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Original Article

Recognition performance on words interrupted (10 ips, 50% duty cycle) with two interruption patterns referenced to word onset: Young listeners with normal hearing for pure tones and older listeners with sensorineural hearing loss

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Abstract

Objective: To determine in an interrupted word paradigm (Maryland CNCs; 10 ips, 50% duty cycle) if different locations of the interruption pattern produce different recognition performances. *Design:* Repeated measures using two interruption patterns that were complementary halves referenced to word onset; one started with word onset (0-ms), the other started 50 ms later. The hypothesis was that recognition performance would be better on the 0-ms condition than on the 50-ms condition, but there would be some words with the reverse relation. *Study sample:* Twenty-four young adults with normal hearing for pure tones and 32 older adults (mean = 67 years) with sensorineural hearing loss participated. *Results:* With the young listeners mean recognition performance on the 0-ms condition (63.1%) was significantly better than the mean performance on the 50-ms condition (47.8%). About twice as many words had better performance on the 0-ms condition. With the older listeners, who were given only stimuli on which performances were > 58% by the young normals, performances on the two conditions were the same. *Conclusions:* The hypothesis was supported with the young listeners. The equal performance by the older listeners on the two conditions was attributed to the manner in which the words were selected.

Key Words: Auditory perception; hearing loss; interrupted speech; speech perception

Miller and Licklider (1950) in their classic study demonstrated that when words were interrupted by silent intervals recognition performance decreased by various amounts depending on the characteristics of the interruptions. Miller and Licklider used monosyllabic words from the PB lists (Egan, 1948) that had an average word duration of 600 ms. Their general findings were that (1) aperiodic interruption patterns produced flatter recognition functions as the interruption rate was varied than did periodic interruption patterns, (2) maximum recognition was obtained with interruption rates between 10 and 100 interruptions per second (ips), and (3) there was a direct relation between recognition performance and the amount of time the speech was *on* (i.e. duty cycle), which earlier had been shown by Miller (1947, Figure 10, page 120). Subsequent to these early investigations, the majority of interrupted word studies, whether interrupted with silent intervals or with noise bursts, used regular/periodic interruption patterns, interruption rates between 5 and 20 ips, and a 50% duty cycle (e.g. Dirks et al, 1969; Wilson & Carhart, 1969; Powers & Speaks, 1973; Nelson et al, 2003; Jin & Nelson, 2006; Wang & Humes, 2010; Wilson et al, 2010; Ardoint et al, 2014).

Two parameters of the interruption word paradigm eluded study until recently, namely, the shape of the onsets and offsets of the on-segments of the target words and where in the target word the interruptions occurred. Turning a signal *on* and *off* instantaneously can produce spectral splatter that possibly could distort the speech signal. To avoid this possibility, some studies shaped the onsets and offsets of the on-segment of the interruption cycle using algorithms like a cosine based function over a 4-ms interval (Jin & Nelson, 2006; Wang & Humes, 2010). Wilson (2014) compared unshaped and shaped (4-ms, $\cos^2$) onsets and offsets of the on-segments of 70 interrupted consonant-vowel-nucleus-consonant (CNC) monosyllabic words preceded by a carrier phrase that were taken from the Northwestern University Auditory Test No. 6 (NU-6; Tillman & Carhart, 1966; Department of Veterans Affairs, 2006). The differences between the recognition performances on the unshaped and shaped conditions by 12 listeners with normal hearing for pure tones and 12 older listeners with hearing loss were minimal and not significant.

For a given word, the silent intervals imposed by the interruptions on the word utterance may or may not obscure part or all of the cues necessary for intelligibility to occur. The question posed by Wilson (2014) was, when the interruption patterns occur at different temporal locations during the target word, does intelligibility change? This question was studied by interrupting each word such that sequentially alternate 50-ms segments of the waveform were assigned to each of

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Abbreviations

ANSI	American National Standards Institute
CD	Compact disc (audio)
CNC	Consonant-vowel-nucleus-consonant
DOS	Disc operating system
ips	Interruptions per second
PB	Phonetically balanced
PCM	Pulse code modulation
PTA	Pure-tone average (500, 1000, and 2000 Hz)
TDH	Telephonics dynamic headphone

two versions of the word, both of which contained completely different temporal waveform information or glimpses (Howard-Jones & Rosen, 1993). To study the effects that the locations of the 10 ips, 50% duty cycle interruptions in the target word had on recognition performance, both interruption conditions were referenced to the onset of the target word, which in effect made each target word its own control. The two conditions (0-ms and 50-ms) are schematized in Figure 1. With the 0-ms condition, the speech was *on* during the odd numbered 50-ms segments of the interruption cycle and the speech signal was *off* during the even numbered 50-ms segments. With the 50-ms condition, the speech was *off* during the odd numbered 50-ms segments and the speech signal was *on* during the even numbered 50-ms segments. With this interruption algorithm, the two conditions were complementary halves of the original speech signal. Previously, this interruption design was employed by Huggins (1964, Figure 4, page 1061) who observed that intelligibility was about equal on the complementary halves of continuous speech passages (130 words of light fiction) interrupted 0.2 to 16 times/s. The continuous passages used by Huggins likely involved substantial top-down processing (semantic and syntactic context) as opposed to the bottom-up weighted processing involved with isolated words that are the interest of this study.

The hypothesis advanced by Wilson (2014) was that for young listeners with normal hearing and older listeners with sensorineural hearing loss overall recognition performance would be better on the 0-ms condition than on the 50-ms condition. Driving this hypothesis was the fact that the 0-ms condition always contained the first 50-ms of the target word, which the literature on gated speech has shown can be critical in the intelligibility task (e.g. Grosjean, 1980; Wingfield et al, 1991; Reinisch et al, 2010). Often the initial consonant of a word is wholly contained within the first 50 ms. Also contributing to the hypothesis was the fact that for most words by definition, the 0-ms condition contained more of the target word duration-wise than was contained in the 50-ms condition. A secondary hypothesis for both listener groups was that a minority of words would exhibit better performance on the 50-ms condition than on the 0-ms condition, which was driven by our lack of understanding exactly what cues in a given utterance are necessary for intelligibility (e.g. Fogerty & Kewley-Port, 2009). The findings from the Wilson study supported the first hypothesis in that 17–18% (12 young listeners with normal hearing) and 10–13% (12 older listeners with hearing loss) better recognition performances were obtained on the 0-ms condition than on the 50-ms condition. Overall, 59% of the words produced better performances on the 0-ms condition; 26% of the words produced better performances on the 50-ms condition, supporting the second hypothesis, with 15% of the words producing the same performances on the two conditions.

The study reported here, which purposed to replicate and verify the Wilson (2014) findings, examined the same hypotheses included in the earlier study using a substantially larger number of participants; 24 listeners with normal hearing for pure tones and 32 older listeners with sensorineural hearing loss. The importance of including both types of listeners cannot be over-emphasized as the performances of these two groups differ substantially on almost all auditory tasks, especially those tasks involving distorted speech signals of which interrupted speech is a prime example. Other differences between the earlier study and the current study were (1) the speaker of the materials, (2) the number of target words, which was increased from 70 to 250 words, and (3) the use of a carrier phrase in which the target words were embedded between words in the carrier phrase as opposed to the previously used paradigm in which the target word was appended to the end of the carrier phrase.

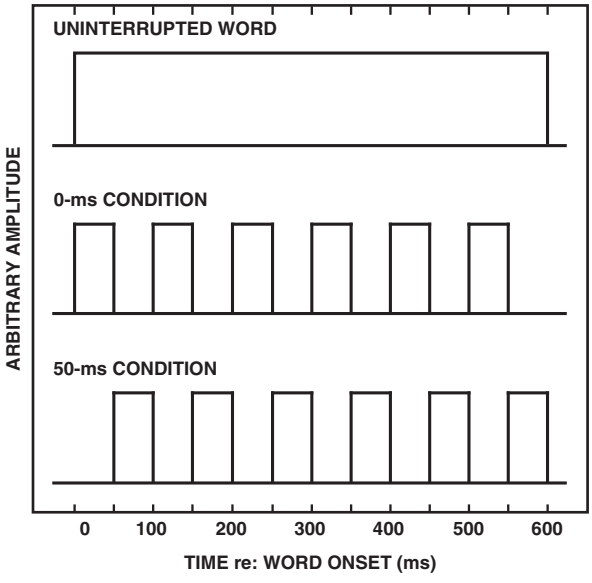

Figure 1. A schematic illustrating how the uninterrupted word (top) is interrupted (10 ips, 50% duty cycle) into complementary halves (middle and bottom) with word onset as the reference.

Method

Materials

The CNC monosyllabic 50-word lists developed by Lehiste and Peterson (1959), revised by Peterson and Lehiste (1962), and recorded by Causey et al (1984) as the Maryland CNC word lists were used as the speech stimuli (Department of Veterans Affairs, 2006). The Maryland version of the CNCs uses the carrier phrase, "Say the _____ again" in which the target word is bounded by other words in the carrier phrase. Lists 1, 3, 6, 7, 9, and 10 were used in this study as they were found to be equivalent with good test-retest reliability in the Causey et al study. Each utterance of the carrier phrase and target word was stored in a unique PCM file (16-bit; 44,100 samples/s). The interruption characteristics were 10 ips, a 50% duty cycle (50-ms on and 50-ms off), and essentially an infinite modulation depth ($>$90 dB). The temporal reference point for each word was the onset of the target word, which was determined auditorily and visually with a waveform editor (CoolEdit Pro) displaying the sample numbers on the x-axis. The accuracy of the word onset was probably $\pm$10 samples ($<$1 ms). The average word duration was 299.2 ms with a standard deviation of 36.6 ms; therefore, the typical 300-ms word when interrupted had three, 50-ms on-segments. In the Supplemental Materials available in the online version of the

journal (http://informahealthcare.com/loi/ija), Supplementary Figure 1 to be found online at http://informahealthcare.com/doi/abs/10.3109/14992027.2015.1055839 shows the distribution of the Maryland CNC word durations that are listed for the individual words in Supplementary Table 1 to be found online at http://informahealthcare.com/doi/abs/10.3109/14992027.2015.1055839.

