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Homogeneity of the 18 QuickSIN™ Lists

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Abstract

The purpose of this study was to determine the list equivalency of the 18 QuickSIN™ (Quick Speech in Noise test) lists. Individuals with normal hearing (n = 24) and with sensorineural hearing loss (n = 72) were studied. Mean recognition performances on the 18 lists by the listeners with normal hearing were 2.8 to 4.3 dB SNR (signal-to-noise ratio), whereas the range was 10.0 to 14.3 dB SNR for the listeners with hearing loss. The psychometric functions for each list showed high performance variability across lists for listeners with hearing loss but not for listeners with normal hearing. For listeners with hearing loss, Lists 4, 5, 13, and 16 fell outside of the critical difference. The data from this study suggest nine lists that provide homogenous results for listeners with and without hearing loss. Finally, there was an 8.7 dB difference in performances between the two groups indicating a more favorable signal-to-noise ratio required by the listeners with hearing loss to obtain equal performance.

Key Words: Auditory perception, hearing loss, QuickSIN™, speech perception, word recognition in multitalker babble

Abbreviations: CD = compact disc; QuickSIN™ = Quick Speech in Noise test; SNR = signal-to-noise ratio

Sumario

El propósito de este estudio fue determinar la equivalencia de las 18 listas QuickSIN™ (Prueba de Lenguaje Rápido en Ruido). Se estudiaron individuos con audición normal (n = 24) y con hipoacusia sensorineural (n = 72). Los desempeños de reconocimiento medio realizados por los sujetos con audición normal en las 18 listas fueron de 2.8 a 4.3 SNR (Tasa de señal/ruido), mientras que el rango de SNR fue de 10.0 a 14.3 dB para los sujetos con hipoacusia. Las funciones psicométricas para cada lista mostraron una gran variabilidad en el desempeño entre las listas para los sujetos con hipoacusia, pero no para aquellos con audición normal. Para los sujetos con hipoacusia, las listas 4, 5, 13 y 16 cayeron fuera de la diferencia crítica. Los datos de este estudio sugieren que hay nueve listas con resultados homogéneos para sujetos con y sin hipoacusia. Finalmente, existió una diferencia de 8.7 dB en los desempeños entre los dos grupos, indicando una tasa más favorable de señal/ruido requerido por los sujetos con hipoacusia para obtener desempeños iguales.

Palabras Clave: Percepción auditiva, hipoacusia, QuickSIN™ , percepción del lenguaje, reconocimiento de palabras en balbuceo de hablantes múltiples

Abreviaturas: CD = disco compacto; QuickSIN™ = Prueba de Lenguaje Rápido en Ruido; SNR = tasa de señal/ruido

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As audiologists realize the importance of evaluating speech recognition in background noise, the QuickSIN™ (Quick Speech in Noise test) has gained popularity because it is quick and easy to administer (Taylor, 2003; Wilson and McArdle, 2004). A recent dispenser survey (Strom, 2003) reported that out of 167 respondents, 42% of the dispensing professionals indicated that they measured performance on a speech-in-noise task. Of these 70 dispensing professionals, 39% indicated the QuickSIN was the instrument of choice.

The QuickSIN is used to evaluate the word-recognition abilities of individuals with hearing loss when listening in a background noise of multitalker babble (Killion et al, 2004). The QuickSIN, which is a shortened version of the Speech in Noise test (SIN) (Killion and Villchur, 1993), is a sentence in multitalker babble protocol that involves the presentation of six IEEE sentences (Institute of Electrical and Electronics Engineers [IEEE], 1969) at six signal-to-noise ratios in 5 dB decrements from 25 to 0 dB. Each sentence has five target words concatenated in appropriate syntactic form with subtle semantic cues creating limited contextual cues in these meaningful sentences. In the following example sentences, the target words are italicized: "A *white silk jacket* goes with *any shoes*" or "A *streak* of *color* ran *down* the *left edge*." The QuickSIN is composed of three practice lists and 18 test lists that can be used separately or in combination. Each list takes ~ 55 sec to administer.

The QuickSIN scores (Killion et al, 2004) are reported in terms of signal-to-noise ratio at which 50% correct recognition occurs for the 30 test words of a list with an adjustment added to correct for performance by listeners with normal hearing. The 50% point is determined with a formula that includes the highest presentation level, the attenuation step size, and the number of correct responses. The QuickSIN manual refers to the computation as the Tillman-Olsen method (1973) that was shown by Wilson et al (1973) to be a long-standing statistical precedent, the Spearman-Kärber equation (Finney, 1952). Because with the QuickSIN five stimulus words are presented at each signal-to-noise ratio and the attenuation step size is five decibels, each word can be thought of as "worth" one decibel. Once the number of correct words on a QuickSIN list is entered in the equation, the signal-to-noise ratio required for 50% correct (termed "SNR-50") is easily computed by subtracting the total number of correct words from 27.5 dB SNR. Killion et al, however, suggest reporting QuickSIN scores in terms of signal-to-noise ratio loss, which represents the increase in signal-to-noise ratio needed by a listener compared to the normed average recognition performance of a group of listeners with normal hearing on the QuickSIN that was 2 dB SNR. The calculation for determining signal-to-noise ratio loss (SNR Loss) per the QuickSIN manual is 25.5 dB SNR minus the number of target words correct. Recognition performances poorer than 2 dB SNR are considered by Killion et al to be abnormal.

