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# The Homogeneity with Respect to Intelligibility of Recorded Word-Recognition Materials

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**Abstract**

**Background:** In developing the PB-50 word lists, J. P. Egan suggested five developmental principles, two of which were "equal average difficulty" and an "equal range of difficulty" among the lists (page 963). Egan was satisfied that each of the 20 PB-50 lists had equivalent ranges of recognition performances and that the lists produced the same average performances. This was accomplished in preliminary studies that measured the recognition performance of each word and eliminated words that were always or never correct. In preparing for studies of interrupted words, we needed to know the range of difficulty inherent in the speaker specific NU-6 and Maryland CNC materials we planned to use when those words were not interrupted. There were only a few studies in the literature that touched on the range of difficulty characteristic of the word-recognition materials in common usage. The paucity of this information prompted this investigation whose scope broadened to include the CID W-22, Maryland CNC, NU-6, and PB-50 materials spoken by a variety of speakers.

**Purpose:** The purpose was to evaluate the homogeneity with respect to intelligibility of the words that comprise several of the common word-recognition materials used in audiologic evaluations.

**Research Design:** Both retrospective (10) and prospective (3) studies were involved. Data from six of the retrospective studies were from our labs. The prospective studies involved both listeners with normal hearing for pure tones and listeners with sensorineural hearing loss.

**Study Sample:** The sample sizes for the 13 data sets ranged from 24 to 1,030, with 24 the typical number for listeners with normal hearing.

**Data Collection and Analysis:** The retrospective data were from published studies and archived data from our laboratories. The prospective studies involved presentation of the word-recognition materials to the listeners at a comfortable level. An item analysis was conducted on each data set with descriptive statistics used to characterize the data. Additionally, skewness coefficients were calculated on the distributions of word performances and the interquartile range was used to determine minor and major outliers within each set of 200 words and their component 50-word lists (300 words for the Maryland CNCs).

**Results:** For listeners with normal hearing the majority of performances on the words within a 50-word list were better than the mean performance, which produced negatively skewed distributions with outlier performances in every list. For listeners with sensorineural hearing loss the performances on the words within a 50-word list were evenly distributed above and below the mean performance, which yielded essentially normal distributions with few outliers. There were a few words on which performances were better by the listeners with hearing loss.

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**Conclusions:** Every list of word-recognition materials has a few words on which recognition performances are noticeably poorer than performances on the majority of the remaining words. If the intention of an experiment is to evaluate performance at the word level, then identifying these "outliers" becomes a necessity. Although not evaluated in this report, the implications for 25-word lists are they should be based on recognition-performance data and not compiled arbitrarily.

**Key Words:** Auditory perception, hearing loss, homogeneity, speech, speech perception, word recognition

**Abbreviations:** CID = Central Institute for the Deaf; CNC = consonant-vowel nucleus-consonant; IQR = interquartile range; NU-6 = Northwestern University Auditory Test No. 6; PB = phonetically balanced; PTA = pure-tone average; SD = standard deviation; S/N, SNR = signal-to-noise ratio; SRT = speech-recognition threshold; SSN = speech-spectrum noise; VA = Veterans Affairs

## INTRODUCTION

During the planning stages of interrupted speech investigations that involved the intelligibility of individual monosyllabic words, it was necessary to determine the recognition performances on each word presented uninterrupted in quiet at a comfortable listening level.[1] This information about the uninterrupted words was necessary for the correct interpretation of the performance data when the words were interrupted. Two word lists were involved in the proposed interrupted word studies, the Northwestern University Auditory No. 6 (NU-6; Tillman and Carhart, 1966) recorded by a female speaker (Department of Veterans Affairs, 2006) and the consonant-vowel nucleus-consonant (CNC) lists developed by Lehiste and Peterson (1959), modified by Peterson and Lehiste (1962), and recorded as the Maryland CNC word lists by Causey et al (1984). This recorded version of the Maryland CNC lists is the designated word-recognition materials used by the Department of Veterans Affairs (VA) in compensation and pension examinations. Although psychometric functions have been generated for both sets of materials using listeners with normal hearing for pure tones and listeners with hearing loss for pure tones, no recognition performance data on the individual words were available. A search of the literature found a few studies that contained item analyses of the words used in word-recognition testing, but these were restricted to the Central Institute for the Deaf (CID) W-22 (Hirsh et al, 1952) and NU-6 materials spoken by speakers unique to those studies. At the same time, we realized that several archived data sets we had contained item analyses of the word-recognition materials. Ultimately, item analyses were available on 13 sets of word-recognition materials spoken by various speakers using combinations of listeners with normal hearing for pure tones and listeners with sensorineural hearing loss. These data are the focus of this report.

The roots of all word-recognition materials used in audiology can be traced to the Egan (1948) report that was a product of studies conducted during World War II. Egan in describing the requirements for "articulation" (intelligibility) tests indicated that "the speech sounds used should be reasonably representative of conversational speech" and that "it is important to group the speech units into balanced lists, each list as difficult as each other list" (pp. 956–957). Regarding item difficulty, Egan suggested the following two somewhat incompatible requirements: (1) to be sensitive to small differences, the test words should be closely distributed on the difficulty continuum and (2) the distribution of difficulty should be sufficiently broad as to reflect the range of difficulty inherent in the stimulus materials. Further, Egan pointed out that sensitivity varies over the range of possible performances (0–100% correct) with the greatest sensitivity typically occurring when performance is around 50% correct where the largest variability also occurs. In describing the so-called "phonetically balanced (PB)-50s" (20 lists of 50 words each), Egan stated that "the spread of difficulty is approximately the same in each list, and each list has nearly the same average difficulty" (p. 963). Important to this paper is the *spread of difficulty* associated with the recognition performances of the individual words that comprise each word list. Although Egan acknowledged that each of the PB-50 word lists contained a spread of difficulty among the performances on the words that composed each list, no data were provided to quantify the magnitude of the spread, even in the OSRD Report 3802 (Egan, 1944) on which the 1948 article was based.

This report is composed of data from the sources listed in Table 1, which include data previously reported in the literature, unpublished archived data from our laboratories and a military laboratory, and data from prospective studies in our laboratories on the word-recognition materials lacking a previous item analyses. In this regard, a search of the literature found three studies that included recognition performance data on the individual words that comprised word-recognition lists, two of which (Campbell, 1965; Thornton and Raffin, 1978) evaluated the Technisonic recordings of the CID W-22s and one study (Hurley and Sells, 2003) that evaluated the Auditec

[1]As of this publication, there have been three communications from the Auditory Research Laboratory at Mountain Home that involve the word recognition of words interrupted by silent intervals (Irish et al, 2013; Hamm and Wilson, 2015; Wilson, 2014).

**Table 1. Data from Studies Used**

| Material/Study | Speaker | Condition | *n*/List | Listener |
|---|---|---|---|---|
| CID W-22 | | | | |
| Campbell, 1965* | Hirsh | Quiet | 40 | HL |
| Thornton and Raffin, 1978* | Hirsh | Quiet | 1030 | HL |
| Wilson et al, 2008* | VA Female #2 | 8-dB S/N | 24 | YN |
| Maryland CNC | | | | |
| Bay Pines* | Maryland Male | Quiet | 24 | YN |
| Mountain Home* | Maryland Male | Quiet | 72 | OHL |
| NU-6 | | | | |
| Hurley and Sells, 2003 | Auditec Male | Quiet | 222–225 | YN and OHL |
| Brungart et al, 2013 | Auditec Male | 9-dB S/N | 340 | YN and OHL |
| Wilson and Cates, 2008* | Auditec Male | 9-dB S/N | 24 and 48 | YN and OHL |
| Bay Pines, 2012* | VA Female #1 | Quiet | 187–302 | OHL |
| Mountain Home, 2014* | VA Female #1 | Quiet | 24 | YN |
| Wilson et al, 2008* | VA Female #2 | 8-dB S/N | 24 | YN |
| PB-50 | | | | |
| Wilson et al, 2008* | VA Female #2 | 8-dB S/N | 24 | YN |

*Note:* *Indicates data from VA Medical Centers.
HL = hearing loss; OHL = older hearing loss; YN = young normal.

recording of the NU-6. The archived data included information on the W-22, NU-6, and PB-50 lists (McArdle and Wilson, 2008; Wilson et al, 2008), and on NU-6 from unpublished studies at the Bay Pines VA Healthcare System and the Walter Reed National Military Medical Center. The prospective studies involved the Maryland CNC and the NU-6 lists with listeners with normal hearing and the Maryland CNC lists on listeners with hearing loss. In the interest of reporting clarity, the usual manuscript format is altered to include an integrated methods and results section with subheadings ordered alphabetically for each of the four word-recognition materials reported.

## DATA ANALYSES

In contrast to most studies of word recognition in which the importance is on the subject performance on a group of words, the focus with the current study was on performances by groups of listeners on the individual words. The performance data from the studies listed in Table 1 are shown graphically in the text with the data also listed in 14 tables in the Supplemental Materials. For the most part, descriptive statistics were used for measures of central tendency and variance. Three figures include linear regressions in which the slope of the function is a major consideration. The recognition data also were subjected to two other statistical measures that consider (1) the shape of the distribution of recognition performances for the words in each list, that is, *skewness* and (2) the identification of words that produced performances that were noticeably different from the performances obtained on the majority of words in the list, that is, *outliers*. As these two analyses are seldom used in the audiology literature, the following provides an introduction or review.

Distributions of scores are either symmetric (bell shaped), which rarely occurs, or asymmetric (skewed), which can be positively (right) skewed or negatively (left) skewed. Generally, the direction of the skewness is determined by the side of the distribution with the longer tail. A simple way to determine the direction of the skewness is to examine the relation between the mean and median values. Generally, but not always, when the mean is to the right of the median, the skew is to the right, and conversely, when the mean is to the left of the median, the skew is to the left. There are certain distributions, however, to which this rule does not apply. More precisely, sample skewness can be evaluated using the *sample coefficient of skewness* (Doane and Seward, 2011), which is a function in Microsoft Excel. A negative coefficient indicates a left-skewed distribution and a positive coefficient indicates a right-skewed distribution. If the skewness coefficient is $<-1$ or $>1$, then the distribution is highly skewed; if the coefficient is between $-1$ and $-0.5$ or between 0.5 and 1, then the distribution is moderately skewed. Finally, coefficients between $-0.5$ and 0.5 indicate a symmetric distribution that can be evaluated further with the *sample coefficient of kurtosis*.

From observations of either the graphic or numeric data, there were obvious recognition performances on some words in each list that were noticeably different (poorer) from the performances on the remaining words in the list. The words on which the performances are noticeably different are termed *outliers* that can be identified statistically using the interquartile range (IQR; Tukey, 1977). Briefly, this technique involves determining from a list of word-recognition scores the lower or 1st quartile (Q1), the median or 2nd quartile (Q2), and the upper or 3rd quartile (Q3), all of which

**Table 2. Listener Data From Studies Used**

| | CID W-22 | | | Maryland CNC | | NU 6 | | | | | | PB-50 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Campbell, 1965 | Thornton and Raffin, 1978 | Wilson et al, 2008 | Mountain Home, 2012 | | Hurley and Sells, 2012 | Brungart et al, 2003 | Wilson and Cates, 2008 | | Bay Pines, 2014 | Mountain Home, 2014 | Wilson et al, 2008 | Wilson et al, 2008 |
| Hearing Status | SNHL | SNHL | YN | YN | SNHL | SNHL | SNHL | YN | SNHL | SNHL | YN | YN | YN |
| Participants/List | 40 | 1030 | 24 | 24 | 72 | 222-225 | 340 | 24 | 48 | 187-302 | 24 | 24 | 24 |
| Condition | Quiet | Quiet | 8-dB S/N | Quiet | Quiet | Quiet | 9-dB S/N | | | Quiet | Quiet | | 8-dB S/N |
| Mean | 75.3 | 82.5 | 91.3 | 94.3 | 85.6 | 69.2 | 86.3 | 92.5 | 65.3 | 73.0 | 97.5 | 89.0 | 87.5 |
| SD | 19.4 | 12.5 | 11.7 | 12.7 | 17.6 | 13.2 | 11.4 | 13.7 | 21.7 | 11.7 | 6.0 | 15.0 | 16.4 |
| Max | 100.0 | 97.2 | 100.0 | 100.0 | 100.0 | 95.5 | 99.0 | 100.0 | 100.0 | 96.4 | 100.0 | 100.0 | 100.0 |
| Min | 14.0 | 25.2 | 29.2 | 4.2 | 6.9 | 33.8 | 37.0 | 12.5 | 10.4 | 36.5 | 54.2 | 16.7 | 8.3 |
| Range | 86.0 | 72.0 | 70.8 | 95.8 | 93.1 | 61.7 | 62.0 | 87.5 | 89.6 | 59.9 | 45.8 | 83.3 | 91.7 |
| Skewness | −1.0 | −1.4 | −2.3 | −4.2 | −2.1 | −0.4 | −1.8 | −3.0 | −0.4 | −0.3 | −4.14 | −2.3 | −2.1 |
| Lower Quartile (Q1) | 64.3 | 76.3 | 87.5 | 95.8 | 81.9 | 59.6 | 82.0 | 91.7 | 47.4 | 64.7 | 95.8 | 83.3 | 83.3 |
| Median (Q2) | 82.0 | 86.9 | 95.8 | 100.0 | 91.7 | 70.7 | 89.0 | 95.8 | 68.8 | 74.2 | 100.0 | 95.8 | 95.8 |
| Upper Quartile (Q3) | 90.0 | 91.3 | 100.0 | 100.0 | 97.2 | 79.7 | 95.0 | 100.0 | 85.4 | 81.8 | 100.0 | 100.0 | 100.0 |
| IQR | 25.8 | 15.0 | 12.5 | 4.2 | 15.3 | 20.1 | 13.0 | 8.3 | 38.0 | 17.1 | 4.2 | 16.7 | 16.7 |
| Lower Inner Fence | 43.4 | 64.4 | 77.1 | 93.7 | 68.8 | 40.6 | 69.5 | 79.2 | −9.6 | 48.5 | 89.6 | 70.8 | 70.8 |
| # Minor Outliers | 19 | 20 | 19 | 66 | 41 | 4 | 14 | 8 | 0 | 4 | 13 | 17 | 24 |
| Lower Outer Fence | 4.8 | 41.8 | 58.3 | 87.4 | 45.8 | 10.5 | 50.0 | 125.0 | 199.5 | 22.9 | 83.3 | 45.7 | 45.7 |
| # Major Outliers | 0 | 2 | 4 | 28 | 15 | 0 | 5 | 5 | 0 | 0 | 9 | 8 | 6 |

*Note:* The data for each study were based on 200 words, except the Maryland CNCs that were based on 300 words. The same data for each list of 50 words are given in Supplemental Tables S1–S14.

SNHL = sensorineural hearing loss; YN = young normal.

are easily obtained in Microsoft Excel. The IQR is the Q3 minus Q1 difference. Typically, when outliers exist, they are classified using markers called *inner fences* and *outer fences*. The inner fences are established by multiplying the IQR by 1.5 and (1) adding the result to Q3 and (2) subtracting the result from Q1; these two arithmetic values are the upper and lower delimiters beyond which *minor* or *mild outliers* are defined. Similarly, the outer fences are established by multiplying the IQR by 3 and (1) adding the result to Q3 and (2) subtracting the result from Q1; these two arithmetic values are the delimiters beyond which *major* or *extreme outliers* are defined. The concern in this article is with the lower delimiters as the upper delimiters often exceed the maximum possible performance (100%). Both the skewness of the distributions of recognition performances and the performance outliers were included in the analyses of the data included in this article.

## METHODS AND RESULTS

This section has four subheadings arranged alphabetically, each of which presents one of the four types of word-recognition test materials evaluated. Each subheading contains a brief description of the procedures used in data acquisition. Each set of materials is evaluated both as a collection of 200 words and as four lists of 50 words each, the exception being the Maryland CNCs that have 300 words and six lists of 50 words. The composite statistics based on the 200- or 300-word sets accurately reflect the statistics based on the four or six lists of 50-word lists that comprise each material. The text includes a mixture of the two presentation methods with the numeric statistics based on the 200- or 300-word sets (Table 2) and the graphic presentations based on the 50-word lists (Figures 1–15). The percent correct recognitions on the 50 words in each list are sorted from poorest to best performance and are listed in Supplemental Materials (Tables S1–S14) along with Figures S1–S3 displaying the mean audiograms of three of the groups of listeners with hearing loss (available with the online version of this article). Our intention is not to point out every nook and cranny in the data, but rather our intention is to provide broad strokes to introduce the data and what are available in the data letting the reader seek their own level of submersion.

### Central Institute for the Deaf W-22

Probably the first two studies that reported item analyses of the individual word data were by Campbell (1965) and by Thornton and Raffin (1978) both of which evaluated the CID W-22 materials recorded by the Technisonic Studio with Ira Hirsh the speaker (Hirsh et al, 1952). In the Campbell study, "about 40 subjects per list" with sensorineural hearing loss were presented the recorded W-22s at 40 dB above the speech-recognition threshold (SRT) through an audiometer (Grason-Stadler, Model 162). The Thornton and Raffin study was retrospective involving 1,030 ears per list with the materials presented in the same manner and same level used by Campbell. The third study with the W-22s involved 24 young listeners with normal hearing for pure tones who were presented 582 mostly monosyllabic words from the W-22, NU-6, and PB-50 lists spoken by VA female speaker #2 presented in speech-spectrum noise (SSN) at four signal-to-noise ratios (SNRs) (McArdle and Wilson, 2008; Wilson et al, 2008). For the current study, only the data from the most positive SNR (8 dB) were evaluated.

The recognition data from the Campbell (1965) study of the W-22s are shown in Figure 1, in the first data column of Table 2, and in Supplemental Table S1. The arbitrary word numbers on the abscissa of Figure 1 correspond to the word numbers in Table S1. Inspection of the percent correct of the individual words (ordinate) depicted in Figure 1 indicates similar shapes of the plots for the individual words (abscissa) within each list. The means and standard deviations (SDs) for the words in each of the four lists are similar, ranging from 73.6 to 77.8% and from 17.0 to 22.5%, respectively, which are reflected by the overall data for the 200 words in Table 2. (Note: throughout this article, the SDs reflect the variability of the recognition performances on the words that compose the list, not the subject variability that is the typically reported source of variability.) The range of recognition performances on the words in each

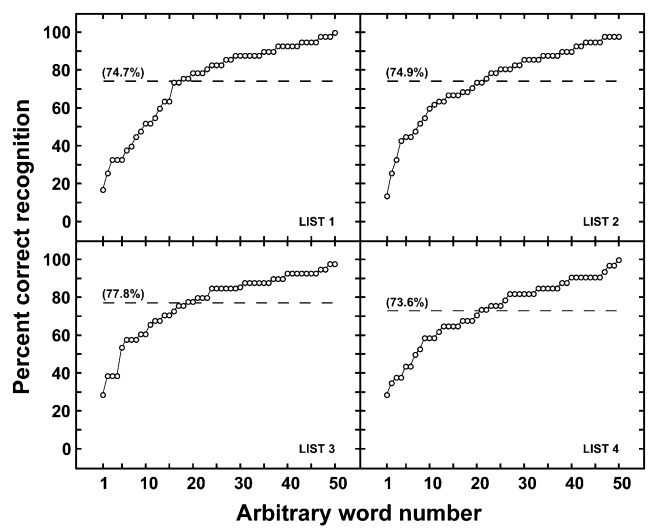


**Figure 1.** The percent correct word recognition for each of the 50 words in the 4 CID W-22 lists (Technisonic Studio version, Hirsh speaker) obtained in quiet. The 40 patients/list were from the VA Outpatient Clinic in Atlanta. The dashed horizontal line and numbers in parenthesis in each panel show the mean recognition performance for that list. Supplemental Table S1 contains a numeric listing of the data in the figure (transformed from Campbell, 1965, Table 4, pp. 20–21).

list, that is, maximum performance minus minimum performance, was 69 to 84%. Within each list of 50 words, the data in Figure 1 indicate that equal intelligibility on the words was not achieved at equal presentation levels. Some words were easy to recognize, whereas other words were difficult to recognize. The overall skewness of the distribution of the 200 words was −1.0 with the skewness of the four lists ranged from −0.8 to −1.2, all of which are considered moderately skewed to the left. As Egan (1948) suggested, the distribution of word-recognition performances only approaches normal when recognition performances are in and around 50% correct, which is the point with potentially the greatest variability and is the point furthest from effects of floor and ceiling. There were two words classified as minor outliers (recognition performances ≤25.6% correct) within the list of 200 words; no words were considered major outliers, that is, performances ≤−13.0%, which was not possible.

The second study with the Technisonic W-22 materials (Thornton and Raffin, 1978) involved a substantially larger set size than the Campbell study in that 4,120 veterans were used (1,030 listeners/list). The data from this larger sample of data are shown in Figure 2, in the second data column of Table 2, and in Supplemental Table S2. The mean recognition performance for the 200 words was 82.5% correct (SD = 12.5%), which is about 7% higher than the Campbell group. The difference between performances by the two groups of listeners is not of concern as the groups with hearing loss were composed of a different number of listeners, probably different selection criteria, etc. Again, the means and SDs for the recognition performances on the words in each list are similar, ranging from 79.3 to 85.5% and from 11.5 to 13.0%, respectively. The range of performances among the 200 words was 72% and among the four lists ranged from 46.0 to 69.6% (see Figure 2 and Supplemental Table S2). Skewness among the four lists ranged from −0.9 to −2.4 with an overall skewness of −1.4, all of which are in either the moderately or highly skewed ranges. From Table 2, recognition performances ≤53.7% defined minor outliers of which there were nine along with one major outlier (≤31.2%). The number of minor outliers was reduced to six when the words were grouped by list, with one major outlier.

The data for the individual words from these first two studies of the W-22s are plotted in the bivariate plots of Figure 3 with the Campbell (1965) data on the ordinate and the Thornton and Raffin (1978) data on the abscissa. Remember, these two studies used the same recorded versions of the W-22 materials. Visual inspection of the data in Figure 3 indicates that generally if performance on a word was good in one study, then it was good on that word in the other study. Likewise, if performance was poor on a word in one study, then performance on that word was poor in the other study. Several relations are noteworthy in Figure 3. First, the

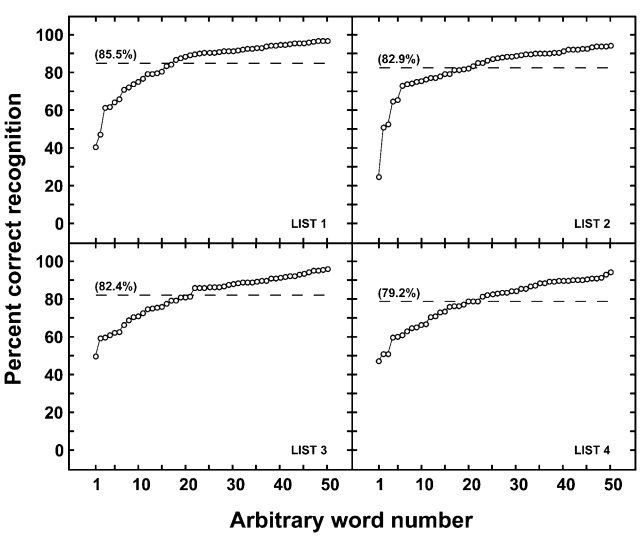


**Figure 2.** The percent correct word recognition for each of the 50 words in the 4 CID W-22 lists (Technisonic Studio version, Hirsh speaker) obtained in quiet. The 1,030 patients/list were from the VA Hospital in Iowa City. The dashed horizontal line and numbers in parenthesis in each panel show the mean recognition performance for that list. Supplemental Table S2 contains a numeric listing of the data in the figure (transformed from Thornton and Raffin, 1978, Table 3, p. 512).