Once the onset of the target word was identified, a simple calculation then was used to determine the length of a silent leader that needed to be added at the beginning of the word file so that in the 0-ms condition, the onset of the on-segment of the interruption cycle coincided with the word onset. An in-house routine was developed to interrupt the materials. Variables in the routine included the interruption rate, the duty cycle, and the rise-fall times of the on-segment of the interruption cycle. Using these variables, the program simply took a one-channel, uninterrupted signal and parsed alternate 50-ms segments of the signal file to the two channels of an output file (an example, 'Say the *jade* again,' is illustrated in Figure 2). At this stage the speech signals resembled the alternating speech task originally described by Cherry (1953). Then each of the two channels was copied onto Channel 1 of separate files with an uninterrupted version of the carrier phrase and target word copied to Channel 2 of each file for use in monitoring and scoring the presentation. Again as shown in Figure 2, in the 0-ms condition the on-segments included the first 50 ms of the target word and alternate 50-ms segments thereafter, whereas in the 50-ms condition the on-segments included the second 50 ms of the target word and alternate 50-ms segments thereafter.

The 50-words from List 10 of the Maryland CNCs were relegated as practice items with the 500 test items (250 words by 2 conditions) from the remaining five CNC lists used with the young listeners having normal hearing. Based on the results from the young listeners, the pool of test items for the older group was reduced to the easiest 250 test items. For each listener with normal hearing and each listener with hearing loss a unique randomization of the 500 or 250 words, respectively, was made by concatenating with a DOS routine the word files in PCM format to tracks of 25 words and then converting the PCM tracks to WAV tracks that were recorded on CD.

Participants

The following two groups of listeners were recruited: (1) 24 young adults (mean = 22.6 years; SD = 3.0 years; range = 18 to 29 years) (11 females and 13 males) with normal pure-tone thresholds,

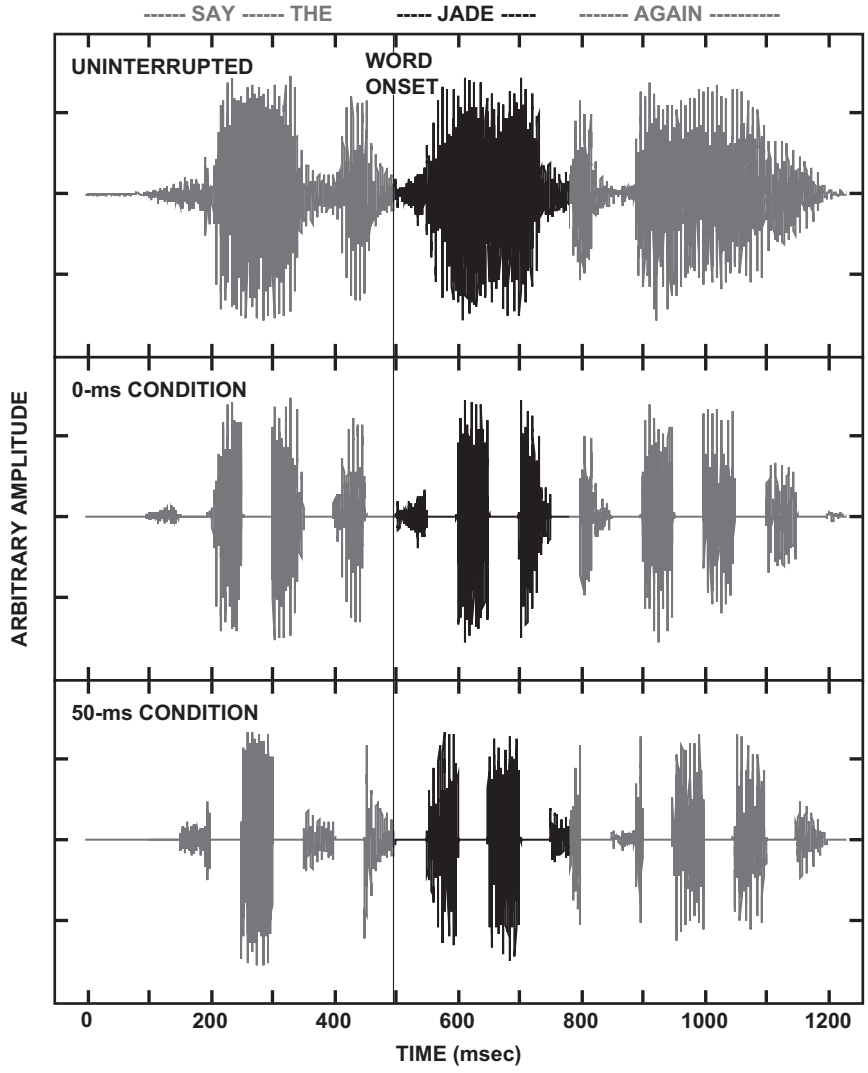

Figure 2. The waveform of an example stimulus, *Say the jade again*, uninterrupted (top), for the 0-ms condition (middle), and for the 50-ms condition (bottom).

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≤20-dB HL, (ANSI, 2010) at the 250–8000 octave frequencies in the test ear, and (2) 32 older adults with sensorineural hearing loss (mean = 67.0 years, SD = 7.1 years; range = 52 to 85 years) (30 males and 2 females) who met the inclusion criteria of thresholds in the test ear at 500 Hz of ≤30-dB HL, at 1000 Hz of ≤40 dB HL, and a three-frequency, pure-tone average (PTA; 500, 1000, and 2000 Hz) ≤40 dB HL with ≥60% correct word-recognition in quiet at 60 to 80 dB HL. The mean audiogram is displayed in Figure 3. Average word recognition performance on a 25-word list using NU-6 stimuli in quiet (Department of Veterans Affairs, 2006) was 88.9% (SD = 8.6%) with a range from 60% to 100%.

Procedures

During the one-hour test session, the participants gave consent information, had their pure-tone thresholds established, were instructed on the task, and were tested with the experimental protocol. The participants were familiarized with the listening/response task by first responding to 10 uninterrupted Maryland CNC words followed by 25 interrupted words, both from List 10. During the experimental protocol, brief breaks were provided following each set of 100 words. The left ears of the odd numbered subjects and the right ears of the even numbered subjects served as the test ear. As detailed below, the procedures for the two groups of listeners then were slightly different, mainly with respect to the number of target words used.

For the listeners with normal hearing, the 500 interrupted words were presented monaurally at 70 dB SPL, whereas for the older listeners with hearing loss the 250 words were presented monaurally at 80 dB SPL. It was anticipated that performance by the listeners with hearing loss on the interrupted materials would be 10–20% poorer than performances by the listeners with normal hearing (Kidd & Humes, 2012; Krull et al, 2013). For this reason and to reduce the frustration level of the older listeners with hearing loss, only the words with performances ≥58% correct by the younger group with normal hearing were used. This criterion produced a pool of 250 words of which 75 words were presented in both the 0-ms and the 50-ms conditions (i.e. complementary halves), 78 words were presented in only the 0-ms condition, and 22 words were presented only in the 50-ms condition. During data collection, a rule was instituted to discontinue testing if the listener failed to obtain ≥30% correct recognition on the first 100 test words; four listeners with hearing loss were discontinued for this reason.

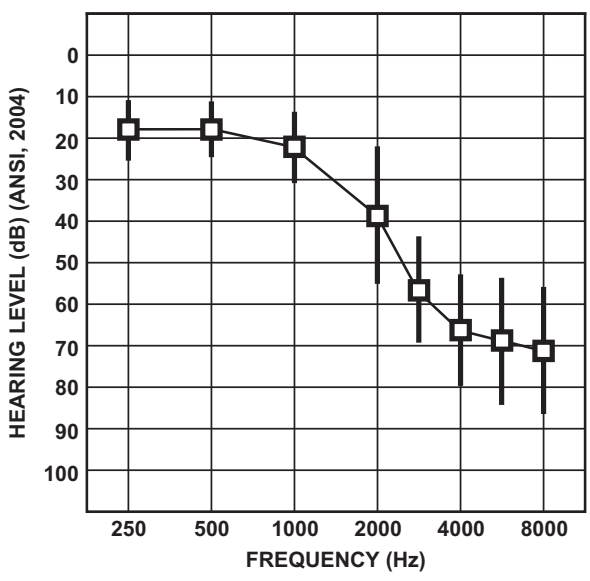

Figure 3. The mean audiogram of the test ear from the 32 older listeners with sensorineural hearing loss. The vertical bars are ±1 standard deviation.

The materials were reproduced on a compact disc player (Sony, Model CDP-CE375), fed through an audiometer (Grason-Stadler, Model 61) to a TDH-50P earphone encased in a MX-AR/41 cushion. The non-test ear was covered with a dummy earphone. All testing was conducted in a double-wall booth with the verbal responses of the participants recorded into a spreadsheet. The participants were reimbursed for their transportation costs. The study was approved by the ETSU/VA Institutional Review Board and the VA Research and Development Committee.

