

Three pre-tests: What they do and why experts say you should use them more

By H. Gustav Mueller



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The *Hearing Journal* always has one Cover Story a year that relates to fitting hearing aids. Sometimes we talk about features, sometimes selection and verification, and other times, like last year, we gather a group of “Knights” at a round table and talk about products.

This year we’re going to visit the “pre-test world” of the overall hearing aid fitting process. There we will consider what tests might provide useful information prior to the fitting of amplification. Usually we’re thinking in terms of new hearing aid users, but it’s reasonable to think that experienced users would benefit from pre-testing too.

There are some commonly conducted pre-tests, such as the pure-tone audiogram, immittance, and word-recognition testing. These, however, really are part of

the diagnostic battery, and are routinely conducted even on people who are not hearing aid candidates. What I’m referring to are pre-tests that are specifically conducted to assist in the selection and fitting of hearing aids. This could involve measures of loudness discomfort, speech understanding, noise annoyance, central auditory processing, cognitive function, expectations of hearing aid performance, or even personality assessment. With so many tests, which do we do?

Pre-testing takes time, and we all know Benjamin Franklin’s adage, “*Time is money.*” However, we must also remember the advice of Mark Twain: “*Always do right. This will gratify some people and astonish the rest.*” All “*Best Practice*” guidelines discuss the importance of pre-testing. But what is the “right” amount of pre-testing to conduct?

One could write a Cover Story about any one of the different areas of pre-testing. For now, I’m going to focus on three different speech-in-noise tests. On the surface, they might seem similar, yet research suggests that they assess different patient attributes—attributes that just might impact on hearing aid use, benefit, and satisfaction. The tests I’m referring to are the QuickSIN (SIN = Speech In Noise), the Acceptable Noise Level (ANL) test, and the Performance-Perceptual Test (PPT), which includes the calculation of the performance/perceptual discrepancy, referred to as the PPDIS.

All three tests have been available for clinical use for at least 10 years, and all have been recommended as part of a pre-fitting protocol.

A UNIQUE POPULARITY SURVEY

Since our three speech tests have been talked about for several years, I thought it might be interesting to take a look at how popular they are today in hearing aid dispensing practices. To determine this, we conducted a survey that was somewhat unique. All respondents (n=107) were licensed hearing aid dispensers attending a hearing aid fitting workshop; approximately 80% were audiologists. In a group setting, a 20-minute PowerPoint lecture was given about each pre-fitting measure, describing the purpose of the test, its administration

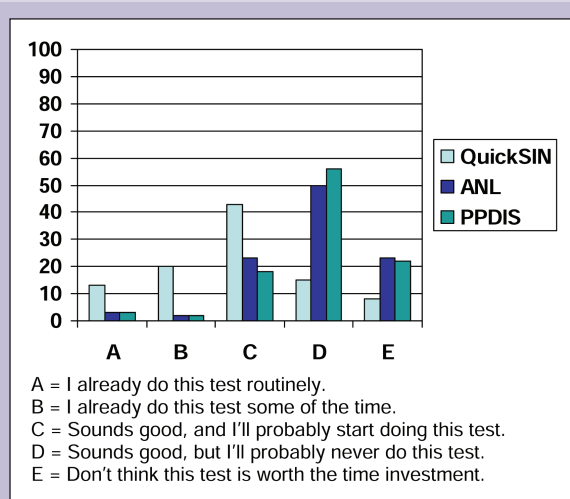


Figure 1. Distribution of popularity, as rated by dispensers ($n=107$), of three speech tests associated with hearing aid fittings.

and scoring, and how the test could be used for fitting and counseling. Supporting literature from peer-reviewed journals also was reviewed.