An analysis of QuickSIN list equivalency was completed using low-pass filtering of the lists on young listeners with normal hearing (Killion et al, 2004). The filtering model reduced the auditory cues in the stimuli in an effort to mimic high-frequency hearing loss. The filtered data from the listeners with normal hearing indicated that QuickSIN Lists 1–12 were "equivalent" for all levels of filtering implying, under one scenario, equivalency of those lists for listeners with hearing loss. The other six lists were reported to be equivalent if administered in pairs (i.e., 13/14, 15/16, 17/18). Killion et al reported that during the equivalence trials, recognition performance by 18 listeners with hearing loss was so diverse that extraction of data was prohibitive and that a large number of listeners with hearing loss would be needed to obtain useful data on list equivalence.

To determine if the QuickSIN was a predictor of successful hearing aid use, Walden and Walden (2004) administered the QuickSIN in sound field for unaided and aided conditions. For a group of 50 veterans (mean age 72.1 years), the mean unaided and aided signal-to-noise ratio hearing losses were 6.3 dB and 4.6 dB, respectively. The results indicated that the unaided and aided QuickSIN scores were the best predictors of successful hearing aid use, compared to audibility measures such as pure-tone averages, unaided and aided audibility index, and word recognition in quiet. Walden and Walden also observed a positive correlation between the QuickSIN scores and age. This relation is not surprising because sentence materials can place a greater cognitive load on working memory for older individuals as compared to younger individuals making it difficult to filter out the effects of age from recognition performance on a sentence-level speech-in-noise task (e.g., Light, 1996; Salthouse, 1990). Walden and Walden combined the data for Lists 5 and 6, thereby prohibiting comparison of mean signal-to-noise ratio loss between the two QuickSIN lists. Based on these combined list results of Walden and Walden it was not clear if normative data such as list equivalency established on listeners with normal hearing (Killion et al, 2004) could be generalized from a group of listeners with normal hearing under filtered conditions to patients with hearing loss.

The QuickSIN was also included in a study of the effect of stimulus type (digit triplets, words, and sentences) on recognition performance in multitalker babble for 72 listeners with sensorineural hearing loss (McArdle et al, 2005). No list differences were observed between lists of digit triplets or between lists of words suggesting list equivalence whereas list differences were observed for the QuickSIN materials suggesting a lack of list equivalence. Specifically, Lists 3 and 4 of the QuickSIN in the McArdle et al study produced significantly different results, which is contrary to the filtering data obtained on listeners with normal hearing reported by Killion et al (2004). This finding prompted the current investigation.

This study was designed to examine the homogeneity of the 18 QuickSIN lists on individuals for whom the test is intended, that is, older listeners with sensorineural hearing loss. The underlying assumption is that what is equivalent or homogeneous for listeners with normal hearing is not necessarily equivalent or homogeneous for listeners with hearing loss. Accordingly, the homogeneity of the 18 sentences at each signal-to-noise ratio and the calculated 50% points were studied on listeners with normal hearing and listeners with hearing loss.

METHODS

Participants

Two groups of listeners were studied. Group 1 consisted of 24 young adult listeners (mean = 22.0 years) with air-conduction thresholds ≤25 dB HL (American National Standards Institute, 1996) from 250–8000 Hz. Group 2 was composed of 72 older listeners (mean = 66.4 years) with high-frequency sensorineural hearing loss. Inclusion criteria for Group 2 included the following: (1) a threshold at 500 Hz of ≤30 dB HL, (2) a threshold at 1000 Hz of ≤40 dB HL, (3) thresholds from 2000–8000 Hz ≥40 dB HL, (4) air-bone gaps of ≤10 dB, and (5) word recognition in quiet ≥40% correct on the NU No. 6 word lists (Department of Veterans Affairs, 1998). These audiometric criteria were required of the better ear to ensure audibility of the QuickSIN materials at the recommended presentation level (Etymotic Research, 2001) and to also control for borderline hearing impairment as well as conductive and retrocochlear impairments. The descriptive data for the test ear of Group 2 are listed in Table 1.

Materials

The commercial CD (compact disc) version of the QuickSIN was used (Etymotic Research, 2001). Each QuickSIN list consisted of six sentences recorded in four-talker babble. The multitalker babble, which is continuous throughout the list of six sentences, is incremented in 5 dB steps from 25 to 0 dB SNR. The sentences, which are spoken by a female, are 2.5 to 3.0 sec with a 5 to 6 sec interval between sentences. Each list of sentences is ~55 sec.