Results and Discussion

The data from this study are presented below in two sections, one for each group of listeners, followed by comparisons of the group performances and comparisons with data from other studies. Although the data are presented in percent correct throughout this section, statistical analyses were conducted on the arcsine transformations of the data (Studebaker, 1985).

Listeners with normal hearing for pure tones

The mean data from the young listeners with normal hearing are presented in Table 1. The mean percent correct performance on the 0-ms condition (63.1%) was significantly better than the mean performance on the 50-ms condition (47.8%) [$t(249) = 6.7$, $p < .001$]. Variability for the two conditions was about the same (~30%). These relations are summarized in Figure 4, which is a bivariate plot of the performances on the complementary halves of the 250 individual words with the mean data depicted with the large filled circle; the diagonal line represents equal performances on the two conditions and the dashed line is the linear regression fit to the data. The distribution of datum points in the figure, the slope of the regression (0.29%/%), and the R^2 value (0.091) suggest an almost random relation between the two conditions. Of the 500 interrupted words recognition performance was better on 154 words (61.6% of the words) in the 0-ms condition, better on 80 words (32.0% of the words) in the 50-ms condition, and the same on 16 words (6.4% of the words).

Figure 5 presents a detailed view of the data for each of the 250 words. In Figure 5 the words are sorted (1 to 250) based on the average performance on the complementary halves of each word (0-ms condition, open circles; 50-ms condition, filled circles) with vertical lines connecting the mean performances on the complementary halves of each word. Additionally, recognition performances are shown for the words uninterrupted (x) obtained from 24 young listeners with normal hearing (Wilson & McArdle, 2015). The data in Figure 5 are presented numerically in the Supplemental Materials (Supplementary Table 1 to be found online at http://informahealthcare.com/doi/abs/10.3109/14992027.2015.1055839). In the figure, when the open circle is higher than the filled circle, better performance is indicated on the 0-ms condition. Several observations can be noted in the data in Figure 5, the most obvious of which is variability. The variability between performances on the complementary halves of each word and among the performances on the complementary halves of all words is substantial with performances by these young listeners with normal hearing ranging from 0% to 100% correct. There are several words on which performance on the uninterrupted word is poorer (typically slightly poorer) than performance on one or both of the

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Table 1. The mean percent correct recognition (and standard deviations) for the 250 interrupted words in the 0-ms and 50-ms conditions by 24 listeners with normal hearing.

	0 ms	*50 ms*
Mean	63.1	47.8
SD	29.8	30.7

complementary halves of the interrupted paradigm (e.g. Words 6, 27, 101, 108, 116, 134, etc.), which is probably a group effect as different participants were involved in the two tasks. Word 150 (*top*) is the extreme example of differences between the performances on the complementary halves with 100% performance on the 0-ms condition and 0% on the 50-ms condition; in the opposite direction is Word 145 (*reach*) that had 4.2% recognition in the 0-ms condition and 95.8% in the 50-ms condition. At the performance extremes, Words 1 and 2 (*third* and *word*) were recognized 100% of the time in both complementary conditions, whereas Words 249 and 250 (*sung* and *joy*) were only recognized 8.3% of the time in both conditions.

The data in Table 2 provide a breakdown of the mean recognition performances on the complementary halves (0- and 50-ms conditions) when better performance was attained on each of the complementary halves; equal performances on the complementary halves also are included in the table. For example, when recognition performance was better on the 0-ms condition than on the 50-ms condition, the mean performance on the 0-ms condition was 73.3% whereas the performance on the 50-ms condition was 37.1%. Just the reverse relation was observed when performance on the 50-ms condition was better. Interestingly, the means of the complementary halves for each of the 'better' conditions were the same, 55.2%, but the difference between the complementary halves when the 0-ms condition was better, 36.2% (i.e., 73.3% − 37.1%), was substantially

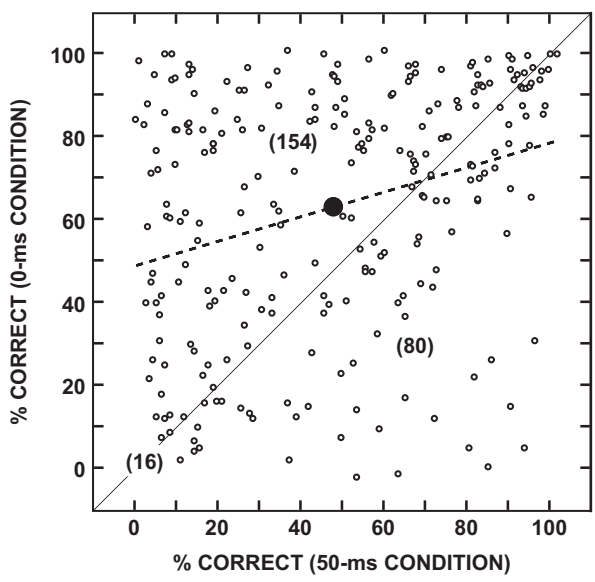

Figure 4. A bivariate plot of the percent correct on each of the complementary halves of the 250 target words. (0-ms condition, ordinate; 50-ms condition abscissa) that were obtained from 24 listeners with normal hearing. The large filled circle depicts the means, the solid diagonal line is the line of equality, and the dotted line is a regression used to describe the data ($y = 49.052 + 0.293x$, $R^2 = 0.091$). The data were jittered using an additive randomized algorithm.

Table 2. The mean percent correct recognition (and standard deviations) on the 500 complementary halves by the 24 young listeners with normal hearing for the 0-ms and 50-ms conditions when the mean performance on the 0-ms condition was better than on the 50-ms condition, when the mean performance on the 50-ms condition was better than on the 0-ms condition, and when performances on the two conditions were equal.

	0 ms > 50 ms		*50 ms > 0 ms*		*0 ms = 50 ms*
	0 ms	*50 ms*	*0 ms*	*50 ms*	
Mean	73.3	37.1	44.2	66.1	59.4
SD	23.7	27.9	29.6	25.0	37.1
n	154		80		16

greater than the difference between the complementary halves when the 50-ms condition was better, 21.9% (i.e., 66.1% − 44.2%). These relations are thought to reflect the importance of the first 50-ms of the waveform in the recognition of many of these words. The data in Tables 1 and 2 and in Figures 4 and 5 support the hypotheses in that with the younger listeners overall better performance was observed with the 0-ms condition than with the 50-ms condition and that with a minority of words the reverse relation was observed, i.e., better performance was observed with the 50-ms condition.

Compared to the performances from the earlier study of 70 CNC words (Wilson, 2014), the performances on the current study are poorer by 23.0% (0-ms condition) and 20.6% (50-ms condition). In both studies performances on the 50-ms condition were poorer than performances on the 0-ms condition with the differences between the two conditions very similar, 17.7% (2014 study) and 15.3% (current study). At the word level, in the 2014 study 58.6% of the 70 NU-6 words had better performances in the 0-ms condition compared to 61.6% in the current study, a striking similarity. When better performance was obtained with the 50-ms condition, the agreement between studies was not as good 21.4%, (2014 study) and 32.0%, (current study). The overall performances by the listeners with normal hearing in the current study, however, were 21–23% poorer than the performances on similar materials in the 2014 study, which is probably attributable to different speakers, different paradigms, and different word durations. In all likelihood, word duration is the major reason for the performance differences in that the mean word durations of the two materials are vastly different. The 70 NU-6 words (mean duration = 487 ms; SD = 77 ms) used in the 2014 study were 38.6% longer than the Maryland CNC words (mean duration = 299.2 ms; SD = 36.6 ms) used in the current study. With 10 ips, these mean word durations translate to 4.8 and 3.0 glimpses or on-segments per word for the NU-6 and Maryland words, respectively. Although many of the words in the two sets of materials are the same words, the NU-6 words were at the end of the carrier phrase, which enabled many final consonants and perhaps the whole words to be more sustained, whereas the Maryland CNC words were between two words in the carrier phrase, which imposed in some respects a duration limit on the final consonants and perhaps somewhat compressing the entire word. The shorter Maryland CNC words had fewer samples from which to glean intelligibility. Even though the overall performances differed for the two sets of words, the performance relations between the study conditions within the two studies were very similar.