The review of each procedure was more or less neutral, although there probably was a slight “pro-test” flavor to the data presentation. At the end of the presentation for each test, the audience “voted” on the test. Five different choices were possible, as listed in Figure 1:

The results of the survey are also shown in Figure 1. As you might expect, of the three tests, the QuickSIN was by far the most popular, being used by 33% of respondents, with another 43% reporting that they would probably start using it. Although over 50% of respondents believed that both the ANL and the PPT sounded like pretty good pre-tests, fewer than 5% of respondents were using them, and only another 18%-23% stated that they thought they might start. If you're a fan of pre-testing, the sad finding is that even after my 20-minute “pep talk,” about 75% of the group indicated that they would probably never use either the ANL or PPT. Why not?

Neither the ANL nor the PPT has the history or the exposure of the QuickSIN, so the QuickSIN's greater popularity isn't surprising. Also, I suspect that most dispensers believe that a person's understanding of speech in background noise has a greater impact on the overall fitting than the patient's perception of their understanding, or how much background noise annoys them. And, relating back to Ben Franklin's quote—if dispensers believe they have time to conduct only one speech pre-test, the QuickSIN probably will win.

Despite that, we'll continue with our discussion of all three tests. After all, people do change their minds. And, we've already collected the opinions of Gaby Saunders and Patrick Plyler regarding the other two tests.

Much has been published about all these tests (see page 23 for a list of articles), but here's a brief review. Note that, although similar material is used, they are designed to measure different things.

ABOUT THE TESTS

❖ **QuickSIN:** Measures the patient's understanding of key words of sentences with background noise present (noise = four-talker babble). The sentences are presented at six different signal-to-noise ratios ranging from +25 to 0 dB. Can be scored either as SNR Loss or percent correct.

○ *Clinical application:* Provides a quick estimate of how a patient understands speech in background noise, which can be used for selecting technology and counseling on expectations for different listening situations.

❖ **ANL:** As the name suggests, this test measures the highest level of background noise that the patient finds “acceptable” while listening to speech at their MCL. The difference in dB between the MCL speech signal and the acceptable background noise (e.g., the SNR) is referred to as the ANL.

○ *Clinical application:* The ANL score has been shown to be associated with the amount of hearing aid use. Individuals with large ANLs can be targeted for counseling.

❖ **PPT:** The test behind the PPT is the Hearing In Noise Test (HINT), which is given to the patient twice. In one condition, referred to as “performance,” the test is scored in the normal manner, which determines the SNR for 50% correct. This is referred to as the speech reception threshold in noise (SRTN), or the reference threshold for sentences (RTS). In the second condition, referred to as “perceptual,” the SRTN is determined based on the patient's report of whether he or she got all the words in the sentence correct. The perceptual score is subtracted from the performance score to obtain the PPDIS.

○ *Clinical application:* The performance HINT provides information similar to the QuickSIN. The PPDIS reveals patients who are either “overestimators” or “underestimators,” and counseling can be then tailored accordingly.

WHAT THE EXPERTS SAY

I could tell you why I think you should consider adding these pre-tests to your fitting protocol, but I'm sure you'd rather hear it from the experts. The first of these is Patty Niquette, AuD, of Etymotic Research, the home of the QuickSIN.

About QuickSIN

HJ: Hello, Patty. It seems that you've been the face of the QuickSIN for quite a few years. How did that come about?

Niquette: I was the project manager at Etymotic on the development of both the QuickSIN™ and BKB-SIN™ speech-in-noise tests. I coordinated data collection and analysis, wrote the instruction manuals, and helped prepare the QuickSIN manuscript for publication in *JASA*. I've been the in-house champion of both tests since their conception.

HJ: Do you see the QuickSIN as a routine measure prior to a hearing aid fitting?

Niquette: Absolutely; I recommend using the QuickSIN



Patty Niquette

for all adult patients as part of the routine audiometric test battery. It was designed to provide a quick and easy estimate of a patient's ability to hear speech in noise. This is obviously important for hearing aid patients, but it's also useful to establish a baseline for patients who aren't hearing aid candidates, such as persons who have high sound exposures. Noise- or music-induced hearing loss is insidious, and the effects may go unnoticed for years. Changes in otoacoustic emissions and hearing-in-noise tests may provide an early indicator of damage.

