AN EVALUATION OF THE IMPACT AND FEASIBILITY OF THE ANSI S3.22 2003 STANDARD FOR TESTING HEARING INSTRUMENTS

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1. Introduction

The purpose of a standard is to maintain comparison and reproducibility of Hearing Instrument (HI) measures across different facilities (Staab, 2002.) This project evaluated the ANSI S3.22-2003 standard adopted this May 2005 to measure its feasibility and to document any electroacoustic changes it would produce.

The 1987 version of the ANSI s3.22 required that all tests on automatic gain control (AGC) hearing aids be done with the AGC set for maximum effect. In 1996, this was changed to allow the manufacturer to specify the settings for the tests. Manufacturer specified settings tend to vary widely. Consequently, the 2003 version reverted back to the 1987 wording for the two tests of AGC function. This is intended to indicate hearing aid function in compression settings. The new standard accomplishes this by requiring the HI be set for "minimal AGC effect" in the first 2 phases of the test, Full on Gain (FOG) and Reference Test Position (RTP), and in "maximal AGC effect" for the final phase (ANSI, 2003.)

2. Method

The goal of this project was to: (1) Test the feasibility of the new standard by: (A) Determining whether a naïve clinician can follow the new wording; (B) Determining the ease and time consumption involved in testing by the new standard; and (2) evaluating the general changes in electroacoustic performance attributable to the new standard. We evaluated fifteen different HI's from seven different manufacturers.

Each HI was set as required by section 5.2.5 of the ANSI s3.22-2003 standard. An AGC HIT test using the Audioscan Verifit© was then performed and adjustments were made where prompted. Without making changes, an input/output test was also performed. This procedure was then repeated for the 1996 standard.

3. Results

3.1 Electroacoustic Comparison

The Figures below display the raw measurements obtained using the ANSI 1996 and 2003 test sequences. Figure A shows the relationship between measured gain at reference test position (RTP) and equivalent input noise (EIN) for each standard. Figure 2 shows the relationship between attack and release times measured with each standard. Repeated measures Analysis of Variance (ANOVA) was completed for the 12 measures obtained from each standard, to determine whether significant differences resulted from the changes between the 1996 and 2003 versions. Results indicated that some test sequence measures differed significantly across the two standards $F(1.88,20.71)=4.59$, $p=0.02$ (degrees of freedom adjusted using Greenhouse-Geisser epsilon for violation of sphericity). Post hoc pair-wise comparisons indicated significant differences for gain at RTP settings, and for attack and release times at certain frequencies (attack at 2000 Hz and 4000 Hz; release at 500 Hz and at 1000 Hz). In general, there was a trend for decreased gain at RTP with the 2003 standard, and for attack and release times to be longer. Some of these results can be explained by a few factors.

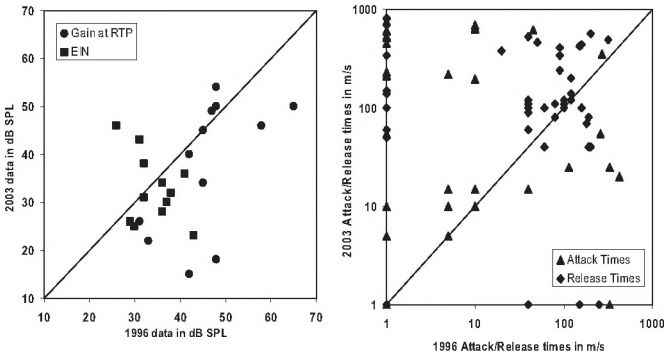

Figure A (Left): Equivalent Input Noise and gain at Reference Test Position with 1996 standard data being plotting against 2003 standard data. Figure B (right): Attack/release times for 1996 standard plotted against data from 2003 standard.

Firstly, many automated tests provided with the manufacturers software for the 1996 standard used a full-on gain setting as the reference test position. Essentially, these tests do not account for gain at RTP. This may account for the lower gain at RTP observed with the 2003 standard, which requires a non-full-on RTP. This is evident in cases that did provide true RTP gain: in these cases, the difference between the 1996 values and the 2003 values were less extreme. No real trend is visible with respect to EIN and no statistical significance was found.