Procedures

In accordance with the QuickSIN instructions, each listener was given two practice lists (21 and 23) to acquaint them with the listening environment and with the listening task (Etymotic Research, 2001). The order of the two practice lists was alternated among the listeners. Then lists 1–18 of the QuickSIN were administered in a random order using 72 randomizations of the 18 lists. Total test time for each listener was <30 minutes.

The level of the sentences was fixed at 70 dB HL with the level of the babble incremented in 5 dB steps from 25 to 0 dB SNR. The QuickSIN materials were reproduced on a CD player (Sony, Model CDP-497) and routed through an audiometer

Table 1. The Descriptive Data for the 72 Listeners with High-Frequency Sensorineural Hearing Loss Including Age (years), Pure-Tone Thresholds (dB HL; American National Standards Institute, 1996), and Maximum Word Recognition (percent correct)

	Age	250	500	1000	2000	3000	4000	8000	WR
Mean	66.4	19.5	20.3	25.3	44.8	61.5	69.2	67.8	81.8
SD	9.8	8.6	8.1	11.3	17.2	15.0	14.0	17.7	17.0

(GSI-61) to a TDH-50 earphone encased in a Telephonics P/N 510C017-1 cushion. The nontest ear was covered with a dummy earphone. All testing was conducted in a double-wall sound booth and the verbal responses of the listeners were recorded into a spreadsheet.

Prior to the practice trials, each participant was given the instructions suggested in the QuickSIN manual (Etymotic Research, 2001, p. 6):

> Imagine that you are at a party. There will be a woman talking and several other talkers in the background. The woman's voice is easy to hear at first, because her voice is louder than the others. Repeat each sentence the woman says. The background talkers will gradually become louder, making it difficult to understand the woman's voice, but please guess and repeat as much of each sentence as possible.

RESULTS

To determine the homogeneity of the 18 QuickSIN lists on older listeners with sensorineural hearing loss, the data for each list were examined at each signal-to-noise ratio and at the 50% points calculated with the Spearman-Kärber equation (Finney, 1952). The recognition-performance psychometric functions for Lists 1–18 and the two practice lists (List 21 and 23) are shown in Figures 1 and 2 for the listeners with hearing loss. Each panel depicts the data from one list including the mean data points for each signal-to-noise ratio connected with dashed lines, the third-degree polynomial used to describe the data (solid line), the 50% point (dB SNR) in parenthesis, and for comparison the overall mean function for the 18 lists (dotted line).

First, consider the overall comparison of the data from the listeners with normal hearing and the listeners with hearing loss that are illustrated in the last three panels of Figure 2. The data in the lower right panel are the functions for Lists 1–18 obtained from the 72 listeners with hearing loss. The spread among the 18 functions indicates high variability in recognition performance among the lists. The lower left panel of Figure 2 illustrates the minimal differences among the 18 functions for listeners with normal hearing. The disparity at the 50% points between the two groups is 8.7 dB (last panel of Figure 2). Thus, for equal recognition performance, the listeners with hearing loss required an 8.7 dB more favorable signal-to-noise ratio, which as other investigators have noted is a substantial disadvantage in terms of signal-to-noise ratio (e.g., Carhart and Tillman, 1970; Plomp and Dusquesnoy, 1982). Interestingly, word materials in multitalker babble provide essentially the same average separation in recognition performances (~9 dB SNR) between the two listener groups (McArdle et al, 2005; Wilson et al, 2003). Thus, based on these studies it appears that sentence and word stimuli (i.e., QuickSIN materials and NU No. 6 word materials) used in similar speech-in-noise paradigms provide the same differentiation between recognition performances by listeners with normal hearing and listeners with hearing loss.

Because the recognition performance patterns of the 72 listeners on each of the 18 lists were similar, List 4 was selected randomly to illustrate the variability in performances by both groups of listeners on a single list. The individual 50% points for List 4 are depicted in Figure 3 for the 72 listeners with hearing loss (squares) and the 24 listeners with normal hearing (filled circles). The shaded region defines the 10th and 90th percentile intervals for the listeners with normal hearing. Only five of the listeners with hearing loss performed in the normal

