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Instructions for Use – EN

QuickSIN

D-0141260-A – 2024/11

Interacoustics

Table of Contents

1. Quick Start

For full instructions, see Chapter 4.

Present the test with earphones or in a sound field, with the attenuator dial set to 70 dB HL. For subjects with PTA hearing losses greater than 45 dB HL, set the attenuator dial to a level that is “loud but OK.”

Instruct the patient to repeat the sentences spoken by the target (female) talker.

When testing in a sound field, have the patient hold the talkback microphone close enough so that responses are clearly audible to the tester.

Score the five key words underlined in each sentence, giving one point for each word repeated correctly.

Add the number of words repeated correctly, totalled across all 6 sentences.
Subtract the total correct from 25.5 to obtain SNR loss.

SNR Loss = 25.5 – Total Correct

To interpret the SNR loss score, see Table 1.

Table 1

SNR LOSS	DEGREE OF SNR LOSS	EXPECTED IMPROVEMENT WITH DIRECTIONAL MIC
0-3 dB	Normal/near normal	May hear better than normals hear in noise
3-7 dB	Mild SNR loss	May hear almost as well as normals hear in noise
7-15 dB	Moderate SNR loss	Directional microphones help. Consider array mic
>15 dB	Severe SNR loss	Maximum SNR improvement is needed. Consider FM system

2. Purpose of the QuickSIN

The primary complaint of hearing-impaired persons is difficulty hearing in background noise. The measurement of SNR loss (signal-to-noise ratio loss) is important because speech understanding in noise cannot be reliably predicted from the pure tone audiogram (Killion & Niquette, 2000).

The QuickSIN test was developed to:

- Provide a one-minute estimate of SNR loss
- Provide a quick way for clinicians to quantify a patient's ability to hear in noise
- Determine if extended high frequency emphasis improves or degrades understanding of speech in noise
- Assist professionals in choosing appropriate amplification and other assistive technologies
- Demonstrate that hearing aids with directional microphones improve speech intelligibility in noise
- Provide a large number of equivalent test lists for use in clinical and research work
- Provide information useful in counselling patients regarding realistic expectations

3. QuickSIN Methodology

A list of six sentences with five key words per sentence is presented in four-talker babble noise. The sentences are presented at pre-recorded signal-to-noise ratios which decrease in 5-dB steps from 25 (very easy) to 0 (extremely difficult). The SNRs used are: 25, 20, 15,10, 5 and 0, encompassing normal to severely impaired performance in noise.

The QuickSIN contains lists of sentences in noise (4-talker babble) that can be used to determine SNR Loss (signal-to-noise ratio loss). Each list takes about one minute to administer. There are eight blocks of recordings:

1. 12 standard equivalent lists - **for basic SNR Loss testing**
2. 3 pairs of standard lists - **additional list pairs for research**
3. 3 practice lists (not equivalent to lists 1-12) - **for practice only**
4. 12 lists with speech on channel 1 and constant-level babble on channel 2 (separated) - **to demonstrate directional microphone effectiveness**
5. 12 lists recorded with 30 dB high frequency emphasis (HFE) - **for use with ski-slope losses**
6. 2 pairs of HFE lists - **additional list pairs for research**
7. 12 lists recorded with 30 dB HFE and low pass filtering (HFE-LP) - **for use in combination with the HFE lists to determine whether hearing aids with extended HFE will help or degrade speech intelligibility in noise**
8. 2 pairs of HFE-LP filtered lists - **additional list pairs for research**

3.1 Lists

Lists A-C These lists are for practice only and are not equivalent to the standard lists or list pairs.

Lists 3-14 Standard QuickSIN lists. These twelve lists are equivalent.

Lists 15-20 List pairs. Lists 13/14, 15/16 and 17/18.

Lists 24- 35 Recorded with sentences on channel 1 and constant-level babble on channel 2. These lists can be used to demonstrate directional microphone performance.

Lists 36-47 30 dB high-frequency emphasis (HFE). The HFE is used to make speech sounds audible for persons with ski-slope loss.

Lists 48-51 Two list pairs with 30 dB HFE. List pairs 13/14 and 15/16.

Lists 52-63 Recorded with HFE plus 3-kHz low-pass brickwall filter; to be used in combination with the HFE lists to predict the outcome of fitting hearing aids with extended HFE.

