



MOVING BEYOND THE AUDIOGRAM

BY DAVID A. FABRY

IT IS TIME TO MOVE BEYOND RELIANCE ON THE ANTIQUATED AUDIOGRAM (WHETHER AUTOMATED OR CREATED BY AN AUDIOLOGIST) TO SUPRATHRESHOLD PSYCHOPHYSICAL AND OBJECTIVE MEASURES THAT ENHANCE INTERVENTION STRATEGIES AND IMPROVE THE FIT OF HEARING AIDS, IMPLANTS, AND AURAL REHABILITATION STRATEGIES.

The audiogram has served as a widely used and highly valued diagnostic tool since its introduction in the United States during the early part of the twentieth century (Dean and Bunch, 1919). James Jerger (2013) provides an excellent historical perspective on the development of the modern audiogram and how it came to be viewed in its “upside down” form. In his article, Jerger discusses the work of numerous researchers, including Fowler, Fletcher, and Wegel, who to varying degrees argued for the inclusion of concepts in the basic test battery beyond the expression of hearing thresholds, such as residual auditory area, suprathreshold sensation, and retained sensory capacity.

Sadly, despite the efforts to modify or improve the audiogram, very little has changed in nearly 100 years. In fact, since the development of the half-gain fitting formula by Lybarger (1944), hearing thresholds still serve as the basic building block for determining degree of loss and “target” gain requirements. Although many would view it as heresy to claim that the audiogram is not needed for modern-day hearing aid fitting, it certainly represents an oversimplification of hearing loss as a “threshold” issue only as it relates to candidacy, verification, and aural rehabilitation for children and adults.

In newborns, even basic behavioral audiometry is challenging, because of their inability to respond reliably to acoustic stimuli near threshold. Fifty years ago, the original report of the Advisory Committee on Education



of the Deaf, also known as the Babbidge Report, was presented to the Secretary of Housing, Education, and Welfare, recommending the development and nationwide implementation of “universally applied procedures for early identification and evaluation of hearing impairment” (Babbidge, 1965). At the time, there were no reliable “objective” test measures available for use with early identification of hearing loss (beyond the Moro reflex, an infantile reflex of the central nervous system).

Two years later, Sohmer and Feinmesser (1967) provided evidence that auditory brainstem response (ABR) measures could be used to obtain cochlear potentials non-invasively with surface electrodes. It would take nearly 11 more years before otoacoustic emissions would be demonstrated experimentally, in 1978, by David Kemp, although Thomas Gold (1948) had predicted their existence many years earlier.

Undaunted, Marion Downs and the other pediatric audiology pioneers of the 1960s and 1970s had the vision and fortitude to challenge those who said that universal newborn hearing screening was not feasible, practical, efficient, or worthwhile. They built an infrastructure around the goal of universal screening, anticipating that technological breakthroughs would take place that would help them realize their long-term objective.

In contrast to the dogged determination of Marion Downs and colleagues to let nothing stand in the way of achieving the Babbidge Report’s recommendations for

universal newborn hearing screening, it is remarkable that the basic audiological test battery has remained essentially the same for decades. Despite increasing evidence in the literature regarding the impact of psychoacoustic (peripheral and central), non-auditory (personality, cognitive factors, motivation, expectations), and lifestyle (speech understanding in complex listening environments) factors, we have clung to a threshold measure of deficit to characterize initial hearing aid candidacy. In so doing, we have failed to create a sense of urgency for action and, as a result, annual hearing aid sales and the average age of first-time hearing aid users have remained roughly the same for years.

Where is the big, hairy, audacious goal (BHAG) that will galvanize the health-care community, audiologists, and Baby Boomers to recognize the importance of healthy hearing in aging individuals (i.e., a Babbidge Report for aging adults)? Hypothetically, if we were provided the opportunity for universal identification and evaluation of hearing impairment in persons ages 65 years and older, would we be able to meet their needs with our current staffing levels and best practice models of care? I will argue that our complacency with the audiogram as the “status quo” has left us short in other areas related to hearing aid candidacy and fitting, including the following.

Two Ears, One Mouth

When I was young, my dad used to tell me that I had two ears and one mouth, and I should use them proportionately. Many clinicians, including myself, have never learned to heed that advice. Despite the fact that most hearing aid patients present to the initial hearing aid consultation with (at best) an approach/avoidance internal conflict that has compromised their “patient journey” to hearing health, many clinicians immediately progress to “problem-solving” mode before addressing fundamental issues. Clark, Maatman, and Gailey (2012), however, point out that the strongest motivations for change arise internally, and have provided tools that may offer a framework to assist patients with tapping into their internal motivation to more readily accept and act upon treatment recommendations. This “patient-centric” approach represents a departure from the “test-first” approach used in many practices.