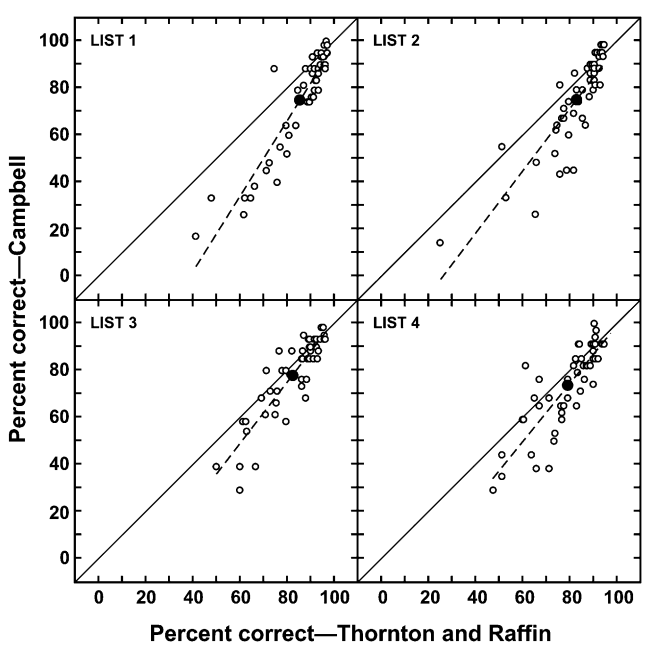


**Figure 3.** Bivariate plots of the individual word performances for the four CID W-22 word lists recorded by Hirsh. The Campbell (1965) data are on the ordinate ($n$ = 40/list) with the Thornton and Raffin (1978) data on the abscissa ($n$ = 1,030/list). The diagonal lines represent equal performances and the dashed lines are linear regressions used to describe the data. The larger, filled circles are the mean data.

majority of recognition performances on the words are below the diagonal line, which is consistent with higher performances on the materials by the participants in the Thornton and Raffin study. Second, the slopes of the regressions were all positive and fairly steep, ranging from 1.2%/% (List 4) to 1.6%/% (List 1). Third, the $R^2$ values ranged from 0.69 (List 4) to 0.85 (List 1), suggesting the regressions accurately describe the relations between the two sets of data. Finally, of the 40 words in each study with the poorest performances, 30 words (75%) were common between the studies, which indicates a consistency between studies with the same recorded version of the W-22 materials.

The third study of the W-22 materials used the VA female speaker #2 (McArdle and Wilson, 2008; Wilson et al, 2008) and presented the words to 24 young listeners with normal hearing at four SNRs in SSN with only the data from 8-dB signal-to-noise ratio (S/N) used in this current analysis. The level of the SSN was 72-dB SPL and the words were presented at 80-dB SPL. The data are displayed in Figure 4, in the third data column of Table 2, and in Supplemental Table S3. The mean performance on the 200 words was 91.3% (SD = 11.7%). The means and SDs on the four lists ranged from 90.4 to 92.1% and from 11.1 to 12.4%, respectively. The range of recognition performances among the 200 words was 70.8% and among the 4 lists shown in Figure 4 ranged from 45.8 to 70.0%. The overall skewness was −2.3, which ranged from −1.5 to −3.6 on the four lists, all of which are considered highly skewed. Of the 200 words, performances on 15 of the words put them in the minor outlier category (≤68.8%) with two words considered major outliers (≤50.0%). Because of the ranges of inner and outer lower fences involved for the four lists (Supplemental Table S3), for the 50-word list groupings, there were two to six minor outlier words (total of 16) and zero to five major outlier words (total of seven). The data in Figure 4 indicate that even with young listeners with normal hearing, there are some words in each of the W-22 word lists that are much more difficult to understand than other words. It would be instructive to compare performances between listeners with hearing loss and listeners with normal hearing on the words recorded by the same speaker; however, those data for the W-22s are elusive.

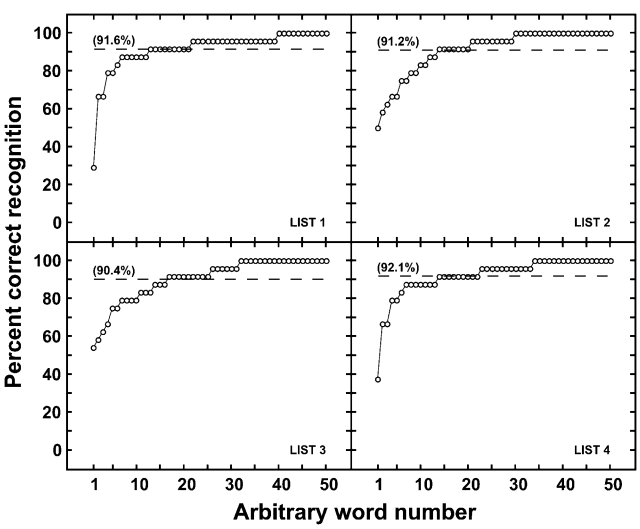


**Figure 4.** The percent correct word recognition for each of the 50 words in the 4 CID W-22 lists (VA female speaker #2) obtained in SSN at 8-dB S/N from 24 young adults with normal hearing for pure tones. The dashed horizontal line and numbers in parenthesis in each panel show the mean recognition performance for that list. Supplemental Table S3 contains a numeric listing of the data in the figure (from Wilson et al., 2008, Supplemental Materials, Table SM1, pp. 1–14).

## Maryland CNC

The 10 Maryland CNC lists were recorded by a male speaker and were subjected to analyses of the words and lists by Causey et al (1984). Each of the words was presented at a comfortable listening level (60–65-dB SPL) to a group of 16 young listeners with normal hearing. Although the data from this procedure were not reported, "no consistent errors among listeners were observed" (p. 556). This statement is interpreted to mean that recognition performances on all of the words were similar, but this is speculation. Equivalency of the lists was then evaluated with 40 veterans (mean = 55 yr), 10 assigned to each of four presentation levels (20, 30, 40, or 44 dB, re: the speech-recognition threshold). Analyses revealed that only six of the lists (1, 3, 6, 7, 9, and 10) were "equivalent" within a range of 3.6%. In the current study, recognition performances were established on these six lists using 24 listeners with normal hearing (mean = 22 yr) and 72 older listeners (mean = 67 yr) with sensorineural hearing loss [pure-tone (threshold) average (PTA) at 500, 1000, and 2000 Hz = 28.5-dB HL; the mean audiogram is shown in Supplemental Figure S1]. The materials were presented in quiet at 60-dB HL (normal hearing) and 70-dB HL (hearing loss) with each listener presented 300 words.

The results for both groups of listeners are depicted in Figures 5 and 6, in the fourth and fifth data columns of Table 2, and in Supplemental Tables S4–S6. The mean recognition performances on the 300 words were 94.3 and 85.6% for the listeners with normal hearing and hearing loss, respectively, (SDs = 12.7 and 17.6%). The ranges of performances on the 300 words were similar for the two groups of listeners, 95.8 and 93.1%. Figures 5 and 6 are different plots of the same data with Figure 5 showing the recognition performances for each word sorted by participant group performance, that is, the word number (abscissa) does not necessarily designate the same word for both listener groups. The horizontal lines in each panel indicate the mean performances on each word list

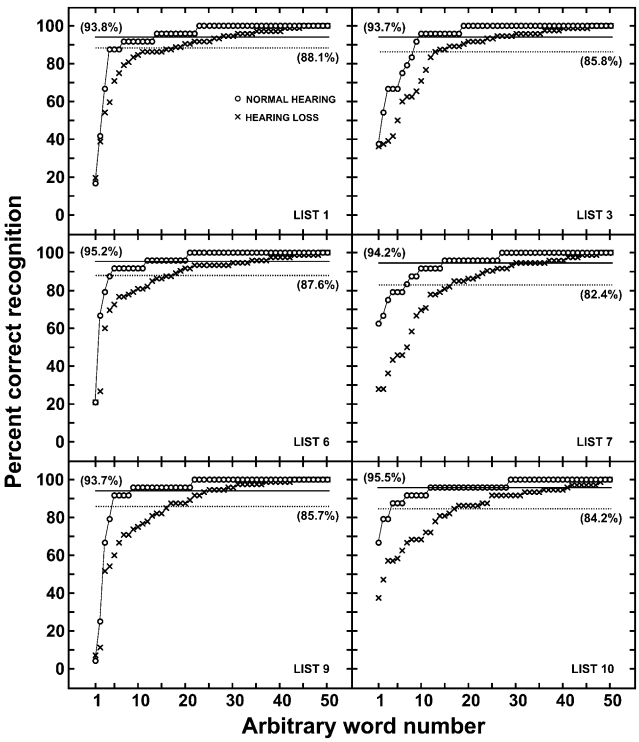


**Figure 5.** The percent correct word recognition for each of the 50 words in the 6 Maryland CNC lists obtained in quiet from 24 younger listeners with normal hearing (circles) and from 72 older listeners with sensorineural hearing loss (Xs). The performances on the words are sorted for each group separately so the word numbers (abscissa) most often apply to different words. The two horizontal lines represent the means for the words in each list by the two groups of listeners. Supplemental Tables S4–S6 contain the numeric listing of the data in the figure.

by the two groups of listeners. The majority of performances on the 300 words were >90% correct with 87.3 and 60.7% of the listeners with normal hearing and hearing loss, respectively, above 90%. As observed previously with the W-22 data, the datum points to the left in each panel in Figure 5 indicate that there were some words, more in the group with hearing loss, on which performances were noticeably poorer than were the performances on the majority of words in each list. The skewness coefficient was twice as large for the listeners with normal hearing (−4.2) as it was for the listeners with hearing loss (−2.1), which was a relation reflected with the six lists of 50-words. With the 300-word grouping in Table 2, the lower inner fence (≤89.5%) produced 37 minor outliers for the listeners with normal hearing that was reduced to 27 minor outliers for the listeners with hearing loss, their lower inner fence being ≤59.0%. In contrast to the number of minor outliers, the number of major outliers for both groups were reduced substantially to 26 (normal hearing) and 7 (hearing loss). Certainly, part of this overall increase in outliers with the Maryland CNCs is because of the additional 100 words included in the protocol, but some of the increase must be attributable to the lack of homogeneity of recognition performances among the words in the lists. The majority of words produce recognition performances that are above the mean performance, with a minority of words producing drastically different results.

Figure 6 is a bivariate plot of the performances on each word by the listeners with normal hearing (ordinate) and the listeners with hearing loss (abscissa); the means for each list are depicted as the larger filled symbols, the dashed lines are the linear regressions used to describe the data, the diagonal lines in each panel represent equal performance, and the data were jittered to provide graphic clarity. Five of the six regressions have reasonably positive slopes indicating a relation between recognition performances on the words by the two listener groups. In general with each list, when the listeners with normal hearing had good performance on a word, usually performance on that word by the listeners with hearing loss was the same or slightly

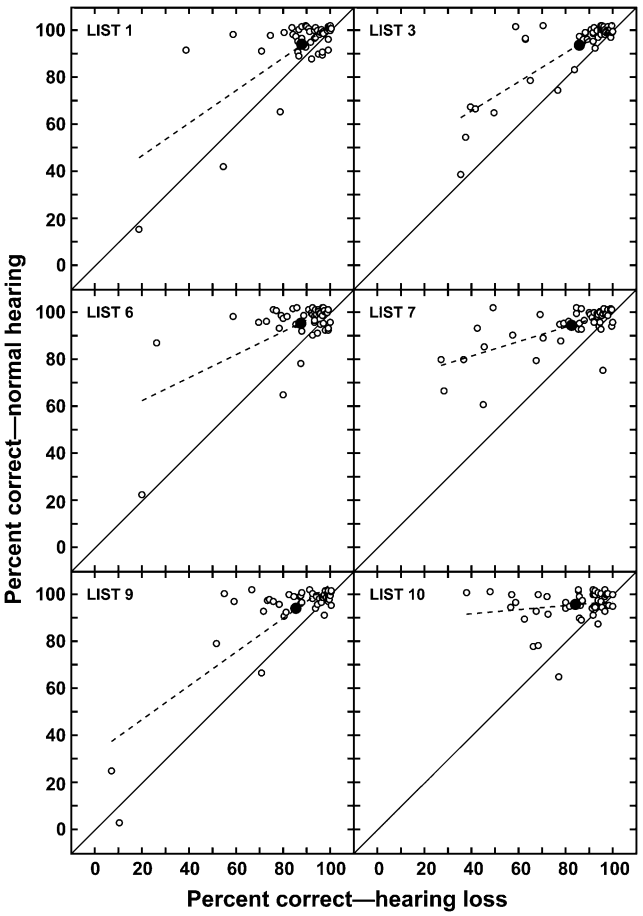


**Figure 6.** Bivariate plots of the performances on each of the 50 words in the 6 Maryland CNC lists for listeners with normal hearing (ordinate, $n = 24$) and for listeners with hearing loss (abscissa, $n = 72$). The dashed lines are linear regressions used to describe the data with the large filled circle representing the means. The data were jittered using an additive algorithm from −2.0 to 2.0% in 0.2% steps (normal hearing) and from −0.8 to 0.8% in 0.1% steps (hearing loss).

poorer, which is especially evident in the clusters of data in the upper right corner of each panel in Figure 6 where performances were maximized. The exception to this relation is observed with List 10, which has a regression slope that is almost flat indicating a tenuous relation between performances on the words by the two listener groups. For the most part, this flatness of the function is attributable to the grouping of so many datum points in the upper right corner of the graph and to the disparity between the two groups displayed to the left of the mean. The extreme examples are the two left-most datum points in List 10, which are the words *chat* and *lot* that had 100% performances by the listeners with normal hearing and 37.5 and 47.2% performances, respectively, by the listeners with hearing loss. In all probability, the final consonant /*t*/ in these two words was missed by the participants with hearing loss. Each of the other lists has several but not an overwhelming number of these estranged datum points. There are also several lists that had poor performance on a word by both groups of listeners. The left-most datum point in List 1 is an example; the word was *lag* that was correct only 16.7 and 19.4% by the listener groups. The listeners with normal hearing performed better on 238 of the 300 words (79.3%) than did the listeners with hearing loss with the average difference 11.9%. Interestingly, the five words with the largest differences, all >50%, had /*t*/ as the final consonant (*bet, lot, fit, jot,* and *chat*). In contrast, the listeners with hearing loss performed better on 36 of the 300 words (12.0%) by an average of 5.8%; the largest difference (20.8%) was with *gun* in List 7. Performances on 26 words (8.7%) were equal.

As with the W-22 materials, each list of the Maryland CNCs contained performances on some words in each 50-word list that were noticeably poorer than the performances on the majority of words within the respective lists. Although the listeners with normal hearing performed better on most words, 12% of the words had better performances by the listeners with hearing loss; most of these differences, however, were small.

## Northwestern University Auditory Test No. 6

Although the NU-6 materials recorded by a variety of speakers have been the subject of numerous investigations over the past 50 yr, only one published study was located that included an item analysis of the words. Hurley and Sells (2003) presented an item analysis of the NU-6 materials, Auditec male version, presented in quiet at 40 dB above the SRT to 92 ears with normal hearing and 891 ears with sensorineural hearing loss (mean = 52 yr; 222–225 listeners/list). The Hurley and Sells data (combined for both listener groups) are presented in Figure 7, in the sixth data column of Table 2, and in Supplemental Table S7. Overall for the 200

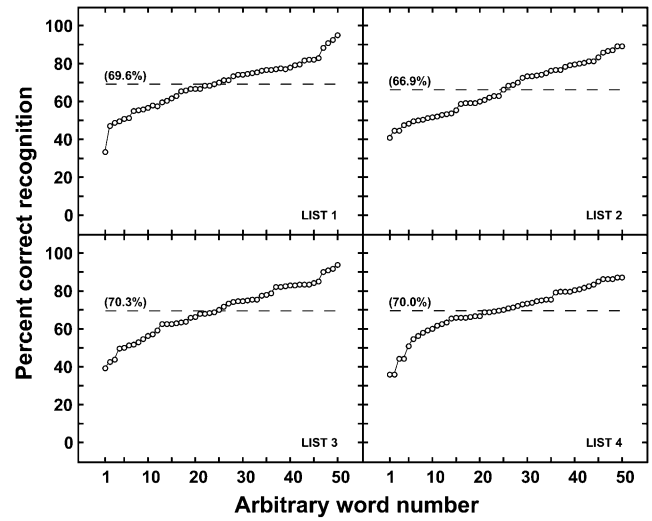


**Figure 7.** The percent correct word recognition for each of the 50 words in the 4 NU No. 6 lists (Auditec male speaker) obtained in quiet from 222 to 225 listeners per list; about 10% of the listeners had normal hearing for pure tones. The dashed horizontal line and numbers in parenthesis in each panel show the mean recognition performance for that list. Supplemental Table S7 contains a numeric listing of the data in the figure (transformed from Hurley and Sells, 2003, Table 2, p. 114).

words, the mean was 69.2% correct (SD = 13.2%). The data in Figure 7 from the 4 lists indicate an approximate number of datum points below and above the mean, which is reflected in the skewness for the 200 words of −0.4 that indicates a symmetric or somewhat normal distribution; for List 1–4, the skewness coefficients were −0.3, −0.0, −0.3, and −0.9, respectively (Supplemental Table S7). These skewness coefficients around zero are a departure from the coefficients observed with the previous materials, which all were skewed to some degree with skewness coefficients <−1.0. Also, the range of recognition performances on the words (i.e., maximum minus minimum) was somewhat more limited than the ranges associated with the previous materials. The relatively normal skewness and the limited range of recognition performances produced no minor or major outliers when the 200 words were considered collectively. With the individual lists, there were only six minor outliers. These departures from the results of the previously discussed studies may be a reflection of the participants being a combination of listeners with normal hearing and listeners with hearing loss, the relatively young mean age of the listeners, and as Egan (1948) suggested an approximation of a normal distribution when performance approaches 50%.

The next three sets of NU-6 data are taken from the Speech Reception in Noise Test (SPRINT) protocol that uses the Auditec male speaker presented binaurally in 9-dB S/N of multitalker babble presented at 50-dB HL (Cord et al, 1992). A study by Brungart et al (2013) proposed to reduce the time required to administer the test in

half by administering 100 words instead of the 200 words used in the original SPRINT. The basis of this reduction was an analysis "of the relative difficulties of the individual words" (p. 4), which was an item analysis of the 200 words given to 340 listeners with a variety of pure-tone thresholds. The results of the item analysis by Brungart et al are shown in Figure 8, listed in the seventh data column in Table 2, and listed for the four, 50-word lists in Supplemental Table S8. The mean is almost identical to the range reported by Hurley and Sells (2003) who used the same words spoken by the same speaker. The overall skewness coefficient was −1.8 (highly skewed), which also was reflected in the skewness coefficients of the four, 50-word lists (−1.5 to −1.9). Observation of the data in Figure 8 suggests six or seven outliers in List 1, one in List 2, four in List 3, and one in List 4. Using the IQR algorithm to define outliers indicates four, one, three, and one minor outliers in Lists 1–4 and two, zero, one, and zero major outliers in Lists 1–4 (Supplemental Table S8).

The SPRINT was the subject of an earlier study (Wilson and Cates, 2008) that examined recognition performances on two words-in-noise tasks using 24 listeners with normal hearing (mean = 23.3 yr) and 48 listeners with sensorineural hearing loss (mean = 69.9 yr; mean PTA = 30-dB HL; see Supplemental Figure S2 for the mean audiogram). The item analyses of those two sets of data are reported in Figures 9 and 10, the eighth and ninth columns in Table 2, and in Supplemental Tables S9 and S10. The mean correct recognition performances on the 200 words were 92.5 and 65.3% (SDs = 13.7 and 21.7%) for the listeners with normal hearing

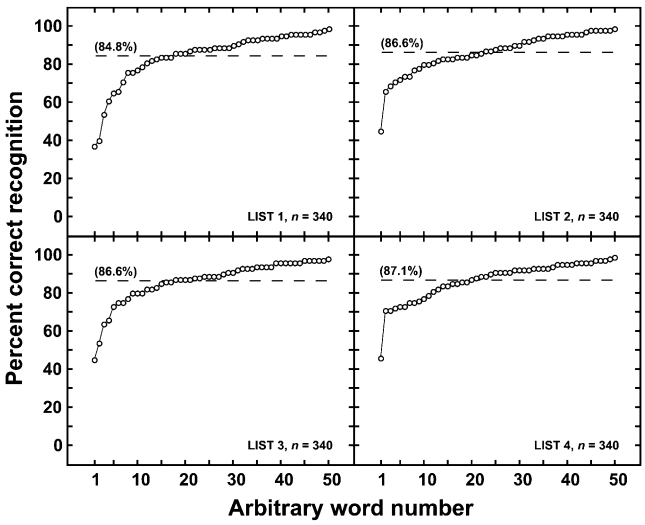


**Figure 8.** The percent correct word recognition for each of the 50 words in the 4 NU No. 6 lists in the SPRINT paradigm (Auditec male speaker) obtained in multitalker babble at 9-dB S/N from adult listeners with a variety of pure-tone thresholds. The dashed horizontal line and numbers in parenthesis in each panel show the mean recognition performance for that list. Supplemental Table S8 contains a numeric listing of the data in the figure (from Brungart et al., 2013, Table 1, p. 5).