Lists 64-67 Two list pairs with HFE-LP. List pairs 13/14 and 15/16.

4. Instructions for Use

The QuickSIN contains the identical recording on left and right channels in all lists, except for Lists 24-35, which have the target talker on the left and the 4-talker babble on the right.

4.1 Setup

The QuickSIN test may be presented via loudspeaker, insert earphones or TDH earphones. When presenting the QuickSIN test via loudspeaker, present it through one loudspeaker only, with the subject seated facing the loudspeaker (00 azimuth). When using insert earphones or TDH earphones, you may present the test either monaurally or binaurally. Most normative data were collected using binaural presentation.

4.2 Presentation Level

For pure tone average (PTA) <45 dB HL, set the attenuator dial to 70 dB HL. For PTA of 50 dB HL or greater, set the attenuator dial to a level that is judged to be “loud, but OK.” The sound should be perceived as loud, but not uncomfortably loud. (See Appendix A.) The practice lists can be used to determine the correct presentation level.

4.3 Test Instructions

“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.”
NOTE: When testing via loudspeaker, the talkback microphone should be held close to the patient’s mouth so that responses are clearly audible to the tester.

4.4 Pausing

Use the PAUSE button between sentences if the patient responds slowly.

5. Practice Lists

Practice Lists A-C. They can be used to familiarize the patient with the test protocol or to determine the "loud but OK" presentation level for persons with hearing loss of 50 dB HL and greater. These lists are NOT equivalent to lists 1-12 or list pairs, and do not reliably predict SNR Loss.

Practice List A		**Score**
1. The lake sparkled in the red hot sun.	S/N 25	______
2. Tend the sheep while the dog wanders.	S/N 20	______
3. Take two shares as a fair profit.	S/N 15	______
4. North winds bring colds and fevers.	S/N 10	______
5. A sash of gold silk will trim her dress.	S/N 5	______
6. Fake stones shine but cost little.	S/N 0	______
	TOTAL	______

Practice List B		**Score**
1. Wake and rise, and step into the green outdoors.	S/N 25	______
2. Next Sunday is the twelfth of the month.	S/N 20	______
3. Every word and phrase he speaks is true.	S/N 15	______
4. Help the weak to preserve their strength.	S/N 10	______
5. Get the trust fund to the bank early.	S/N 5	______
6. A six comes up more often than a ten.	S/N 0	______
	TOTAL	______

Practice List C		**Score**
1. One step more and the board will collapse.	S/N 25	______
2. Take the match and strike it against your shoe.	S/N 20	______
3. The baby puts his right foot in his mouth.	S/N 15	______
4. The pup jerked the leash as he saw a feline shape.	S/N 10	______
5. Leave now and you will arrive on time.	S/N 5	______
6. She saw a cat in the neighbour's house.	S/N 0	______
	TOTAL	______

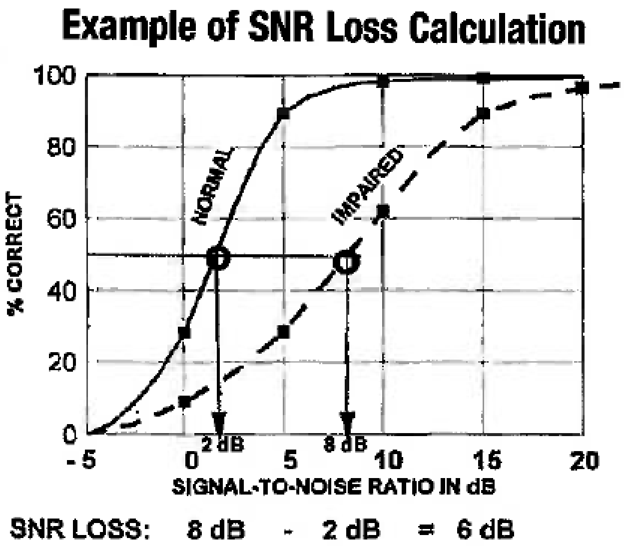
6. What is SNR Loss?

We are interested in the patient's performance in noise compared to normal-hearing persons' performance in noise. We consider this difference in performance the SNR Loss.

