

# Utility of the ORCA Nonsense Syllable Test

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## INTRODUCTION

A nonsense syllable test was developed to help assess speech identification and hearing aid benefit with today's more advanced features in hearing aids such as open fit, extended bandwidth and frequency lowering. Traditional word tests, which score by whole word correct, do not allow easy analysis such as error pattern. This 115 item nonsense syllable test uses a computerized presentation and scoring method. The nonsense syllables were formatted in a C-V-C-V-C order using the consonants /p, t, k, b, d, g, m, n, ŋ, f, v, θ, ð, s, z, ʒ, ʃ, tʃ, l, w, wh, dʒ, j, h, ʃ/. Each phoneme was presented in all three consonant positions. The exceptions: w, wh, ŋ, j, and ʒ may not have been in all three positions because the sound may not have occurred in a particular position in English. There were 5 vowels used /i, a, æ, ʌ, u/, covering the full range of vowel formant frequencies. An open format was used. Each item was preceded by the phrase "Please say the word..." by either a female or male talker.

This poster will briefly illustrate a comparison between a traditional word test [W-22] and the nonsense syllable test as well as the different levels of analysis available with the nonsense syllable test.

## METHOD

### Test Material

- W-22 [full list] and 115 item nonsense syllable test was presented in quiet at MCL.
- Speech was presented at a 0° azimuth one meter from the participant.
- The list of test items in the nonsense syllable test was randomized for each presentation of the test.
  - Each phoneme of the nonsense syllable test was scored using a phonetic response form.
  - Complete results were displayed at then end of test, Figure 1.
  - Results immediately seen for: whole item, all phonemes, all vowels and consonants, phoneme class, individual phonemes, by composite or by position; e.g.: C1, C2, C3



Figure 1: Composite results screen; bar graph and data

### Presentation Level

- Presentation level determined by using speech MCL obtained in sound field
  - Continuous speech passage from Connected Sentence Test [CST]
  - Presented at 0° azimuths
  - Bracketing procedure used to determine MCL

The average unaided MCL was 77 dB HL with a standard deviation of 5.6 dB. The average aided MCL was 63 dB HL with a standard deviation of 3.8 dB.

## PARTICIPANTS

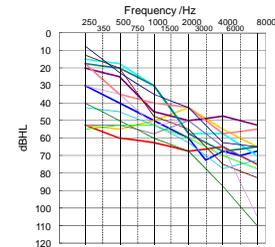


Figure 2: Average right/left audiogram for participants

- Thirteen participants; all native English speakers
- Ages 62-79 years; average age of 69 years
- All had experience with hearing aid use except 2 new users
- No obvious speech impediments to interfere with understanding of responses
- Average right/left audiogram shown in Figure 2

## RESULTS

A power analysis was performed to determine the number of participants needed to show a significant correlation between the W-22 and the ORCA speech test. The results in Table 1 revealed that a maximum number required would be 11. There were 13 participants in this study.

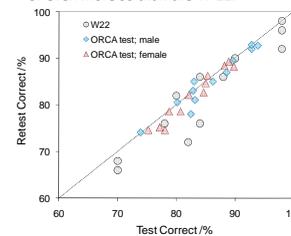
Table 1: Number of subjects required for a power of 0.8 for a significant correlation (one-tailed, 0.05 significance level) between W22 scores and ORCA speech test word scores.

	Number of subjects required for power of 0.8					
	unaided, quiet	unaided, noise	aided, quiet test	aided, quiet retest	aided, noise test	aided, noise retest
Male talker	5	5	4	4	11	7
Female talker	7	11	4	4	8	8

### Comparison to Traditional Word Test

Figure 3 shows a scatter plot of the test/re-test scores for the W-22, ORCA speech test [phoneme score] with female and male talker in quiet and in noise.

- All test/retest data correlation was significant ( $p < 0.001$ , power of test 0.99) with  $R^2 = 0.88$  for the W22,  $R^2 = 0.93$  for the ORCA speech test male talker, and  $R^2 = 0.95$  for the ORCA speech test female talker.
- The test/re-test data illustrate that the ORCA speech test was just as reliable as or even more so than the W-22.



The test/re-test range was within 4% for the ORCA speech test and 12% for the W-22; however, the ORCA speech test also provided more in depth data.

Figure 3: Scatter plot of test/retest of W-22 whole word score [black circles] and ORCA speech test all phoneme score for male [blue diamonds] and female [red triangle] talkers

## RESULTS (cont.)

### Levels of Analysis

Breaking down the phoneme analysis, the composite scores can also be viewed by all consonants and all vowels shown in Figure 4.

