BLOG

Testing for Cochlear Dead Regions Using a Piano

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The identification of cochlear dead regions has been the subject of much research over the last 15 years, and its importance cannot be overemphasized for the clinic. Given a cochlear dead region, *less* is typically *more*. Minimizing gain (or shifting away) from frequency regions with significant cochlear damage can result in a better hearing aid fitting.
Clinically there are three major approaches to handle cochlear dead regions:

1) Wait for complaints from the consumer during the trial period and then make adjustments;

2) Use a hearing aid fitting approach that automatically specifies non-linear frequency compression, and

3) Use some form of diagnostic clinical test.

A commonly used diagnostic test is the Threshold Equalizing Noise (TEN) test that is a "clinically efficient" pre-recorded psychophysical test based on cochlear tuning curves.[1-3] I have used the TEN test, but it takes me about 15-20 minutes to obtain results (2 dB steps and 4 test frequencies); others may have more luck, but perhaps I am just slow.
Over the past decade I have instead been using a "poor man's" version of the TEN test, utilizing my clinic piano. This test takes about 20 seconds and allows for a clear discussion with the

potential hearing aid consumer about some fine-tuning modifications that may be necessary apart from hearing aid fitting formulae. Actually, any garage-sale electronic keyboard would suffice, since this test is merely about a person judging whether two adjacent notes are the "same" or "different."

Here is how it goes…

Ask the hard-of-hearing person (without hearing aids) to sit down at the keyboard and begin somewhere on the middle-right side (250+ Hz) by playing every adjacent note going upwards (white key, black key, white key, black key…). They are to judge whether any two adjacent notes (semitones) are the same or different in pitch. Even for people with significant sensorineural hearing loss, the first octave or so will be quite easy, but as one reaches the last upper octave (2000-4000 Hz), this becomes a more difficult task. Once they find a region where they are beginning to have difficulty distinguishing the pitch, or simply cannot distinguish if there was a change in pitch, then this may be considered a cochlear dead region. The result is quickly converted from notes on the piano keyboard to frequency in Hz. The "C" that is one octave below the top note is 2000 Hz, the "G" above that is close to 3000 Hz, and the top note "C" is close to 4000 Hz.

This 20-second exercise can then be used to adjust frequency compression (speech) or gain reduction (music) depending on the results. In fact, this is also something that the potential hearing aid consumer can do for themselves before attending the initial appointment, using their own or a friend's piano.

How does this compare with the TEN test? In a pilot study of 10 hard-of-hearing people given a criteria of being within ½-octave, 8 out of the 10 gave results that were within ½-octave of the more time-consuming TEN test (2 of the 10 showed results that were greater than ½-octave).

Although this has only been investigated in my clinic at this point, an interesting piece of anecdotal information is that, for those hard-of-hearing people who as children had chemotherapy which impacted their hearing status, they appear to have a relatively low frequency cochlear dead region. This was surprising, given their audiogram. I don't see a lot of adults who had ototoxic chemotherapy as youngsters in my clinic, but two who had normal hearing up to 1000 Hz with a gradual audiometric roll-off to the 70 dB HL level at 8000 Hz, had cochlear dead regions (on both the TEN test and the piano same/different task) for frequencies as low at 1500 Hz (where the audiometric threshold was only 35 dB HL).

Given this more clinically efficient version of the TEN test, questions about cochlear dead regions might be addressed quickly and sometimes with surprising results. This might present a

neat AuD Capstone project for an interested student to study further by comparing and contrasting the two approaches.

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