Similar to the definition of pure tone hearing loss, SNR Loss is defined as the dB increase in signal-to-noise ratio required by a hearing-impaired person to understand speech in noise, compared to someone with normal hearing. A normal-hearing person requires about +2 dB signal-to-noise ratio (speech louder than the background noise by 2 dB) to identify 50% of key words in sentences on the QuickSIN test. The value of SNR Loss is derived from the SNR-50 (signal-to-noise ratio for 50% correct) score. A hearing-impaired person who requires speech to be 8 dB higher than the noise to achieve a 50% correct score would have a 6 dB SNR Loss (see Figure 1).

Different tests will give different values of SNR-50 for the same patient. We have found that changing from a female to male talker and using easier sentences decreases the normal SNR-50 by 5 dB from +2 to –3 dB, even though the babble noise is identical in both tests. Similarly, when continuous speech-spectrum noise is used, the reported SNR will differ by about 7 dB between computed rms calibration and traditional frequent-peak VU-meter readings (Ludvigsen and Killion, 1997). We've chosen to report QuickSIN scores in SNR Loss because it is substantially independent of calibration and test material. Calibration and/or test material differences that affect the SNR-50 values equally for normal and hearing-impaired subjects will cancel out in the SNR Loss calculation.

Figure 1 (From Killion, 2002)



7. Scoring

Five key words are scored in each sentence. The key words are underlined on the score sheets. One point is given for each key word repeated correctly. The number of correct words for each sentence should be written in the space provided at the end of the sentence and the total correct calculated for the list. SNR Loss is calculated for each list by using the formula: SNR Loss = 25.5 – Total Correct.

Note: For greater accuracy, two or more lists should be averaged (see Chapter 11).

7.1 Where does the Number 25.5 come from

First we need to explain where the number 27.5 comes from. Following the Tillman- Olsen (1973) recommended method for obtaining spondee thresholds, we have a simple method for estimating SNR-50 using nothing more than the total number of words correct. In the Tillman-Olsen method, two spondees are presented at each level, starting at a level where all spondees are repeated correctly and decreasing in two dB steps until no responses are obtained for several words. The starting level plus 1 dB, minus the total number of spondees repeated correctly, is the spondee threshold. The simple arithmetic comes from the use of 2 dB steps and 2 words per step. If the audiometer only has 5 dB steps, the corresponding method would use 5 words per step and take the starting level plus 2.5 dB (half of the step size, just as in the case of 2 dB steps), minus the total number of spondees repeated correctly.

The QuickSIN has five words per step and 5 dB per step. Our highest SNR is 25 dB so we take 25 + 2.5 = 27.5 minus the total number of words repeated correctly. This gives what we call SNR-50, the signal-to-noise ratio required for the patient to repeat 50% of the words correctly. For example, if someone repeats all the words correctly down to 15 dB SNR and then misses everything beyond that point, they gave 15 correct responses (five each at 25, 20, and 15 dB SNR). Since they scored 100% correct at 15 dB SNR and 0% correct at 10 dB SNR, their SNR-50 would be about 12.5 dB, halfway between 15 and 10. This is the value given by the formula 27.5-15 = 12.5 dB.

7.2 The Formula for SNR Loss

Since SNR-50 for normal-hearing persons is 2 dB, we subtract 2 dB to derive the formula for a patient's SNR LOSS: 25.5 – (Total words correct in 6 sentences)

SNR loss = SNR-50 – 2 dB
= 27.5 – (total words correct) – 2 dB
= 25.5 – (total words correct)

7.3 Guilt-free QuickSIN Test: For Ski-Slope Loss

High-Frequency Lists & Low-Pass-Filtered Lists

Figure 2 shows the high-frequency emphasis added to the QuickSIN lists to obtain the recordings labeled HFE. This frequency response was obtained from FIG 6 (1997) for 65 dB (normal speech) inputs for a patient with 60-70 dB ski-slope loss.

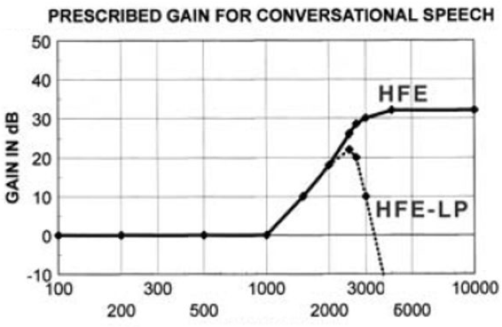


Figure 2

Data on ski-slope hearing loss from Skinner (1980), Rankovic (1991), and Turner and Cummings (1999) indicate that some patients do worse with the extended high frequency emphasis prescribed by popular formulae than if the emphasis is restricted to regions of better hearing. Other patients with similar audiograms seem to benefit from the extended high-frequency amplification.