HJ: So, are you saying that the QuickSIN should be as routine as monosyllabic word-recognition testing?

Niquette: That's right, and here's another example why. A few years ago an audiologist who uses the QuickSIN on every patient told me he had identified at least three acoustic tumors based on QuickSIN results. The patients had vague complaints, normal hearing thresholds, and normal middle ear studies. The only clinical finding was asymmetric QuickSIN results (significantly different scores in each ear), and he referred for MRI based on those results. Obviously we could use research in this area, but I was impressed by his findings.

HJ: Getting back to pre-testing for hearing aids, how would you suggest the average dispenser use specific results for counseling or making technology decisions?

Niquette: The QuickSIN manual provides SNR Loss categories. When you know the degree of SNR loss and the amount of SNR improvement each technology provides, you can counsel the patient on what to realistically expect. For example, the best directional-microphone hearing aids provide about a 5-dB improvement in SNR. Someone with a mild (0-3 dB) or moderate (2-7 dB) SNR loss will probably do well in noisy situations with good directional-microphone products. However, someone with a moderate (7-15 dB) or severe (>15 dB) SNR loss needs more SNR improvement than directional microphones can provide to be able to function in noise.

HJ: How about the administration of the test? Any suggestions?

Niquette: Although the QuickSIN can be administered under earphones or via loudspeaker, I prefer using earphones because (1) I do it as part of the audiologic evaluation, and (2) it's easier to hear the patient's responses. The test should be administered at 70 dB HL or higher (if the three-frequency pure-tone average is greater than 45 dB HL, presentation should be at a level the patient judges as loud, but not uncomfortably loud). For a quick estimate of SNR loss, it's okay to test binaurally. For ear-specific information, test each ear separately. Insert earphones reduce the need for masking the non-test ear. Use two to three lists per condition and average the scores. If you train the patient using test instructions from the QuickSIN manual, a practice list often isn't neces-

sary. It's okay to pause between sentences if the patient needs a little extra time to respond. Information on reliability and comparing two conditions is in the QuickSIN manual, and I'm available by phone or email to answer questions.

HJ: As you mentioned earlier, there also is the BKB-SIN. When do you recommend using that version?

Niquette: Always when testing children, and sometimes when testing adults (those for whom the QuickSIN is too difficult, such as elderly patients with auditory memory difficulties or some cochlear implant patients). The QuickSIN sentences are at approximately a high-school language level, so there are no norms for children. The BKB-SIN has shorter, simpler sentences at approximately a first-grade language level. The BKB-SIN has norms for both adults and children.

ANL began in Tennessee

Our next guest is Patrick Plyler, PhD, who has conducted extensive research with the ANL. Patrick is associate professor, Department of Audiology and Speech Pathology, University of Tennessee. The ANL is also a speech in noise test, but the task is quite different.

HJ: Patrick, you and the ANL both have University of Tennessee roots, right?

Plyler: True on both accounts. The Acceptable Noise Level (originally termed tolerated signal-to-noise ratio) was developed by Anna Nabelek, Frances Tucker, and Tomasz Letowski in 1991. In the early 2000s, Dr. Nabelek teamed with Sam Burchfield to determine if the ANL could serve as a predictor of hearing aid use. Over the past several years, many people here at the University of Tennessee have conducted research on the ANL, and we continue to do so.

HJ: Our survey shows that the ANL really hasn't caught on as a routine hearing aid fitting pre-test. What are your thoughts?

Plyler: I'm a little puzzled by that finding. I definitely recommend using the ANL as a routine pre-test measure for all hearing aid patients. There are several reasons to do so, all related to the fact that it is a good predictor of hearing aid use. In this sense, the ANL serves as the "front porch" to the hearing aid fitting process. Luckily, ANL values can be obtained in about 2-3 minutes, are highly reliable, and easy to interpret. The results can be used both for technology decisions and patient counseling.