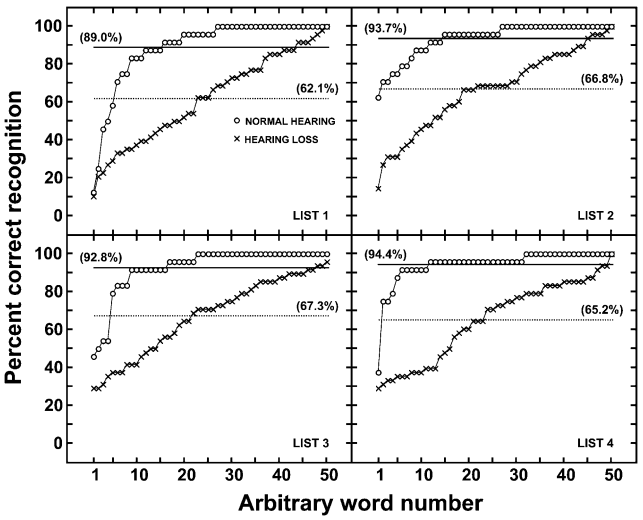


**Figure 9.** The percent correct word recognition for each of the 50 words in the 4 NU No. 6 lists (Auditec male speaker) obtained in multitalker babble at 9-dB S/N in the SPRINT paradigm (from Wilson and Cates, 2008). The words are sorted separately for the two groups of listeners. The two horizontal lines represent the mean performances by the two groups of listeners. Supplemental Tables S9 and S10 contain the numeric listing of the data in the figure.

and the listeners with hearing loss, respectively. The ranges of performances were essentially the same, 87.5 and 89.6%. As can be seen in Figure 9, the majority of datum points for the listeners with normal hearing are above the mean performances indicated by the solid horizontal lines, whereas the datum points are about equally divided above and below the mean performances for the listeners with hearing loss. For the 200 words, these relations translate to skewness coefficients of −3.0 and −0.4 for listeners with normal hearing and hearing loss, respectively. There were eight minor outliers and five major outliers for the listeners with normal hearing and no outliers for the listeners with hearing loss. These overall outlier findings were maintained with the four lists of 50 words with which collectively there were 19 minor outliers and 12 major outliers, all with the listeners with normal hearing. As before, the outliers in Figure 9 are intuitive, at least for the listeners with normal hearing. The SPRINT data from the Wilson and Cates study present a unique opportunity to compare recognition performances on each of the 200 NU-6 words obtained from listeners with normal hearing and listeners with hearing loss. Although not the topic of the current article, it is instructive to compare the performance differences between listeners with normal hearing and listeners with hearing loss in a quiet condition (Figure 5) and in a background noise (Figure 9). In quiet, the difference between the two groups was about 10%, whereas in a mild background noise condition (9-dB S/N), the difference was increased to 25–30%, which exemplifies the difficulty that listeners with sensorineural hearing loss have understanding speech in background noise that we believe is

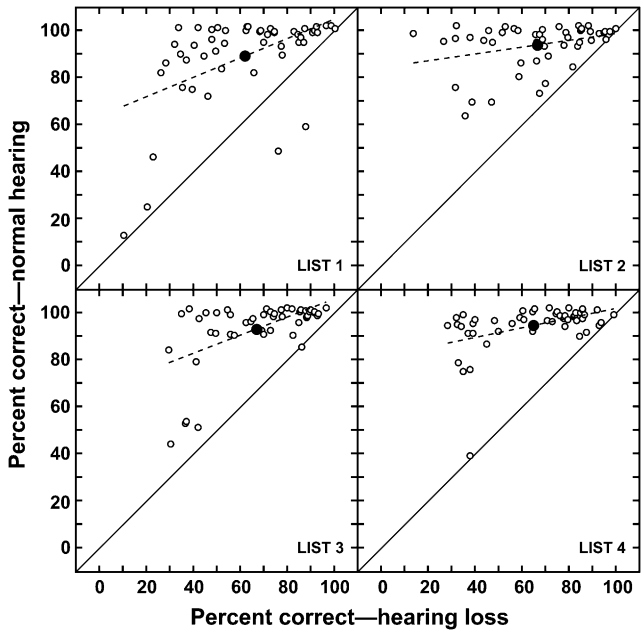


**Figure 10.** Bivariate plots of the performances on each of the 50 words in the 4 NU-6 lists in the SPRINT paradigm of 9-dB S/N multitalker babble for listeners with normal hearing (ordinate, $n = 24$) and for listeners with hearing loss (abscissa, $n = 48$) (from Wilson and Cates, 2008). The dashed lines are linear regressions used to describe the data with the large filled symbol representing the means. The data were jittered randomly using additive algorithms from −1 to 1% in 0.1% steps (normal hearing) and from −2 to 2% in 0.2% steps (hearing loss).

attributable to a decline in peripheral and central auditory function. This relation prompted the suggestion in an earlier article that words-in-noise testing is the "stress test" of auditory function (Wilson, 2011).

The individual word data for the two groups of listeners are presented as bivariate plots in Figure 10 with the listeners with normal hearing (ordinate) and the listeners with hearing loss (abscissa). For graphic clarity, the datum points were jittered with an additive algorithm. Almost all of the performances on the words are above the diagonal line indicating better performance by the listeners with normal hearing. The two notable exceptions, which are below the diagonal in List 1, are the words *door* (58.3 and 87.5%) and *fall* (50.0 and 77.1%) on which performances for unknown reasons were notably better by the listeners with hearing loss. Again, as with the Maryland CNC materials (Figure 6), with the NU-6 materials presented in Figure 10, different words have different sensitivities to the effects of hearing loss. Under the conditions presented here, good performance on some words, that is, those in the upper right corner of each graph, is attained by both groups of listeners. In contrast, there are other words on which performance by listeners with normal hearing is very good and performance is substantially degraded for older listeners with end-organ hearing loss and the general decline in auditory function associated with aging.

A second popular version of the NU-6 materials was recorded by Causey et al (1983) using a female speaker "with considerable experience in radio and stage productions" (VA female speaker #1; Department of Veterans Affairs, 2006). An item analysis of this version of NU-6 was conducted with 953 patients matriculating through the Audiology Clinic at the Bay Pines VA Healthcare System (mean = 69.9 yr; mean PTA = 34.9-dB HL; the mean audiogram is shown in Supplemental Figure S3). Each participant was assigned to one list that resulted in 187–302 listeners/list. The data are presented in Figures 11 and 12, in the tenth data column in Table 2, and in Supplemental Table S11. The overall mean recognition performance on the 200 words was 73.0% (SD = 11.7%), with mean performances of 72.6, 74.6, 73.4, and 71.4% for Lists 1–4, respectively. As with the data from the other studies involving older listeners with hearing loss, the data in Figure 11 show that the means for the four lists are approximately in the middle of the individual word data, which suggests normal distributions with few, if any, outliers. Indeed, the skewness coefficients ranged from −0.1 to −0.4 and there were only two minor outliers, one each in Lists 1 and 2. Figure 12 is a bivariate plot of these NU-6 data for each word spoken by the Auditec male (ordinate, from Hurley and Sells, 2003) and spoken by the VA female speaker #1 (abscissa). The $R^2$ values ranged from 0.02 (List 4) to 0.38 (List 2) indicating the regressions were not necessarily good fits. Although the slopes of the regressions all were positive, ranging from 0.15%/% to 0.79%/%, the scatter of datum points in each graph almost have "shotgun" or random patterns,

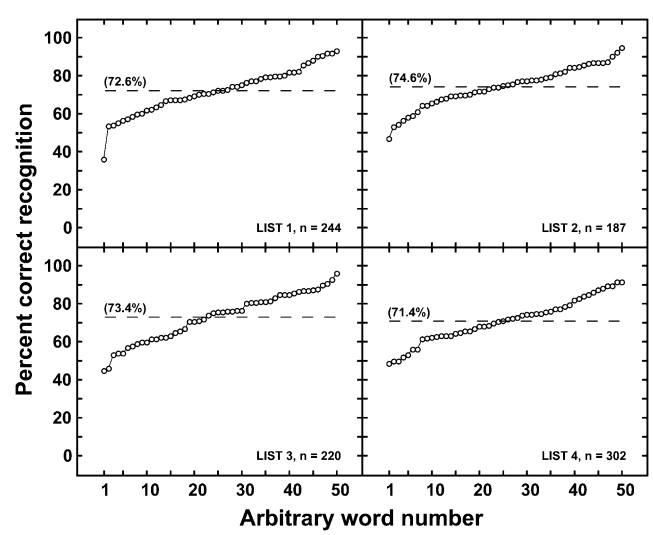


**Figure 11.** The percent correct word recognition for each of the 50 words in the four NU No. 6 lists spoken by the VA female speaker #1 (Department of Veterans Affairs, 2006) obtained in quiet from older listeners with sensorineural hearing loss from the Bay Pines VA Healthcare System. The dashed horizontal line and numbers in parenthesis in each panel show the mean recognition performance for that list. Supplemental Table S11 contains a numeric listing of the data in the figure.

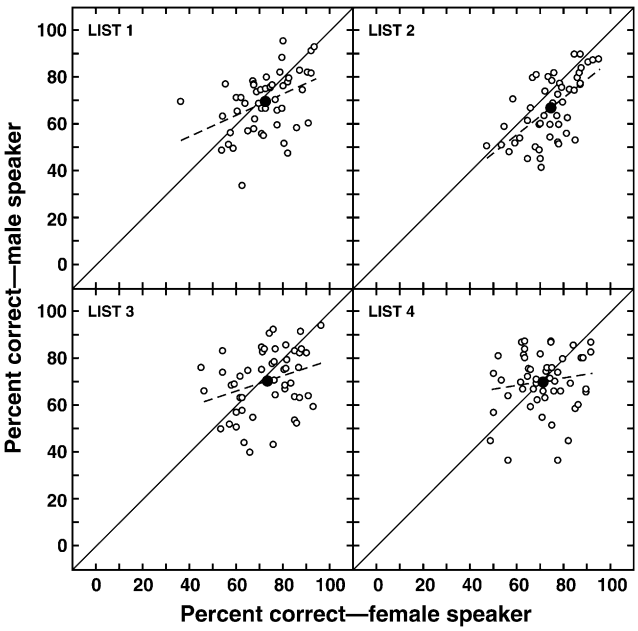


**Figure 12.** Bivariate plots of the individual word performances for the four NU 6 word lists recorded by the Auditec male speaker (ordinate) and by the VA female speaker #1 (abscissa). The Hurley and Sells (2003) data are on the ordinate ($n$ = 222–225/list) with the data from Bay Pines on the abscissa ($n$ = 187–302/list). The diagonal lines represent equal performances, the dashed lines are linear regressions used to describe the data, and the larger, filled circles are the mean data.

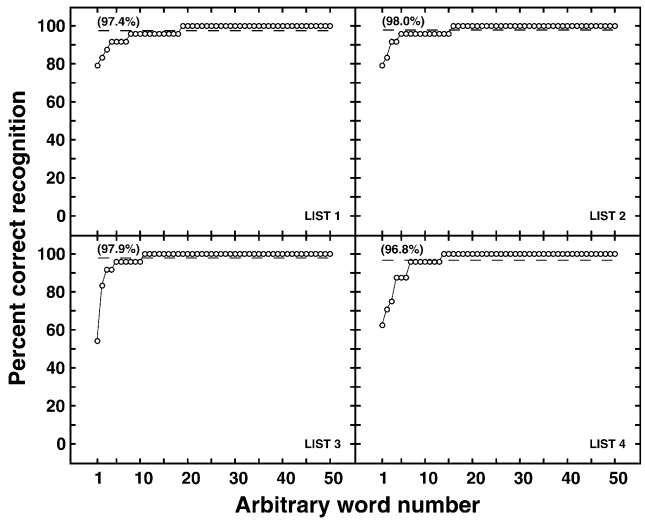


**Figure 13.** The percent correct word recognition for each of the four 50-word NU-6 lists spoken by VA female speaker #1 (Department of Veterans Affairs, 2006) obtained in quiet from 24 young listeners with normal hearing. The dashed horizontal line and numbers in parenthesis in each panel show the mean recognition performance for that list. Supplemental Table S12 contains a numeric listing of the data in the figure.

List 2 being the notable exception. The data in Figure 12 are another demonstration that different speakers of the same materials typically produce different results, especially when examined at the level of the individual words.

Recognition of the NU-6 words recorded by Causey et al (1983) was studied on young listeners (mean = 23.3 yr; SD = 3.3 yr) with normal hearing for pure tones (≤20 dB HL, American National Standards Institute, 2010) at the usual octave frequencies; these are the recordings of NU-6 included on the VA CD (Department of Veterans Affairs, 2006). The study was conducted at the VA Medical Center, Mountain Home. The 200 words were randomized with each listener receiving a unique randomization presented monaurally at 60-dB HL. The recognition data for each list are presented in Figure 13 with the corresponding numeric listing in Supplemental Table S12; the data are summarized in the eleventh data column of Table 2. The overall recognition performance was 97.5% correct (SD = 6.0%) with scores ranging from 96.8 to 98.0% on the individual word lists. The majority of recognition performances on the 200 words (144 or 72%) were 100% correct. The mean performance is slightly better than the performances by other young listeners with normal hearing on other materials or other versions of NU-6. These differences are probably related to speaker differences or the use of data from words presented at favorable SNRs as opposed to words presented in quiet. Although the SNRs were favorable with the other data sets reported, only diminishing overall performances a few percent, the noise may have precipitated poorer performances on a select few of the words thereby producing more outliers than are seen in Figure 13. The majority of recognition performances on the 200 words (144 or 72%) were 100% correct with the poorest performance on the word *calm* (54.2%) in List 3.

The final set of NU-6 materials evaluated were recorded by the VA female speaker #2 (McArdle and Wilson, 2008; Wilson et al, 2008) and were presented to 24 young listeners with normal hearing in SSN at an 8-dB S/N. The results are depicted in Figure 14, with the overall data from the 200 words listed in the twelfth data column in Table 2, and the data for the four lists given in Supplemental Table S13. On the collective 200 words, the mean recognition performance was 89.0% (SD = 15.0%). From Figure 14, again the majority of datum points are above the mean performances with each of the lists with about 10–20% of the datum points demonstrating notably poorer performances. Overall from Table 2, the skewness coefficient was −2.3, which for the four, 50-word lists ranged from −1.9 to −2.4. From Figure 14, one would estimate 13 or so outliers, which is close to the number of outliers calculated with the IQR method. From the 200-word analysis, there were nine minor and two major outliers and from the four, 50-word list analyses, there were 16 minor and four major outliers.

## Psycho-Acoustic Laboratory PB-50

Finally in our list of word-recognition materials, an item analysis was available on four of the PB-50 word

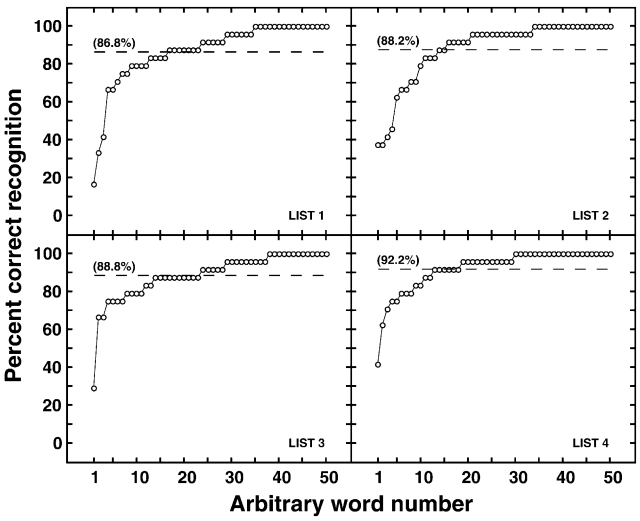


**Figure 14.** The percent correct word recognition for each of the 50 words in the four NU No. 6 lists (VA female speaker #2) obtained in SSN at 8-dB S/N from 24 young adults with normal hearing for pure tones. The dashed horizontal line and numbers in parenthesis in each panel show the mean recognition performance for that list. Supplemental Table S13 contains a numeric listing of the data in the figure (from Wilson et al., 2008).

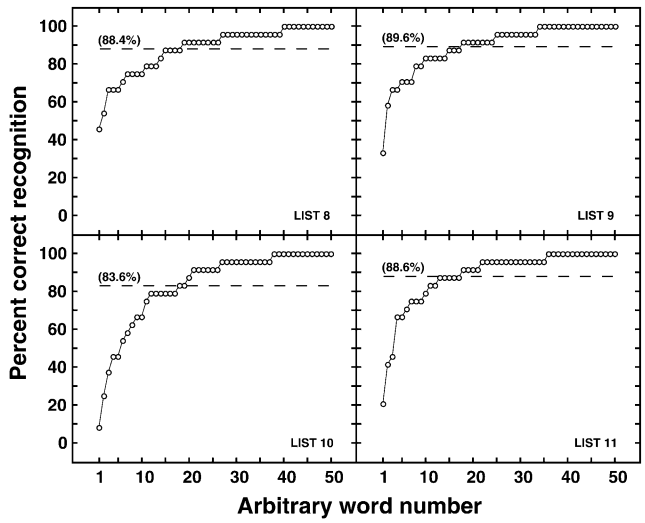


**Figure 15.** The percent correct word recognition for each of the 50 words in four of the PB-50 lists (VA female speaker #2) obtained in SSN at 8-dB S/N from 24 young adults with normal hearing for pure tones. The dashed horizontal line and numbers in parenthesis in each panel show the mean recognition performance for that list. Supplemental Table S14 contains a numeric listing of the data in the figure (from Wilson et al., 2008).

lists (8, 9, 10, and 11) developed by Egan (1948, 1957). These words were recorded with VA female speaker #2, who also recorded the W-22 and NU-6 materials shown in Figures 4 and 13, respectively. The materials were presented in SSN at 8-dB S/N to young listeners with normal hearing (McArdle and Wilson, 2008; Wilson et al, 2008). The PB-50 data are shown in Figure 15, listed in the thirteenth data column in Table 2, and detailed in Supplemental Table S14. (Note: yes, some of the numbers in the last two columns of Table 2 are the same.) The overall mean performance on the 200 PB-50 words was 87.5% (SD = 16.4%), which are almost identical to the same measures observed for the W-22 and NU-6 materials spoken by the same speaker (Table 2, columns 4 and 13). As with the previous data from young listeners with normal hearing, the majority of recognition performances were near or at maximum. Even the skewness coefficient for the PB-50 materials (−2.1) is almost identical to the skewness coefficients for the W-22 and NU-6 materials (−2.3) recorded by the same speaker. From the 200 word analysis, there were 12 minor outliers and 3 major outliers, all of which are fairly obvious from the data in Figure 15.

## CONCLUSIONS

The data in this article lead to several generalized observations about recorded word-recognition materials presented at a comfortable listening level to listeners with normal hearing for pure tones and to listeners, especially older listeners, with sensorineural hearing loss including aberrations throughout the auditory system produced by the aging processes. For young listeners with normal hearing, the distributions of performances typically are negatively skewed with the majority of the performances on the words better than the mean performance, regardless of the word list and the speaker of those words. Most of the performances on the words, probably >80%, produce recognition performances that are above the mean value and maximized at or near 100%. Recognition performances on these words are homogeneous with respect to intelligibility. The remaining 20% of the words have performances that are progressively poorer than the performances on the majority of words with a few of the words in each list having performances that are substantially poorer than the performances on the majority of words. These latter words that are not homogeneous with respect to intelligibility can be classified as outliers. This distribution characteristic, which is consistent among the lists of words that comprise each set of materials and among the various sets of materials studied, produces moderately or highly skewness coefficients. The interesting aspect of this deviation is that the word lists were compiled using criteria that were not related to psychophysically generated recognition performance data on the words, but rather related to the inclusion determiners like familiarity of the words, how the words fit in the list being compiled (e.g., phonetically balanced), the syllable characteristics (CVC versus non-CVC), etc. For a given set of materials, all of the words with the poorest performances could have ended up on the same list, but interestingly that did not happen and there was a fairly even

distribution of these "bad words" among the lists of a given set of materials.

Recognition performances on the individual words have different characteristics when listeners with hearing loss are involved. Typically, overall performances on words by listeners with hearing loss are 10–30% poorer than the performances on the same materials by listeners with normal hearing; this difference can even be more if the paradigm involves a background noise. As the data demonstrate, among the lists of the various sets of materials, the distributions of performances on the words presented to listeners with hearing loss tended to be about equally distributed above and below the mean values with few word performances at maximum. This relation produces little skewing of the distribution of recognition performances on the words by listeners with hearing loss and also precludes a large number of word-performance outliers.

To this juncture, all considerations have focused on the 200 or 300 word corpora of the various materials and on the component 50-word lists. The impact of the homogeneity with respect to intelligibility (or lack thereof) among the recognition performances on the words of a 50-word list has not been considered in terms of the 25-word lists that are popularly used in audiological practice. The overall findings of this report indicate that when compiling 25-word lists consideration should be given the recognition performances on each word by both listeners with normal hearing and by listeners with sensorineural hearing loss. That is, 25-word lists or any derivation thereof should not be compiled arbitrarily, but rather should require some thought and investigation. The data in this report provide a good starting point.

Beyond the word-recognition paradigm considered in this report and as outlined by Bilger (1984), the requirements needed for developing and standardizing speech-recognition materials should include a preliminary evaluation of the pool of test items from which the finalized test materials are selected. For any speech-recognition material from CVs to sentences and for any intended population from listeners with normal hearing for pure tones to patients with cochlear implants, this preliminary evaluation should be accomplished "by administering them to a large number of subjects drawn from the population to which the final form of the test will be administered" (p. 2). Regardless of both the test paradigm and the intended population, incorporating this principle into the formulation of the test materials will help ensure the appropriateness of the involved materials.

**Acknowledgments.** The authors acknowledge the contributions made to the project by Heather Hamm and Melissa Anderson and the memory of Daniel.

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**Supplemental Figure S1**

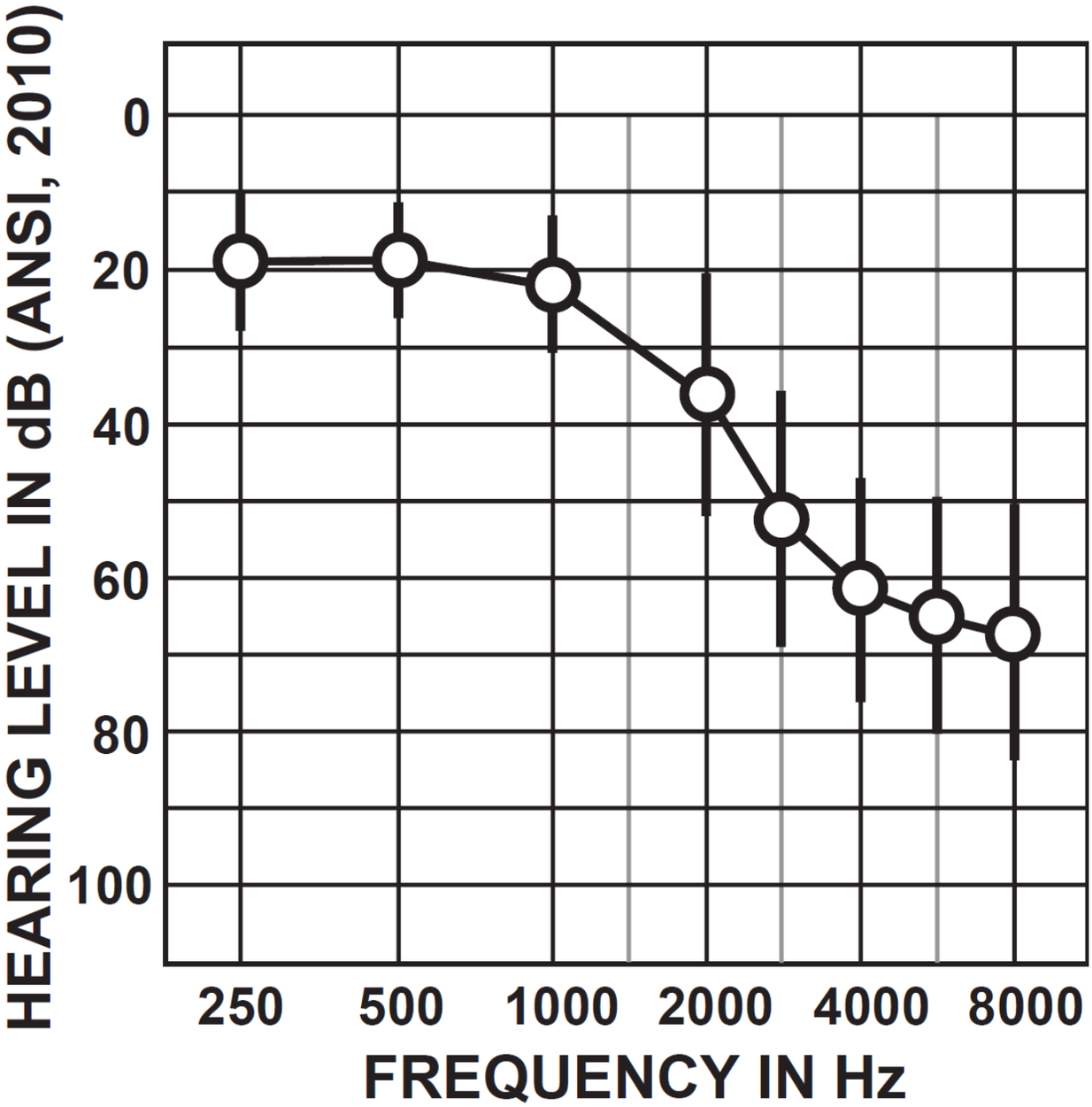


**Figure SM1.** The mean right ear audiogram and ±1 standard deviation for the 72 listeners with hearing loss in the study with the Maryland CNC materials.