A new set of recordings labeled HFE-LP were generated by low-pass filtering the HFE recordings with a brickwall filter set at 2.5 kHz. The resulting frequency response is also shown in Figure 2.

By comparing the SNR results obtained with the HFE and HFE-LP lists, it is possible to determine whether or not extended high-frequency amplification is useful. For a test accurate to 1.9 dB (95% confidence interval for the difference between the two conditions), four HFE and four HFE-LP lists are required, a total of 8 independent lists used alternately.

Example: List 1 with HFE list 2 with HFE-LP
List 3 with HFE list 4 with HFE-LP
List 5 with HFE list 6 with HFE-LP
List 7 with HFElist 8 with HFE-LP

Note: The same list is never used twice in this example.

8. Separated Speech & Noise Channels

Lists 24-35 contain the 12 standard QuickSIN lists recorded with the speech and noise on two separate channels (target speech on channel one and 4-talker babble on channel two). The purpose of these lists is to provide a quick way to verify the effectiveness of hearing aids that have switchable directional microphones. In these lists, both speech and babble were recorded at constant levels; therefore, the tester must establish and control the signal-to-noise ratios by selecting the presentation levels for both speech and babble channels, and manually change the level of the babble channel for each sentence to adjust the signal-to-noise ratio.

9. Directional Comparisons

A complete measurement of a directional hearing aid requires extensive laboratory facilities, but a good demonstration of the ability of directional hearing aids to reject sound from the sides and rear can be obtained in a standard test booth with loudspeakers located in the corners (at +45º and -45º or 0º and 180º azimuth).

It is important to remember that any test conducted in a sound booth will not precisely reflect results in the real world. By design, sound booths have minimal reverberation, and testing is conducting using a limited number of loudspeakers (usually two) that are in fixed locations. In this setup, it is possible that the location of the speakers may interact with the null of the directional microphone(s). Therefore, these measures should not be used to assess effectiveness of one directional microphone design vs. another (where differences are usually small) but rather as a general measure comparing OMNI to Directional, to verify that the directional microphones are working and providing directivity (rejection of sound from the sides and rear).

Procedure:
If the loudspeakers are located at +45º and -45º, test each ear separately. Position the patient in the sound booth so that speech is presented from in front at 45º and babble from behind at approximately 135º. Direct the speech (channel one) to the loudspeaker at 45º and direct the babble (channel two) to the loudspeaker at 135º.

Note: There are two possible “45 degree” orientations for the patient. The desired orientation places the aided ear between the loudspeakers. See Figure 3. When the other ear is tested, the patient will need to be rotated to face the opposite wall and the speech and babble switched to the opposite speakers.