HJ: How do you categorize ANL findings?

Plyler: I suggest classifying the patients in one of three ANL groups: Low (7 dB or less), Mid-Range (8 to 12 dB), or High (13 dB or greater). Patients with low ANLs have a high probability of success (over 75%) with hearing aids regardless of the technology or counseling implemented. For patients with mid-range ANLs, the probability of success with hearing aids varies from around 75% to 20%. Recent research conducted in our laboratory indicates that combining directionality and digital noise reduction (DNR) improves ANL values by

an average of almost 8 dB (relative to omnidirectional without DNR). If these benefits are also obtained in real-world use, the listener's probability of becoming a successful user improves substantially.

Unfortunately, listeners with high ANLs (above 13 dB) may improve with technology, but not enough to become successful. Possibly auditory training techniques could be developed to physiologically improve acceptance of noise. If so, listeners with high ANL values may undergo training to improve their ANL prior to initiating the hearing aid trial.



Patrick Plyler

HJ: *Anything related to bilateral fittings?*

Plyler: We've found that ANL values do not improve when tested binaurally (versus monaurally) or when aided bilaterally (compared to unilaterally); however, a small percentage of listeners do exhibit intra-aural differences in terms of acceptance of noise. In the case of someone with a bilateral hearing loss who will be receiving a unilateral hearing aid fitting I suggest measuring ANLs monaurally to determine if an intra-aural difference exists. If so, the ear with the lower ANL should be fitted.

HJ: *Any tips for someone starting out on the this test?*

Plyler: When I conduct the measurement, I like to start by using the example of the "three little bears." For the MCL and BNL measurements, we are identifying the levels that are "too hot, too cold, and then just right." Also, ANLs can be accurately measured under earphones or in the sound field and can be measured monaurally or binaurally, depending on the needs of the patient.

HJ: *It's certainly easy and inexpensive to obtain the standard CD for ANL testing, but what if people use other speech and noise material? Are you okay with that?*

Plyler: Sort of. Since ANL values are not related to the type of background noise used or the type of speech signal used, clinicians that do not possess the standard ANL materials may still obtain ANL data by using stimuli available in their clinics. A patient with a low ANL using the standard materials would have a low ANL using alternative materials; however, the ANL value may not be exactly the same.

HJ: *Anything else?*

Plyler: Just one more thing. Although the ANL should not supplant speech-in-noise tests for CI patients, it may be a useful addition to the battery, particularly for those who cannot complete the understanding tasks.

Measuring perception of performance

The person behind the PPT is Gabrielle Saunders, PhD, investigator at the VA National Center for Rehabilitative Auditory Research in Portland, OR. The PPT uses the HINT for data

collection, but the interpretation goes beyond the typical HINT score.

HJ: *You are indeed the person who developed the performance-perceptual test, right?*

Saunders: That's correct. Back in 1988 we developed the PPT as a tool for assessing individuals with Obscure Auditory Dysfunction (OAD), i.e., people who have clinically normal hearing thresholds yet who complain of difficulties hearing. It was a way to determine if these individuals misjudged their speech understanding ability. We did this by measuring actual understanding of speech-in-noise (performance) and perceived understanding of speech-in-noise (perceptual). By computing the difference between these two variables we obtained a measure of "misjudgment" of hearing (the PPDIS). We found that about 50% of people with OAD underestimated their hearing ability. We then wondered if the PPT could be used to understand why some people resist getting hearing aids and why others say they don't get hearing aid benefit—even though objective speech testing suggests that they do.



Gabrielle Saunders

HJ: *Do you see this test as being a routine pre-test measure before the hearing aid selection and fitting?*

Saunders: The PPT probably has the greatest use as a post-fitting measure, but I know that wasn't your question. I think it certainly provides useful information for patients who believe they don't need hearing aids. And, since documentation of unaided hearing disability, hearing aid benefit, and the extent to which the patient misjudges either or both of these is valuable, the routine use of the PPT as a pre-test definitely can be beneficial, if time permits.