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Low ‘Face Validity’

From a consumer perspective, audiometric testing completed in a test booth consistently ranks lower on “likelihood to recommend” a professional and/or protocol in comparison to other parameters, including sound quality, verification, and objective benefit measurements in multiple listening environments (Kochkin et al, 2010). The reality is that one of the first signs of hearing loss is often an inability to hear and understand speech in noisy environments, and hearing aid candidates often do not understand why they are being evaluated with pure-tones in a sound-isolated test booth. This perception, in combination with lack of proper counseling, often leads to the perception that “they didn’t understand my problem because they didn’t test me in the situations where I have trouble.” Even when speech tests are used as part of the basic audiological battery, speech is usually presented in quiet—without the presence of background noise.

This practice dates back to the time when most hearing aid fittings were monaural and the ear with the best word recognition was selected as the ear to aid. Now that the United States has one of the world’s highest binaural fitting rates, this rationale has outlived its utility. So has the use of phonetically-balanced (PB) speech “rollover” measures for differential

diagnosis of acoustic neuromas; electrophysiological measures are far more sensitive and specific for the presence of retrocochlear pathology.

The most effective use of speech testing is in the presence of background noise (Killion et al, 2004; Wilson et al, 2007), which provides compelling evidence that you cannot predict speech recognition results from speech recognition in noise or from pure-tone thresholds. In addition, speech-in-noise testing has high face validity with patients and their families because the test is conducted where they have trouble, and may also assist with the selection of advanced features such as directional microphones and/or remote microphone technology.

TABLE 1 illustrates a metric based on the QuickSIN speech-in-noise test (Killion et al, 2004) that supports the use of advanced signal-processing strategies for persons with more significant impairments. The literature clearly supports the use of speech-in-noise testing to augment audiometric testing, yet few clinicians have incorporated this into their routine. There are other measures, including the Hearing in Noise Test (HINT) or Acceptable Noise Level (ANL), but the speech-in-noise measure is the one test that should be added to the basic test battery—now.

TABLE 1. Categorizing signal-to-noise ratio loss by severity and relating it to technology needs (based on Killion et al, 2004).

SNR Loss	Category	Technology Needs
0–2 dB	Normal	Omni-directional microphones
2–7 dB	Mild	Fixed/dynamic directional microphones
7–15 dB	Moderate	Dynamic/adaptive directional microphones
>15 dB	Severe	FM/remote microphone system

Too Peripheral

Much attention has been focused on the Lin et al (2011) study that found hearing loss to be independently associated with incident all-cause dementia. If there is one word that strikes fear into the hearts and minds of most Baby Boomers, it is “dementia,” as many have had first-hand experience with the disease through family or friends. The fact that untreated hearing loss has been correlated with dementia provides audiologists with a tremendous opportunity to create a sense of urgency among Boomers for

diagnosis and treatment of hearing loss. That said, we have not adapted our test protocols adequately to incorporate memory, divided-attention tasks, or cognitive function. More attention needs to be focused on differentiating peripheral versus central hearing losses, particularly as related to sensory deprivation and the “brain nourishment” provided by hearing aids and cochlear implants.

Nina Kraus and her colleagues have published a series of studies that investigate the brainstem correlates of speech-in-noise perception

and neural response degradation with age (Anderson et al, 2010; Anderson et al, 2011). In addition, it has been reported that musicians are better at hearing speech in noise and better with increased musical experience (Parberry-Clark et al, 2009). By increasing our thinking outside the “test box” and pure tones, we will be better prepared to address how hearing aids may help slow the aging process for a Baby Boom generation obsessed with youth.

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Too Labor Intensive

Audiology is one of the few doctoral-level health-care professions that does not routinely use support personnel for basic clinical procedures. To meet the needs of the burgeoning number of individuals with hearing loss, we will need to more actively develop and engage support personnel into our clinical practice. Regardless of whether we are simply control freaks, or professionally insecure, we must operate more efficiently, and that means taking greater advantage of automated testing (when appropriate) and working with support personnel.



THE LITERATURE CLEARLY SUPPORTS THE USE OF SPEECH-IN-NOISE TESTING TO AUGMENT AUDIOMETRIC TESTING, YET FEW CLINICIANS HAVE INCORPORATED THIS INTO THEIR ROUTINE.

Moving Beyond Reliance

In summary, to increase awareness and hearing aid use, we need to be emboldened by the same spirit that challenged advocates of universal newborn hearing screening to build a sustainable model of hearing care when “best practice” measures were still being developed. This will require moving beyond reliance on the antiquated audiogram (whether automated or created by an audiologist) to suprathreshold psycho-physical (speech-in-noise tests, loudness normalization) and objective measures (otoacoustic emissions, auditory evoked potentials, and positron emission tomography) that enhance intervention strategies and optimize the fit of hearing aids and cochlear implants. Finally, incorporating a patient-centric approach prioritizes the needs of the patient as essential to increasing hearing aid use among the emerging hearing aid users in the Baby Boom generation. 

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