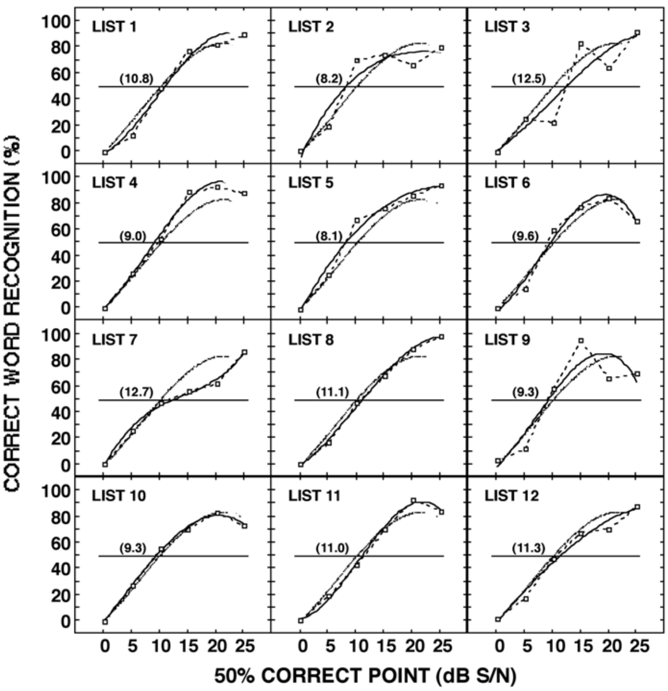

Figure 1. The psychometric functions for Lists 1–12 of the QuickSIN are shown. Each panel includes the mean data points connected with dashed lines, a third-degree polynomial used to describe the data (solid line), the overall mean of the 18 functions for the listeners with hearing loss (dotted line), and the calculated 50% point (dB SNR) in parenthesis.

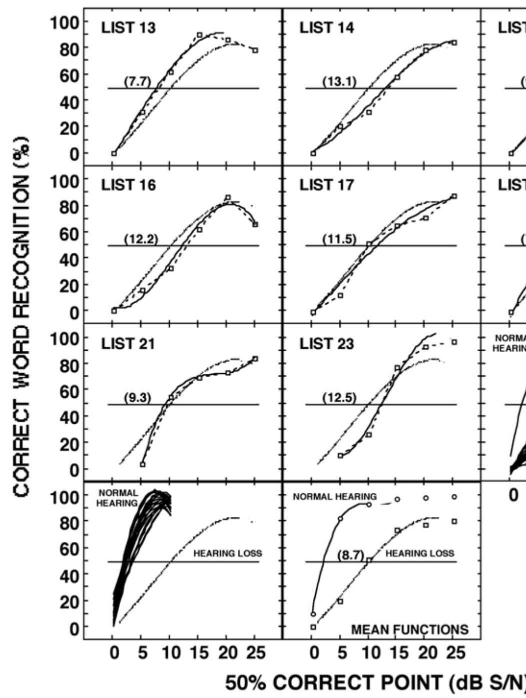

Figure 2. The psychometric functions for Lists 13–18 and the two practice lists (Lists 21 and 23) of the QuickSIN are shown. Each panel includes the mean data points connected with dashed lines, a third-degree polynomial used to describe the data (solid line), the overall mean of the 18 functions for the listeners with hearing loss (dotted line), and the calculated 50% point (dB SNR) in parenthesis. The final three panels contain the 18 functions for the listeners with hearing loss and for the listeners with normal hearing and the mean functions.

range, and the spread among the 50% points for listeners with hearing loss is remarkable, varying between 2.5 and 23.5 dB SNR.

The means (dB SNR) and standard deviations for the two practice lists (21 and 23) and the 18 test lists of the QuickSIN derived with the Spearman-Kärber equation are depicted in Figure 4 and listed in Table 2 and Table 3 for listeners with normal hearing (circles) and listeners with hearing loss (squares), respectively. The mean recognition performances on the 18 lists by the listeners with normal hearing ranged from 2.8 to 4.3 dB SNR, whereas the range was 10.0 to 14.3 dB SNR for the listeners with hearing loss. In addition to the mean data on recognition performance, the slopes (%/dB) of the psychometric functions shown in Figures 1 and 2 are listed in Tables 2 and 3 for the listeners with normal hearing and the listeners with hearing loss, respectively. The slopes of the mean functions for the two groups illustrated in the last panel of Figure 2 indicate that the slope of the function for the listeners with normal hearing is substantially steeper than the function for the listeners with hearing loss (12.6%/dB vs. 4.8%/dB). The slopes of the 18 functions for the listeners with normal hearing ranged from 10.0%/dB (Lists 9 and 11) to 14.9%/dB (Lists 2 and 7) with a mean of 12.7%/dB (SD = 1.7%/dB). The slopes of the functions for the listeners with hearing loss were different from the slopes of the functions with normal hearing ranging from 1.8%/dB (List 7) to 6.2%/dB (List 4) with a mean of 5.0%/dB (SD = 1.7%/dB).

As Wilson and Margolis (1983) described,

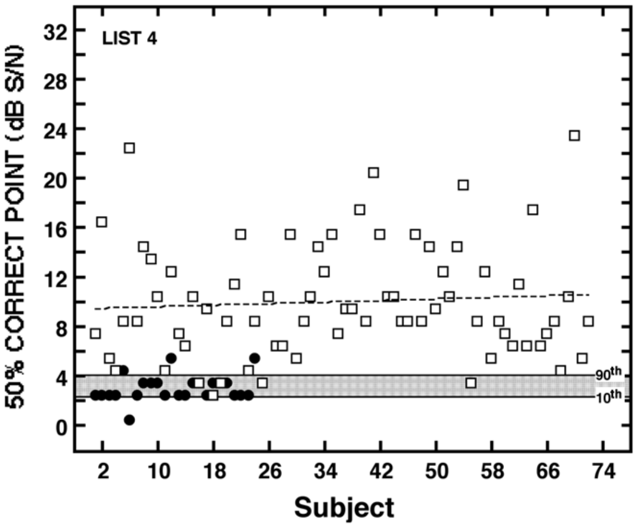

Figure 3. A plot of the 50% points calculated with the Spearman-Kärber equation on List 4 by the listeners with hearing loss (squares) and the listeners with normal hearing (filled circles). The shaded region defines the 10th and 90th percentiles for the listeners with normal hearing.