**Supplemental Figure S2**

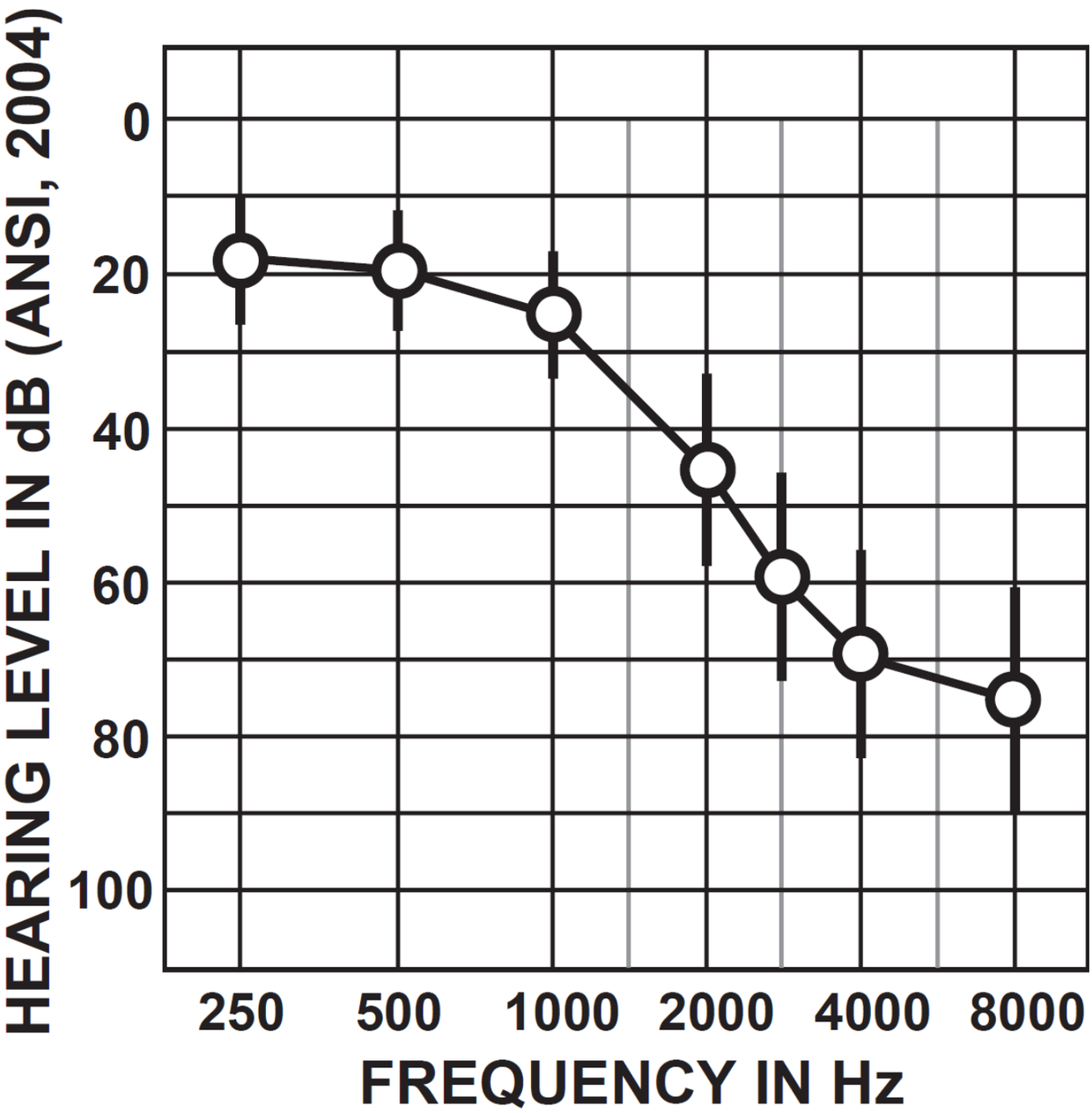


**Figure SM2.** The mean right ear audiogram and ±1 standard deviation for the 48 listeners with hearing loss in the study with the NU-6 materials in the SPRINT paradigm (Wilson and Cates, 2008).

**Supplemental Figure S3**

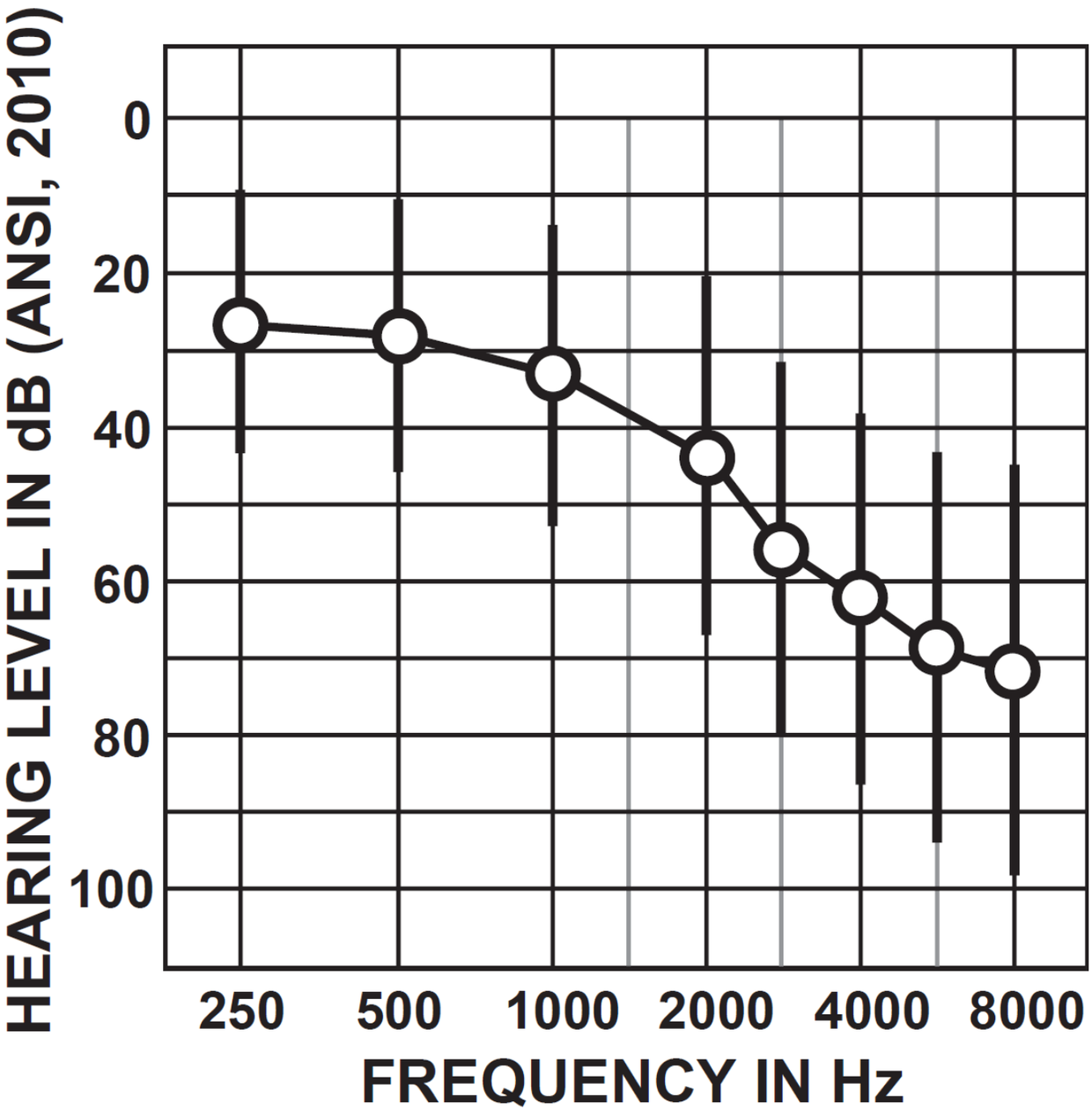


**Figure SM3.** The mean right ear audiogram and ±1 standard deviation for the 953 listeners with hearing loss in the study with the NU-6 materials in quiet (from the Bay Pines VA Healthcare System).

**Supplemental Table S1**

**Table SM1.** Recognition performances obtained in quiet with the CID W-22 materials (Technisonic Studios, Hirsh speaker) presented in quiet at 40-dB above the SRT. There were 40 listeners for each list with each listener receiving minimally 2 lists. The data are illustrated in Figure 1 of the manuscript (transformed from Campbell, 1965, Table 4, pages 20-21).

| | List 1 | | List 2 | | List 3 | | List 4 | |
|---|---|---|---|---|---|---|---|---|
| | Word | % | Word | % | Word | % | Word | % |
| 1 | MEW | 17 | KNEE | 14 | WEST | 29 | DOLLS | 29 |
| 2 | KNEES | 26 | KEY | 26 | DULL | 39 | DUST | 35 |
| 3 | ACHE | 33 | ROOMS | 33 | KNIT | 39 | DARN | 38 |
| 4 | BATHE | 33 | GAVE | 43 | NEST | 39 | SAVE | 38 |
| 5 | DEAF | 33 | ILL | 45 | OWES | 54 | NUTS | 44 |
| 6 | ACE | 38 | TEAR | 45 | CHAIR | 58 | STIFF | 44 |
| 7 | EAST | 40 | PEW | 48 | EARS | 58 | CHIN | 50 |
| 8 | CHEW | 45 | AIL | 52 | TAN | 58 | EAR | 53 |
| 9 | BELLS | 48 | SEND | 55 | AIM | 61 | EYES | 59 |
| 10 | CARVE | 52 | CARS | 60 | WOOL | 61 | NET | 59 |
| 11 | OWL | 52 | ELSE | 62 | KING | 66 | TEA | 59 |
| 12 | THING | 55 | CAP | 64 | CUTE | 68 | ALL | 62 |
| 13 | SEE | 60 | JAW | 64 | START | 68 | AM | 65 |
| 14 | JAM | 64 | CHEST | 67 | CAMP | 71 | CAN | 65 |
| 15 | TWINS | 64 | EASE | 67 | SAY | 71 | FEW | 65 |
| 16 | EARN | 74 | ICE | 67 | SMOOTH | 73 | HANG | 65 |
| 17 | SHE | 74 | SHOW | 69 | BILL | 76 | ARM | 68 |
| 18 | SKIN | 76 | WITH | 71 | HAND | 76 | THAN | 68 |
| 19 | TRUE | 76 | NEW | 74 | TEN | 78 | TIN | 68 |
| 20 | LAW | 79 | THIN | 74 | THREE | 78 | WILL | 71 |
| 21 | LOW | 79 | DUMB | 76 | THOUGH | 80 | PALE | 74 |
| 22 | STOVE | 79 | AND | 79 | WE | 80 | SO | 74 |
| 23 | THEM | 81 | BIN | 79 | YEAR | 80 | GO | 76 |
| 24 | AS | 83 | HIT | 79 | ATE | 85 | NEAR | 76 |
| 25 | GIVE | 83 | BY | 81 | GLOVE | 85 | YET | 76 |
| 26 | ISLE | 83 | MOVE | 81 | JAR | 85 | YES | 79 |
| 27 | TOE | 86 | OWN | 81 | LIE | 85 | ART | 82 |
| 28 | WET | 86 | DOES | 83 | PIE | 85 | HIS | 82 |
| 29 | AN | 88 | OAK | 83 | SHOVE | 85 | LEAVE | 82 |
| 30 | COULD | 88 | HAM | 86 | TIE | 85 | OF | 82 |
| 31 | DAY | 88 | HURT | 86 | ADD | 88 | SHOE | 82 |
| 32 | HIGH | 88 | OFF | 86 | END | 88 | THEY | 82 |
| 33 | HIM | 88 | TOO | 86 | FARM | 88 | BEE | 85 |
| 34 | WIRE | 88 | SMART | 88 | IS | 88 | MY | 85 |
| 35 | HUNT | 90 | THEN | 88 | OIL | 88 | OUGHT | 85 |
| 36 | OR | 90 | TREE | 88 | USE | 88 | TOY | 85 |
| 37 | US | 90 | YOUNG | 88 | HAVE | 90 | WHERE | 85 |
| 38 | DAD | 93 | FLAT | 90 | MAY | 90 | AID | 88 |
| 39 | FELT | 93 | LIVE | 90 | THIS | 90 | BREAD | 88 |
| 40 | POOR | 93 | WAY | 90 | ARE | 93 | AT | 91 |
| 41 | RAN | 93 | AIR | 93 | DONE | 93 | CLOTHES | 91 |
| 42 | THERE | 93 | EAT | 93 | HE | 93 | COOK | 91 |
| 43 | ME | 95 | DIE | 95 | IF | 93 | MEN | 91 |
| 44 | NOT | 95 | STAR | 95 | ON | 93 | OUR | 91 |
| 45 | UP | 95 | THAT | 95 | OUT | 93 | THROUGH | 91 |
| 46 | WHAT | 95 | YORE | 95 | RAW | 93 | WHY | 91 |
| 47 | IT | 98 | NOW | 98 | DO | 95 | WOOD | 94 |
| 48 | NONE | 98 | ODD | 98 | WHEN | 95 | IN | 97 |
| 49 | YOU | 98 | ONE | 98 | BOOK | 98 | JUMP | 97 |
| 50 | YARD | 100 | WELL | 98 | NO | 98 | WHO | 100 |
| Mean | | 74.7 | | 74.9 | | 77.8 | | 73.6 |
| SD | | 22.5 | | 20.1 | | 17.0 | | 17.9 |
| Max | | 100.0 | | 98.0 | | 98.0 | | 100.0 |
| Min | | 17.0 | | 14.0 | | 29.0 | | 29.0 |
| Range | | 83.0 | | 84.0 | | 69.0 | | 71.0 |
| Skewness | | -1.0 | | -1.1 | | -1.2 | | -0.8 |
| Lower Quartile (Q1) | | 61.0 | | 64.8 | | 68.8 | | 65.0 |
| Median (Q2) | | 83.0 | | 81.0 | | 85.0 | | 77.5 |
| Upper Quartile (Q3) | | 92.3 | | 89.5 | | 90.0 | | 87.3 |
| Interquartile Range (IQR) | | 31.3 | | 24.8 | | 21.3 | | 22.3 |
| Inner Fence (Lower) | | 14.1 (0) | | 27.6 (2) | | 36.9 (1) | | 31.6 (1) |
| Inner Fence (Upper) | | 139.1 | | 126.6 | | 121.9 | | 120.6 |
| Outer Fence (Lower) | | -32.8 (0) | | -9.5 (0) | | 5.0 (0) | | -1.8 (0) |
| Outer Fence (Upper) | | 186.0 | | 163.8 | | 153.8 | | 154.0 |
| Kurtosis | | -0.1 | | 0.9 | | 0.8 | | -0.2 |

**Supplemental Table S2**

**Table SM2.** Recognition performances obtained in quiet with the CID W-22 materials (Technisonic Studios, Hirsh speaker) presented in quiet at 40-dB above the SRT. There were 1030 listeners for each list. The data are illustrated in Figure 2 of the manuscript (transformed from Thornton and Raffin, 1978, Table 3, page 512).

| | List 1 | | List 2 | | List 3 | | List 4 | |
|---|---|---|---|---|---|---|---|---|
| | Word | % | Word | % | Word | % | Word | % |
| 1 | MEW | 41.1 | KNEE | 25.2 | NEST | 50.2 | DOLLS | 47.6 |
| 2 | DEAF | 47.8 | SEND | 51.3 | KNIT | 59.8 | DUST | 51.3 |
| 3 | KNEES | 61.7 | ROOMS | 53.0 | WEST | 60.1 | NUTS | 51.4 |
| 4 | ACHE | 62.2 | KEY | 65.2 | TAN | 61.4 | NET | 60.2 |
| 5 | BATHE | 64.6 | PEW | 66.0 | EARS | 62.4 | TEA | 60.6 |
| 6 | ACE | 66.2 | AIL | 73.6 | OWES | 63.1 | ART | 61.2 |
| 7 | CHEW | 71.2 | ELSE | 74.3 | DULL | 66.6 | STIFF | 63.6 |
| 8 | BELLS | 72.5 | CAP | 74.8 | START | 69.2 | TIN | 65.1 |
| 9 | AN | 74.4 | MOVE | 75.6 | AIM | 70.8 | DARN | 65.7 |
| 10 | EAST | 75.7 | GAVE | 76.0 | YEAR | 71.4 | NEAR | 66.9 |
| 11 | THING | 77.0 | EASE | 76.8 | CAMP | 72.9 | CAN | 67.1 |
| 12 | JAM | 79.7 | CHEST | 77.5 | WOOL | 74.9 | SAVE | 71.1 |
| 13 | CARVE | 79.8 | WITH | 77.6 | KING | 75.4 | THAN | 71.4 |
| 14 | OWL | 79.9 | TEAR | 78.6 | SAY | 75.9 | CHIN | 73.4 |
| 15 | SEE | 81.0 | CARS | 79.5 | USE | 76.5 | EAR | 73.9 |
| 16 | TWINS | 83.9 | THIN | 79.5 | WE | 78.0 | HANG | 76.2 |
| 17 | STOVE | 84.7 | ILL | 81.7 | THOUGH | 79.5 | ALL | 76.7 |
| 18 | THEM | 87.2 | SHOW | 81.7 | CHAIR | 79.7 | EYES | 76.8 |
| 19 | HIGH | 88.1 | HAM | 82.2 | TEN | 81.3 | FEW | 77.5 |
| 20 | SHE | 88.9 | HIT | 82.7 | THREE | 81.5 | ARM | 79.1 |
| 21 | EARN | 89.5 | NEW | 83.9 | IS | 81.9 | SO | 79.2 |
| 22 | WIRE | 89.9 | ICE | 85.4 | HAND | 86.3 | GO | 79.2 |
| 23 | SKIN | 90.4 | BIN | 85.5 | SMOOTH | 86.4 | HIS | 81.8 |
| 24 | RAN | 90.8 | JAW | 86.6 | TIE | 86.4 | WHERE | 82.5 |
| 25 | FELT | 91.0 | THEN | 87.7 | END | 86.6 | AM | 83.1 |
| 26 | TOE | 91.0 | DUMB | 88.2 | FARM | 86.6 | YES | 83.3 |
| 27 | TRUE | 91.3 | WAY | 88.6 | LIE | 86.8 | THROUGH | 83.8 |
| 28 | LAW | 91.7 | DOES | 88.7 | DO | 87.2 | CLOTHES | 84.0 |
| 29 | DAY | 91.8 | OFF | 88.9 | CUTE | 87.9 | WILL | 84.6 |
| 30 | GIVE | 91.9 | LIVE | 89.4 | BILL | 88.5 | BEE | 84.8 |
| 31 | ISLE | 92.1 | SMART | 89.7 | SHOVE | 88.8 | LEAVE | 86.0 |
| 32 | AS | 92.4 | AND | 90.2 | RAW | 89.1 | YET | 86.1 |
| 33 | NOT | 93.1 | OAK | 90.3 | GLOVE | 89.4 | SHOE | 87.0 |
| 34 | COULD | 93.2 | HURT | 90.5 | IF | 89.4 | THEY | 87.4 |
| 35 | LOW | 93.3 | TOO | 90.5 | HAVE | 89.5 | OF | 88.7 |
| 36 | WET | 93.4 | FLAT | 90.6 | ADD | 90.0 | OUR | 89.0 |
| 37 | OR | 94.1 | YOUNG | 90.6 | MAY | 90.0 | AT | 89.8 |
| 38 | POOR | 94.5 | DIE | 90.9 | JAR | 91.2 | BREAD | 89.8 |
| 39 | ME | 94.7 | OWN | 91.0 | PIE | 91.3 | AID | 89.9 |
| 40 | DAD | 95.2 | STAR | 91.8 | HE | 91.6 | PALE | 90.1 |
| 41 | THERE | 95.2 | AIR | 92.6 | THIS | 92.3 | TOY | 90.2 |
| 42 | HUNT | 95.6 | TREE | 92.6 | DONE | 92.4 | WHO | 90.4 |
| 43 | IT | 95.8 | BY | 92.7 | ATE | 92.7 | MY | 90.7 |
| 44 | YOU | 96.0 | YORE | 93.1 | OIL | 93.5 | WOOD | 90.7 |
| 45 | US | 96.1 | ODD | 93.2 | ARE | 94.0 | COOK | 91.0 |
| 46 | HIM | 96.4 | THAT | 93.7 | NO | 94.8 | JUMP | 91.2 |
| 47 | YARD | 96.6 | EAT | 94.2 | BOOK | 95.4 | IN | 91.4 |
| 48 | NONE | 97.1 | ONE | 94.3 | ON | 95.7 | OUGHT | 91.9 |
| 49 | WHAT | 97.1 | WELL | 94.4 | WHEN | 96.0 | MEN | 93.6 |
| 50 | UP | 97.2 | NOW | 94.8 | OUT | 96.2 | WHY | 94.5 |
| Mean | | 85.5 | | 82.9 | | 82.4 | | 79.3 |
| SD | | 13.0 | | 13.0 | | 11.5 | | 12.2 |
| Max | | 97.2 | | 94.8 | | 96.2 | | 94.5 |
| Min | | 41.1 | | 25.2 | | 50.2 | | 47.6 |
| Range | | 56.1 | | 69.6 | | 46.0 | | 46.9 |
| Skewness | | -1.7 | | -2.4 | | -1.0 | | -0.9 |
| Lower Quartile (Q1) | | 79.8 | | 77.9 | | 75.5 | | 71.9 |
| Median (Q2) | | 91.0 | | 88.0 | | 86.6 | | 83.2 |
| Upper Quartile (Q3) | | 94.4 | | 90.8 | | 90.9 | | 89.8 |
| Interquartile Range (IQR) | | 14.6 | | 13.0 | | 15.4 | | 17.9 |
| Inner Fence (Lower) | | 58.0 (2) | | 58.4 (3) | | 52.5 (1) | | 45.1 (0) |
| Inner Fence (Upper) | | 116.3 | | 110.3 | | 114.0 | | 116.7 |
| Outer Fence (Lower) | | 36.1 (0) | | 38.9 (1) | | 29.4 (0) | | 18.2 (0) |
| Outer Fence (Upper) | | 138.1 | | 129.8 | | 137.0 | | 143.5 |
| Kurtosis | | | | | | 0.1 | | 0.0 |

**Supplemental Table S3**

**Table SM3**. Recognition performances obtained with the CID W-22 materials (VA female speaker #2) presented in speech-spectrum noise (8-dB SNR) to 24 listeners with normal hearing for pure tones. The data are illustrated in Figure 4 of the manuscript (from Wilson et al., 2008, Supplemental Materials, Table SM1, pages 1-14).