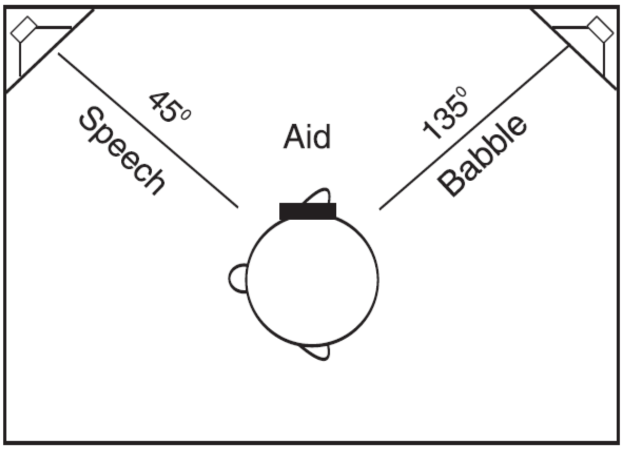


Figure 3

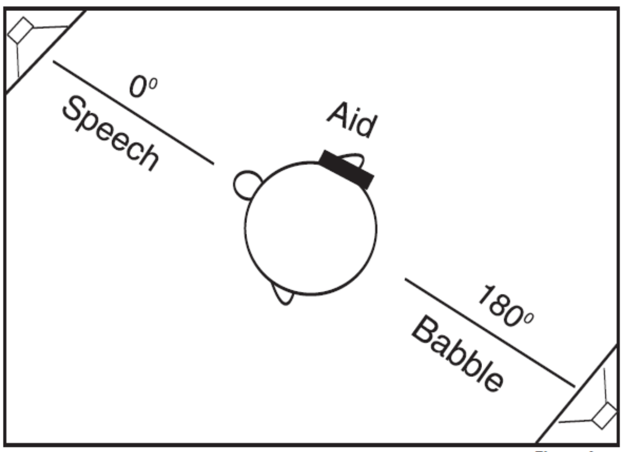


Figure 4

If the loudspeakers are located at 0º and 180º, you may test each ear separately or both ears together. Position the patient in the sound booth so that speech is presented from in front at 0º and babble from behind at 180º. See Figure 4.

Since the babble noise in lists 24-35 is at a constant level, two types of demonstrations are possible:

1. Subjective. Calibrate both channels. Have the patient set the hearing aid/s to OMNI. Adjust the speech to 50 dB HL (65 dB SPL conversational speech level) and then adjust the noise to the level where the patient reports that it just prevents understanding the speech. Have the patient switch back and forth between OMNI and Directional positions on the hearing aid/s. The improved intelligibility in the directional mode should be obvious.

2. Objective. Calibrate both channels. Set the dial for channel one (front speaker) to 50 dB HL. Set the dial for channel two to 25 dB HL for the first sentence, and increase the dial setting for channel two (babble) by 5 dB for each succeeding sentence (see Table 2). Score each list as before to obtain SNR Loss. Test in OMNI and Directional. A minimum of three lists in each condition (six total) is required for a valid comparison to an accuracy of 1.5 dB at the 80% confidence level (see page 20). If you find a difference greater than 4 dB with one list in each condition, you have already reached the 95% confidence level.

Table 2

	Channel 1 Dial (dB HL)	Channel 2 Dial (dB HL)	SNR (dB)
Sentence 1	50	25	25
Sentence 2	50	30	20
Sentence 3	50	35	15
Sentence 4	50	40	10
Sentence 5	50	45	5
Sentence 6	50	50	0

10. Test Development

10.1 The Original SIN Test

The original Etymotic Research Speech-In-Noise (SIN) Test was designed to assess word recognition performance in noise, with and without hearing aids. Test results are reported as signal-to-noise ratio (SNR) for 50% correct. This is consistent with normal audiometric practice, where threshold is defined as the level at which the patient responds 50% of the time. The recommended presentation levels for the SIN Test (70 dB HL and 40 dB HL) were selected to represent the range of typically loud and quiet speech levels encountered by most people in everyday life.

10.2 SIN Test Format

Sentence materials were used in the SIN Test because sentences spoken with natural dynamics have greater dynamic range than monosyllabic words, and are thus a more valid representation of real speech (Villchur, 1982). In the real world, the speech dynamic range is increased by the stress given to some words and syllables vs. the drop in level given to others. The effects of co-articulation are not well represented on monosyllabic word lists. Monosyllabic words, recorded and played back at specific intensity levels, are not representative of speech in the real world.

One drawback of using sentence materials, however, is that tests which use sentence formats sometimes present an entire sentence to obtain one scorable item (i.e. one word or the entire sentence is scored as correct or incorrect). The result is that significantly greater test time is needed for a given reliability compared to word scoring. The SIN and QuickSIN tests are “words in sentences” tasks, in which 5 words are scored in each sentence, providing a larger amount of scorable material in a given amount of time. The sentence materials used in the SIN and QuickSIN tests (IEEE sentences) use words that are typically not highly predictable from the surrounding context, resulting in a performance-intensity function that is not unlike that obtained with NU-6 monosyllables (Rabinowitz et. al., 1992). Indeed, an analysis of the relative independence of these words indicated that 25 words in five sentences, using half-word scoring, give the equivalent of 27 independent words with whole-word scoring.

