A§E MANUAL VS SELF-TEST CLINICAL VALIDATION: A§E PHONEME DISCRIMINATION

Introduction

Audiqueen has a function to perform various psychoacoustic tests in self-test mode (ST). In this mode, the patient can perform the test without help or instruction from an audiologist. The patient records his or her answers via a touch screen.

This study aimed to validate the clinical effectiveness of the Phoneme Discrimination (PD, Govaerts, et al., 2006) self-test compared with the normal testing procedure in which an audiologist gives instructions and performs the test.

PD manual (M) test procedure

The A§E PD test is an oddity test in which two phonemes are presented and the listener has to react to the odd phoneme. For this test, 20 phoneme contrasts (a-r, u-ʃ, u-a, u-i, i-a, o-a, i-ɛ, m-z, s-ʃ, ɛ-a, u-o, ə-a, ə-o, ə-ɛ, ə-i, z-s, v-z, ə-u, u-y, y-i) are typically presented at 70 dB HL, referenced to a 70 dB SPL 1 kHz narrow-band noise. A result of “yes” or “no” is recorded by the audiologist for the discrimination of each contrast, after two consecutive correct responses or after 5 out of 8 responses after a brief training mode.

PD self-test procedure

To perform a self-test, listeners are placed in front of a touch screen, while wearing the appropriate transducer, for example, headphones inside a soundproof test booth. Before running the test, the audiologist must select the appropriate phoneme contrasts to be tested. After a short introduction to get acquainted with the stimulus sound and buttons on the touch screen the actual test starts.

Materials and Methods

Subjects entry criteria

The validation was performed on 29 patients consisting of two groups: hearing aid (HA) and cochlear implant (CI) users. All subjects were at least 16 years of age and willing and able to:

- Perform a psychoacoustic test twice.
- Able to read and interpret detailed instructions and work with a touch screen.

Test procedure

Psychoacoustic testing is performed in a random sequence in ST mode or through M testing. Thirteen participants were first tested with M test and then with the ST, while 16 participants were tested first with the ST and then with the M test. After performing the 20 contrasts with one of the methods, the test is repeated by using the other one. In the second test, in addition to the contrasts that were not discriminated in the first test, five other random contrasts were tested too. In case more than five contrasts were not discriminated correctly, all the contrasts were repeated.

HA users were tested in free-field with a loudspeaker placed at 0° azimuth, 1m away from the listener. Either Otocube[1] or Coala[2] was used in the testing of CI users. Testing was conducted in Audiqueen psychoacoustic test suite (Otoconsult NV, Antwerp, Belgium).

Statistics

Descriptive statistics were used for the analysis of data. Vertical stacked bar charts were used for the presentation of data.

McNemar's test was used to detect significant within-subject differences between the results of the two methods. For McNemar's analysis, 2x2 crosstabs were applied for each phoneme contrast, as shown in **Table 1**.

Table 1. An example of a 2x2 crosstab used in McNemar's analysis.

		Self-test	
Manual test	Correct	Correct 22	Wrong 1
	Wrong	0	0

The significance level was set at 0.05. IBM SPSS Statistics for Windows, Version 20.0 (IBM Corp., Armonk-New York, United States) was used for data analysis.

[1] Otocube™: A portable desktop box which replaces a fully equipped audiological room for CI recipients.
[2] Coala™ is a testing environment in Audiqueen for Nucleus CP910 CI recipients through an AUX cable. This feature is developed by Otoconsult and Cochlear.

Results

Figure 1**, Figure 2**, and **Figure 3**) show how frequently the two test methods agreed or disagreed on the results of each phoneme contrast.