| | List 1 | | List 2 | | List 3 | | List 4 | |
|---|---|---|---|---|---|---|---|---|
| | Word | % | Word | % | Word | % | Word | % |
| 1 | MEW | 29.2 | HAM | 50.0 | BILL | 54.2 | AID | 37.5 |
| 2 | DEAF | 66.7 | AIL | 58.3 | RAW | 58.3 | BEE | 66.7 |
| 3 | OWL | 66.7 | TREE | 62.5 | END | 62.5 | MY | 66.7 |
| 4 | AS | 79.2 | DUMB | 66.7 | DULL | 66.7 | AM | 79.2 |
| 5 | ISLE | 79.2 | JAW | 66.7 | MAY | 75.0 | DARN | 79.2 |
| 6 | AN | 83.3 | OWN | 75.0 | ON | 75.0 | IN | 83.3 |
| 7 | HIGH | 87.5 | YORE | 75.0 | AIM | 79.2 | OUGHT | 87.5 |
| 8 | LOW | 87.5 | CAP | 79.2 | HAVE | 79.2 | OUR | 87.5 |
| 9 | ME | 87.5 | DIE | 79.2 | THOUGH | 79.2 | THAN | 87.5 |
| 10 | OR | 87.5 | BIN | 83.3 | WOOL | 79.2 | THEY | 87.5 |
| 11 | POOR | 87.5 | THEN | 83.3 | ARE | 83.3 | TIN | 87.5 |
| 12 | SEE | 87.5 | BY | 87.5 | GLOVE | 83.3 | TOY | 87.5 |
| 13 | ACHE | 91.7 | KNEE | 87.5 | OWES | 83.3 | WHO | 87.5 |
| 14 | BELLS | 91.7 | AND | 91.7 | KING | 87.5 | BREAD | 91.7 |
| 15 | CARVE | 91.7 | KEY | 91.7 | LIE | 87.5 | CAN | 91.7 |
| 16 | HUNT | 91.7 | NEW | 91.7 | OIL | 87.5 | COOK | 91.7 |
| 17 | JAM | 91.7 | NOW | 91.7 | ADD | 91.7 | DOLLS | 91.7 |
| 18 | NOT | 91.7 | PEW | 91.7 | BOOK | 91.7 | EAR | 91.7 |
| 19 | TOE | 91.7 | THAT | 91.7 | DONE | 91.7 | HANG | 91.7 |
| 20 | UP | 91.7 | WAY | 91.7 | FARM | 91.7 | PALE | 91.7 |
| 21 | WET | 91.7 | CARS | 95.8 | KNIT | 91.7 | WHERE | 91.7 |
| 22 | ACE | 95.8 | GAVE | 95.8 | PIE | 91.7 | WHY | 91.7 |
| 23 | BATHE | 95.8 | HIT | 95.8 | SAY | 91.7 | ARM | 95.8 |
| 24 | CHEW | 95.8 | ILL | 95.8 | THREE | 91.7 | CLOTHES | 95.8 |
| 25 | COULD | 95.8 | OAK | 95.8 | YEAR | 91.7 | DUST | 95.8 |
| 26 | DAY | 95.8 | ODD | 95.8 | IF | 95.8 | HIS | 95.8 |
| 27 | EAST | 95.8 | ROOMS | 95.8 | IS | 95.8 | JUMP | 95.8 |
| 28 | HIM | 95.8 | SHOW | 95.8 | JAR | 95.8 | LEAVE | 95.8 |
| 29 | IT | 95.8 | WELL | 95.8 | NO | 95.8 | MEN | 95.8 |
| 30 | LAW | 95.8 | AIR | 100.0 | SHOVE | 95.8 | NEAR | 95.8 |
| 31 | SKIN | 95.8 | CHEST | 100.0 | WE | 95.8 | SAVE | 95.8 |
| 32 | THEM | 95.8 | DOES | 100.0 | ATE | 100.0 | TEA | 95.8 |
| 33 | THING | 95.8 | EASE | 100.0 | CAMP | 100.0 | THROUGH | 95.8 |
| 34 | TRUE | 95.8 | EAT | 100.0 | CHAIR | 100.0 | ALL | 100.0 |
| 35 | TWINS | 95.8 | ELSE | 100.0 | CUTE | 100.0 | ART | 100.0 |
| 36 | WHAT | 95.8 | FLAT | 100.0 | DO | 100.0 | AT | 100.0 |
| 37 | WIRE | 95.8 | HURT | 100.0 | EARS | 100.0 | CHIN | 100.0 |
| 38 | YARD | 95.8 | ICE | 100.0 | HAND | 100.0 | EYES | 100.0 |
| 39 | YOU | 95.8 | LIVE | 100.0 | HE | 100.0 | FEW | 100.0 |
| 40 | DAD | 100.0 | MOVE | 100.0 | NEST | 100.0 | GO | 100.0 |
| 41 | EARN | 100.0 | OFF | 100.0 | OUT | 100.0 | NET | 100.0 |
| 42 | FELT | 100.0 | ONE | 100.0 | SMOOTH | 100.0 | NUTS | 100.0 |
| 43 | GIVE | 100.0 | SEND | 100.0 | START | 100.0 | OF | 100.0 |
| 44 | KNEES | 100.0 | SMART | 100.0 | TAN | 100.0 | SHOE | 100.0 |
| 45 | NONE | 100.0 | STAR | 100.0 | TEN | 100.0 | SO | 100.0 |
| 46 | RAN | 100.0 | TEAR | 100.0 | THIS | 100.0 | STIFF | 100.0 |
| 47 | SHE | 100.0 | THIN | 100.0 | TIE | 100.0 | WILL | 100.0 |
| 48 | STOVE | 100.0 | TOO | 100.0 | USE | 100.0 | WOOD | 100.0 |
| 49 | THERE | 100.0 | WITH | 100.0 | WEST | 100.0 | YES | 100.0 |
| 50 | US | 100.0 | YOUNG | 100.0 | WHEN | 100.0 | YET | 100.0 |
| Mean | | 91.6 | | 91.2 | | 90.4 | | 92.1 |
| SD | | 11.7 | | 12.4 | | 11.8 | | 11.1 |
| Max | | 100.0 | | 100.0 | | 100.0 | | 100.0 |
| Min | | 29.2 | | 50.0 | | 54.2 | | 37.5 |
| Range | | 70.8 | | 50.0 | | 45.8 | | 62.5 |
| Skewness | | -3.6 | | -1.7 | | -1.5 | | -3.0 |
| Lower Quartile (Q1) | | 91.7 | | 88.6 | | 84.4 | | 88.6 |
| Median (Q2) | | 95.8 | | 95.8 | | 93.8 | | 95.8 |
| Upper Quartile (Q3) | | 95.8 | | 100.0 | | 100.0 | | 100.0 |
| Interquartile Range (IQR) | | 4.1 | | 11.5 | | 15.7 | | 11.5 |
| Inner Fence (Lower) | | 85.6 (6) | | 71.4 (5) | | 60.9 (2) | | 71.4 (3) |
| Inner Fence (Upper) | | 102.0 | | 117.2 | | 123.5 | | 117.2 |
| Outer Fence (Lower) | | 79.4 (5) | | 54.2 (1) | | 37.4 (0) | | 54.2 (1) |
| Outer Fence (Upper) | | 108.1 | | 134.4 | | 147.0 | | 134.4 |

**Supplemental Table S4**

**Table SM4.** Recognition performances obtained in quiet with Lists 1 and 3 of the Maryland CNC materials (Department of Veterans Affairs, 2006) from 24 young listeners with normal hearing for pure tones and from 72 older listeners with sensorineural hearing loss. The data are illustrated Figures 5 and 6 of the manuscript.

| | List 1 | | | | List 3 | | | |
|---|---|---|---|---|---|---|---|---|
| | Normal Hearing | | Hearing Loss | | Normal Hearing | | Hearing Loss | |
| | Word | % | Word | % | Word | % | Word | % |
| 1 | LAG | 16.7 | LAG | 19.4 | WHAT | 37.5 | WHAT | 36.1 |
| 2 | HULL | 41.7 | FIT | 38.9 | WITH | 54.2 | WITH | 37.5 |
| 3 | YEARN | 66.7 | HULL | 54.2 | GULL | 66.7 | GULL | 38.9 |
| 4 | PAD | 87.5 | WOOD | 59.7 | SUNG | 66.7 | SUNG | 41.7 |
| 5 | BOIL | 87.5 | SEIZE | 70.8 | POD | 66.7 | POD | 50.0 |
| 6 | DIME | 87.5 | KITE | 75.0 | FADE | 75.0 | HUT | 59.7 |
| 7 | FIT | 91.7 | YEARN | 79.2 | KEEN | 79.2 | RAT | 62.5 |
| 8 | SEIZE | 91.7 | TOUGH | 80.6 | TOLL | 83.3 | MATE | 62.5 |
| 9 | MESS | 91.7 | LEASE | 83.3 | RIG | 91.7 | KEEN | 65.3 |
| 10 | DEAD | 91.7 | RIPE | 84.7 | RAT | 95.8 | FAITH | 70.8 |
| 11 | SHORE | 91.7 | PAD | 86.1 | MATE | 95.8 | FADE | 76.4 |
| 12 | WHEEL | 91.7 | MESS | 86.1 | CHIN | 95.8 | TOLL | 83.3 |
| 13 | WRECK | 91.7 | CAPE | 86.1 | DAB | 95.8 | CHIN | 86.1 |
| 14 | KITE | 95.8 | CHECK | 86.1 | FOUR | 95.8 | DAB | 87.5 |
| 15 | CAPE | 95.8 | THIN | 86.1 | NUMB | 95.8 | FOUR | 87.5 |
| 16 | CHECK | 95.8 | SALVE | 87.5 | LEAVE | 95.8 | NUMB | 88.9 |
| 17 | SALVE | 95.8 | BOAT | 87.5 | BELL | 95.8 | VOTE | 88.9 |
| 18 | BOAT | 95.8 | DEAD | 88.9 | JAIL | 95.8 | DIP | 88.9 |
| 19 | CHORE | 95.8 | TOAD | 88.9 | HUT | 100.0 | LAKE | 90.3 |
| 20 | BEAN | 95.8 | ROUTE | 90.3 | FAITH | 100.0 | LEAVE | 91.7 |
| 21 | WISH | 95.8 | SOB | 90.3 | VOTE | 100.0 | DIKE | 91.7 |
| 22 | SUN | 95.8 | BOIL | 91.7 | DIP | 100.0 | ROUGE | 91.7 |
| 23 | WOOD | 100.0 | CHORE | 91.7 | LAKE | 100.0 | YAM | 91.7 |
| 24 | TOUGH | 100.0 | MAKE | 91.7 | DIKE | 100.0 | RIG | 93.1 |
| 25 | LEASE | 100.0 | HATE | 91.7 | ROUGE | 100.0 | KEG | 93.1 |
| 26 | RIPE | 100.0 | JUG | 93.1 | YAM | 100.0 | BELL | 94.4 |
| 27 | THIN | 100.0 | GALE | 93.1 | KEG | 100.0 | SIZE | 94.4 |
| 28 | TOAD | 100.0 | BEAN | 94.4 | SIZE | 100.0 | LIFE | 94.4 |
| 29 | ROUTE | 100.0 | WISH | 94.4 | LIFE | 100.0 | MAN | 94.4 |
| 30 | SOB | 100.0 | PATCH | 94.4 | MAN | 100.0 | SOON | 95.8 |
| 31 | MAKE | 100.0 | SHORE | 95.8 | SOON | 100.0 | WELL | 95.8 |
| 32 | HATE | 100.0 | VAN | 95.8 | WELL | 100.0 | PERCH | 95.8 |
| 33 | JUG | 100.0 | KNIFE | 95.8 | PERCH | 100.0 | PIECE | 95.8 |
| 34 | GALE | 100.0 | KING | 95.8 | PIECE | 100.0 | PURGE | 95.8 |
| 35 | PATCH | 100.0 | DIME | 97.2 | PURGE | 100.0 | SHINE | 95.8 |
| 36 | VAN | 100.0 | WHEEL | 97.2 | SHINE | 100.0 | TOSS | 97.2 |
| 37 | KNIFE | 100.0 | SHIRT | 97.2 | TOSS | 100.0 | ROOM | 97.2 |
| 38 | KING | 100.0 | DITCH | 97.2 | ROOM | 100.0 | MORE | 97.2 |
| 39 | SHIRT | 100.0 | PICK | 97.2 | MORE | 100.0 | NOISE | 97.2 |
| 40 | DITCH | 100.0 | FALL | 97.2 | NOISE | 100.0 | JAIL | 98.6 |
| 41 | PICK | 100.0 | WRECK | 98.6 | BUSH | 100.0 | BUSH | 98.6 |
| 42 | FALL | 100.0 | SUN | 98.6 | GAP | 100.0 | GAP | 98.6 |
| 43 | TOOTH | 100.0 | TOOTH | 98.6 | TONE | 100.0 | TONE | 98.6 |
| 44 | MERGE | 100.0 | MERGE | 98.6 | WORK | 100.0 | WORK | 98.6 |
| 45 | JAR | 100.0 | JAR | 100.0 | HEAD | 100.0 | HEAD | 98.6 |
| 46 | GOOSE | 100.0 | GOOSE | 100.0 | KID | 100.0 | KID | 100.0 |
| 47 | HOME | 100.0 | HOME | 100.0 | SHEEP | 100.0 | SHEEP | 100.0 |
| 48 | ROSE | 100.0 | ROSE | 100.0 | HOUSE | 100.0 | HOUSE | 100.0 |
| 49 | LOOP | 100.0 | LOOP | 100.0 | BAR | 100.0 | BAR | 100.0 |
| 50 | NAME | 100.0 | NAME | 100.0 | JOKE | 100.0 | JOKE | 100.0 |
| Mean | | 93.8 | | 88.1 | | 93.7 | | 85.8 |
| SD | | 14.7 | | 15.7 | | 13.5 | | 18.3 |
| Max | | 100.0 | | 100.0 | | 100.0 | | 100.0 |
| Min | | 16.7 | | 19.4 | | 37.5 | | 36.1 |
| Range | | 83.3 | | 80.6 | | 62.5 | | 63.9 |
| Skewness | | -4.1 | | -2.7 | | -2.6 | | -1.7 |
| Lower Quartile (Q1) | | 92.7 | | 86.1 | | 95.8 | | 86.5 |
| Median (Q2) | | 100.0 | | 92.4 | | 100.0 | | 93.8 |
| Upper Quartile (Q3) | | 100.0 | | 97.2 | | 100.0 | | 97.2 |
| Interquartile Range (IQR) | | 7.3 | | 11.1 | | 4.2 | | 10.8 |
| Inner Fence (Lower) | | 81.8 (3) | | 69.5 (4) | | 89.5 (8) | | 70.3 (9) |
| Inner Fence (Upper) | | 110.9 | | 113.9 | | 106.3 | | 113.3 |
| Outer Fence (Lower) | | 70.9 (3) | | 52.8 (2) | | 83.2 (7) | | 54.2 (5) |
| Outer Fence (Upper) | | 121.8 | | 130.5 | | 112.6 | | 129.5 |

**Supplemental Table S5**

**Table SM5.** Recognition performances obtained in quiet with Lists 6 and 7 of the Maryland CNC materials (Department of Veterans Affairs, 2006) from 24 young listeners with normal hearing and from 72 older listeners with sensorineural hearing loss. The data are illustrated in Figures 5 and 6 of the manuscript.

| | List 6 | | | | List 7 | | | |
|---|---|---|---|---|---|---|---|---|
| | Normal Hearing | | Hearing Loss | | Normal Hearing | | Hearing Loss | |
| | Word | % | Word | % | Word | % | Word | % |
| 1 | DULL | 20.8 | DULL | 20.8 | WAS | 62.5 | WIT | 27.8 |
| 2 | BAD | 66.7 | JOT | 26.4 | WIT | 66.7 | BET | 27.8 |
| 3 | MODE | 79.2 | SIT | 59.7 | GUN | 75.0 | GEM | 36.1 |
| 4 | JOT | 87.5 | SOUR | 69.4 | BET | 79.2 | CAUGHT | 43.1 |
| 5 | BUD | 91.7 | CAT | 72.2 | GEM | 79.2 | WAS | 45.8 |
| 6 | NIECE | 91.7 | CALF | 76.4 | SIDE | 79.2 | JOIN | 45.8 |
| 7 | FAN | 91.7 | GET | 76.4 | JOIN | 83.3 | DID | 50.0 |
| 8 | VEAL | 91.7 | BUD | 77.8 | SHALL | 87.5 | LED | 58.3 |
| 9 | LOOK | 91.7 | TURN | 79.2 | BUN | 87.5 | SIDE | 66.7 |
| 10 | BED | 91.7 | BAD | 80.6 | CAUGHT | 91.7 | TAR | 69.4 |
| 11 | TUBE | 91.7 | HOWL | 80.6 | LED | 91.7 | SHALL | 70.8 |
| 12 | SOUR | 95.8 | SHONE | 81.9 | FAR | 91.7 | BUN | 77.8 |
| 13 | CAT | 95.8 | WHIP | 84.7 | LOOT | 91.7 | DUMB | 77.8 |
| 14 | HOWL | 95.8 | JAM | 86.1 | COKE | 91.7 | HEAT | 79.2 |
| 15 | JAM | 95.8 | HISS | 86.1 | DUMB | 95.8 | SUCH | 80.6 |
| 16 | GONE | 95.8 | MODE | 87.5 | HEAT | 95.8 | DOOM | 81.9 |
| 17 | TEAM | 95.8 | NIECE | 87.5 | SUCH | 95.8 | FAR | 84.7 |
| 18 | LIVE | 95.8 | NIGHT | 88.9 | DOOM | 95.8 | HAVE | 84.7 |
| 19 | RUG | 95.8 | LAWN | 90.3 | PASS | 95.8 | CHEEK | 84.7 |
| 20 | MOVE | 95.8 | RAISE | 91.7 | MINE | 95.8 | LOOT | 86.1 |
| 21 | SIT | 100.0 | WING | 91.7 | NOTE | 95.8 | PASS | 86.1 |
| 22 | CALF | 100.0 | FAN | 93.1 | REACH | 95.8 | SURE | 87.5 |
| 23 | GET | 100.0 | GONE | 93.1 | HOLE | 95.8 | MINE | 88.9 |
| 24 | TURN | 100.0 | TEAM | 93.1 | PINE | 95.8 | MOUTH | 90.3 |
| 25 | SHONE | 100.0 | CHAIN | 93.1 | PEARL | 95.8 | FACE | 90.3 |
| 26 | WHIP | 100.0 | WEB | 93.1 | LOSE | 95.8 | NOTE | 91.7 |
| 27 | HISS | 100.0 | CAGE | 93.1 | DID | 100.0 | REACH | 91.7 |
| 28 | NIGHT | 100.0 | DIG | 93.1 | TAR | 100.0 | BIG | 91.7 |
| 29 | LAWN | 100.0 | MAP | 93.1 | HAVE | 100.0 | RIDGE | 93.1 |
| 30 | RAISE | 100.0 | VEAL | 94.4 | CHEEK | 100.0 | COKE | 94.4 |
| 31 | WING | 100.0 | COOL | 94.4 | SURE | 100.0 | HOLE | 94.4 |
| 32 | CHAIN | 100.0 | SEARCH | 94.4 | MOUTH | 100.0 | PINE | 94.4 |
| 33 | WEB | 100.0 | BIRTH | 94.4 | FACE | 100.0 | SAVE | 94.4 |
| 34 | CAGE | 100.0 | LIVE | 95.8 | BIG | 100.0 | MOLE | 94.4 |
| 35 | DIG | 100.0 | CHEESE | 95.8 | RIDGE | 100.0 | LAUGH | 94.4 |
| 36 | MAP | 100.0 | RUSH | 95.8 | SAVE | 100.0 | TOP | 94.4 |
| 37 | COOL | 100.0 | POLE | 95.8 | MOLE | 100.0 | GUN | 95.8 |
| 38 | SEARCH | 100.0 | RUG | 97.2 | LAUGH | 100.0 | TAPE | 95.8 |
| 39 | BIRTH | 100.0 | POPE | 97.2 | TOP | 100.0 | SACK | 95.8 |
| 40 | CHEESE | 100.0 | SHOCK | 97.2 | TAPE | 100.0 | CALL | 95.8 |
| 41 | RUSH | 100.0 | DOOR | 97.2 | SACK | 100.0 | THIRD | 97.2 |
| 42 | POLE | 100.0 | WIFE | 97.2 | CALL | 100.0 | NAP | 97.2 |
| 43 | POPE | 100.0 | LOOK | 98.6 | THIRD | 100.0 | GEESE | 97.2 |
| 44 | SHOCK | 100.0 | BED | 98.6 | NAP | 100.0 | VAGUE | 98.6 |
| 45 | DOOR | 100.0 | FIRE | 98.6 | GEESE | 100.0 | YOUNG | 98.6 |
| 46 | WIFE | 100.0 | PACE | 98.6 | VAGUE | 100.0 | RIB | 98.6 |
| 47 | FIRE | 100.0 | KNOCK | 98.6 | YOUNG | 100.0 | NECK | 98.6 |
| 48 | PACE | 100.0 | HIKE | 98.6 | RIB | 100.0 | PEARL | 100.0 |
| 49 | KNOCK | 100.0 | TUBE | 100.0 | NECK | 100.0 | LOSE | 100.0 |
| 50 | HIKE | 100.0 | MOVE | 100.0 | FISH | 100.0 | FISH | 100.0 |
| Mean | | 95.2 | | 87.6 | | 94.2 | | 82.4 |
| SD | | 12.3 | | 15.9 | | 8.9 | | 20.0 |
| Max | | 100.0 | | 100.0 | | 100.0 | | 100.0 |
| Min | | 20.8 | | 20.8 | | 62.5 | | 27.8 |
| Range | | 79.2 | | 79.2 | | 37.5 | | 72.2 |
| Skewness | | -4.9 | | -2.9 | | -2.0 | | -1.5 |
| Lower Quartile (Q1) | | 95.8 | | 85.1 | | 91.7 | | 78.2 |
| Median (Q2) | | 100.0 | | 93.1 | | 95.8 | | 91.0 |
| Upper Quartile (Q3) | | 100.0 | | 96.9 | | 100.0 | | 95.8 |
| Interquartile Range (IQR) | | 4.2 | | 11.8 | | 8.3 | | 17.7 |
| Inner Fence (Lower) | | 89.5 (4) | | 67.4 (3) | | 79.3 (6) | | 51.7 (7) |
| Inner Fence (Upper) | | 106.3 | | 114.6 | | 112.5 | | 122.3 |
| Outer Fence (Lower) | | 83.2 (3) | | 49.7 (2) | | 66.8 (2) | | 25.2 (0) |
| Outer Fence (Upper) | | 112.6 | | 132.3 | | 124.9 | | 148.8 |

**Supplemental Table S6**

**Table SM6.** Recognition performances obtained in quiet with Lists 9 and 10 of the Maryland CNC materials (Department of Veterans Affairs, 2006) from 24 young listeners with normal hearing and from 72 older listeners with sensorineural hearing loss. The data are illustrated in Figures 5 and 6 of the manuscript.