10.3 Origin of SIN Test Sentence Materials

The IEEE (Institute of Electrical and Electronics Engineers) sentences were derived from the Harvard Phonetically Balanced Sentences, developed at Harvard University during World War II (Braida, 2000). The IEEE formed a subcommittee that was charged with developing practice guidelines for speech quality measurements to help communication engineers assess speech transmission systems. The 720 IEEE sentences (72 lists of 10 sentences each, with five key words in each sentence) were published as Appendix C in the 1969 document, “IEEE Recommended Practice for Speech Quality Measurements.” According to Silbiger (2000), the sentences used in the IEEE document were originally published in 1944 (Egan, 1944). The IEEE sentences were designed to have few contextual cues to aid in understanding, i.e. if a listener hears the first part of the sentence, s/he cannot likely “fill in” the remainder based on contextual cues and knowledge of the language.

As part of her doctoral dissertation, Fikret-Pasa (1993) obtained recordings of the IEEE sentences (female talker) from the Massachusetts Institute of Technology on DAT, and equalized them to correct for the high-frequency attenuation caused by the chest position of the recording microphone used at MIT. This recording was used in generating sentences for both the SIN and the QuickSIN tests.

10.4 Problems with the SIN Test

Many practitioners reported that administration of the SIN Test was too time- consuming for clinical use, and scoring the test was difficult and cumbersome. After several in-depth analyses of the SIN Test, it was discovered that several of the lists were not equivalent, resulting in too few lists available for some clinical comparisons and research purposes (Bentler 2000). Some subjects could not attain a 50% correct score, even at the best (+15 dB) signal-to-noise ratio.

10.5 Background Noise

The choice of background noise is an important component of any test. The purpose of the SIN test was to obtain an estimate of difficulty hearing in noise that is representative of real-world performance. Sperry, Wiley & Chial (1997) found that a meaningful speech competitor had a significantly more adverse effect on

word recognition performance compared to non-meaningful competitors (e.g. shaped noise or backward multitalker). While the spectrum and masking effects of speech-shaped noise are much easier to control, speech-shaped noise is not representative of the type of noise encountered by normal-hearing persons in their everyday environments.
The SIN and QuickSIN tests use a four-talker babble recording (Auditec of St. Louis) with one male and three females. The four-talker babble represents a realistic simulation of a social gathering, in which the listener may “tune out” the target talker and “tune in” one or more of the background talkers. It provides a good representation of the difficulty that patients face—the situation in which what they want to hear is speech, and what they don’t want to hear is also speech. During the QuickSIN test development, research subjects frequently commented, “This is what it sounds like to me; this is what it sounds like to have a hearing loss and try to listen in a noisy place!”

10.6 QuickSIN Search for Sentence Equivalence

10.6.1 Alpha Versions

The original SIN Test used the first 360 sentences (lists 1-36) of the 720 IEEE sentences. The QuickSIN sentences were selected from among the remaining 360 sentences (lists 37-72) and were re-recorded, along with the four-talker babble, in separate lists of an eight-track digital recorder. Thus, all subsequent re-recordings of a given sentence had the same time-locked sequence of babble. This was important because the conversational ebb and flow of the natural conversational speech produced by the four babble talkers meant that the overall noise level varied from moment to moment. Moreover, not all of the IEEE sentences are equivalent in terms of difficulty.

In order to determine the SNR-50 of each sentence in its accompanying babble segment, IEEE sentence lists 37-72 were recorded on the “Alpha-1 version” set at nominal signal-to-noise-ratios of -1, +2, and +5 dB. The sentences were presented to sixteen normal-hearing subjects at 70 dB HL via ER-3A insert earphones. The three signal-to-noise ratios (-1, +2, and +5 dB) were presented in that order. An across-subject average SNR-50 was obtained for each sentence. This value was used to adjust the SNR on a sentence-by-sentence basis to an expected value of 2 dB, the grand average value. The resulting set of recordings became the Alpha-2 set.

At this point, the sentences were subjected to a taste test committee that required the sentences to be grammatically acceptable and contemporary (as opposed to the 1940s when the IEEE sentences were created). Sentences surviving the taste test were subjected to the following statistical criteria for SNR equivalence:

1. The standard deviation of the SNR-50 values across six normal-hearing adult subjects was less than 1.5 dB on the Alpha-2 recordings;

2. The mean SNR-50 value on six normal-hearing adult subjects was within

1.5 dB of their grand average on the Alpha-2 recordings;

3. The mean SNR-50 value on eight high-frequency-loss adult subjects was within 2 dB of their grand average on the Alpha-2 recordings;

4. The range of individual-word SNR-50 values within a given sentence exceeded 2 dB (data from six randomly-selected subjects from the 16 normal-hearing adult subject pool on the Alpha-1 recordings).