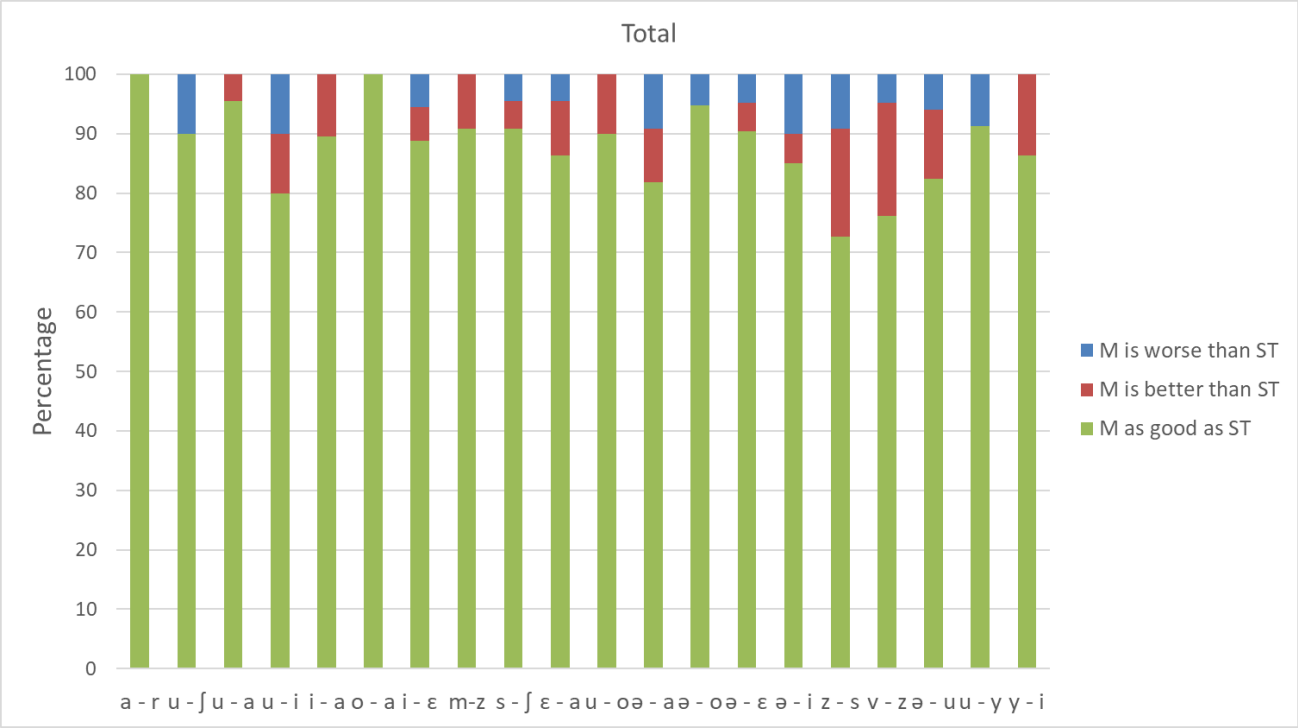

Figure 1. Frequency distribution of the cases in which both tests agreed or disagreed.

On average, both tests gave the same results in 88±7% (n= 367) of cases. M test results were better in 7±6% (n= 30) of the cases, and the ST results were better in 5±4% (n= 19) of the cases. McNemar's analysis did not reveal a significant difference between the M and the ST methods for any phoneme contrast ($p>0.05$).