Listeners with sensorineural hearing loss

We knew *a priori* from earlier studies (Kidd & Humes, 2012; Krull et al, 2013; Wilson, 2014) that performances on the interrupted materials by the older listeners with sensorineural hearing loss would be

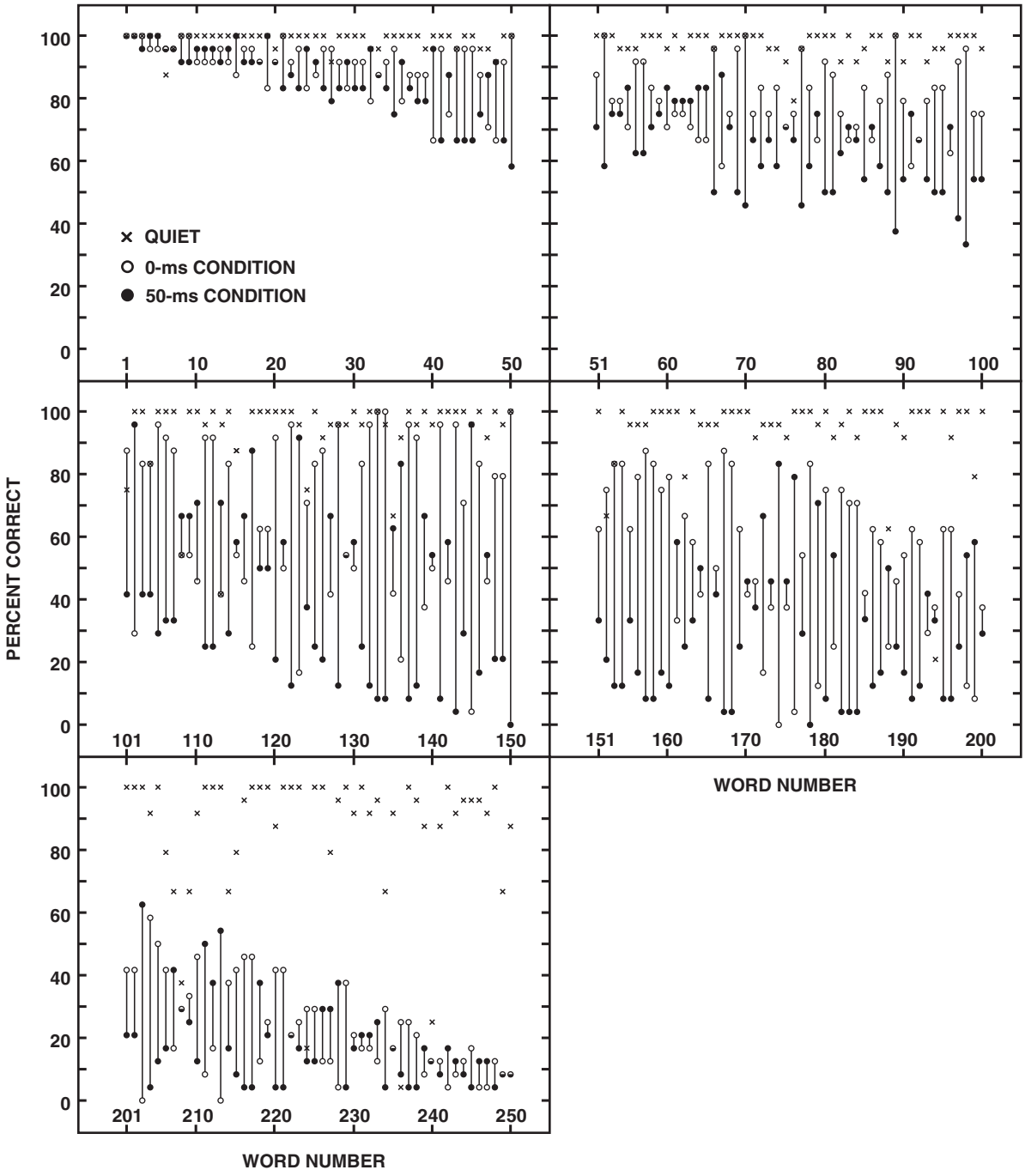

Figure 5. The mean percent correct for each of the 250 words by 24 young adult listeners with normal hearing on the uninterrupted words (x) from Wilson and McArdle (2015) and on the words interrupted in the 0-ms condition (open circles) and in the 50-ms condition (filled circles). The words are arranged according to the mean performance on the complementary halves. The corresponding numerical values are listed in Supplementary Table 1 in the Supplemental Materials to be found online at http://informahealthcare.com/doi/abs/10.3109/14992027.2015.1055839.

somewhat poorer than the performances by their younger counterparts, which is a relation observed with most (if not all) distorted speech materials. To avoid frustration by the older listeners having to experience a multitude of words that they could not understand, only words on which recognition performances by the young listeners were > 58% correct were evaluated with the older listeners. This criterion provided a pool of 250 interrupted words that included 75 words with complementary halves (150 words), 78 words in the 0-ms condition, and 22 words in the 50-ms condition, which in terms of complementary halves totaled 153 words in the 0-ms condition and 97 words in the 50-ms condition. Recognition performance on these uninterrupted 175 Maryland CNC words by 72 older listeners with sensorineural hearing loss similar to those included in the current study was 90.3% correct (SD = 12.2%) (Wilson & McArdle, 2015), which indicates that the selected words uninterrupted were easily understood by older listeners with hearing loss.

The mean recognition data from the older listeners with sensorineural hearing loss are presented in Table 3 (1) for the overall

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Table 3. The mean percent correct recognition (and standard deviations) for the 250 complementary halves of the interrupted words in the 0-ms and 50-ms conditions by 32 listeners with sensorineural hearing loss.

	0 ms	*50 ms*
Overall 250 words		
Mean	56.4	53.6
SD	23.7	23.0
n	153	97
75 words with complementary halves		
Mean	54.0	56.6
SD	24.9	22.1
n	75	75

250 stimulus words with an unequal *n* for the 0- and 50-ms conditions and (2) for the 75 words on which there were recognition data for both the 0- and 50-ms conditions. For both sets of data, the mean recognition performances by the older listeners on the 0- and 50-ms conditions were not significantly different, all being ~55% correct with SDs around 24%. Compared to recognition performances on the same words uninterrupted in quiet, performance on the interrupted words was reduced by 35 percentage points from 90% to 55% correct. The bivariate plots in Figure 6 summarize the recognition performances on each of the 75 select words in the 0-ms and 50-ms conditions by the older listeners (open circles) by the younger group of listeners (filled circles). The data from the younger listeners are grouped closely in the upper right corner of the graph reflecting the inclusion of only those words on which performance was > 58% correct. For the older listeners, there are a few datum points intermingled with the data from the younger listeners, but for the most part the data from the older listeners are dispersed throughout the graph to the lower performance levels. In the figure the equality of performances by the older listeners on the two conditions is apparent with 38 words (50.7% of the words) having better performance on the 0-ms condition and 35 words (46.7% of the words) having better performance on the 50-ms condition; two words (2.7% of the words) had equal performances on the two conditions. From the data in Table 3 and Figure 6, it is obvious that performances on the select words by the older listeners with hearing loss were essentially the same on the 0- and 50-ms conditions, which is a result that does not support the hypotheses that were posed. The reasons for these unexpected findings are considered in the Conclusions section.

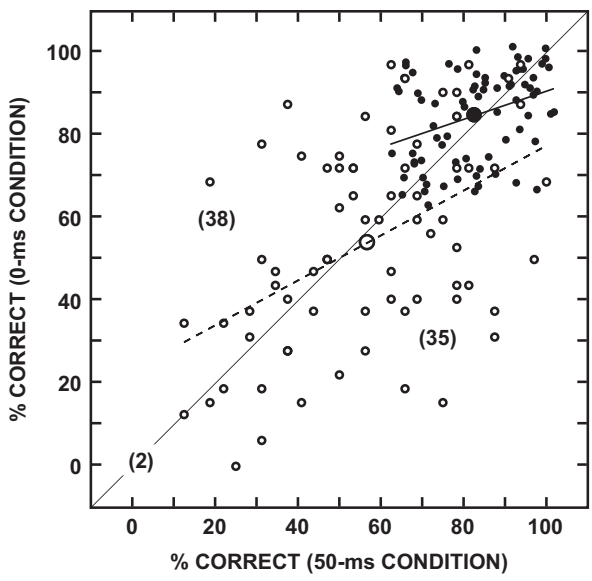

Figure 6. A bivariate plot of the percent correct on each of the complementary halves of the 75 target words (0-ms condition, ordinate; 50-ms condition abscissa) used with the older listeners (open circles). Data on the same words by the 24 listeners with normal hearing also are shown (filled circles). The large circles depict the means, the solid diagonal line is the line of equality, and the dotted lines are regressions used to describe the data (normal hearing, $y = 57.421 + 0.331x$, $R^2 = 0.117$; hearing loss, $y = 23.278 + 0.544x$, $R^2 = 0.233$). The data were jittered using an additive randomized algorithm.

Table 4 provides a breakdown of the mean recognition performances on the select 75 complementary halves when better performance was attained on each of the respective halves; equal performance data also are included as are corresponding recognition data on the 75 select words from the listeners with normal hearing. Obviously, the overall recognition performances by the younger listeners were better than the performances by the older listeners by 21.3% to 52.9% and the younger listeners had smaller variability. The differences between the performances on the 0-ms and 50-ms conditions within the two categories were greater for the older listeners with hearing loss than for the younger listeners, which probably reflects the performances by the younger listeners being closer to ceiling.

The data on the 75 words are recast in Figure 7 to illustrate the differences in performances between the two groups of listeners and among the three listening conditions within each listener group. Again, the recognition data in the figure (x) from the words uninterrupted data are from Wilson and McArdle (2015) and the numeric values for the data in Figure 7 are listed in Supplementary Table 2. As with Figure 5 earlier, the data in Figure 7 are ordered for words 1–75 based on the average performances on the 0-ms (open symbols) and 50-ms (filled symbols) conditions by the younger group of listeners, which is why the data in the upper panel appear much more systematic than the data from the older listeners with sensorineural hearing loss in the lower panel. The data for each word in both panels coincide, i.e. Word 1 is the same word (*third*) in both panels, Word 2 (*word*) is the same, etc.

Table 4. The mean percent correct recognition (and standard deviations) by the 32 older listeners with sensorineural hearing loss on the 75 words with complementary halves (the 0-ms and 50-ms conditions); when the mean performance on the 0-ms condition was better than on the 50-ms condition, when the mean performance on the 50-ms condition was better than on the 0-ms condition, and when performances on the two conditions were equal. For reference the same data were extracted for the 24 young listeners with normal hearing.