10.6.2 Beta Version

Starting with the original 360 sentences, the procedure just described eliminated all but 89 sentences, giving enough sentences for 14 lists of six sentences, one each at 25, 20, 15, 10, 5, and 0 dB SNR. Lists 1-14 on the Beta version used these 14 lists. Since we wanted at least 20 lists, we obtained another seven lists by opening up the standard deviation in #2 from 1.5 to 2.0 dB. Lists 15-21 on the Beta version of the QuickSIN test used the more lax criteria.

Beta Site Protocol
Recordings of the beta version QuickSIN lists (21 lists of six sentences each) were sent to approximately two dozen sites. The test protocol controlled for order and learning effects. Test/retest data were required for all 21 lists for both normal and hearing-impaired subjects.

Normal Subjects
Beta version QuickSIN tests were analyzed for 26 normal-hearing listeners (14 subjects from eleven sites, and 12 subjects from a University of Iowa clinic) and 18 hearing-impaired subjects from ten sites. Some data were excluded from analysis if the test protocol was not followed correctly. Analysis of list presentation order indicated that adequate counter-balancing for list order was achieved. The across-subject average across lists for normal-hearing subjects was SNR-50 = 1.9 dB, nearly identical to the original SIN Test average of 2 dB.

Hearing-Impaired (Simulated)
Normal-subject results alone are not adequate to determine list equivalence, since performance for normal-hearing listeners is typically determined primarily by the sentences recorded at 0 and 5 dB SNR. In order to check list equivalence for higher SNR levels, we simulated varying degrees of high-frequency hearing loss using filtering.

The 21 Beta-test lists were re-recorded using low-pass brickwall filter settings of 750 Hz, 850 Hz, 1100 Hz, 1400 Hz, and 2000 Hz. Each recording was presented to 25 normal-hearing subjects. Subjects were tested in three sessions over several days, and list number presentation order was varied to counterbalance for potential order effects. The most difficult condition (750 Hz low pass) was presented first, followed in order by the less difficult conditions. Testing was completed over several days, thus “learning effects” were not expected despite repeated presentations of the same lists.

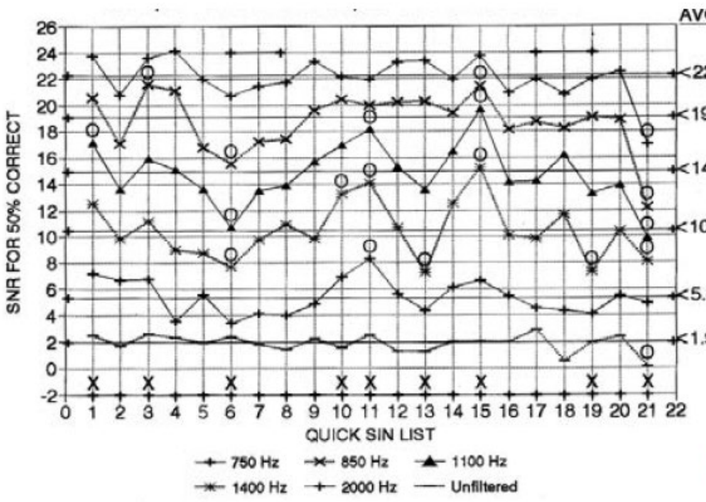


Figure 5

Figure 5 shows a plot of across-subject QuickSIN Beta averages for 25 normal-hearing adult subjects at each filtering condition. The twelve lists without an X exhibited SNR-50 values at each filtering condition that fell within ± 2.2 dB of the grand average. In addition, three pairs of lists were found whose pair average met those criteria. (Typically one list score would be high and the other would be low under similar conditions.) By adding those paired lists, a total of 15 equivalent lists became available (12 lists plus 3 list pairs).