Second, with respect to attack/release times, the old standard allowed the aids to be run at linear, in which case attack/release times were fast, as would be expected for a peak clipping device. The new standard requires use of compression, which, for many devices, resulted in appropriately longer attack and release times because the compression processing was active during ANSI testing.

3.2 Specification Sheets

The data sheets provided for any given hearing instrument are a necessity for verifying device performance. Data sheets provided by manufactures should provide complete documentation of HI test settings and expected test results; however, this is not always the case. Figure C below displays the frequency that standard test measures appear in specification data provided by manufacturers. While some measures like EIN appear frequently (14/15 cases) others such as attack/release times appear infrequently (8/15). This is problematic, as information is often required to replicate specification data. However, even when this is not the case (and a software mediated test mode is provided) data is important for quality assurance and device comparison.

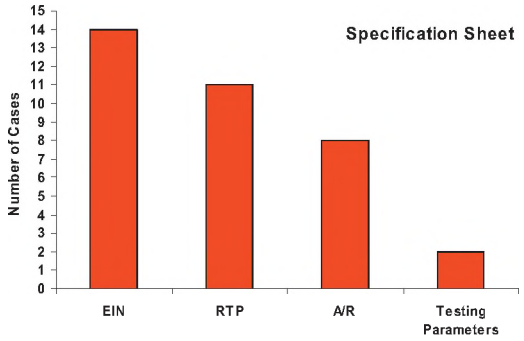

Figure C: Shows the frequency of various standard measures on manufacturer specification sheets

3.3 Software Mediated Test Modes

When properly implemented a test mode has the potential to eliminate error and increase reproducibility of results across different labs. Most manufactures (5 of 7 tested) use software mediated test modes. When not used, some (preferably all) test parameters need to be included. In practice, however, test modes are often not well labelled and lack critical stages in required by the standard (i.e. only 1 of the 5 manufactures using test modules included RTP setting.)

3.4 Confounds to Feasibility: Setting

Wording and issues of interpretation were a matter for concern. The 2003 standard asks for "minimal AGC effect", various clinicians could interpret this differently (ANSI, 2003.) For example minimal AGC effect might be construed to mean either linear or expansion. Another confound to feasibility was the association between HI setting controls. That is to say, a change in one control might inadvertently change another. This means that even when noticed, the clinician may have to choose which control is of greater importance (e.g. let max compression limit gain OR max gain limit compression.) Reproducibility may be compromised when a clinician must make a choice between two options.

Software flexibility proved another difficulty. The effects of having associated controls means one must learn the quirks of each setting program for each aid in order to "coax" the aid into maximal and minimal effects. The result is time consuming, frustrating and likely to be error prone. Some software also lacked control over critical features such as compression ratios, knee points and adaptive features that require adjustment according to the new standard.

3.5 Compliance

Compliance is a major issue for concern as it has been lacking in the past as was seen in the case of missing RTP settings, missing values on specification sheets and lack parameters being provided. For example, one manufacturer sent specification data on a new HI supposedly using the 2003 standard. However, it was run in a linear setting, which directly conflicts with the 5.2.5 wording of the test.

4. Conclusion

Some electroacoustic changes are present as a result of the change in wording, namely a decrease in gain at RTP and an increase in attack and release times at some frequencies. In addition, we found the feasibility of manually setting the 2003 standard to be low.

Therefore, it is our recommendation that: (A) Manufactures provide specification sheets including all fitting parameters and (B) Manufacturers include a test module that is clearly labelled and includes at least one stage for each of the three phases in the ANSI 2003 standard.

5. References

Staab, W. J. (2002) Characteristics and Use of Hearing Aids. In J. Katz (Ed.) *Handbook of Clinical Audiology*. New York: Lippincott Williams & Wilkins.

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