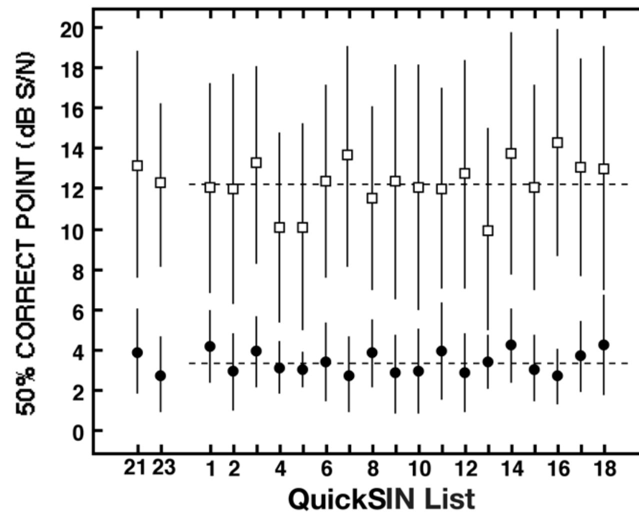

Figure 4. The mean 50% points for the listeners with hearing loss (squares) and the listeners with normal hearing (filled circles) calculated with the Spearman-Kärber equation for each of the 20 lists. The vertical lines represent ±1 standard deviation.

the slope of a mean function is more gradual than the mean slope of the individual functions. Because of the homogeneity of the functions for the individual lists from the listeners with normal hearing (Figure 2, lower left panel), the difference between the

Table 2. The Means (dB SNR) and Standard Deviations for the Two Practice Lists (21 and 23) and the 18 Test Lists of the QuickSIN from 24 Listeners with Normal Hearing Derived with the Spearman-Kärber Equation along with the 50% Points and Slopes (%/dB) at the 50% Points of the Mean Functions Shown in Figures 1 and 2

	Spearman-Kärber Equation		Psychometric Functions		
List	Mean	SD	Mean	Slope	% Regular
21	3.9	2.1	3.2	10.5	95.8
23	2.8	1.9	2.1	13.1	62.5
1	4.2	1.8	3.1	12.2	87.5
2	3.0	1.9	2.1	14.9	83.3
3	4.0	1.8	2.8	12.2	75.0
4	3.2	1.3	2.3	14.5	70.8
5	3.1	0.9	2.4	14.4	62.5
6	3.5	1.9	1.9	13.5	25.0
7	2.8	1.9	1.8	14.9	45.8
8	3.9	1.7	3.1	10.8	83.3
9	2.9	2.0	2.1	10.0	75.0
10	3.0	2.1	2.2	13.6	66.7
11	4.0	2.4	2.8	10.0	45.8
12	2.9	1.9	2.2	12.6	75.0
13	3.5	1.4	2.6	13.6	83.3
14	4.3	1.9	3.1	11.9	66.7
15	3.1	1.6	2.3	10.2	75.0
16	2.8	1.3	2.2	14.5	83.3
17	3.8	1.8	2.8	12.6	75.0
18	4.3	2.4	3.0	11.7	75.0
Mean Function			2.5	12.6	
Lists 1–18					
Mean	3.4		2.5	12.7	69.7
SD	0.5		0.4	1.7	16.2

Note: The "% regular" is the percent of the 24 individual functions for a list that were regular (see text).

Table 3. The Means (dB SNR) and Standard Deviations for the Two Practice Lists (21 and 23) and the 18 Test Lists of the QuickSIN from 72 Listeners with Hearing Loss Derived with the Spearman-Kärber Equation along with the 50% Points and Slopes (%/dB) at the 50% Points of Both the Mean (Figures 1 and 2) and the Individual Functions of Each Listener