| | List 9 | | | | List 10 | | | |
|---|---|---|---|---|---|---|---|---|
| | Normal Hearing | | Hearing Loss | | Normal Hearing | | Hearing Loss | |
| | Word | % | Word | % | Word | % | Word | % |
| 1 | CHEER | 4.2 | THINE | 6.9 | SELL | 66.7 | CHAT | 37.5 |
| 2 | THINE | 25.0 | CHEER | 11.1 | DIN | 79.2 | LOT | 47.2 |
| 3 | LATHE | 66.7 | HEN | 51.4 | LUNG | 79.2 | THATCH | 56.9 |
| 4 | HEN | 79.2 | LACK | 54.2 | HURT | 87.5 | NEAT | 56.9 |
| 5 | GOT | 91.7 | WHITE | 59.7 | FINE | 87.5 | BIT | 58.3 |
| 6 | SANE | 91.7 | CUT | 66.7 | RIDE | 87.5 | HURT | 62.5 |
| 7 | REAP | 91.7 | LATHE | 70.8 | GUESS | 91.7 | DIN | 66.7 |
| 8 | CURVE | 91.7 | GOT | 70.8 | GORE | 91.7 | LUNG | 68.1 |
| 9 | WHITE | 95.8 | BOTH | 73.6 | SAG | 91.7 | GUESS | 68.1 |
| 10 | BOTH | 95.8 | PUN | 75.0 | CONE | 91.7 | HIT | 68.1 |
| 11 | PUN | 95.8 | BEAT | 76.4 | ROPE | 91.7 | GORE | 72.2 |
| 12 | BEAT | 95.8 | TICK | 77.8 | THATCH | 95.8 | MOUSE | 72.2 |
| 13 | TICK | 95.8 | SANE | 80.6 | BIT | 95.8 | SELL | 77.8 |
| 14 | MIRE | 95.8 | REAP | 81.9 | DEATH | 95.8 | DEATH | 80.6 |
| 15 | DECK | 95.8 | SIN | 81.9 | MEEK | 95.8 | MEEK | 80.6 |
| 16 | MOB | 95.8 | FEET | 84.7 | LOAD | 95.8 | LOAD | 81.9 |
| 17 | NEED | 95.8 | MIRE | 87.5 | LOOSE | 95.8 | CAUSE | 84.7 |
| 18 | LOAF | 95.8 | DECK | 87.5 | YOUR | 95.8 | SAG | 86.1 |
| 19 | LIP | 95.8 | JAZZ | 87.5 | WHILE | 95.8 | LOOSE | 86.1 |
| 20 | WATCH | 95.8 | CATCH | 87.5 | BAKE | 95.8 | YOUR | 86.1 |
| 21 | SOAP | 95.8 | SHADE | 88.9 | TOWEL | 95.8 | DEEP | 86.1 |
| 22 | LACK | 100.0 | PILL | 91.7 | FOOL | 95.8 | WITCH | 86.1 |
| 23 | CUT | 100.0 | FUDGE | 91.7 | TERM | 95.8 | FINE | 87.5 |
| 24 | SIN | 100.0 | SHOUT | 93.1 | MOOD | 95.8 | WHILE | 87.5 |
| 25 | FEET | 100.0 | MOB | 94.4 | CAVE | 95.8 | CONE | 91.7 |
| 26 | JAZZ | 100.0 | NEED | 94.4 | PALM | 95.8 | BAKE | 91.7 |
| 27 | CATCH | 100.0 | HAZE | 94.4 | PEAK | 95.8 | TOWEL | 91.7 |
| 28 | SHADE | 100.0 | MUD | 94.4 | BURN | 95.8 | COIN | 91.7 |
| 29 | PILL | 100.0 | LOAF | 95.8 | CHAT | 100.0 | NICK | 91.7 |
| 30 | FUDGE | 100.0 | POWER | 95.8 | LOT | 100.0 | SAFE | 91.7 |
| 31 | SHOUT | 100.0 | CURVE | 97.2 | NEAT | 100.0 | SHACK | 91.7 |
| 32 | HAZE | 100.0 | WORD | 97.2 | HIT | 100.0 | RIDE | 93.1 |
| 33 | MUD | 100.0 | CHAIR | 97.2 | MOUSE | 100.0 | FOOL | 93.1 |
| 34 | POWER | 100.0 | WRONG | 97.2 | CAUSE | 100.0 | SUB | 93.1 |
| 35 | WORD | 100.0 | VOICE | 97.2 | DEEP | 100.0 | JADE | 93.1 |
| 36 | CHAIR | 100.0 | BALL | 97.2 | WITCH | 100.0 | TERM | 94.4 |
| 37 | WRONG | 100.0 | LIP | 98.6 | COIN | 100.0 | MOOD | 94.4 |
| 38 | VOICE | 100.0 | NAIL | 98.6 | NICK | 100.0 | CAVE | 94.4 |
| 39 | BALL | 100.0 | BOOK | 98.6 | SAFE | 100.0 | CHILL | 94.4 |
| 40 | NAIL | 100.0 | RAG | 98.6 | SHACK | 100.0 | PATH | 94.4 |
| 41 | BOOK | 100.0 | DOG | 98.6 | SUB | 100.0 | PALM | 95.8 |
| 42 | RAG | 100.0 | DISH | 98.6 | JADE | 100.0 | ROPE | 97.2 |
| 43 | DOG | 100.0 | WATCH | 100.0 | CHILL | 100.0 | JUDGE | 97.2 |
| 44 | DISH | 100.0 | SOAP | 100.0 | PATH | 100.0 | WASH | 97.2 |
| 45 | TOOL | 100.0 | TOOL | 100.0 | JUDGE | 100.0 | ROB | 97.2 |
| 46 | HAM | 100.0 | HAM | 100.0 | WASH | 100.0 | PILE | 97.2 |
| 47 | YES | 100.0 | YES | 100.0 | ROB | 100.0 | RUN | 97.2 |
| 48 | GIRL | 100.0 | GIRL | 100.0 | PILE | 100.0 | PEAK | 98.6 |
| 49 | TIME | 100.0 | TIME | 100.0 | RUN | 100.0 | BURN | 100.0 |
| 50 | ROOF | 100.0 | ROOF | 100.0 | HAIR | 100.0 | HAIR | 100.0 |
| Mean | | 93.7 | | 85.7 | | 95.5 | | 84.2 |
| SD | | 17.4 | | 20.2 | | 6.5 | | 14.8 |
| Max | | 100.0 | | 100.0 | | 100.0 | | 100.0 |
| Min | | 4.2 | | 6.9 | | 66.7 | | 37.5 |
| Range | | 95.8 | | 93.1 | | 33.3 | | 62.5 |
| Skewness | | -4.2 | | -2.5 | | -2.5 | | -1.3 |
| Lower Quartile (Q1) | | 95.8 | | 80.9 | | 95.8 | | 78.5 |
| Median (Q2) | | 100.0 | | 94.4 | | 95.8 | | 91.7 |
| Upper Quartile (Q3) | | 100.0 | | 98.6 | | 100.0 | | 94.4 |
| Interquartile Range (IQR) | | 4.2 | | 17.7 | | 4.2 | | 15.9 |
| Inner Fence (Lower) | | 89.5 (4) | | 54.4 (4) | | 89.5 (6) | | 54.7 (2) |
| Inner Fence (Upper) | | 106.3 | | 125.1 | | 106.3 | | 118.3 |
| Outer Fence (Lower) | | 83.2 (4) | | 27.9 (2) | | 83.2 (3) | | 30.8 (0) |
| Outer Fence (Upper) | | 112.6 | | 151.6 | | 112.6 | | 142.1 |

**Supplemental Table S7**

**Table SM7.** Recognition performances by younger listeners with normal hearing and older listeners with sensorineural hearing loss (combined) on the NU 6 materials (Auditec male speaker) presented in quiet. The data are illustrated in Figure 7 of the manuscript. (transformed from Hurley and Sells, 2003, Table 2, page 114).

| | List 1 (*n* = 222) | | List 2 (*n* = 225) | | List 3 (*n* = 222) | | List 4 (*n* = 222) | |
|---|---|---|---|---|---|---|---|---|
| | Word | % | Word | % | Word | % | Word | % |
| 1 | DEATH | 33.8 | GIN | 41.3 | CHAT | 39.6 | YEARN | 36.5 |
| 2 | KNOCK | 47.8 | PIKE | 45.3 | THIN | 43.2 | PERCH | 36.5 |
| 3 | LAUD | 49.1 | KEG | 45.3 | MOUSE | 44.1 | FIT | 44.6 |
| 4 | PUFF | 50.0 | PICK | 48.0 | MESS | 50.0 | PASS | 44.6 |
| 5 | KEEN | 51.4 | KEEP | 48.9 | PEARL | 50.5 | SHIRT | 51.4 |
| 6 | BURN | 51.8 | TURN | 50.2 | GERM | 51.8 | RIPE | 55.0 |
| 7 | TAKE | 55.4 | DAB | 50.7 | DITCH | 52.3 | CAME | 56.8 |
| 8 | THIRD | 55.9 | GAZE | 51.1 | DODGE | 53.6 | PEG | 58.6 |
| 9 | MET | 56.3 | LEARN | 51.6 | CHEEK | 55.0 | TAPE | 59.5 |
| 10 | POOL | 57.2 | TON | 52.0 | TELL | 56.8 | KICK | 60.4 |
| 11 | KITE | 58.6 | SHACK | 52.4 | BEG | 57.7 | NEAT | 62.2 |
| 12 | HURL | 58.0 | PAD | 53.3 | PAIN | 59.5 | LEASE | 63.1 |
| 13 | JAR | 59.9 | MILL | 53.8 | TEAM | 63.1 | BATH | 64.0 |
| 14 | FAT | 60.8 | THOUGHT | 54.2 | RING | 63.1 | BACK | 65.8 |
| 15 | SELL | 62.2 | NICE | 56.0 | MOP | 63.1 | GAS | 66.2 |
| 16 | TIP | 63.5 | WAG | 59.1 | HIT | 63.5 | CHECK | 66.2 |
| 17 | LOT | 65.8 | ROT | 59.6 | TALK | 64.0 | THUMB | 66.2 |
| 18 | CHALK | 66.2 | MATCH | 59.6 | YOUTH | 64.4 | WASH | 66.7 |
| 19 | WEEK | 67.0 | SAID | 59.6 | CAUSE | 66.2 | JOIN | 67.0 |
| 20 | WHICH | 67.0 | CHIEF | 60.4 | POLE | 66.7 | JUDGE | 67.0 |
| 21 | PAGE | 67.0 | LORE | 61.3 | SEARCH | 68.5 | SHOULD | 69.4 |
| 22 | GAP | 68.9 | BOUGHT | 62.7 | SHEEP | 68.5 | MAKE | 69.4 |
| 23 | SHOUT | 68.9 | DEAD | 63.6 | SHALL | 68.9 | LONG | 69.8 |
| 24 | DIME | 69.8 | SHAWL | 63.6 | JUG | 69.4 | SUCH | 70.3 |
| 25 | HASH | 70.7 | CALM | 66.7 | LID | 70.7 | WIFE | 70.7 |
| 26 | NAG | 71.6 | GOAL | 68.9 | SEIZE | 72.1 | SOUR | 71.2 |
| 27 | MODE | 71.6 | WITCH | 69.3 | HALF | 73.9 | KILL | 71.6 |
| 28 | TOUGH | 73.9 | MERGE | 70.7 | CAB | 74.8 | GET | 72.5 |
| 29 | SUB | 74.8 | FAR | 72.9 | RAT | 75.2 | CHAIN | 73.4 |
| 30 | RAISE | 74.8 | TOOL | 73.8 | PHONE | 75.2 | BONE | 73.9 |
| 31 | YES | 75.2 | FAIL | 73.8 | DATE | 75.7 | DOLL | 74.3 |
| 32 | SIZE | 75.7 | CHAIR | 74.2 | FIVE | 76.0 | DIP | 75.2 |
| 33 | WHIP | 76.1 | HUSH | 74.7 | RUSH | 76.0 | TIME | 75.7 |
| 34 | KING | 76.6 | LIVE | 75.6 | HIRE | 77.9 | WHEAT | 76.1 |
| 35 | FALL | 77.0 | HAZE | 76.9 | LIFE | 78.4 | TIRE | 76.1 |
| 36 | CHOICE | 77.0 | BITE | 77.3 | VOID | 79.3 | HOLE | 79.7 |
| 37 | BEAN | 77.5 | SOAP | 77.3 | BASE | 82.4 | RED | 80.2 |
| 38 | LIMB | 78.0 | SOUTH | 78.7 | RODE | 82.4 | MOB | 80.2 |
| 39 | MOON | 77.5 | LOAF | 79.6 | WIRE | 82.9 | MOOD | 80.2 |
| 40 | VINE | 78.4 | VOICE | 80.0 | BAR | 83.3 | ROUGH | 81.1 |
| 41 | RAG | 79.7 | DEEP | 80.4 | WHEN | 83.3 | SALE | 81.5 |
| 42 | GOOSE | 80.2 | YOUNG | 80.9 | NAME | 83.8 | NEAR | 82.0 |
| 43 | DOOR | 82.0 | JUICE | 81.8 | LUCK | 83.8 | DOG | 82.9 |
| 44 | SURE | 82.4 | NUMB | 81.8 | GUN | 83.8 | VOTE | 83.8 |
| 45 | REACH | 82.4 | READ | 83.8 | LATE | 84.7 | ROSE | 85.6 |
| 46 | JAIL | 83.3 | BOOK | 86.4 | NOTE | 85.6 | FOOD | 86.9 |
| 47 | RAID | 88.7 | HATE | 87.1 | WALK | 90.5 | HALL | 86.9 |
| 46 | BOAT | 91.4 | WHITE | 87.6 | COOL | 91.4 | HAVE | 86.9 |
| 49 | HOME | 93.2 | RAIN | 89.8 | SOUP | 92.3 | LOSE | 87.4 |
| 50 | LOVE | 95.5 | ROOM | 89.8 | GOOD | 94.1 | LEAN | 87.4 |
| Mean | | 69.6 | | 66.9 | | 70.3 | | 70.0 |
| SD | | 12.8 | | 13.7 | | 13.7 | | 12.7 |
| Max | | 95.5 | | 89.8 | | 94.1 | | 87.4 |
| Min | | 33.8 | | 41.3 | | 39.6 | | 36.5 |
| Range | | 61.7 | | 48.5 | | 54.5 | | 50.9 |
| Skewness | | -0.3 | | 0.0 | | -0.3 | | -0.9 |
| Lower Quartile (Q1) | | 60.1 | | 53.9 | | 63.1 | | 64.5 |
| Median (Q2) | | 71.2 | | 67.8 | | 71.4 | | 71.0 |
| Upper Quartile (Q3) | | 77.5 | | 78.4 | | 82.4 | | 80.2 |
| Interquartile Range (IQR) | | 17.4 | | 24.5 | | 19.3 | | 15.8 |
| Inner Fence (Lower) | | 34.1 (1) | | 17.2 (0) | | 34.2 (0) | | 40.8 (2) |
| Inner Fence (Upper) | | 103.6 | | 115.0 | | 111.4 | | 103.8 |
| Outer Fence (Lower) | | 8.0 (0) | | -19.5 (0) | | 5.2 (0) | | 17.2 (0) |
| Outer Fence (Upper) | | 129.6 | | 151.7 | | 140.3 | | 127.5 |
| Kurtosis | | 0.1 | | -1.2 | | -0.6 | | 0.6 |

**Supplemental Table S8**

**Table SM8.** Recognition performances obtained with the NU 6 materials (Auditec male speaker) presented in multitalker babble (9-dB SNR) from 340 adults with a variety of pure-tone thresholds. The data are illustrated in Figure 8 of the manuscript. (from Brungart et al., 2013, Table 1, page 5)

| | List 1 | | List 2 | | List 3 | | List 4 | |
|---|---|---|---|---|---|---|---|---|
| | Word | % | Word | % | Word | % | Word | % |
| 1 | PUFF | 36.8 | GIN | 45.3 | SHEEP | 45.0 | RIPE | 46.5 |
| 2 | KNOCK | 40.0 | PICK | 65.6 | RING | 53.8 | CAME | 70.6 |
| 3 | POOL | 53.5 | CHIEF | 69.4 | CHEEK | 64.1 | FIT | 70.6 |
| 4 | THIRD | 60.6 | PIKE | 70.9 | LIFE | 65.9 | TAPE | 71.8 |
| 5 | KEEN | 65.3 | TURN | 72.1 | YOUTH | 72.9 | PEG | 72.9 |
| 6 | LAUD | 65.9 | ROT | 73.8 | JUG | 74.7 | WIFE | 72.9 |
| 7 | DEATH | 70.9 | SHACK | 74.1 | PEARL | 75.0 | HOLE | 74.7 |
| 8 | FAT | 75.6 | PAD | 76.8 | LID | 76.8 | YEARN | 75.0 |
| 9 | LOT | 75.9 | FAR | 77.9 | PAIN | 79.7 | PASS | 75.6 |
| 10 | TAKE | 76.8 | DAB | 79.7 | POLE | 79.7 | GET | 77.4 |
| 11 | RAISE | 79.1 | LOAF | 80.3 | VOID | 80.3 | MOOD | 79.1 |
| 12 | TIP | 80.9 | BITE | 80.9 | CHAT | 82.4 | LEASE | 80.6 |
| 13 | CHALK | 81.8 | NICE | 82.4 | TEAM | 82.4 | SOUR | 81.8 |
| 14 | VINE | 82.9 | DEEP | 82.6 | THIN | 82.6 | BATH | 83.5 |
| 15 | FALL | 83.5 | GAZE | 82.6 | HALF | 85.3 | JOIN | 83.8 |
| 16 | GAP | 83.8 | LORE | 82.9 | FIVE | 85.9 | SHIRT | 84.7 |
| 17 | MODE | 84.1 | FAIL | 83.8 | SEIZE | 86.5 | WHEAT | 85.3 |
| 18 | GOOSE | 85.6 | KEEP | 84.1 | BASE | 86.8 | LONG | 85.9 |
| 19 | JAR | 86.2 | THOUGHT | 84.1 | LATE | 87.1 | VOTE | 86.2 |
| 20 | WEEK | 86.2 | TOOL | 85.3 | MESS | 87.1 | PERCH | 87.1 |
| 21 | HURL | 87.4 | WAG | 85.3 | RAT | 87.4 | NEAT | 88.2 |
| 22 | KITE | 87.6 | MATCH | 86.2 | CAUSE | 87.6 | BACK | 88.8 |
| 23 | MET | 87.9 | BOUGHT | 87.4 | PHONE | 87.9 | ROUGH | 89.1 |
| 24 | PAGE | 88.2 | TON | 87.4 | MOP | 88.8 | CHAIN | 90.0 |
| 25 | SUB | 88.2 | SAID | 88.2 | NAME | 89.1 | HALL | 91.2 |
| 26 | BURN | 88.5 | KEG | 88.5 | SHALL | 89.1 | MAKE | 91.2 |
| 27 | DOOR | 88.5 | SHAWL | 88.8 | SOUP | 89.4 | SALE | 91.5 |
| 28 | NAG | 89.1 | WHITE | 89.4 | TALK | 89.7 | THUMB | 91.5 |
| 29 | TOUGH | 89.4 | GOAL | 90.0 | DODGE | 90.9 | DIP | 92.1 |
| 30 | BEAN | 90.0 | LEARN | 90.3 | LUCK | 91.2 | GAS | 92.1 |
| 31 | SIZE | 90.9 | CALM | 92.1 | MOUSE | 92.1 | MOB | 92.1 |
| 32 | CHOICE | 92.4 | MILL | 92.1 | BEG | 92.6 | SUCH | 92.4 |
| 33 | BOAT | 92.6 | MERGE | 92.6 | DATE | 93.2 | FOOD | 92.9 |
| 34 | DIME | 92.6 | LIVE | 94.1 | HIT | 93.2 | KICK | 93.2 |
| 35 | RAG | 92.9 | SOAP | 94.4 | CAB | 93.5 | ROSE | 93.2 |
| 36 | HASH | 93.5 | BOOK | 95.0 | GERM | 93.8 | WASH | 93.2 |
| 37 | JAIL | 93.8 | CHAIR | 95.3 | SEARCH | 94.4 | SHOULD | 93.8 |
| 38 | MOON | 93.8 | DEAD | 95.3 | WALK | 94.4 | CHECK | 94.7 |
| 39 | WHIP | 94.4 | SOUTH | 95.3 | BAR | 95.6 | DOLL | 94.7 |
| 40 | RAID | 95.0 | HAZE | 95.9 | COOL | 95.6 | TIME | 95.0 |
| 41 | SHOUT | 95.3 | HUSH | 95.9 | DITCH | 95.9 | TIRE | 95.0 |
| 42 | KING | 96.2 | JUICE | 96.2 | NOTE | 96.2 | HAVE | 95.6 |
| 43 | REACH | 96.2 | WITCH | 96.5 | RUSH | 96.2 | JUDGE | 95.9 |
| 44 | SELL | 96.2 | NUMB | 96.8 | TELL | 96.5 | LEAN | 95.9 |
| 45 | WHICH | 96.2 | HATE | 97.6 | GUN | 96.8 | NEAR | 96.2 |
| 46 | YES | 96.5 | RAIN | 97.6 | HIRE | 96.8 | BONE | 96.8 |
| 47 | LIMB | 96.8 | READ | 97.6 | RODE | 97.4 | LOSE | 97.1 |
| 48 | SURE | 97.1 | ROOM | 97.9 | WHEN | 97.4 | RED | 97.4 |
| 49 | LOVE | 98.2 | YOUNG | 97.9 | WIRE | 97.4 | KILL | 97.6 |
| 50 | HOME | 98.8 | VOICE | 98.8 | GOOD | 97.9 | DOG | 98.5 |
| Mean | | 84.8 | | 86.6 | | 86.6 | | 87.1 |
| SD | | 13.9 | | 10.5 | | 11.2 | | 10.1 |
| Max | | 98.8 | | 98.8 | | 97.9 | | 98.5 |
| Min | | 36.8 | | 45.3 | | 45.0 | | 46.5 |
| Range | | 62.1 | | 53.5 | | 52.9 | | 52.1 |
| Skewness | | -1.9 | | -1.5 | | -1.8 | | -1.7 |
| Lower Quartile (Q1) | | 82.3 | | 82.3 | | 82.3 | | 82.5 |
| Median (Q2) | | 88.5 | | 88.5 | | 89.0 | | 91.0 |
| Upper Quartile (Q3) | | 94.0 | | 95.0 | | 94.0 | | 94.8 |
| Interquartile Range (IQR) | | 11.8 | | 12.8 | | 11.8 | | 12.3 |
| Inner Fence (Lower) | | 64.6 (4) | | 63.1 (1) | | 64.6 (3) | | 64.1 (1) |
| Inner Fence (Upper) | | 111.6 | | 114.1 | | 111.6 | | 113.1 |
| Outer Fence (Lower) | | 47.0 (2) | | 44.0 (0) | | 47.0 (1) | | 45.8 (0) |
| Outer Fence (Upper) | | 129.3 | | 133.3 | | 129.3 | | 131.5 |