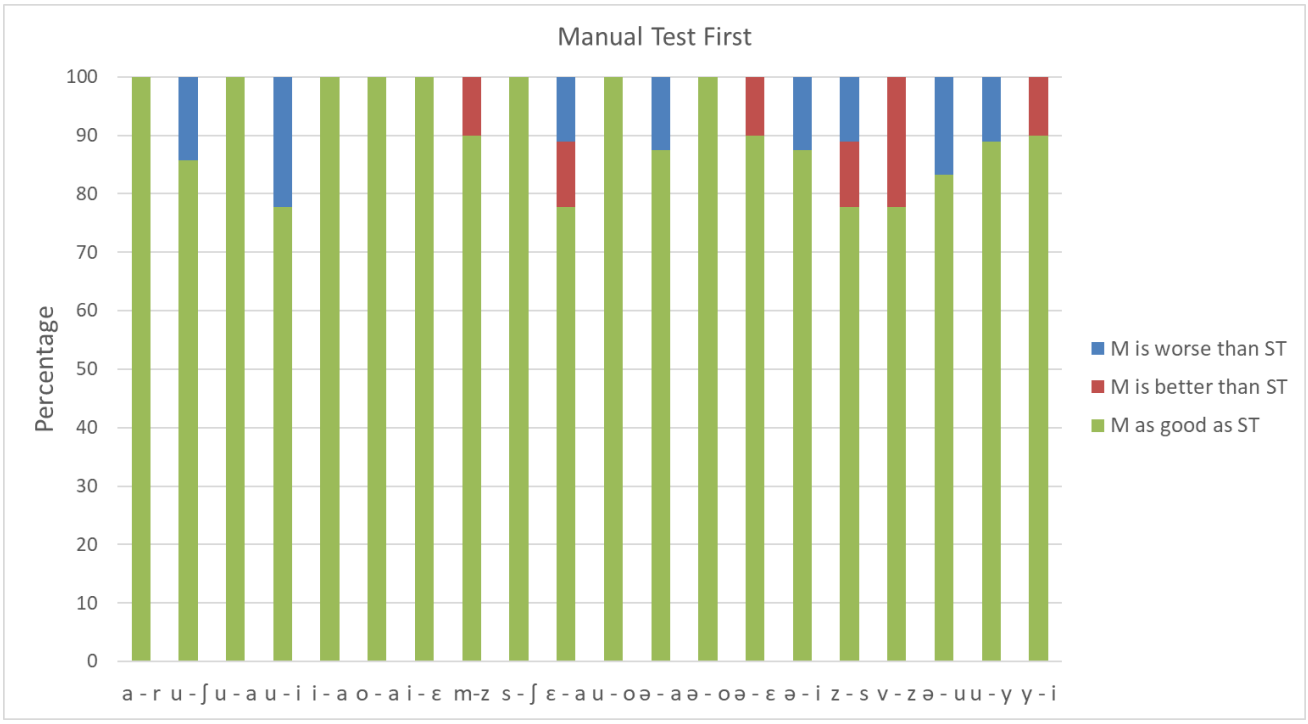

Figure 2. The frequency of cases where the results of the two tests agreed or differed when the manual test was performed first.