	0 ms > 50 ms		*50 ms > 0 ms*		
	0 ms	*50 ms*	*0 ms*	*50 ms*	*0 ms = 50 ms*
Listeners with hearing loss ($n = 32$)					
Mean	68.0	51.9	39.9	62.9	35.9
SD	20.0	19.9	21.0	22.7	33.1
n	38		35		2
Listeners with normal hearing ($n = 24$)					
Mean	89.3	76.9	77.8	88.2	88.8
SD	8.5	9.9	10.6	9.5	12.1
n	38		28		9

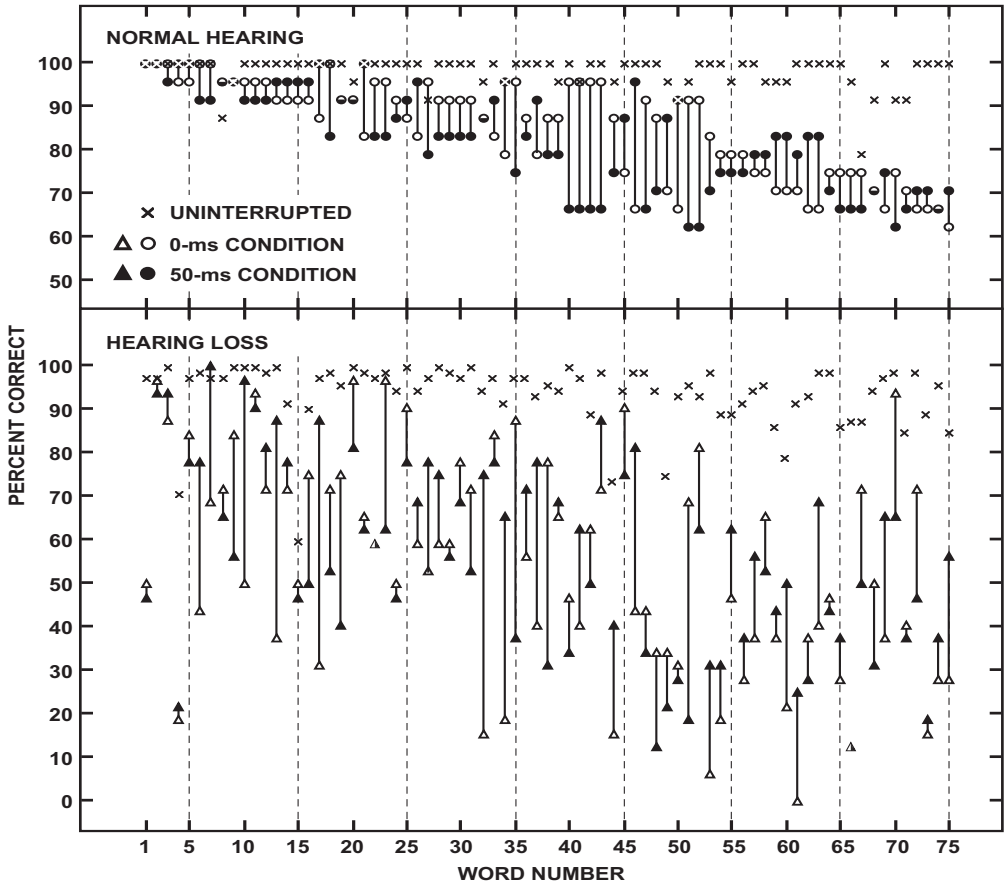

Figure 7. The mean percent correct for each of the 75 words with complementary halves used with the 32 older listeners with hearing loss (lower panel) and with the 24 young adult listeners with normal hearing (upper panel) on the words interrupted in the 0-ms condition (open symbols) and in the 50-ms condition (filled symbols). For reference the recognition performances on the words uninterrupted are shown (x) (Wilson & McArdle, 2015). The words are arranged according to the mean performance on the complementary halves by the younger listeners. The corresponding numerical values are listed in Supplementary Table 2 in the Supplemental Material to be found online at http://informahealthcare.com/doi/abs/10.3109/14992027.2015.1055839.

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The apparent relation from the data in Figure 7 is the randomness of the performances within and between the two groups of listeners. For example, in both groups of listeners 38 words had better recognition performances on the 0-ms condition than on the 50-ms condition; however, only 17 of the 38 words were common to the two groups of listeners, which illustrates a lack of consistency between listener groups at the word level.

Conclusions

The data on the 250 complementary halves from the young listeners with normal hearing confirmed the results by Wilson (2014) that overall recognition performance was better on the 0-ms condition than on the 50-ms condition and that there were a minority number of words on which better performance was obtained on the 50-ms condition. In the Wilson study, these two relations also were observed on a group of 12 older listeners with sensorineural hearing loss. Contrary to the Wilson findings, the current data from 32 older listeners with sensorineural hearing loss indicate an insignificant 2.6% difference in recognition performance on the 0-ms (54.0% correct) and 50-ms (56.6% correct) conditions. There are basically two reasons that can account for the different results from the two studies, group differences or procedural differences. Based on the data in Table 4, we suspect that procedural differences were the culprit. The data from the younger listeners on the same 75 select words indicated an insignificant 2.4% difference between the 0-ms (84.9% correct) and the 50-ms (82.5% correct) conditions. Thus, although in the current study the between-group performances on the select 75 words were different, the within-group recognition performances on the 0- and 50-ms conditions were insignificant at about 2.5%. Comparison of the recognition performances on the non-complementary halves, not shown but calculated from the data in Table 3, indicates a 15.3% better performance on the 0-ms condition (58.7%, $n = 78$) than on the 50-ms condition (43.4%, $n = 22$). For two reasons this comparison, although interesting, is probably inappropriate. First, the words are not complementary halves of one another. Second, the number of samples in the two groups is substantially different.

In summary, it appears that by 'cherry picking' the stimulus words (i.e., selecting the words on which the listeners with normal hearing had recognition performances > 58%), a bias inadvertently infiltrated the pool of stimulus words that were used to evaluate the older listeners with hearing loss. The reason for using these particular 'high performance' words was well intended, i.e., to avoid the older listeners with sensorineural hearing loss from having to listen to a number of stimuli that we anticipated they would not be able to understand, but the selection criterion probably introduced a bias in the study that obscured the answers to the questions that were posed. In compiling the words for the older listeners, only the performances by the young

listeners with normal hearing on the independent, complementary halves were considered, not the relations between the performances on the complementary halves.

Following submission of this manuscript, a third project from our laboratory with 70 interrupted NU-6 CNC words (10 ips, 50% duty cycle) was completed (Wilson & Hamm, 2015). That study examined the effects on intelligibility that 0- to 90-ms onset conditions in 10-ms increments had on intelligibility. Analysis of the recognition performances of each word revealed that 46% of the 70 words had flat functions across the 10 onset conditions, most of which were > 80% correct. In contrast to the words with flat functions, 49% of the 70 words had U-shaped functions that were maximum at the 0- and 10-ms conditions, minimal between the 20- and 70-ms conditions, and returning to maximum at the 80- and 90-ms conditions. If these two patterns of recognition performance functions also were characteristic of the Maryland CNC materials, then the equal performances observed in the current study with the 0- and 50-ms conditions are better understood. By selecting the words in the current study with recognition performances > 58% correct on listeners with normal hearing for use on the listeners with sensorineural hearing loss, the probability was that those words would be characterized by flat recognition functions across the onset conditions that would produce the equal performances observed with the 0- and 50-ms conditions. This word selection bias will be verified and hopefully corrected by replicating in the near future the Wilson and Hamm study using older adults with sensorineural hearing loss.

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Declaration of interest: The authors report no conflicts of interest.

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Supplementary material available online

Supplementary Figure 1, Tables 1 and 2 available online at http://informahealthcare.com/doi/abs/10.3109/14992027.2015.1055839.

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Supplemental Materials

for

Recognition Performance on Words Interrupted (10 ips, 50% Duty Cycle) with Two Interruption Patterns Referenced to Word Onset: Young Listeners with Normal Hearing for Pure Tones and Older Listeners with Sensorineural Hearing Loss

