in order to illustrate the audibility of a hearing aid fitting. Looking at real-ear measures taken from an Audioscan Verifit helps to illustrate this point. FIGURE 1 shows a screen capture from a measurement of the REIG. The red arrow points to the REIG of a typical hearing aid fitting. The magenta response curve is the REIG with an excellent match to the NAL-NL1 targets generated for a 65 dB input. The green response curve below the magenta curve is the same hearing aid best fit to the manufacturer's default NAL-NL1 settings. In this example, the default NAL-NL1 settings underfit the Audioscan targets: with simple adjustments, the same hearing aid easily matched these prescribed targets.

However, a patient may make comments related to sound quality or comfort. This patient may even prefer the default fitting (green) over the adjusted fitting (magenta). If the patient were to wear the "preferred" green response, would they have appropriate access to audible, conversational speech? The answer to that question is not available when the measured response is reported in gain.

FIGURE 2 shows a recording of the real-ear aided response (REAR) from the same hearing aid using the same Audioscan Verifit. Looking at FIGURE 2, differences are immediately apparent. First, the scale is in dB SPL, and second, the patient's audiogram, converted to dB SPL, is shown in blue. Again, with manual adjustment, the hearing aid response matches the NAL-NL1 prescribed targets. Now with the audiogram as a reference point, it can be seen that the default NAL-NL1 response falls below the threshold of audibility at approximately 3,000 Hz. If a patient's requests for reduced amplification resulted in a fitting that compromised audibility above 3,000 Hz, would you counsel differently? My personal answer is *yes*. My counseling strategies now include showing the patient his or her aided response recordings. As I make adjustments, I counsel that patient on the relationship of the hearing aid output to the audiogram, attempting to maintain broadband audibility whenever possible.

It should be noted that the response curve of the hearing aid shown in FIGURE 2 is the average response for a 65 dB speech stimulus. If this average response falls below the audiogram at a given frequency, it does not mean that all speech at that frequency is inaudible; it simply means that average speech in that frequency range, for that talker, has fallen below the audiometric thresholds. If a 30 dB dynamic range is assumed for speech (+15/–15 around the average), it is likely that some components of speech will be audible (ANSI S3.5-1997; ANSI, 1997). This is a consideration that will vary greatly across talkers and environments in the real world.

In many ways, referencing a hearing aid's response in dB gain has become a point of comfort and habit for many audiologists. Unfortunately, it has also numbed many of us to the consideration of quantifying audibility in our hearing aid fittings. For future applications, it is entirely possible to derive a measure of minimum audible gain and superimpose these values onto the REIG and REAG response measurements, but this is not an approach that is currently available. Even if this were done, the REAR is the most basic measure of how a hearing aid performs in the patient's ear, and the patient's audiogram is the fundamental reference for the prescription of a hearing aid. These two data sets can be used within a simple protocol:

1. Fit the hearing aid of your choice to the patient's ear, ensuring that the earmold or earbud fits comfortably and is oriented appropriately inside the ear canal.

2. Select a fitting configuration (open vs. closed) in the manufacturer's software and select your preferred prescriptive formula. This formula will need to be available in your real-ear equipment as well.

3. Set your real-ear equipment to record the real-ear aided response and select the same prescriptive formula that is being used in the manufacturer's software.

4. Record the real-ear aided response, adjusting the hearing aid to match prescribed targets.

5. Present this information to the patient, pointing out the relationship of the hearing aid response to his or her audiogram. Inquire about sound quality and listening comfort.

6. If the patient requests adjustments to the prescribed response, adjust the response to address these comments while illustrating how these adjustments relate to the patient's audiometric information. Most patients will understand that hearing aid output must be audible in order to provide appropriate benefit. If the patient has visual confirmation that he or she is requesting the hearing aid be turned down below the audiogram, this will help establish realistic expectations for that patient and may present an opportunity to develop a treatment plan that includes increasing audibility over time.

This discussion is a reminder that the fundamental goal during a hearing aid fitting is restoration of audibility of conversational speech. Prescriptive targets ensure that we meet the needs of our patients with regard to speech audibility, but these targets are only a part of the process. To ensure that a patient is successful with hearing aids, we must also optimize sound quality for the patient based on her specific needs and preferences. This individualized balance between ensuring audibility and optimizing sound quality is something that can only be achieved by measuring the hearing aid response in the patient's ear.

Jason A. Galster, PhD, is the manager of clinical and comparative research at Starkey Laboratories, Inc. Readers may contact Dr. Galster at jason_galster@starkey.com.

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