	Spearman-Kärber Equation		Psychometric Functions				
			Mean Functions		Individual Functions		
List	Mean	SD	Mean	Slope	Mean	Slope	% Regular
21	13.2	5.6	9.3	7.0			54.2
23	12.3	4.1	12.5	7.8			72.2
1*	12.1	5.2	10.8	5.6	11.5	14.3	56.9
2*	12.0	5.7	8.2	4.5	8.8	13.4	34.7
3	13.3	4.9	12.5	4.2	11.1	16.0	30.6
4	10.1	4.6	9.0	6.2	8.5	11.0	59.7
5	10.1	5.1	8.1	5.1	8.5	14.1	51.4
6*	12.4	4.7	9.6	6.1	8.7	12.4	31.9
7	13.7	5.4	12.7	1.8	8.7	12.4	22.2
8*	11.6	4.5	11.1	5.2	10.9	11.3	72.2
9	12.4	5.8	9.3	5.9	8.7	17.1	34.7
10*	12.1	6.1	9.3	4.8	9.5	11.7	34.7
11*	12.0	4.9	11.0	6.0	10.1	12.0	48.6
12*	12.8	5.7	11.3	3.9	10.3	10.9	36.1
13	10.0	5.0	7.7	6.1	7.9	9.6	51.4
14	13.8	6.0	13.1	4.4	12.0	10.9	54.2
15*	12.1	5.0	9.6	5.1	9.2	10.0	36.1
16	14.3	5.6	12.2	5.9	11.5	12.1	30.6
17*	13.1	5.4	11.5	4.0	11.1	12.4	39.9
18	13.0	6.1	7.6	5.0	7.3	12.8	18.1
	Mean Function		10.2	4.8			
Lists 1–18							
Mean	12.3	5.3	10.3	5.0	9.7	12.5	41.3
SD	1.2	0.5	1.8	1.1	1.4	1.9	14.1
*Select 9 Lists							
Mean	12.2	5.3	10.3	5.0	10.0	12.0	43.4
SD	0.5	0.5	1.1	0.8	1.0	1.3	13.5

Note: The "% regular" is the percent of the 72 individual functions for a list that were regular (see text).

two slopes is minimal and is not presented. For the listeners with hearing loss, however, the difference is substantial with a 5.0%/dB slope of the mean function (Figure 2, last panel) and a mean slope of 12.5%/dB for the 18 individual functions. This difference reflects the lack of homogeneity in recognition performances across lists among the listeners with hearing loss. When viewed in this manner, the mean slopes of the individual functions for each list are steep with little disparity in slopes between the two groups of listeners. The mean 12.5%/dB slope of the 18 functions for the listeners with hearing loss is very close to the corresponding slope of the mean function for the listeners with normal hearing (~12.7%/dB). On an individual listener basis, then, the slopes of the functions obtained from a listener with normal hearing are about the same as the slopes of the functions obtained from a listener with hearing loss. If the measurements were made in smaller step sizes, then there might have been a larger disparity between the slopes of the functions for the two groups. The last column of Table 2 and Table 3 (% regular) are considered in detail in the discussion section of this paper.

To examine the recognition performances by the listeners with hearing loss in more detail, the data from which the 50% points for each list were derived (shown in Figure 4) were expanded to include the data at five of the six signal-to-noise ratios. The mean percent correct on each QuickSIN sentence at five of the signal-to-noise ratios (the 0 dB SNR had essentially 0% correct and is not plotted) is displayed in Figure 5. The mean recognition performances at the 5 dB SNR are around 20% correct, which is somewhat biased by a floor effect. For the remaining four signal-to-noise ratios, the performances vary widely from 22–73% (10 dB SNR) to 56–95% (15 dB SNR) to 62–93% (20 dB SNR) and to

59–98% (25 dB SNR). The variability of the sentences within each list appears random. The aforementioned overall variability for listeners with hearing loss was mirrored by the variability of the sentences at each signal-to-noise ratio.

Finally, the data displayed in Figure 6 show the deviation from mean performance by the listeners with hearing loss at the 50% point for each list (squares). The critical difference from mean performance calculated at the 95% confidence limits adjusted for multiple comparisons is ±1.92 dB SNR. The shaded area represents the range of scores within which performance on any one list is not significantly different from mean performance. As can be seen in Figure 6, Lists 4, 5, 13, and 16 fall outside of the critical difference area suggesting that performance on each of these lists was significantly different from the other 14 lists for listeners with hearing loss.

DISCUSSION

Few published studies have used the QuickSIN as an outcome measure (Bochner et al, 2003; Walden and Walden, 2004), and to date no other published study has examined the recognition performance of older listeners with hearing loss on individual lists. Walden and Walden utilized Lists 5 and 6 of the QuickSIN on a population similar to the current study, but the materials were presented in sound field, and recognition performance was averaged between lists, precluding comparison between studies. The mean 50% points for the current study, 13.3 dB SNR and 10.1 dB SNR for List 3 and 4, respectively, were identical to previous mean data on Lists 3 and 4 for listeners with hearing loss (McArdle et al, 2005). This replication of mean data suggests that recognition performances measured with Lists 3 and 4 of the QuickSIN are reliable across groups of listeners when using the same testing protocol. Additionally, only slight differences (< 1 dB) were observed for listeners with normal hearing on List 3 (4.0