HJ: *Our recent survey showed that there are many dispensers considering using the PPT as a pre-test. How would you suggest they use the findings?*

Saunders: We've all seen patients who insist they don't need hearing aids, even though audiometry and observation show they do. Showing a patient that their Performance SRTN is poorer than that of age-appropriate norms can help them realize the extent of their hearing impairment. Further, if such a patient is an overestimator, i.e., believes they can hear better than they actually can, PPDIS counseling can further help him/her to "recalibrate" to reality.

On the other hand, if the patient is an "underestimator," this would also be good to know when you send them out the door with a new pair of hearing aids. In this case the PPT counseling for underestimators would remind them to have confidence in their ability to hear.

HJ: *Anything special we need to know about administering the test?*

Saunders: Running the PPT with the HINT system is

straightforward. You should always run the Perceptual SRTN before the Performance SRTN. If you plan to run the PPT both unaided and aided, which is highly encouraged, it is necessary to do sound field testing. I recommend fixing the presentation level of the background noise at 65 dB SPL and adaptively adjusting the level of the speech. It is not unusual that patients have to be encouraged initially to make the judgments during the Perceptual SRTN. But, generally, after one or two sentences, they understand the task and can conduct it reliably.

HJ: *Just curious, why always do the “perceptual” portion first?*

Saunders: We suggest running the Perceptual SRTN before the Performance SRTN so that patients don't try to guess what the PPT is about. I have always assumed that if someone might think you are trying to “catch them out” as it were, this could water down the potential difference between the perceptual and performance SRTNs.

HJ: *Finally, our survey polls show that many dispensers already do the QuickSIN. Could they then just do a perceptual version of the QuickSIN and calculate the PPDIS? Wouldn't this be pretty much the same as a HINT PPDIS?*

Saunders: This is a great question and something we need to look into. To run the QuickSIN in the Perceptual

condition, patients could specify how many of the key words they think they heard correctly. We could use this to compute their perceptual SNR loss. Patients would be doing a different task from that used for the current PPT, which just requires a simple yes/no judgment. But I don't see why people shouldn't be able to do it. I think you've just come up with a new study for us. Thanks.

SAME OR DIFFERENT?

So now you've heard from the experts about all three of our speech-in-noise pre-tests. Recall that I mentioned earlier that it's generally believed that the tests tend to measure different patient attributes. This, of course, is an important question when you're deciding if you really need to do all three, or even two of the three. For example, if people with a poor QuickSIN score also tended to have an unusually large ANL, and their PPDIS always showed they were a significant “underestimator,” then there wouldn't be much reason to do all three tests.

There has been some research suggesting that performance scores among these tests would not be significantly correlated, although they haven't been compared directly. I'd like to summarize some research that Earl Johnson, Jenny Weber, and I recently completed on this topic.*

We conducted testing bilaterally in the sound field for hearing-impaired individuals with downward-sloping, high-frequency hearing loss. While the testing was conducted unaided, all participants were satisfied users of bilateral hearing aids. In

* For the complete article see: Mueller HG, Johnson E, Weber J: Fitting hearing aids: A comparison of three pre-fitting speech tests. *AudiologyOnline.com* March 2010.

SUPPORTING INFORMATION

QuickSIN

- QuickSIN User Manual; www.Etymotic.com
 - Developing a quick speech-in-noise test for measuring signal-to-noise ratio in normal-hearing and hearing-impaired listeners Killion, et al.: *JASA*, 116 (4), 2004; www.Etymotic.com
- To order test: CD available from www.Etymotic.com, or www.Auditec.com

ANL

- Page Ten: Acceptance of background noise: Recent developments. Plyler: *Hear J* April 2009; www.TheHearingJournal.com
 - Acceptable noise level: Research and current application Freyaldenhoven, *AudiologyOnline*, Feb 2007; www.AudiologyOnline.com
- To order test: CD available from www.Frye.com

PPT

- Page Ten: Understanding in noise: Perception vs. performance. Saunders: *Hear J* May 2009; www.TheHearingJournal.com
 - The performance perceptual test (PPT): Clinical applications. Saunders, *Audiology Online*, March 2009; www.AudiologyOnline.com.
- To order test: HINT Pro system (software and hardware) available from www.natus.com. HINT CD no longer available.