Results for the male talker were better than the results for the female talker. Repeated-measures ANOVA statistics indicated that the gender difference was significant: ( $F(1,12)=177.58, p < 0.001$ , partial eta squared = 0.94).

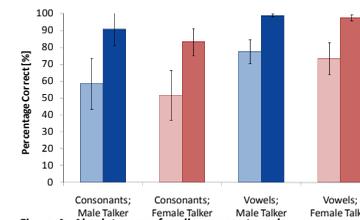
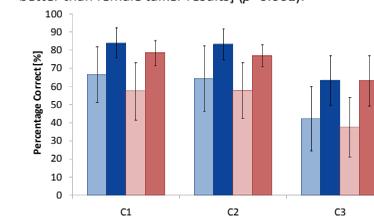


Figure 4: Absolute score for all consonants and vowels; unaided [light shade] and aided [dark shade]

A post hoc analysis also revealed that the aided performance was significantly better than the unaided performance for both talkers and for both the consonants and the vowels ( $p < 0.001$ ).

In addition to viewing the performance of all consonants as a group, the consonant performance can be examined by their position in the test item: initial position [C1], medial position [C2] and final position [C3]. The average results were shown in Figure 5.

- The unaided results [lighter shaded bars] demonstrated a significant difference between position [C1, C2, C3] ( $p < 0.001$ ) and also gender [male talker results were better than female talker results] ( $p < 0.001$ ).

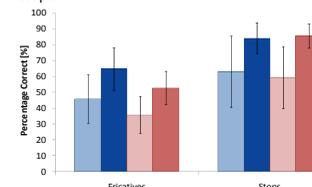


The aided results showed a significant improvement for both the male and female talkers.

Figure 5: Percentage correct by consonant position; male [blue] and female [red] talker; unaided [light shade] and aided [dark shade]

The data can be examined further by comparing performance according to manner of articulation such as: fricatives, stops, nasals, approximants, and affricates. The average results for fricatives and stops were shown in Fig. 6.

- Performance of fricative identification was poorer than the identification of the stops both unaided and aided.
- The identification of the fricative sounds was more difficult with the female talker than with the male talker; however, this gender difference was not seen with the stops.



These details can help the clinician determine which manner of articulation should be more of a focus for auditory training: ie: for this group, more auditory training would be needed for the fricative sounds than the plosive sounds.

Figure 6: Percentage correct for fricatives and stops: male [blue] and female [red] talker; unaided [light shade] and aided [dark shade]

## RESULTS (cont.)

Not only can the data of the ORCA speech test be examined by phoneme position, and manner of articulation, but the data can also be examined by individual phoneme itself. The average results for voiceless phonemes such as /f/ and /p/ as well as approximants such as /r/ were shown in Figure 7.

For this group of listeners:

- As in the previous graphs, a gender difference was seen in the unaided condition and not the aided condition.
- The identification of the voiceless fricative /f/ was poorer than voiceless stop /p/.
- The identification of /r/ dramatically improved with amplification.

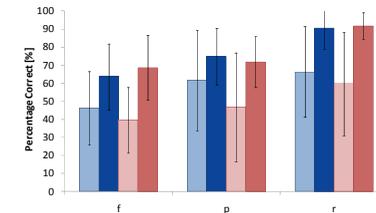


Figure 7: Percentage correct for phonemes /f/, /p/, and /r/; male [blue] and female [red] talker; unaided [lighter shade] and aided [darker shade]

## CONCLUSIONS

The test/re-test results from this study have shown that the results from the ORCA speech test for both the male and female talker were just as reliable or slightly more so than the results with the W-22 [a commonly used test]. In addition to whole item information, which is available with the W-22, there is additional information that is provided and automatically calculated for the tester. This information includes data on all phonemes, all consonants, all vowels, position effect, manner of articulation, and individual phonemes. The results of this study had shown that this group of listeners had more difficulty identifying the consonants than the vowels; they had more difficulty with the final consonant; and of the consonants, they had more difficulty with the fricative sounds. If a clinician or researcher is interested in greater detail as to where their patient is having difficulty, this test is able to provide many more details that other tests may not readily provide. In addition, the results from this study demonstrated that these listeners had more difficulty with the female talker than the male talker. In evaluating hearing losses that may plateau with traditional tests, the use of the female talker may identify the problem areas that cannot be seen in other tests that score the whole word instead of by phoneme.

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