by

Richard H. Wilson and Staci E. Irish

Figure SM1 2

Table SM1..... 3

Table SM2..... 9

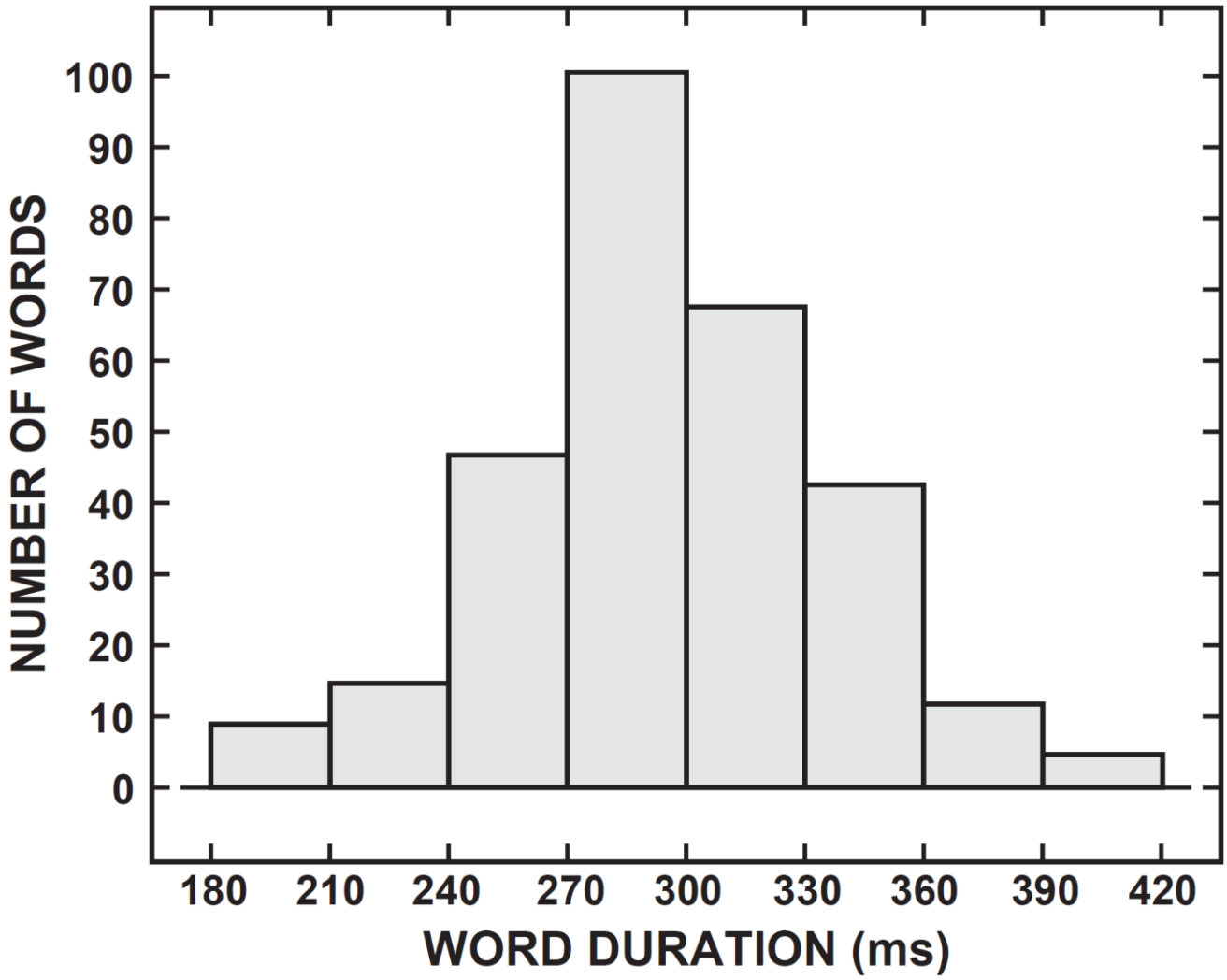

Figure SM1. A distribution of the durations of the Maryland CNC words.

Table SM1. The mean percent correct for the 250 complementary word halves used with the 24 young listeners with normal hearing for pure tones are listed along with the mean percent correct of the same words uninterrupted from a second group of young listeners with normal hearing (Wilson & McArdle, 2015). Also included are the durations of each word.

Word #	List #	Word	Duration (ms)	Uninterrupted (%)	0 ms (%)	50 ms (%)	0-ms − 50-ms Difference
1	7	THIRD	295.0	100.0	100.0	100.0	0.0
2	9	WORD	286.3	100.0	100.0	100.0	0.0
3	1	NAME	235.7	100.0	100.0	95.8	4.2
4	3	FAITH	343.3	100.0	95.8	100.0	-4.2
5	3	ROOM	274.0	100.0	95.8	100.0	-4.2
6	1	DIME	263.3	87.5	95.8	95.8	0.0
7	6	MOVE	276.0	95.8	95.8	95.8	0.0
8	7	YOUNG	282.7	100.0	100.0	91.7	8.3
9	9	VOICE	354.3	100.0	100.0	91.7	8.3
10	1	HOME	302.7	100.0	91.7	95.8	-4.2
11	1	MAKE	283.0	100.0	91.7	95.8	-4.2
12	1	WOOD	272.0	100.0	91.7	95.8	-4.2
13	3	HOUSE	331.3	100.0	95.8	91.7	4.2
14	7	MOUTH	312.0	100.0	91.7	95.8	-4.2
15	9	WRONG	325.0	100.0	87.5	100.0	-12.5
16	9	GIRL	274.0	100.0	95.8	91.7	4.2
17	9	RAG	352.0	100.0	95.8	91.7	4.2
18	1	KNIFE	279.7	100.0	91.7	91.7	0.0
19	3	GAP	272.0	100.0	83.3	100.0	-16.7
20	9	WATCH	336.3	95.8	91.7	91.7	0.0
21	9	BOOK	269.0	100.0	100.0	83.3	16.7
22	3	LIFE	323.0	100.0	91.7	87.5	4.2
23	6	WIFE	307.0	100.0	95.8	83.3	12.5
24	7	LAUGH	315.7	100.0	83.3	95.8	-12.5
25	9	ROOF	332.0	100.0	87.5	91.7	-4.2
26	9	DOG	326.7	100.0	95.8	83.3	12.5
27	1	WHEEL	268.7	91.7	95.8	79.2	16.7
28	3	BAR	300.3	100.0	91.7	83.3	8.3
29	3	MORE	274.0	100.0	83.3	91.7	-8.3
30	6	FIRE	393.0	100.0	91.7	83.3	8.3
31	6	DOOR	346.7	100.0	91.7	83.3	8.3
32	7	NOTE	306.3	95.8	79.2	95.8	-16.7
33	7	HOLE	266.3	95.8	87.5	87.5	0.0
34	9	HAM	276.3	100.0	91.7	83.3	8.3
35	1	FALL	306.7	100.0	95.8	75.0	20.8
36	6	WEB	235.0	100.0	79.2	91.7	-12.5
37	7	NAP	292.7	100.0	87.5	83.3	4.2
38	1	VAN	267.0	100.0	87.5	79.2	8.3
39	9	NEED	263.0	95.8	87.5	79.2	8.3
40	3	WORK	290.7	100.0	66.7	95.8	-29.2
41	3	JOKE	282.7	100.0	95.8	66.7	29.2
42	3	MAN	276.7	100.0	75.0	87.5	-12.5
43	6	RUG	297.7	95.8	95.8	66.7	29.2

Table SM1, continued

44	6	NIGHT	289.7	100.0	95.8	66.7	29.2
45	9	NAIL	281.0	100.0	95.8	66.7	29.2
46	9	BOTH	292.3	95.8	87.5	75.0	12.5
47	1	KITE	320.0	95.8	70.8	87.5	-16.7
48	3	RIG	259.7	91.7	66.7	91.7	-25.0
49	3	HEAD	256.0	100.0	91.7	66.7	25.0
50	3	NOISE	275.7	100.0	100.0	58.3	41.7
51	6	BIRTH	265.7	100.0	87.5	70.8	16.7
52	9	LACK	346.7	100.0	100.0	58.3	41.7
53	3	VOTE	263.3	100.0	79.2	75.0	4.2
54	3	NUMB	274.3	95.8	79.2	75.0	4.2
55	3	CHIN	290.3	95.8	70.8	83.3	-12.5
56	6	LIVE	282.0	95.8	91.7	62.5	29.2
57	6	MAP	274.0	100.0	91.7	62.5	29.2
58	6	HIKE	296.3	100.0	83.3	70.8	12.5
59	7	BIG	278.3	100.0	79.2	75.0	4.2
60	7	HEAT	280.0	95.8	70.8	83.3	-12.5
61	7	MOLE	259.3	100.0	75.0	79.2	-4.2
62	9	LOAF	342.3	95.8	75.0	79.2	-4.2
63	1	HATE	262.0	100.0	70.8	79.2	-8.3
64	1	GALE	256.7	100.0	66.7	83.3	-16.7
65	7	NECK	294.0	100.0	66.7	83.3	-16.7
66	1	CHORE	341.7	95.8	95.8	50.0	45.8
67	3	LAKE	279.7	100.0	58.3	87.5	-29.2
68	7	VAGUE	282.3	100.0	75.0	70.8	4.2
69	9	CHAIR	329.7	100.0	95.8	50.0	45.8
70	9	FUDGE	368.7	100.0	100.0	45.8	54.2
71	1	THIN	300.7	100.0	75.0	66.7	8.3
72	1	MERGE	270.3	100.0	83.3	58.3	25.0
73	1	BOAT	250.7	95.8	75.0	66.7	8.3
74	3	FOUR	359.0	95.8	83.3	58.3	25.0
75	6	VEAL	230.7	91.7	70.8	70.8	0.0
76	6	MODE	263.3	79.2	75.0	66.7	8.3
77	9	MOB	296.7	95.8	95.8	45.8	50.0
78	9	HAZE	333.3	100.0	83.3	58.3	25.0
79	9	BALL	285.7	100.0	66.7	75.0	-8.3
80	9	FEET	320.7	100.0	91.7	50.0	41.7
81	6	CALF	310.3	100.0	87.5	50.0	37.5
82	6	BED	233.3	91.7	75.0	62.5	12.5
83	6	KNOCK	304.7	100.0	66.7	70.8	-4.2
84	7	FAR	350.7	91.7	70.8	66.7	4.2
85	7	MINE	254.3	95.8	83.3	54.2	29.2
86	9	SHADE	326.7	100.0	66.7	70.8	-4.2
87	9	YES	344.7	100.0	79.2	58.3	20.8
88	9	CURVE	351.3	91.7	87.5	50.0	37.5
89	9	TIME	303.7	100.0	100.0	37.5	62.5
90	1	WRECK	283.3	91.7	79.2	54.2	25.0
91	3	YAM	309.0	100.0	58.3	75.0	-16.7
92	3	WELL	253.3	100.0	66.7	66.7	0.0