**Supplemental Table S9**

**Table SM9.** Recognition performances obtained with Lists 1 and 2 of the SPRINT materials (Department of Veterans Affairs, 2006) from 24 young listeners with normal hearing for pure tones and from 72 older listeners with sensorineural hearing loss. The materials were presented in speech-spectrum noise at a 9-dB S/N. The data are illustrated in Figure 9 and of the manuscript. (from Wilson and Cates, 2008)

| | ---------- List 1 ---------- | | | | | ---------- List 2 ---------- | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Normal Hearing | | Hearing Loss | | | Normal Hearing | | Hearing Loss | | |
| | Word | % | Word | % | | Word | % | Word | % | |
| 1 | PUFF | 12.5 | PUFF | 10.4 | | PIKE | 62.5 | TURN | 14.6 | |
| 2 | KNOCK | 25.0 | KNOCK | 20.8 | | ROT | 70.8 | PAD | 27.1 | |
| 3 | KEEN | 45.8 | KEEN | 22.9 | | CHIEF | 70.8 | GIN | 31.3 | |
| 4 | FALL | 50.0 | VINE | 27.1 | | GIN | 75.0 | GAZE | 31.3 | |
| 5 | DOOR | 58.3 | LAUD | 29.2 | | THOUGHT | 75.0 | PICK | 31.3 | |
| 6 | POOL | 70.8 | BURN | 33.3 | | BITE | 79.2 | PIKE | 35.4 | |
| 7 | THIRD | 75.0 | TAKE | 33.3 | | DAB | 79.2 | NICE | 37.5 | |
| 8 | MODE | 75.0 | THIRD | 35.4 | | GOAL | 83.3 | CHIEF | 39.6 | |
| 9 | HURL | 83.3 | SUB | 35.4 | | FAR | 87.5 | MATCH | 43.8 | |
| 10 | DIME | 83.3 | RAISE | 37.5 | | DEEP | 87.5 | TON | 45.8 | |
| 11 | VINE | 83.3 | TIP | 39.6 | | LORE | 87.5 | ROT | 47.9 | |
| 12 | RAISE | 87.5 | MODE | 39.6 | | RAIN | 91.7 | WAG | 47.9 | |
| 13 | BEAN | 87.5 | MOON | 41.7 | | LIVE | 91.7 | BOUGHT | 52.1 | |
| 14 | LOT | 87.5 | LOT | 43.8 | | KEEP | 91.7 | SHACK | 52.1 | |
| 15 | LAUD | 87.5 | POOL | 45.8 | | JUICE | 95.8 | KEG | 56.3 | |
| 16 | TIP | 91.7 | DEATH | 47.9 | | CALM | 95.8 | DAB | 58.3 | |
| 17 | FAT | 91.7 | PAGE | 47.9 | | MATCH | 95.8 | LEARN | 58.3 | |
| 18 | GOOSE | 91.7 | MET | 50.0 | | LOAF | 95.8 | DEEP | 60.4 | |
| 19 | SUB | 91.7 | FAT | 50.0 | | NICE | 95.8 | SOUTH | 66.7 | |
| 20 | BURN | 95.8 | HURL | 52.1 | | WHITE | 95.8 | FAR | 66.7 | |
| 21 | SELL | 95.8 | CHALK | 54.2 | | PAD | 95.8 | SAID | 66.7 | |
| 22 | DEATH | 95.8 | KITE | 54.2 | | GAZE | 95.8 | JUICE | 68.8 | |
| 23 | CHALK | 95.8 | JAR | 62.5 | | TOOL | 95.8 | MERGE | 68.8 | |
| 24 | RAID | 95.8 | CHOICE | 62.5 | | HAZE | 95.8 | YOUNG | 68.8 | |
| 25 | GAP | 95.8 | TOUGH | 62.5 | | SAID | 95.8 | SHAWL | 68.8 | |
| 26 | SHOUT | 95.8 | DIME | 66.7 | | WAG | 95.8 | TOOL | 68.8 | |
| 27 | SURE | 100.0 | NAG | 68.8 | | DEAD | 100.0 | KEEP | 68.8 | |
| 28 | MET | 100.0 | SIZE | 68.8 | | MERGE | 100.0 | THOUGHT | 68.8 | |
| 29 | REACH | 100.0 | GAP | 70.8 | | YOUNG | 100.0 | BITE | 70.8 | |
| 30 | JAR | 100.0 | WEEK | 72.9 | | BOOK | 100.0 | LORE | 70.8 | |
| 31 | WHICH | 100.0 | BOAT | 72.9 | | BOUGHT | 100.0 | CHAIR | 75.0 | |
| 32 | MOON | 100.0 | KING | 75.0 | | TON | 100.0 | RAIN | 77.1 | |
| 33 | KING | 100.0 | HASH | 75.0 | | SHAWL | 100.0 | LOAF | 79.2 | |
| 34 | YES | 100.0 | BEAN | 77.1 | | HATE | 100.0 | FAIL | 79.2 | |
| 35 | WEEK | 100.0 | FALL | 77.1 | | SHACK | 100.0 | GOAL | 81.3 | |
| 36 | WHIP | 100.0 | GOOSE | 77.1 | | FAIL | 100.0 | LIVE | 83.3 | |
| 37 | CHOICE | 100.0 | REACH | 83.3 | | ROOM | 100.0 | WHICH | 83.3 | |
| 38 | RAG | 100.0 | SELL | 85.4 | | SOUTH | 100.0 | DEAD | 85.4 | |
| 39 | JAIL | 100.0 | WHICH | 85.4 | | MILL | 100.0 | CALM | 85.4 | |
| 40 | HOME | 100.0 | SHOUT | 85.4 | | WHICH | 100.0 | MILL | 85.4 | |
| 41 | BOAT | 100.0 | DOOR | 87.5 | | NUMB | 100.0 | SOAP | 85.4 | |
| 42 | TOUGH | 100.0 | RAG | 87.5 | | PICK | 100.0 | BOOK | 87.5 | |
| 43 | TAKE | 100.0 | RAID | 87.5 | | TURN | 100.0 | HAZE | 89.6 | |
| 44 | PAGE | 100.0 | WHIP | 91.7 | | VOICE | 100.0 | HUSH | 89.6 | |
| 45 | LIMB | 100.0 | JAIL | 91.7 | | READ | 100.0 | NUMB | 93.8 | |
| 46 | NAG | 100.0 | HOME | 91.7 | | HUSH | 100.0 | WHITE | 95.8 | |
| 47 | SIZE | 100.0 | SURE | 93.8 | | CHAIR | 100.0 | HATE | 95.8 | |
| 48 | HASH | 100.0 | YES | 95.8 | | KEG | 100.0 | VOICE | 95.8 | |
| 49 | LOVE | 100.0 | LIMB | 97.9 | | SOAP | 100.0 | READ | 97.9 | |
| 50 | KITE | 100.0 | LOVE | 100.0 | | LEARN | 100.0 | ROOM | 100.0 | |
| Mean | | 89.0 | | 62.1 | | | 93.7 | | 66.8 | |
| SD | | 19.4 | | 23.8 | | | 9.5 | | 21.5 | |
| Max | | 100.0 | | 100.0 | | | 100.0 | | 100.0 | |
| Min | | 12.5 | | 10.4 | | | 62.5 | | 14.6 | |
| Range | | 87.5 | | 89.6 | | | 37.5 | | 85.4 | |
| Skewness | | -2.5 | | -0.2 | | | -1.7 | | -0.5 | |
| Lower Quartile (Q1) | | 87.5 | | 42.2 | | | 91.7 | | 52.1 | |
| Median (Q2) | | 95.8 | | 64.6 | | | 95.8 | | 68.8 | |
| Upper Quartile (Q3) | | 100.0 | | 84.9 | | | 100.0 | | 84.9 | |
| Interquartile Range (IQR) | | 12.5 | | 42.7 | | | 8.3 | | 32.8 | |
| Inner Fence (Lower) | | 68.8 | (5) | -21.9 | (0) | | 79.2 | (5) | 2.9 | (0) |
| Inner Fence (Upper) | | 118.8 | | 149.0 | | | 112.5 | | 134.1 | |
| Outer Fence (Lower) | | 50.0 | (3) | -85.9 | (0) | | 66.7 | (1) | -46.4 | (0) |
| Outer Fence (Upper) | | 137.5 | | 213.0 | | | 125.0 | | 183.3 | |
| Kurtosis | | 6.4 | | -1.1 | | | 2.2 | | -0.6 | |

**Supplemental Table S10**

**Table SM10.** Recognition performances obtained with Lists 3 and 4 of the SPRINT materials (Department of Veterans Affairs, 2006) from 24 young listeners with normal hearing for pure tones and from 72 older listeners with sensorineural hearing loss. The materials were presented in speech-spectrum noise at a 9-dB S/N. The data are illustrated in Figure 9 and of the manuscript. (from Wilson and Cates, 2008)

| | ---------- List 3 ---------- | | | | ---------- List 4 ---------- | | | |
|---|---|---|---|---|---|---|---|---|
| | Normal Hearing | | Hearing Loss | | Normal Hearing | | Hearing Loss | |
| | Word | % | Word | % | Word | % | Word | % |
| 1 | CHEEK | 45.8 | YOUTH | 29.2 | RIPE | 37.5 | GET | 29.2 |
| 2 | SHEEP | 50.0 | TEAM | 29.2 | PASS | 75.0 | PERCH | 31.3 |
| 3 | RING | 54.2 | CHEEK | 31.3 | CAME | 75.0 | YEARN | 33.3 |
| 4 | PEARL | 54.2 | CHAT | 35.4 | JOIN | 79.2 | JOIN | 33.3 |
| 5 | LIFE | 79.2 | RING | 37.5 | WIFE | 87.5 | PASS | 35.4 |
| 6 | SHALL | 83.3 | CAUSE | 37.5 | BATH | 91.7 | LEASE | 35.4 |
| 7 | YOUTH | 83.3 | PEARL | 37.5 | SOUR | 91.7 | PEG | 35.4 |
| 8 | TEAM | 83.3 | LIFE | 41.7 | FOOD | 91.7 | SOUR | 37.5 |
| 9 | BASE | 91.7 | SHEEP | 41.7 | SAIL | 91.7 | CAME | 37.5 |
| 10 | HALF | 91.7 | VOID | 41.7 | WHEAT | 91.7 | RIPE | 37.5 |
| 11 | PAIN | 91.7 | SEIZE | 45.8 | HOLE | 91.7 | BATH | 39.6 |
| 12 | RAT | 91.7 | PAIN | 47.9 | PERCH | 95.8 | FIT | 39.6 |
| 13 | POLE | 91.7 | MESS | 50.0 | FIT | 95.8 | TAPE | 39.6 |
| 14 | LID | 91.7 | POLE | 50.0 | NEAT | 95.8 | WIFE | 45.8 |
| 15 | FIVE | 91.7 | THIN | 54.2 | MOB | 95.8 | MOOD | 47.9 |
| 16 | MOUSE | 91.7 | LID | 56.3 | DOLL | 95.8 | HOLE | 50.0 |
| 17 | MOP | 95.8 | DODGE | 56.3 | VOTE | 95.8 | CHAIN | 56.3 |
| 18 | GUN | 95.8 | HALF | 58.3 | TIME | 95.8 | SUCH | 58.3 |
| 19 | TALK | 95.8 | JUG | 62.5 | NEAR | 95.8 | VOTE | 60.4 |
| 20 | PHONE | 95.8 | MOP | 64.6 | LEASE | 95.8 | LONG | 60.4 |
| 21 | VOID | 95.8 | TALK | 64.6 | LOSE | 95.8 | SHIRT | 64.6 |
| 22 | JUG | 95.8 | RAT | 68.8 | TAPE | 95.8 | MAKE | 64.6 |
| 23 | TELL | 100.0 | GERM | 70.8 | YEARN | 95.8 | SAIL | 64.6 |
| 24 | GERM | 100.0 | SEARCH | 70.8 | GAS | 95.8 | ROSE | 70.8 |
| 25 | SEIZE | 100.0 | NAME | 70.8 | RED | 95.8 | GAS | 70.8 |
| 26 | GOOD | 100.0 | MOUSE | 70.8 | MOOD | 95.8 | TIME | 72.9 |
| 27 | SEARCH | 100.0 | BASE | 72.9 | SUCH | 95.8 | THUMB | 72.9 |
| 28 | MESS | 100.0 | DITCH | 72.9 | HALL | 95.8 | KICK | 75.0 |
| 29 | LATE | 100.0 | HIT | 75.0 | GET | 95.8 | DIP | 75.0 |
| 30 | WHEN | 100.0 | LUCK | 75.0 | CHAIN | 95.8 | NEAT | 77.1 |
| 31 | NAME | 100.0 | BEG | 77.1 | THUMB | 95.8 | ROUGH | 77.1 |
| 32 | DITCH | 100.0 | LATE | 79.2 | BACK | 100.0 | MOB | 79.2 |
| 33 | HIRE | 100.0 | CAB | 79.2 | BONE | 100.0 | SHOULD | 79.2 |
| 34 | DATE | 100.0 | TELL | 81.3 | SHIRT | 100.0 | LEAN | 79.2 |
| 35 | ROAD | 100.0 | FIVE | 83.3 | WASH | 100.0 | HALL | 79.2 |
| 36 | CAUSE | 100.0 | SHALL | 85.4 | TIRE | 100.0 | DOG | 83.3 |
| 37 | BAR | 100.0 | DATE | 85.4 | MAKE | 100.0 | NEAR | 83.3 |
| 38 | HIT | 100.0 | PHONE | 85.4 | DOG | 100.0 | KILL | 83.3 |
| 39 | COOL | 100.0 | WALK | 85.4 | ROSE | 100.0 | CHECK | 83.3 |
| 40 | RUSH | 100.0 | GUN | 87.5 | KILL | 100.0 | BACK | 85.4 |
| 41 | THIN | 100.0 | SOUP | 87.5 | SHOULD | 100.0 | WASH | 85.4 |
| 42 | BEG | 100.0 | WHEN | 89.6 | CHECK | 100.0 | DOLL | 85.4 |
| 43 | WALK | 100.0 | BAR | 89.6 | KICK | 100.0 | WHEAT | 85.4 |
| 44 | LUCK | 100.0 | RUSH | 89.6 | LONG | 100.0 | JUDGE | 85.4 |
| 45 | SOUP | 100.0 | WIRE | 89.6 | LEAN | 100.0 | TIRE | 87.5 |
| 46 | DODGE | 100.0 | HIRE | 91.7 | HAVE | 100.0 | FOOD | 87.5 |
| 47 | CHAT | 100.0 | NOTE | 91.7 | DIP | 100.0 | HAVE | 91.7 |
| 48 | NOTE | 100.0 | GOOD | 93.8 | ROUGH | 100.0 | LOSE | 93.8 |
| 49 | WIRE | 100.0 | ROAD | 93.8 | PEG | 100.0 | RED | 93.8 |
| 50 | CAB | 100.0 | COOL | 95.8 | JUDGE | 100.0 | BONE | 100.0 |
| Mean | | 92.8 | | 67.3 | | 94.4 | | 65.2 |
| SD | | 13.5 | | 20.4 | | 10.1 | | 21.1 |
| Max | | 100.0 | | 95.8 | | 100.0 | | 100.0 |
| Min | | 45.8 | | 29.2 | | 37.5 | | 29.2 |
| Range | | 54.2 | | 66.7 | | 62.5 | | 70.8 |
| Skewness | | -2.5 | | -0.4 | | -4.2 | | -0.3 |
| Lower Quartile (Q1) | | 91.7 | | 50.0 | | 95.8 | | 41.1 |
| Median (Q2) | | 100.0 | | 70.8 | | 95.8 | | 71.9 |
| Upper Quartile (Q3) | | 100.0 | | 85.4 | | 100.0 | | 83.3 |
| Interquartile Range (IQR) | | 8.3 | | 35.4 | | 4.2 | | 42.2 |
| Inner Fence (Lower) | | 79.2 (4) | | -3.1 (0) | | 89.6 (5) | | -22.1 (0) |
| Inner Fence (Upper) | | 112.5 | | 138.5 | | 106.3 | | 146.6 |
| Outer Fence (Lower) | | 66.7 (4) | | -56.3 (0) | | 83.3 (4) | | -85.4 (0) |
| Outer Fence (Upper) | | 125.0 | | 191.7 | | 112.5 | | 209.9 |
| Kurtosis | | 5.6 | | -1.1 | | 21.3 | | -1.3 |

**Supplemental Table S11**

**Table SM11.** Recognition performances by older listeners with sensorineural hearing loss on the NU 6 materials presented in quiet (VA female speaker #1, Department of Veterans Affairs, 2006) from the Bay Pines VA Healthcare System. The data are illustrated in Figure 9 of the manuscript.

| | List 1 (*n* = 244) | | List 2 (*n* = 187) | | List 3 (*n* = 220) | | List 4 (*n* = 302) | |
|---|---|---|---|---|---|---|---|---|
| | Word | % | Word | % | Word | % | Word | % |
| 1 | DIME | 36.5 | DAB | 47.1 | FIVE | 45.0 | FIT | 49.0 |
| 2 | LAUD | 53.7 | GAZE | 53.5 | CAUSE | 46.4 | CAME | 50.3 |
| 3 | TIP | 54.1 | WAG | 54.5 | MESS | 53.6 | CHAIN | 50.3 |
| 4 | MOON | 55.7 | PICK | 56.7 | BAR | 54.1 | ROUGH | 52.0 |
| 5 | KEEN | 56.6 | MERGE | 58.3 | HALF | 54.1 | WIFE | 53.6 |
| 6 | MET | 57.4 | TON | 59.4 | GERM | 57.3 | BATH | 56.3 |
| 7 | PUFF | 59.0 | MILL | 61.5 | SHEEP | 58.2 | YEARN | 56.3 |
| 8 | NAG | 60.2 | LORE | 64.7 | SHALL | 59.1 | LONG | 61.6 |
| 9 | LOT | 60.7 | PIKE | 64.7 | PEARL | 60.0 | HAVE | 62.3 |
| 10 | MODE | 62.3 | CALM | 65.8 | TELL | 60.0 | JOIN | 62.6 |
| 11 | DEATH | 62.7 | LOAF | 66.8 | SEIZE | 61.8 | SALE | 62.9 |
| 12 | GAP | 63.9 | TURN | 67.9 | TEAM | 61.8 | LEAN | 63.6 |
| 13 | POOL | 65.2 | YOUNG | 68.4 | BEG | 62.7 | MOB | 63.6 |
| 14 | VINE | 67.2 | KEEP | 69.5 | MOP | 62.7 | VOTE | 63.6 |
| 15 | BEAN | 67.6 | ROT | 69.5 | MOUSE | 63.6 | GET | 64.6 |
| 16 | CHOICE | 67.6 | CHIEF | 70.1 | CAB | 65.0 | TIME | 65.2 |
| 17 | HURL | 67.6 | KEG | 70.1 | CHAT | 65.9 | DIP | 65.9 |
| 18 | SELL | 68.0 | GIN | 70.6 | CHEEK | 67.3 | TAPE | 65.9 |
| 19 | TOUGH | 68.9 | SHAWL | 71.7 | LATE | 70.9 | WASH | 67.2 |
| 20 | SHOUT | 69.7 | FAIL | 72.2 | RAT | 70.9 | SHOULD | 68.5 |
| 21 | SUB | 70.5 | TOOL | 72.2 | WIRE | 71.4 | SOUR | 68.5 |
| 22 | THIRD | 70.9 | DEEP | 73.3 | NAME | 72.3 | NEAT | 68.9 |
| 23 | WEEK | 70.9 | MATCH | 74.3 | WALK | 74.1 | NEAR | 69.9 |
| 24 | TAKE | 71.7 | THOUGHT | 74.3 | HIRE | 75.5 | RIPE | 70.9 |
| 25 | WHICH | 72.5 | SOUTH | 74.9 | SOUP | 75.9 | GAS | 71.5 |
| 26 | YES | 72.5 | GOAL | 75.4 | THIN | 75.9 | LEASE | 72.2 |
| 27 | GOOSE | 73.0 | NUMB | 75.9 | LID | 76.4 | DOLL | 72.5 |
| 28 | SIZE | 74.6 | DEAD | 77.0 | LIFE | 76.4 | WHEAT | 73.2 |
| 29 | WHIP | 74.6 | FAR | 77.5 | LUCK | 76.8 | KILL | 74.2 |
| 30 | FALL | 75.4 | SHACK | 77.5 | YOUTH | 76.8 | LOSE | 74.5 |
| 31 | HASH | 76.6 | LEARN | 78.1 | PHONE | 80.5 | HALL | 74.8 |
| 32 | CHALK | 77.5 | SAID | 78.1 | POLE | 80.9 | SHIRT | 75.2 |
| 33 | JAR | 77.5 | BITE | 78.6 | SEARCH | 80.9 | TIRE | 75.2 |
| 34 | REACH | 78.7 | LIVE | 79.1 | DATE | 81.4 | CHECK | 75.8 |
| 35 | PAGE | 79.5 | WITCH | 79.7 | NOTE | 81.4 | SUCH | 76.2 |
| 36 | RAID | 79.5 | NICE | 81.3 | VOID | 81.8 | BONE | 77.5 |
| 37 | KING | 79.9 | BOUGHT | 81.8 | JUG | 83.6 | PERCH | 77.5 |
| 38 | LOVE | 79.9 | HUSH | 82.4 | DODGE | 85.0 | THUMB | 78.8 |
| 39 | BURN | 80.7 | CHAIR | 84.5 | HIT | 85.0 | HOLE | 79.8 |
| 40 | KNOCK | 82.0 | ROOM | 84.5 | WHEN | 85.0 | PASS | 82.1 |
| 41 | LIMB | 82.0 | PAD | 85.0 | DITCH | 85.9 | MAKE | 83.1 |
| 42 | RAG | 82.4 | VOICE | 86.1 | RUSH | 86.8 | ROSE | 84.1 |
| 43 | KITE | 86.1 | JUICE | 86.6 | BASE | 87.3 | PEG | 85.1 |
| 44 | JAIL | 87.3 | HAZE | 87.2 | RING | 87.3 | KICK | 86.4 |
| 45 | RAISE | 88.5 | RAIN | 87.2 | COOL | 87.7 | MOOD | 87.7 |
| 46 | SURE | 90.6 | SOAP | 87.2 | GUN | 88.2 | RED | 88.4 |
| 47 | FAT | 91.0 | READ | 87.7 | RODE | 90.0 | BACK | 89.7 |
| 48 | BOAT | 92.2 | BOOK | 90.4 | TALK | 90.9 | JUDGE | 89.7 |
| 49 | DOOR | 92.2 | HATE | 92.5 | PAIN | 93.2 | DOG | 91.7 |
| 50 | HOME | 93.4 | WHITE | 95.2 | GOOD | 96.4 | FOOD | 91.7 |
| Mean | | 72.6 | | 74.6 | | 73.4 | | 71.4 |
| SD | | 11.9 | | 10.7 | | 12.8 | | 11.4 |
| Max | | 93.4 | | 95.2 | | 96.4 | | 91.7 |
| Min | | 36.5 | | 47.1 | | 45.0 | | 49.0 |
| Range | | 56.9 | | 48.1 | | 51.4 | | 42.7 |
| Skewness | | -0.4 | | -0.4 | | -0.3 | | -0.1 |
| Lower Quartile (Q1) | | 65.7 | | 68.7 | | 62.7 | | 63.6 |
| Median (Q2) | | 72.5 | | 75.2 | | 75.9 | | 71.9 |
| Upper Quartile (Q3) | | 79.9 | | 82.3 | | 84.7 | | 78.5 |
| Interquartile Range (IQR) | | 14.2 | | 13.6 | | 22.0 | | 14.9 |
| Inner Fence (Lower) | | 44.4 (1) | | 48.3 (1) | | 29.8 (0) | | 41.3 (0) |
| Inner Fence (Upper) | | 101.2 | | 102.6 | | 117.6 | | 100.8 |
| Outer Fence (Lower) | | 23.1 (0) | | 28.0 (0) | | -3.2 (0) | | 19.0 (0) |
| Outer Fence (Upper) | | 122.5 | | 123.0 | | 150.5 | | 123.1 |
| Kurtosis | | 0.4 | | -0.1 | | -0.8 | | -0.6 |