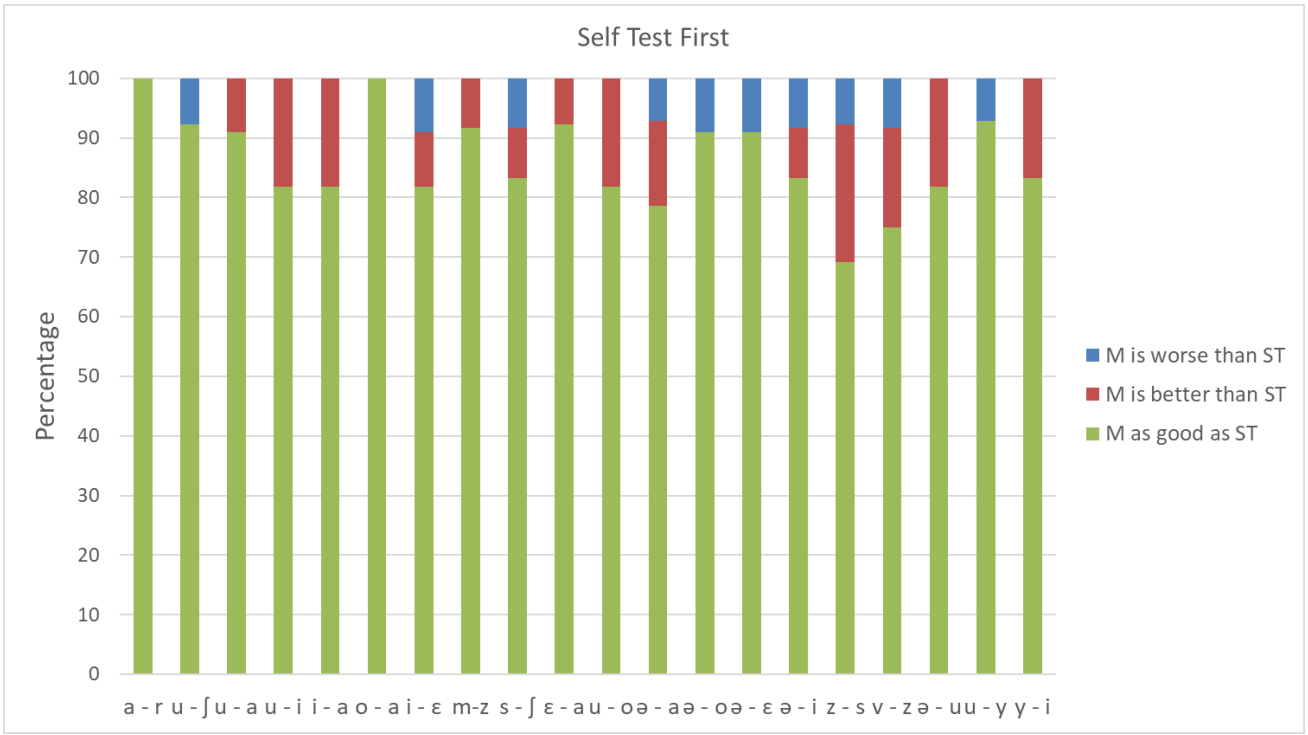

Figure 3. The frequency of cases where the results of the two tests agreed or differed when the self-test was performed first.

The average frequency of the two tests giving the same result when the first test was the M method was 91±9% (n= 163). Results from M tests were better in 4±6% (n= 7) of the cases, and ST results were better in 5±7% (n= 9) of the cases.

The two tests yielded the same results in 86±8% (n= 204) of cases when the ST method was used first. In 10±8 % (n= 23) of the cases, M test results were better, while in 4±4% (n= 10) of cases, ST results were better.

McNemar's analysis found no significant differences for any phoneme contrast based on the order of administration of the tests ($p>0.05$). However, although not statistically significant, the frequency of obtaining better results in the M method was more apparent in the two most difficult phoneme contrasts (/v-z/ and /y-i/). Furthermore, the frequency of improvement was two times higher than the frequency of deterioration in the second test results in cases where the order of administration of the tests was first ST and then M method (23 vs. 10) (**Table 2**).

Table 2. Distribution of the change in the results by test order.

	M is worse than ST	**M is better than ST**
First M	9	7
First ST	10	23

Discussion

The self-test and manual test results revealed no statistically significant differences for any phoneme contrast.

However, results were slightly better with the M-test method than with the ST method for the two most challenging phoneme contrasts ((/v-z/ and /y-i/), especially when the M-test was performed after the ST. A possible reason for this is the fact that the listener receives extra encouragement from the audiologist during the M test. During an ST, feedback to the listener is only given in written language by the computer. However, audiologists can provide feedback by making facial expressions and signs, which can help the patient, especially with more challenging phoneme contrasts.

Another reason may be that audiologists make patients train longer and more intensively for specific phoneme contrasts. In case of a wrong answer during the ST, the training mode is reactivated only once. If the listener still fails after training, the algorithm considers the discrimination failed and continues the test with the next phoneme contrast. In contrast, an audiologist can switch to training mode more than once for a specific phoneme contrast.

In any case, the difference between the two testing methods was not significant for any phoneme contrast and the ST method produced slightly worse results only for the two most difficult phoneme contrasts. In this case, the audiologist would put more effort into adjusting the T and C/M levels corresponding to the frequency ranges of these phoneme contrasts. In other words, obtaining more failures in the ST method for the most difficult phoneme contrasts would only benefit the patient, as the audiologist would focus more on those contrasts.

Conclusions

A§E PD manual and self-test results were compared in HA and CI users.

No significant differences were found between the two methods for any phoneme contrast. The results of this study show that the A§E PD self-test is a valid and reliable method and can be used as an alternative to the manual testing method.

References

Govaerts PJ, Daemers K, Yperman M, De Beukelaer C, De Saegher G, De Ceulaer G. *Auditory speech sounds evaluation (A§E): a new test to assess detection, discrimination, and identification in hearing impairment*. Cochlear Implants International, vol. 7(2) pp. 92-106 (2006)