Table SM1, continued

93	6	FAN	280.0	91.7	79.2	54.2	25.0
94	7	DOOM	269.0	95.8	83.3	50.0	33.3
95	7	PEARL	345.7	95.8	83.3	50.0	33.3
96	7	HAVE	289.0	100.0	62.5	70.8	-8.3
97	9	MUD	294.7	100.0	91.7	41.7	50.0
98	1	ROUTE	300.3	100.0	95.8	33.3	62.5
99	3	KEG	293.0	100.0	75.0	54.2	20.8
100	3	LEAVE	295.0	95.8	75.0	54.2	20.8
101	7	GUN	244.3	75.0	87.5	41.7	45.8
102	1	ROSE	332.0	100.0	29.2	95.8	-66.7
103	6	CHAIN	294.7	100.0	83.3	41.7	41.7
104	7	JOIN	281.3	83.3	83.3	41.7	41.7
105	7	CALL	314.7	100.0	95.8	29.2	66.7
106	3	KID	232.7	100.0	91.7	33.3	58.3
107	3	TONE	279.3	100.0	87.5	33.3	54.2
108	3	WITH	310.3	54.2	54.2	66.7	-12.5
109	7	RIB	258.3	100.0	54.2	66.7	-12.5
110	6	WHIP	255.7	100.0	45.8	70.8	-25.0
111	3	JAIL	275.0	95.8	91.7	25.0	66.7
112	7	TAPE	287.0	100.0	91.7	25.0	66.7
113	3	RAT	296.3	95.8	41.7	70.8	-29.2
114	7	RIDGE	315.0	100.0	83.3	29.2	54.2
115	1	BOIL	285.0	87.5	54.2	58.3	-4.2
116	1	HULL	269.0	41.7	45.8	66.7	-20.8
117	1	LOOP	278.7	100.0	25.0	87.5	-62.5
118	6	CHEESE	330.0	100.0	62.5	50.0	12.5
119	7	FISH	341.3	100.0	62.5	50.0	12.5
120	9	PILL	289.0	100.0	91.7	20.8	70.8
121	1	JAR	327.3	100.0	50.0	58.3	-8.3
122	1	DITCH	290.7	100.0	95.8	12.5	83.3
123	3	MATE	261.7	95.8	16.7	91.7	-75.0
124	3	FADE	308.0	75.0	70.8	37.5	33.3
125	6	POPE	285.7	100.0	83.3	25.0	58.3
126	6	TUBE	295.0	91.7	87.5	20.8	66.7
127	6	CAT	315.0	95.8	41.7	66.7	-25.0
128	6	TEAM	244.7	95.8	95.8	12.5	83.3
129	6	HOWL	285.7	95.8	54.2	54.2	0.0
130	7	FACE	362.7	100.0	50.0	58.3	-8.3
131	7	DUMB	256.0	95.8	83.3	25.0	58.3
132	9	TOOL	292.7	100.0	95.8	12.5	83.3
133	7	CHEEK	401.3	100.0	100.0	8.3	91.7
134	7	LOSE	307.7	95.8	100.0	8.3	91.7
135	1	YEARN	279.0	66.7	41.7	62.5	-20.8
136	7	LOOT	277.0	91.7	20.8	83.3	-62.5
137	1	TOUGH	294.7	100.0	95.8	8.3	87.5
138	1	CHECK	288.3	95.8	91.7	12.5	79.2
139	3	ROUGE	326.0	100.0	37.5	66.7	-29.2
140	3	BELL	257.0	95.8	50.0	54.2	-4.2
141	6	COOL	290.7	100.0	95.8	8.3	87.5

Table SM1, continued

142	6	DIG	249.3	100.0	45.8	58.3	-12.5
143	1	TOOTH	284.0	100.0	95.8	4.2	91.7
144	6	RAISE	289.7	100.0	70.8	29.2	41.7
145	7	REACH	293.7	95.8	4.2	95.8	-91.7
146	9	POWER	391.0	100.0	83.3	16.7	66.7
147	6	LOOK	282.0	91.7	45.8	54.2	-8.3
148	6	CAGE	373.3	100.0	79.2	20.8	58.3
149	6	GONE	269.0	95.8	79.2	20.8	58.3
150	7	TOP	311.3	100.0	100.0	0.0	100.0
151	1	SHIRT	327.3	100.0	62.5	33.3	29.2
152	3	GULL	261.7	66.7	75.0	20.8	54.2
153	3	TOLL	254.7	83.3	83.3	12.5	70.8
154	6	POLE	286.3	100.0	83.3	12.5	70.8
155	9	TICK	309.0	95.8	62.5	33.3	29.2
156	9	BEAT	242.3	95.8	79.2	16.7	62.5
157	7	PINE	271.0	95.8	87.5	8.3	79.2
158	3	PERCH	293.3	100.0	83.3	8.3	75.0
159	6	LAWN	296.7	100.0	75.0	16.7	58.3
160	6	GET	276.7	100.0	79.2	12.5	66.7
161	6	WING	255.7	100.0	33.3	58.3	-25.0
162	7	GEM	284.7	79.2	66.7	25.0	41.7
163	9	DISH	325.7	100.0	58.3	33.3	25.0
164	9	MIRE	368.0	95.8	41.7	50.0	-8.3
165	9	PUN	301.0	95.8	83.3	8.3	75.0
166	9	DECK	314.3	95.8	50.0	41.7	8.3
167	9	CUT	298.0	100.0	87.5	4.2	83.3
168	1	TOAD	267.3	100.0	83.3	4.2	79.2
169	1	JUG	286.3	100.0	62.5	25.0	37.5
170	6	RUSH	305.3	100.0	41.7	45.8	-4.2
171	1	MESS	305.0	91.7	45.8	37.5	8.3
172	1	SUN	313.3	95.8	16.7	66.7	-50.0
173	3	DAB	281.7	95.8	37.5	45.8	-8.3
174	6	JAM	273.7	95.8	0.0	83.3	-83.3
175	6	BUD	249.7	91.7	37.5	45.8	-8.3
176	7	TAR	339.7	100.0	4.2	79.2	-75.0
177	7	SURE	359.0	100.0	54.2	29.2	25.0
178	9	CATCH	344.0	100.0	83.3	0.0	83.3
179	9	SOAP	334.0	95.8	12.5	70.8	-58.3
180	1	KING	266.7	100.0	75.0	8.3	66.7
181	9	SANE	356.0	91.7	25.0	54.2	-29.2
182	9	WHITE	323.0	95.8	75.0	4.2	70.8
183	3	PIECE	316.0	100.0	70.8	4.2	66.7
184	6	NIECE	288.3	91.7	70.8	4.2	66.7
185	1	GOOSE	307.0	100.0	41.7	33.3	8.3
186	3	DIP	231.0	100.0	62.5	12.5	50.0
187	3	SHEEP	321.3	100.0	58.3	16.7	41.7
188	7	WAS	304.3	62.5	25.0	50.0	-25.0
189	1	BEAN	219.0	95.8	45.8	25.0	20.8
190	1	DEAD	237.7	91.7	54.2	16.7	37.5

Table SM1, continued

191	1	PICK	241.0	100.0	62.5	8.3	54.2
192	3	PURGE	334.0	100.0	58.3	12.5	45.8
193	3	HUT	270.3	100.0	29.2	41.7	-12.5
194	6	DULL	265.0	20.8	37.5	33.3	4.2
195	6	SEARCH	343.3	100.0	62.5	8.3	54.2
196	9	REAP	257.7	91.7	62.5	8.3	54.2
197	3	SHINE	334.7	100.0	41.7	25.0	16.7
198	7	SAVE	357.7	100.0	12.5	54.2	-41.7
199	7	SIDE	332.7	79.2	8.3	58.3	-50.0
200	9	JAZZ	370.0	100.0	37.5	29.2	8.3
201	1	RIPE	278.7	100.0	41.7	20.8	20.8
202	6	SHOCK	352.3	100.0	41.7	20.8	20.8
203	7	SACK	369.3	100.0	0.0	62.5	-62.5
204	1	SHORE	390.0	91.7	58.3	4.2	54.2
205	6	PACE	317.7	100.0	50.0	12.5	37.5
206	7	BET	285.3	79.2	41.7	16.7	25.0
207	7	WIT	284.7	66.7	16.7	41.7	-25.0
208	3	WHAT	306.3	37.5	29.2	29.2	0.0
209	6	BAD	223.3	66.7	33.3	25.0	8.3
210	7	COKE	304.7	91.7	45.8	12.5	33.3
211	9	SIN	347.3	100.0	8.3	50.0	-41.7
212	3	SOON	317.7	100.0	16.7	37.5	-20.8
213	6	SIT	281.3	100.0	0.0	54.2	-54.2
214	9	LATHE	289.0	66.7	37.5	16.7	20.8
215	3	KEEN	252.7	79.2	41.7	8.3	33.3
216	1	CAPE	266.7	95.8	45.8	4.2	41.7
217	6	TURN	313.3	100.0	45.8	4.2	41.7
218	9	SHOUT	381.3	100.0	12.5	37.5	-25.0
219	6	SHONE	339.0	100.0	25.0	20.8	4.2
220	7	BUN	255.7	87.5	41.7	4.2	37.5
221	7	GEESE	301.3	100.0	41.7	4.2	37.5
222	1	PATCH	323.3	100.0	20.8	20.8	0.0
223	1	LEASE	320.0	100.0	25.0	16.7	8.3
224	1	LAG	291.3	16.7	29.2	12.5	16.7
225	3	SIZE	393.7	100.0	29.2	12.5	16.7
226	3	BUSH	268.3	100.0	12.5	29.2	-16.7
227	9	HEN	286.3	79.2	12.5	29.2	-16.7
228	6	SOUR	387.0	95.8	4.2	37.5	-33.3
229	7	DID	232.3	100.0	37.5	4.2	33.3
230	1	FIT	294.7	91.7	20.8	16.7	4.2
231	6	HISS	315.3	100.0	16.7	20.8	-4.2
232	7	LED	285.7	91.7	16.7	20.8	-4.2
233	9	LIP	288.0	95.8	12.5	25.0	-12.5
234	3	POD	276.3	66.7	29.2	4.2	25.0
235	9	GOT	271.3	91.7	16.7	16.7	0.0
236	9	CHEER	331.0	4.2	25.0	8.3	16.7
237	1	SOB	358.0	100.0	25.0	4.2	20.8
238	1	WISH	297.0	95.8	20.8	4.2	16.7
239	7	SHALL	345.7	87.5	8.3	16.7	-8.3