**Supplemental Table S12**

**Table SM12.** Recognition performances by 24 young listeners with normal hearing for pure tones on the NU 6 materials presented in quiet (VA female speaker #1, Department of Veterans Affairs, 2006). The data from the VA Medical Center, Mountain Home are illustrated in Figure 13 of the manuscript.

| | List 1 | | List 2 | | List 3 | | List 4 | |
|---|---|---|---|---|---|---|---|---|
| | Word | % | Word | % | Word | % | Word | % |
| 1 | MODE | 79.2 | HALF | 79.2 | CALM | 54.2 | CHAIN | 62.5 |
| 2 | TIP | 83.3 | FIVE | 83.3 | LORE | 83.3 | CHECK | 70.8 |
| 3 | DEATH | 87.5 | SHALL | 91.7 | SHACK | 91.7 | ROUGH | 75.0 |
| 4 | KEEN | 91.7 | CHAT | 91.7 | FAR | 91.7 | WHEAT | 87.5 |
| 5 | GAP | 91.7 | MESS | 95.8 | ROOM | 95.8 | NEAT | 87.5 |
| 6 | KNOCK | 91.7 | CAUSE | 95.8 | SOUTH | 95.8 | CAME | 87.5 |
| 7 | KING | 91.7 | MOP | 95.8 | PIKE | 95.8 | DOLL | 95.8 |
| 8 | LIMB | 95.8 | GUN | 95.8 | ROT | 95.8 | PEG | 95.8 |
| 9 | DIME | 95.8 | RAT | 95.8 | BOOK | 95.8 | JOIN | 95.8 |
| 10 | SELL | 95.8 | VOID | 95.8 | BITE | 95.8 | FOOD | 95.8 |
| 11 | TAKE | 95.8 | WHEN | 95.8 | PICK | 100.0 | RIPE | 95.8 |
| 12 | RAISE | 95.8 | BAR | 95.8 | NICE | 100.0 | TIME | 95.8 |
| 13 | MET | 95.8 | HIT | 95.8 | SAID | 100.0 | SHOULD | 95.8 |
| 14 | CHOICE | 95.8 | PHONE | 95.8 | FAIL | 100.0 | PASS | 100.0 |
| 15 | LOT | 95.8 | COOL | 95.8 | WHITE | 100.0 | BACK | 100.0 |
| 16 | MOON | 95.8 | BASE | 100.0 | KEEP | 100.0 | RED | 100.0 |
| 17 | RAG | 95.8 | GOOD | 100.0 | DEAD | 100.0 | WASH | 100.0 |
| 18 | CHALK | 95.8 | LUCK | 100.0 | LOAF | 100.0 | SOUR | 100.0 |
| 19 | LAUD | 100.0 | WALK | 100.0 | DAB | 100.0 | BONE | 100.0 |
| 20 | BOAT | 100.0 | YOUTH | 100.0 | NUMB | 100.0 | GET | 100.0 |
| 21 | POOL | 100.0 | PAIN | 100.0 | JUICE | 100.0 | THUMB | 100.0 |
| 22 | NAG | 100.0 | DATE | 100.0 | CHIEF | 100.0 | SALE | 100.0 |
| 23 | SHOUT | 100.0 | PEARL | 100.0 | MERGE | 100.0 | YEARN | 100.0 |
| 24 | SUB | 100.0 | SEARCH | 100.0 | WAG | 100.0 | WIFE | 100.0 |
| 25 | VINE | 100.0 | DITCH | 100.0 | RAIN | 100.0 | SUCH | 100.0 |
| 26 | GOOSE | 100.0 | TALK | 100.0 | WITCH | 100.0 | MOB | 100.0 |
| 27 | WHIP | 100.0 | RING | 100.0 | SOAP | 100.0 | GAS | 100.0 |
| 28 | TOUGH | 100.0 | GERM | 100.0 | YOUNG | 100.0 | LEASE | 100.0 |
| 29 | PUFF | 100.0 | LIFE | 100.0 | TON | 100.0 | LONG | 100.0 |
| 30 | FALL | 100.0 | TEAM | 100.0 | KEG | 100.0 | KILL | 100.0 |
| 31 | THIRD | 100.0 | LID | 100.0 | TOOL | 100.0 | HOLE | 100.0 |
| 32 | FAT | 100.0 | POLE | 100.0 | MILL | 100.0 | LEAN | 100.0 |
| 33 | JAR | 100.0 | RODE | 100.0 | HUSH | 100.0 | TAPE | 100.0 |
| 34 | DOOR | 100.0 | LATE | 100.0 | READ | 100.0 | TIRE | 100.0 |
| 35 | LOVE | 100.0 | CHEEK | 100.0 | HATE | 100.0 | DIP | 100.0 |
| 36 | SURE | 100.0 | BEG | 100.0 | LIVE | 100.0 | ROSE | 100.0 |
| 37 | HASH | 100.0 | JUG | 100.0 | VOICE | 100.0 | FIT | 100.0 |
| 38 | RAID | 100.0 | SHEEP | 100.0 | GAZE | 100.0 | MAKE | 100.0 |
| 39 | HURL | 100.0 | RUSH | 100.0 | PAD | 100.0 | VOTE | 100.0 |
| 40 | PAGE | 100.0 | WIRE | 100.0 | THOUGHT | 100.0 | JUDGE | 100.0 |
| 41 | YES | 100.0 | NOTE | 100.0 | BOUGHT | 100.0 | HAVE | 100.0 |
| 42 | REACH | 100.0 | NAME | 100.0 | TURN | 100.0 | KICK | 100.0 |
| 43 | HOME | 100.0 | THIN | 100.0 | CHAIR | 100.0 | LOSE | 100.0 |
| 44 | WHICH | 100.0 | TELL | 100.0 | HAZE | 100.0 | NEAR | 100.0 |
| 45 | WEEK | 100.0 | MOUSE | 100.0 | MATCH | 100.0 | PERCH | 100.0 |
| 46 | SIZE | 100.0 | HIRE | 100.0 | LEARN | 100.0 | SHIRT | 100.0 |
| 47 | BEAN | 100.0 | CAB | 100.0 | SHAWL | 100.0 | BATH | 100.0 |
| 48 | JAIL | 100.0 | SOUP | 100.0 | DEEP | 100.0 | HALL | 100.0 |
| 49 | BURN | 100.0 | DODGE | 100.0 | GIN | 100.0 | MOOD | 100.0 |
| 50 | KITE | 100.0 | SEIZE | 100.0 | GOAL | 100.0 | DOG | 100.0 |
| Mean | | 97.4 | | 98.0 | | 97.9 | | 96.8 |
| SD | | 4.5 | | 4.1 | | 7.0 | | 7.8 |
| Max | | 100.0 | | 100.0 | | 100.0 | | 100.0 |
| Min | | 79.2 | | 79.2 | | 54.2 | | 62.5 |
| Range | | 20.8 | | 20.8 | | 45.8 | | 37.5 |
| Skewness | | -2.3 | | -3.0 | | -5.4 | | -3.1 |
| Lower Quartile (Q1) | | 95.8 | | 95.8 | | 100.0 | | 96.9 |
| Median (Q2) | | 100.0 | | 100.0 | | 100.0 | | 100.0 |
| Upper Quartile (Q3) | | 100.0 | | 100.0 | | 100.0 | | 100.0 |
| Interquartile Range (IQR) | | 4.2 | | 4.2 | | 0.0 | | 3.1 |
| Inner Fence (Lower) | | 89.6 (3) | | 89.6 (2) | | 100.0 (10) | | 92.2 (6) |
| Inner Fence (Upper) | | 106.3 | | 106.3 | | 100.0 | | 104.7 |
| Outer Fence (Lower) | | 83.3 (2) | | 83.3 (2) | | 100.0 (10) | | 87.5 (6) |
| Outer Fence (Upper) | | 112.5 | | 112.5 | | 100.0 | | 109.4 |

**Supplemental Table S13**

**Table SM13.** Recognition performances obtained with the NU 6 materials (VA female speaker #2) presented in speech-spectrum noise (8-dB SNR) to 24 listeners with normal hearing for pure tones. The data are illustrated in Figure 14 of the manuscript. (from Wilson et al., 2008, Supplemental Materials, Table SM1, pages 1-14)

| | List 1 | | List 2 | | List 3 | | List 4 | |
|---|---|---|---|---|---|---|---|---|
| | Word | % | Word | % | Word | % | Word | % |
| 1 | BEAN | 16.7 | LORE | 37.5 | CAB | 29.2 | SOUR | 41.7 |
| 2 | LAUD | 33.3 | NUMB | 37.5 | BAR | 66.7 | MOB | 62.5 |
| 3 | LIMB | 41.7 | DAB | 41.7 | POLE | 66.7 | DOLL | 70.8 |
| 4 | DIME | 66.7 | GIN | 45.8 | BEG | 75.0 | BONE | 75.0 |
| 5 | SUB | 66.7 | GOAL | 62.5 | JUG | 75.0 | LONG | 75.0 |
| 6 | KEEN | 70.8 | READ | 66.7 | NAME | 75.0 | HALL | 79.2 |
| 7 | POOL | 75.0 | TOOL | 66.7 | SHALL | 75.0 | HAVE | 79.2 |
| 8 | RAID | 75.0 | BOUGHT | 70.8 | FIVE | 79.2 | HOLE | 79.2 |
| 9 | HURL | 79.2 | KEG | 70.8 | LUCK | 79.2 | RIPE | 83.3 |
| 10 | LOT | 79.2 | FAIL | 79.2 | MESS | 79.2 | TAPE | 83.3 |
| 11 | MET | 79.2 | MILL | 83.3 | MOP | 79.2 | SALE | 87.5 |
| 12 | PUFF | 79.2 | PICK | 83.3 | GERM | 83.3 | THUMB | 87.5 |
| 13 | KNOCK | 83.3 | PIKE | 83.3 | RUSH | 83.3 | BATH | 91.7 |
| 14 | MOON | 83.3 | HAZE | 87.5 | BASE | 87.5 | GAS | 91.7 |
| 15 | RAG | 83.3 | TON | 87.5 | CHEEK | 87.5 | KILL | 91.7 |
| 16 | VINE | 83.3 | BITE | 91.7 | COOL | 87.5 | LOSE | 91.7 |
| 17 | FALL | 87.5 | BOOK | 91.7 | GUN | 87.5 | NEAT | 91.7 |
| 18 | GAP | 87.5 | PAD | 91.7 | LATE | 87.5 | TIME | 91.7 |
| 19 | HASH | 87.5 | ROT | 91.7 | LID | 87.5 | CAME | 95.8 |
| 20 | KING | 87.5 | WAG | 91.7 | RING | 87.5 | FOOD | 95.8 |
| 21 | NAG | 87.5 | CHIEF | 95.8 | RODE | 87.5 | LEAN | 95.8 |
| 22 | SURE | 87.5 | DEAD | 95.8 | TELL | 87.5 | LEASE | 95.8 |
| 23 | TIP | 87.5 | FAR | 95.8 | VOID | 87.5 | NEAR | 95.8 |
| 24 | CHALK | 91.7 | GAZE | 95.8 | DITCH | 91.7 | PEG | 95.8 |
| 25 | JAIL | 91.7 | LOAF | 95.8 | HALF | 91.7 | PERCH | 95.8 |
| 26 | KITE | 91.7 | RAIN | 95.8 | HIRE | 91.7 | ROSE | 95.8 |
| 27 | MODE | 91.7 | ROOM | 95.8 | LIFE | 91.7 | SHOULD | 95.8 |
| 28 | SELL | 91.7 | SAID | 95.8 | SHEEP | 91.7 | TIRE | 95.8 |
| 29 | BURN | 95.8 | SHACK | 95.8 | CAUSE | 95.8 | VOTE | 95.8 |
| 30 | HOME | 95.8 | SHAWL | 95.8 | CHAT | 95.8 | BACK | 100.0 |
| 31 | JAR | 95.8 | THOUGHT | 95.8 | HIT | 95.8 | CHAIN | 100.0 |
| 32 | WEEK | 95.8 | WHITE | 95.8 | NOTE | 95.8 | CHECK | 100.0 |
| 33 | WHICH | 95.8 | WITCH | 95.8 | RAT | 95.8 | DIP | 100.0 |
| 34 | WHIP | 95.8 | CALM | 100.0 | SEIZE | 95.8 | DOG | 100.0 |
| 35 | BOAT | 100.0 | CHAIR | 100.0 | TALK | 95.8 | FIT | 100.0 |
| 36 | CHOICE | 100.0 | DEEP | 100.0 | TEAM | 95.8 | GET | 100.0 |
| 37 | DEATH | 100.0 | HATE | 100.0 | WIRE | 95.8 | JOIN | 100.0 |
| 38 | DOOR | 100.0 | HUSH | 100.0 | DATE | 100.0 | JUDGE | 100.0 |
| 39 | FAT | 100.0 | JUICE | 100.0 | DODGE | 100.0 | KICK | 100.0 |
| 40 | GOOSE | 100.0 | KEEP | 100.0 | GOOD | 100.0 | MAKE | 100.0 |
| 41 | LOVE | 100.0 | LEARN | 100.0 | MOUSE | 100.0 | MOOD | 100.0 |
| 42 | PAGE | 100.0 | LIVE | 100.0 | PAIN | 100.0 | PASS | 100.0 |
| 43 | RAISE | 100.0 | MATCH | 100.0 | PEARL | 100.0 | RED | 100.0 |
| 44 | REACH | 100.0 | MERGE | 100.0 | PHONE | 100.0 | ROUGH | 100.0 |
| 45 | SHOUT | 100.0 | NICE | 100.0 | SEARCH | 100.0 | SHIRT | 100.0 |
| 46 | SIZE | 100.0 | SOAP | 100.0 | SOUP | 100.0 | SUCH | 100.0 |
| 47 | TAKE | 100.0 | SOUTH | 100.0 | THIN | 100.0 | WASH | 100.0 |
| 48 | THIRD | 100.0 | TURN | 100.0 | WALK | 100.0 | WHEAT | 100.0 |
| 49 | TOUGH | 100.0 | VOICE | 100.0 | WHEN | 100.0 | WIFE | 100.0 |
| 50 | YES | 100.0 | YOUNG | 100.0 | YOUTH | 100.0 | YEARN | 100.0 |
| Mean | | 86.8 | | 88.2 | | 88.8 | | 92.2 |
| SD | | 17.4 | | 17.3 | | 12.7 | | 11.6 |
| Max | | 100.0 | | 100.0 | | 100.0 | | 100.0 |
| Min | | 16.7 | | 37.5 | | 29.2 | | 41.7 |
| Range | | 83.3 | | 62.5 | | 70.8 | | 58.3 |
| Skewness | | -2.3 | | -1.9 | | -2.4 | | -2.3 |
| Lower Quartile (Q1) | | 83.3 | | 84.4 | | 84.4 | | 91.7 |
| Median (Q2) | | 91.7 | | 95.8 | | 91.7 | | 95.8 |
| Upper Quartile (Q3) | | 100.0 | | 100.0 | | 99.0 | | 100.0 |
| Interquartile Range (IQR) | | 16.7 | | 15.7 | | 14.6 | | 8.3 |
| Inner Fence (Lower) | | 58.3 (3) | | 60.9 (4) | | 62.5 (1) | | 79.3 (8) |
| Inner Fence (Upper) | | 125.1 | | 123.5 | | 120.9 | | 112.5 |
| Outer Fence (Lower) | | 33.2 (1) | | 37.4 (0) | | 40.6 (1) | | 66.8 (2) |
| Outer Fence (Upper) | | 150.1 | | 147.0 | | 142.8 | | 124.9 |

**Supplemental Table S14**

**Table SM14.** Recognition performances obtained with the PB-50 materials (VA female speaker #2) presented in speech-spectrum noise (8-dB SNR) to 24 listeners with normal hearing for pure tones. The data are illustrated in Figure 15 of the manuscript. (from Wilson et al., 2008, Supplemental Materials, Table SM1, pages 1-14)

| | List 8 | | List 9 | | List 10 | | List 11 | |
|---|---|---|---|---|---|---|---|---|
| | Word | % | Word | % | Word | % | Word | % |
| 1 | CLOD | 45.8 | REED | 33.3 | BOB | 8.3 | BEAM | 20.8 |
| 2 | JELL | 54.2 | SPUD | 58.3 | GULL | 25.0 | DRAKE | 41.7 |
| 3 | BID | 66.7 | BEEF | 66.7 | THUG | 37.5 | REEF | 45.8 |
| 4 | DUMB | 66.7 | WIPE | 66.7 | JAY | 45.8 | DULL | 66.7 |
| 5 | LOOK | 66.7 | BIRTH | 70.8 | SLUG | 45.8 | HOG | 66.7 |
| 6 | HUM | 70.8 | BIT | 70.8 | REAL | 54.2 | PROD | 70.8 |
| 7 | BIND | 75.0 | MASS | 70.8 | AIL | 58.3 | LAG | 75.0 |
| 8 | COD | 75.0 | RUDE | 79.2 | TREE | 62.5 | PUNK | 75.0 |
| 9 | LEFT | 75.0 | TUB | 79.2 | LINE | 66.7 | TAB | 75.0 |
| 10 | ROLL | 75.0 | FUME | 83.3 | VALVE | 66.7 | HAVE | 79.2 |
| 11 | BOLT | 79.2 | GRACE | 83.3 | DIED | 75.0 | ARC | 83.3 |
| 12 | FREAK | 79.2 | ITCH | 83.3 | CORD | 79.2 | CRY | 83.3 |
| 13 | RHYME | 79.2 | NOOSE | 83.3 | LOCK | 79.2 | BLISS | 87.5 |
| 14 | ROPE | 83.3 | TAX | 83.3 | RAKE | 79.2 | CLASH | 87.5 |
| 15 | LICK | 87.5 | FOE | 87.5 | RIP | 79.2 | LOW | 87.5 |
| 16 | PINT | 87.5 | THAN | 87.5 | SNIPE | 79.2 | RISK | 87.5 |
| 17 | QUEEN | 87.5 | TROOP | 87.5 | WAKE | 79.2 | WAVE | 87.5 |
| 18 | REST | 87.5 | CARVE | 91.7 | BUG | 83.3 | CHUNK | 91.7 |
| 19 | CALF | 91.7 | DITCH | 91.7 | RUSH | 83.3 | CODE | 91.7 |
| 20 | CRACK | 91.7 | HOOF | 91.7 | THOSE | 87.5 | JOB | 91.7 |
| 21 | FORTH | 91.7 | KEY | 91.7 | CHAMP | 91.7 | KIT | 91.7 |
| 22 | FROCK | 91.7 | SIP | 91.7 | CLOTHE | 91.7 | ARM | 95.8 |
| 23 | KILL | 91.7 | THRONE | 91.7 | CUE | 91.7 | CRUTCH | 95.8 |
| 24 | ROT | 91.7 | YEAR | 91.7 | FLIGHT | 91.7 | FINE | 95.8 |
| 25 | TILL | 91.7 | CHESS | 95.8 | LAP | 91.7 | FUDGE | 95.8 |
| 26 | WIG | 91.7 | CLOWN | 95.8 | PINK | 91.7 | GOAT | 95.8 |
| 27 | ASK | 95.8 | CLUB | 95.8 | COW | 95.8 | LATCH | 95.8 |
| 28 | BORED | 95.8 | FUSE | 95.8 | DUST | 95.8 | LOSS | 95.8 |
| 29 | CATCH | 95.8 | LIT | 95.8 | EARTH | 95.8 | PROBE | 95.8 |
| 30 | CHEW | 95.8 | ODD | 95.8 | FORCE | 95.8 | PURSE | 95.8 |
| 31 | DAY | 95.8 | ROOT | 95.8 | MAZE | 95.8 | SAP | 95.8 |
| 32 | DEUCE | 95.8 | SKILL | 95.8 | NUDGE | 95.8 | SHOP | 95.8 |
| 33 | FAD | 95.8 | WEEK | 95.8 | PLUS | 95.8 | SIGN | 95.8 |
| 34 | FLIP | 95.8 | ARCH | 100.0 | SCRUB | 95.8 | SKIN | 95.8 |
| 35 | FOOD | 95.8 | BOOST | 100.0 | SPIN | 95.8 | SPY | 95.8 |
| 36 | FRONT | 95.8 | CHEST | 100.0 | STAFF | 95.8 | DIP | 100.0 |
| 37 | GUESS | 95.8 | CROWD | 100.0 | WADE | 95.8 | DOOR | 100.0 |
| 38 | ROD | 95.8 | FLAG | 100.0 | BACK | 100.0 | DOUBT | 100.0 |
| 39 | SHACK | 95.8 | GATE | 100.0 | CHANCE | 100.0 | FEEL | 100.0 |
| 40 | CHANT | 100.0 | GIVE | 100.0 | EARS | 100.0 | FIST | 100.0 |
| 41 | EACH | 100.0 | ICE | 100.0 | FIR | 100.0 | MOST | 100.0 |
| 42 | EASE | 100.0 | NERVE | 100.0 | FLAUNT | 100.0 | MOUTH | 100.0 |
| 43 | HORSE | 100.0 | NUTS | 100.0 | GOLD | 100.0 | NET | 100.0 |
| 44 | NIGHT | 100.0 | PHONE | 100.0 | GOOSE | 100.0 | POND | 100.0 |
| 45 | SLIDE | 100.0 | SMART | 100.0 | HAT | 100.0 | RICE | 100.0 |
| 46 | SPICE | 100.0 | TEN | 100.0 | HURT | 100.0 | SHOT | 100.0 |
| 47 | THIS | 100.0 | THANK | 100.0 | PAGE | 100.0 | SNOW | 100.0 |
| 48 | THREAD | 100.0 | TOAD | 100.0 | PUT | 100.0 | STIFF | 100.0 |
| 49 | US | 100.0 | WILD | 100.0 | TAG | 100.0 | URGE | 100.0 |
| 50 | YEAST | 100.0 | WITH | 100.0 | YOUTH | 100.0 | WOOD | 100.0 |
| Mean | | 88.4 | | 89.6 | | 83.6 | | 88.6 |
| SD | | 12.8 | | 13.5 | | 21.4 | | 16.5 |
| Max | | 100.0 | | 100.0 | | 100.0 | | 100.0 |
| Min | | 45.8 | | 33.3 | | 8.3 | | 20.8 |
| Range | | 54.2 | | 66.7 | | 91.7 | | 79.2 |
| Skewness | | -1.5 | | -2.0 | | -1.8 | | -2.4 |
| Lower Quartile (Q1) | | 80.2 | | 83.3 | | 79.2 | | 87.5 |
| Median (Q2) | | 91.7 | | 95.8 | | 91.7 | | 95.8 |
| Upper Quartile (Q3) | | 95.8 | | 100.0 | | 99.0 | | 100.0 |
| Interquartile Range (IQR) | | 15.6 | | 16.7 | | 19.8 | | 12.5 |
| Inner Fence (Lower) | | 56.9 (2) | | 58.3 (1) | | 49.6 (5) | | 68.8 (5) |
| Inner Fence (Upper) | | 119.2 | | 125.1 | | 128.6 | | 118.8 |
| Outer Fence (Lower) | | 33.5 (0) | | 33.2 (0) | | 20.0 (1) | | 50.0 (3) |
| Outer Fence (Upper) | | 142.5 | | 150.1 | | 158.2 | | 137.5 |