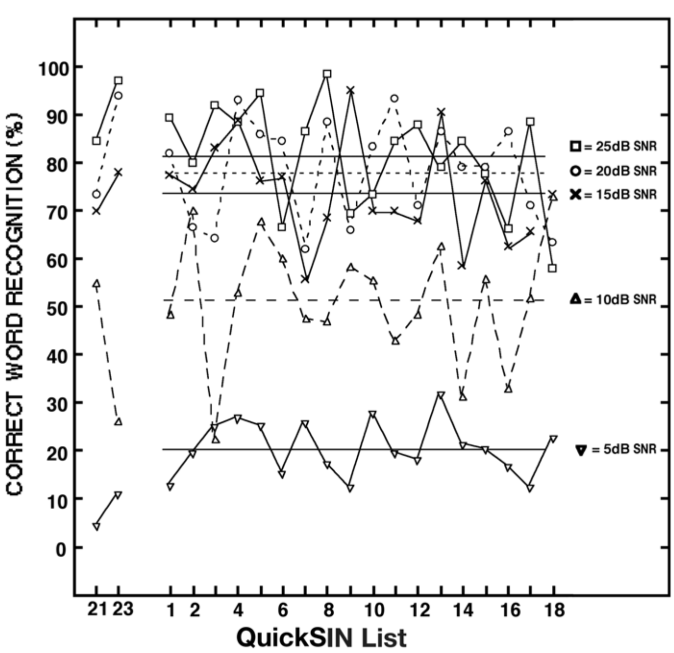

Figure 5. The percent correct recognition by the listeners with hearing loss on the sentences at each level for each sentence (inverted triangle: 5 dB SNR; triangles: 10 dB SNR; X's: 15 dB SNR; circles: 20 dB SNR; and squares: 25 dB SNR). The horizontal lines represent the mean for each level.

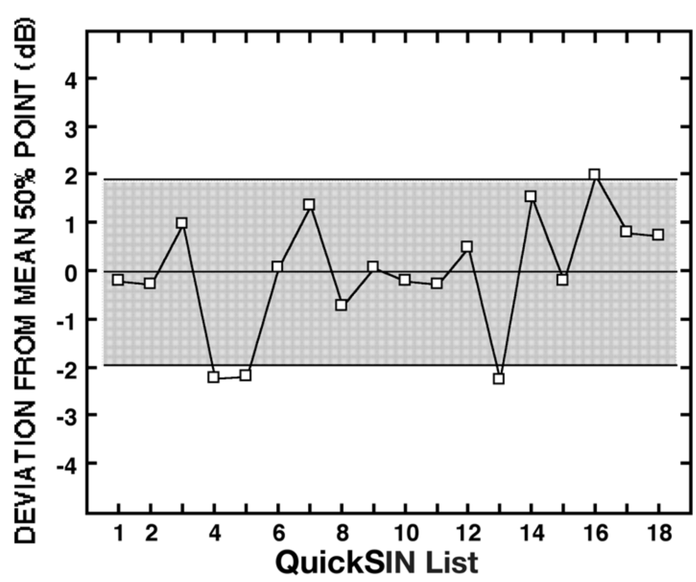

Figure 6. The 50% correct data for Lists 1–18 calculated with the Spearman-Kärber equation for the listeners with hearing loss are shown as the decibel deviation from the overall mean 50% point (12.3 dB SNR). The shaded region represents the critical difference (±1.92 dB) calculated at the 95% confidence limits adjusted for multiple comparisons.

vs. 4.3 dB SNR) and List 4 (3.2 vs. 3.9 dB SNR).

The goal of this study was to examine the homogeneity of the recognition performances for listeners with normal hearing and listeners with sensorineural hearing loss on the 18 QuickSIN lists. The data were presented in Figures 1 and 2 and Tables 2 and 3. For listeners with normal hearing, 50% correct points varied over a 1.5 dB SNR range from 2.8 dB SNR (List 7) to 4.3 dB SNR (Lists 14 and 18). For listeners with hearing loss, 50% correct points varied over a 4.3 dB SNR range from 10.0 dB SNR (List 13) to 14.3 dB SNR (List 16). Also, as exemplified by the psychometric function for List 3 (Figure 1), the functions for most of the lists were irregular. Ideally, the QuickSIN lists should be used individually with close to identical 50% points for each list. The underlying assumption that what is equivalent or homogeneous for listeners with normal hearing is not necessarily equivalent or homogeneous for listeners with hearing loss was confirmed and can be seen in the last three panels of Figure 2.

For the young listeners with normal hearing in the current study, the mean 50% point derived with the Spearman-Kärber equation for Lists 1–18 of the QuickSIN was 3.4 dB SNR. This value is slightly higher than the average threshold of 2 dB SNR previously reported by Killion et al (2004) for the QuickSIN materials. Some of the slight difference in recognition performance may reflect differences in monaural (current study) and binaural (Killion et al, 2004) presentation modes.