Table SM1, continued

240	9	THINE	306.0	25.0	12.5	12.5	0.0
241	1	PAD	276.0	87.5	12.5	8.3	4.2
242	3	DIKE	287.0	100.0	4.2	16.7	-12.5
243	7	CAUGHT	317.0	91.7	8.3	12.5	-4.2
244	7	PASS	352.3	95.8	12.5	8.3	4.2
245	7	SUCH	357.7	95.8	16.7	4.2	12.5
246	1	SALVE	357.0	95.8	4.2	12.5	-8.3
247	1	SEIZE	371.7	91.7	4.2	12.5	-8.3
248	3	TOSS	349.7	100.0	12.5	4.2	8.3
249	3	SUNG	314.0	66.7	8.3	8.3	0.0
250	6	JOT	311.3	87.5	8.3	8.3	0.0
	Mean		299.2	94.1	63.1	47.8	15.3
	SD		36.6	13.6	29.8	30.7	35.8
	Maximum		401.3	100.0	100.0	100.0	100.0
	Minimum		219.0	4.2	0.0	0.0	-91.7
	Range		182.3	95.8	100.0	100.0	191.7

Table SM2. The mean percent correct for the 75 words with complementary halves used with the older listeners with sensorineural hearing loss (HearLoss). For comparison the corresponding data for the young listeners with normal hearing (Normals) are listed along with the data on the words uninterrupted (Wilson & McArdle, 2015).

Word			Uninterrupted		0-ms Condition		50-ms Condition	
#	List #	Word	Normals	HearLoss	Normals	HearLoss	Normals	HearLoss
1	7	THIRD	100.0	97.2	100.0	50.0	100.0	46.9
2	9	WORD	100.0	97.2	100.0	96.9	100.0	93.8
3	3	FAITH	100.0	70.8	95.8	18.8	100.0	21.9
4	3	ROOM	100.0	97.2	95.8	84.4	100.0	78.1
5	1	NAME	100.0	100.0	100.0	87.5	95.8	93.8
6	6	MOVE	95.8	100.0	95.8	84.4	95.8	56.3
7	1	DIME	87.5	97.2	95.8	71.9	95.8	65.6
8	7	YOUNG	100.0	98.6	100.0	43.8	91.7	78.1
9	9	VOICE	100.0	97.2	100.0	68.8	91.7	100.0
10	1	WOOD	100.0	59.7	91.7	50.0	95.8	46.9
11	7	MOUTH	100.0	90.3	91.7	75.0	95.8	50.0
12	1	MAKE	100.0	91.7	91.7	71.9	95.8	78.1
13	9	RAG	100.0	98.6	95.8	71.9	91.7	81.3
14	9	WRONG	100.0	97.2	87.5	31.3	100.0	87.5
15	1	HOME	100.0	100.0	91.7	37.5	95.8	87.5
16	9	GIRL	100.0	100.0	95.8	93.8	91.7	90.6
17	3	HOUSE	100.0	100.0	95.8	50.0	91.7	96.9
18	1	KNIFE	100.0	95.8	91.7	75.0	91.7	40.6
19	9	BOOK	100.0	98.6	100.0	71.9	83.3	53.1
20	3	GAP	100.0	98.6	83.3	65.6	100.0	62.5
21	9	WATCH	95.8	100.0	91.7	96.9	91.7	81.3
22	3	LIFE	100.0	94.4	91.7	50.0	87.5	46.9
23	6	WIFE	100.0	97.2	95.8	59.4	83.3	59.4
24	9	DOG	100.0	98.6	95.8	96.9	83.3	62.5
25	7	LAUGH	100.0	94.4	83.3	59.4	95.8	68.8
26	9	ROOF	100.0	100.0	87.5	90.6	91.7	78.1
27	9	HAM	100.0	100.0	91.7	71.9	83.3	53.1
28	6	FIRE	100.0	98.6	91.7	59.4	83.3	56.3
29	7	NOTE	95.8	91.7	79.2	18.8	95.8	65.6
30	6	DOOR	100.0	97.2	91.7	78.1	83.3	68.8
31	7	HOLE	95.8	94.4	87.5	15.6	87.5	75.0
32	3	BAR	100.0	100.0	91.7	59.4	83.3	75.0
33	1	WHEEL	91.7	97.2	95.8	53.1	79.2	78.1
34	3	MORE	100.0	97.2	83.3	84.4	91.7	78.1
35	1	FALL	100.0	97.2	95.8	87.5	75.0	37.5
36	7	NAP	100.0	97.2	87.5	56.3	83.3	71.9
37	6	WEB	100.0	93.1	79.2	40.6	91.7	78.1
38	1	VAN	100.0	95.8	87.5	78.1	79.2	31.3
39	9	NEED	95.8	94.4	87.5	65.6	79.2	68.8
40	3	JOKE	100.0	100.0	95.8	46.9	66.7	34.4
41	9	BOTH	95.8	73.6	87.5	15.6	75.0	40.6
42	6	NIGHT	100.0	88.9	95.8	62.5	66.7	50.0

Table SM2, continued

43	6	RUG	95.8	97.2	95.8	40.6	66.7	62.5
44	3	MAN	100.0	94.4	75.0	90.6	87.5	75.0
45	3	WORK	100.0	98.6	66.7	43.8	95.8	81.3
46	9	NAIL	100.0	98.6	95.8	71.9	66.7	87.5
47	6	BIRTH	100.0	94.4	87.5	34.4	70.8	12.5
48	1	KITE	95.8	75.0	70.8	34.4	87.5	21.9
49	3	RIG	91.7	93.1	66.7	31.3	91.7	28.1
50	3	HEAD	100.0	98.6	91.7	43.8	66.7	34.4
51	6	LIVE	95.8	95.8	91.7	68.8	62.5	18.8
52	6	HIKE	100.0	98.6	83.3	6.3	70.8	31.3
53	3	VOTE	100.0	88.9	79.2	18.8	75.0	31.3
54	7	BIG	100.0	91.7	79.2	28.1	75.0	37.5
55	3	CHIN	95.8	86.1	70.8	37.5	83.3	43.8
56	7	HEAT	95.8	79.2	70.8	21.9	83.3	50.0
57	9	LOAF	95.8	95.8	75.0	65.6	79.2	53.1
58	7	MOLE	100.0	94.4	75.0	37.5	79.2	56.3
59	3	NUMB	95.8	88.9	79.2	46.9	75.0	62.5
60	6	MAP	100.0	93.1	91.7	81.3	62.5	62.5
61	1	HATE	100.0	91.7	70.8	0.0	79.2	25.0
62	1	GALE	100.0	93.1	66.7	37.5	83.3	28.1
63	7	NECK	100.0	98.6	66.7	40.6	83.3	68.8
64	7	VAGUE	100.0	98.6	75.0	46.9	70.8	43.8
65	1	BOAT	95.8	87.5	75.0	12.5	66.7	12.5
66	6	VEAL	91.7	94.4	70.8	50.0	70.8	31.3
67	1	THIN	100.0	86.1	75.0	28.1	66.7	37.5
68	6	MODE	79.2	87.5	75.0	71.9	66.7	50.0
69	9	BALL	100.0	97.2	66.7	37.5	75.0	65.6
70	9	SHADE	100.0	88.9	66.7	15.6	70.8	18.8
71	7	FAR	91.7	84.7	70.8	40.6	66.7	37.5
72	6	KNOCK	100.0	98.6	66.7	71.9	70.8	46.9
73	6	BED	91.7	98.6	75.0	93.8	62.5	65.6
74	3	WELL	100.0	95.8	66.7	28.1	66.7	37.5
75	7	HAVE	100.0	84.7	62.5	28.1	70.8	56.3
		Mean	98.2	93.8	84.9	54.0	82.6	56.6
		SD	3.6	7.4	11.1	24.9	11.5	22.1
		Min	79.2	59.7	62.5	0.0	62.5	12.5
		Max	100.0	100.0	100.0	96.9	100.0	100.0
		Range	20.8	40.3	37.5	96.9	37.5	87.5