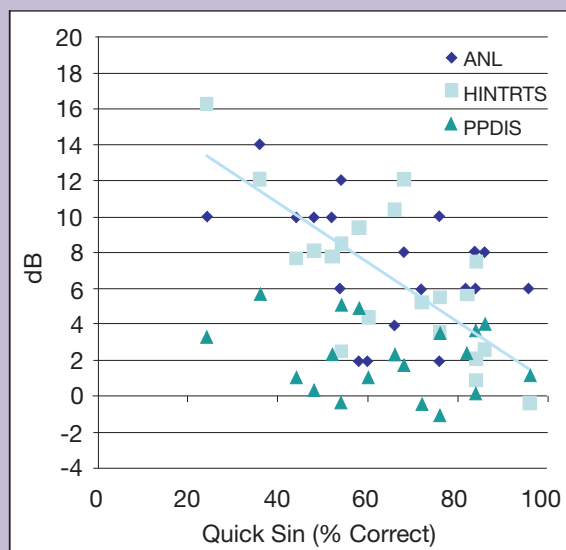


Figure 2. Distribution of test results for the QuickSIN (shown on X-axis in percent correct), HINT RTS, PPDIS, and ANL. The light-blue regression line indicates the only significant correlation ($p < .01$), which was between the HINT RTS and the QuickSIN. Adapted from Mueller, HG, Johnson E, Weber J: Fitting hearing aids: A comparison of three pre-fitting speech tests. *AudiologyOnline.com* March 2010.

randomized order the participants received the PPT (PPDIS calculated), the QuickSIN, and the ANL test.

The distribution of results for the three speech tests is shown in Figure 2, along with the performance score for the HINT, which is part of the PPT. For this display, we converted the QuickSIN score to percent correct rather than the more common SNR loss (e.g., SNR loss 0 dB = 85% correct). This is shown on the X-axis; the Y-axis is the dB score for either the HINT RTS (SRTN), PPDIS, or ANL. What can be visualized in Figure 2 is that the only test significantly

associated with the QuickSIN was the HINT RTS ($p < .01$). That is an expected finding since both are speech-in-noise intelligibility tasks. Note, however, that there is no significant relationship between the QuickSIN and the PPDIS or the ANL. The ANL and the PPDIS also were not correlated.

Also, none of the three tests that we studied were significantly correlated with the age of the respondents or degree of hearing loss. In general, these findings are in agreement with previous studies and they support the notion that the QuickSIN, ANL, and PPDIS are measuring somewhat different auditory functions.

IN CLOSING

Back in 2001 we published a Cover Story titled: “Speech testing and hearing aid fitting: Going steady or just casual acquaintances?” Our conclusion at the time was that other than the time-honored monosyllabic word-recognition testing in quiet, speech testing didn’t play much of a role in the fitting of hearing aids—a casual acquaintance thing at best. Our 2009 survey reported in Figure 1 shows that not much has changed, at least not concerning the three speech tests we’ve been talking about. Even though tests such as the ANL and the PPT appear to bring new information to the fitting table, there seems to be little interest in making them part of a routine test battery.

So in closing, if we return to Mark Twain’s quote about doing what is “right,” more testing just seems more right than less, although we certainly do need some well-conducted research to support the notion that knowing the results of these additional tests really would make a difference.

We do know, however, that routinely conducting these tests prior to the fitting requires only a modest amount of time, can do no harm, will nearly always provide useful information, and will likely improve counseling strategies, which just might increase the benefit and satisfaction that the patient derives from hearing aids. That last statement reminds me of another Mark Twain quote: “All generalizations are false, including this one.”

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