Hawkins and Stevens (1950) demonstrated that as the levels of the signal and masker are changed with respect to one another by a given amount, the behavior being measured reflects the same change that is, for the most part, linear. Thus, a 10 dB increase in the level of the masker produces a threshold that is 10 dB higher. From this principle, as the level of the QuickSIN babble increases, a corresponding decrease in recognition performance should follow. At each subsequent poorer signal-to-noise ratio, recognition performance should continually decrease. A *regular* function, then, is a function that has unchanged or decreased recognition performance at each adjacent signal-to-noise ratio decrement. When this systematic characteristic is not followed, the function is *irregular*. The data for the various QuickSIN lists in Figures 1 and 2 suggest that the majority of the mean functions from the listeners with hearing loss are irregular. Some of the irregularities in the mean functions are minor (e.g., Lists 2, 4, 10, 11, 13, and 16), whereas other irregularities are substantial (e.g., Lists 3, 9, and 18). The right columns in both Tables 2 and 3 list the percent of the listeners in each group that had regularly shaped functions for each of the 18 lists. For the listeners with normal hearing, about 70% of the functions were regular, whereas only about 41% of the functions for the listeners with hearing loss were regular. This is to alert the clinician that irregularly shaped functions are the rule, not the exception to the rule. The irregularities in the shapes of the functions are attributable to several factors including individual listener differences, limited number of samples at each level, and a lack of homogeneity among the sentences. These data demonstrate that signal-to-noise ratio is not the exclusive determinant of recognition performance. Given enough data as in the mean functions for all 18 lists in the last panel of Figure 2, the mean QuickSIN functions are regular for both listener groups.

Killion et al (2004) reported that the use of Lists 1–12 in isolation is accurate at an 80% confidence level to 2.2 dB SNR based on equivalency data obtained from a group of listeners with normal hearing who listened to filtered stimuli to simulate decreases in auditory sensitivity. In addition, the QuickSIN manual states that averaging the signal-to-noise ratio loss of multiple lists improve the reliability compared to single list administration (Thornton and Raffin, 1978). According to the data in Figure 6, care must be given to which lists provide the most homogenous results. For example, if an individual with hearing loss performed similar to the mean 50% points reported in this study, repeat administration of the QuickSIN using List 3 at an initial visit (10.1) followed by List 4 (13.3) at a follow-up visit would suggest a clinically significant drop in performance based on the 95% confidence interval of ±2.7 dB published in the QuickSIN manual (Etymotic Research, 2001). The present data suggest that list differences could provide spurious results unrelated to the ability of an individual to understand speech in noise.

To derive a group of QuickSIN lists that were homogeneous, the following procedures were used. First, the mean 50% points for each list obtained with the Spearman-Kärber equation from the 72 listeners with hearing loss were rank ordered. The standard deviations for sequential blocks of 12 lists each were examined to determine which groups of 12 lists had the smallest standard deviation. This procedure resulted in the elimination of the three lists with the lowest 50% points (Lists 4, 5, and 13) and the three lists with the highest 50% points (Lists 7, 14, and 16). The remaining 12 lists were examined with respect to the psychometric functions in Figures 1 and 2. The functions for Lists 3, 9, and 18 were irregular; thus, these three lists were excluded from the final selection. This left nine lists (1, 2, 6, 8, 10, 11, 12, 15, and 17) that were homogeneous with a mean of 12.2 dB SNR (SD = 0.5 dB). The data for these nine lists are presented in Figure 7 using the format previously used with Figure 6. As can be seen in Figure 7, the deviations from the mean for each of the nine lists are <1 dB and are well within the shaded area, suggesting that group mean performance on any one of the nine select lists should produce homogenous results.

In summary, the QuickSIN can be used as an instrument for providing patient-focused health care considering one of the most common complaints of older adults with hearing loss is difficulty understanding a conversation in a listening situation that contains background noise. Also, the information gained from administering the QuickSIN or any other speech-in-noise protocol can be useful for selecting amplification strategies (i.e., directional microphones or FM systems), and counseling on realistic expectations for hearing-aid performance. The data from the current study indicate that for purposes of homogeneity of test results the smaller subset of lists (1, 2, 6, 8, 10, 11, 12, 15, and 17) should be used.

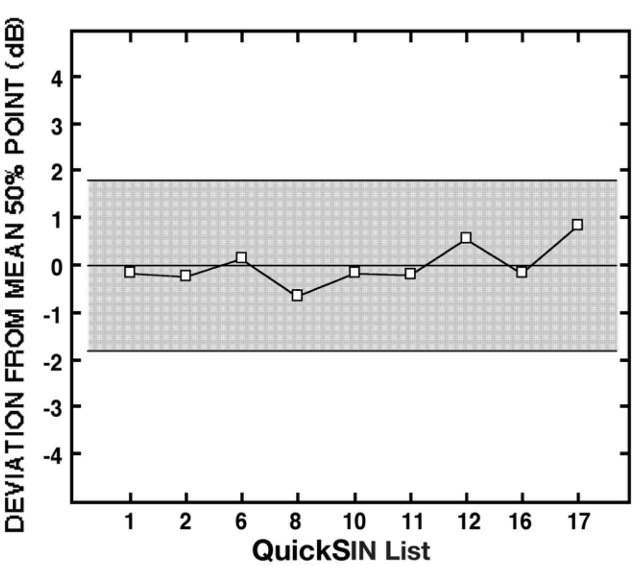

Figure 7. The 50% correct data for the select nine lists calculated with the Spearman-Kärber equation for the listeners with hearing loss are shown as the decibel deviation from the overall mean 50% point (12.2 dB SNR). The shaded region represents the critical difference (±1.8 dB) calculated at the 95% confidence limits adjusted for multiple comparisons.

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