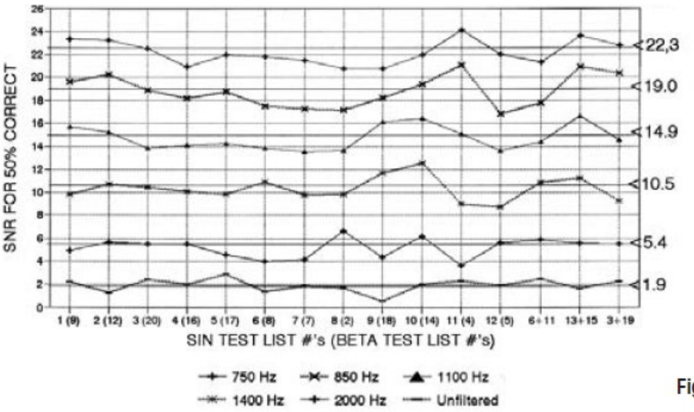


Figure 6

Figure 6 shows a plot of the across- subject average data (renumbered lists) for the lists included on the final QuickSIN recording.

11. Reliability (Statistics Made Useful)

A QuickSIN score obtained in one minute from a single list is accurate to about 1.8 dB at the 80% confidence level. By “about” we mean that 80% of the time (four times out of five) the “true” score (obtained from many lists) will be within 1.8 dB of the single-list test score. Statisticians would say we have “an 80% confidence level” that the true QuickSIN score will be within + 1.8 dB of the measured score. To put these numbers in perspective, a typical clinical threshold is accurate to about 5 dB at the 80% confidence level. In other words, one time out of five a threshold can be expected to be 5 dB or more above or below the recorded value. An 80% confidence level is normally adequate for clinical testing, where the results of any one test are used in context with other factors. In the case of a test of SNR Loss, for example, the clinician will already have formed an idea of the patient’s communication difficulty from conversations with the patient. A 95% confidence level is common for research reporting, where a reduced risk of error is normally required. Using a statistical criterion that gives a 95% confidence level reduces the probability of error to one time in twenty.

Table 3 below shows the number of lists required for a given accuracy for confidence levels of 80%, 90% and 95%.

Table 3

Number of Lists	1	2	3	4	5	6	7	8	9
95% C.I. ±, in dB	2.7	1.9	1.6	1.4	1.2	1.1	1.0	1.0	0.9
90% C.I. ±, in dB	2.2	1.6	1.3	1.1	1.0	0.9	0.8	0.8	0.7
80% C.I. ±, in dB	1.8	1.3	1.0	0.9	0.8	0.7	0.7	0.6	0.6

The numbers in Table 3 are based on the rms average standard deviation of 1.4 dB in SNR found for the hearing-impaired subjects included in the Beta-site testing. This figure comes from two numbers: a) the 1.3 standard deviation derived from the combined individual test-retest scores, and b) the across-list standard deviation of 0.6 dB. If only normal-hearing subjects are used, the appropriate standard deviation drops from 1.4 dB to 1.25 dB. A standard deviation of 1.4 dB is slightly better than the standard deviation which would have been expected based on the original SIN Test. That standard deviation of 0.7 dB, multiplied by the square root of five, would predict a standard deviation of 1.6 dB for the QuickSIN test which uses only one sentence at each level compared to five sentences at each level on the SIN Test. The more careful preselection of sentences used in the QuickSIN test may have contributed to the slightly better result.

Comparison Between Two Conditions
Averaging the results of several QuickSIN lists improves the reliability compared to a single list. This is particularly important when QuickSIN lists are used to compare two conditions, often two hearing aids or hearing aid adjustments. In this case, the real differences may not be large.

Table 4 below gives the number of lists required for the comparison between two conditions at an 80%, 90% or 95% confidence level. For a critical difference of 1.9 dB, for example, four lists are required for each condition at the 95% level. For a critical difference of 1.4 dB at the 95% confidence level, eight lists are required for each condition. For a simple example, one list in each condition with the assumed standard deviation of 1.4 dB gives a 95% confidence level of 1.96 x 1.41 x 1.4 = 3.9 dB.
To improve from 80% to 95% confidence level at a given criterion requires an approximate doubling of test time. Example: Two lists in each condition gives a 1.8 dB critical difference at the 80% confidence level; four lists in each condition provide 1.9 dB at the 95% confidence level, and five lists in each condition provide 1.7 dB at the 95% confidence level.

Table 4

Lists per Condition	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
95% C.D. ±, in dB	3.9	2.7	2.2	1.9	1.7	1.6	1.5	1.4	1.3
90% C.D. ±, in dB	3.2	2.2	1.8	1.6	1.4	1.3	1.2	1.1	1.1
80% C.D. ±, in dB	2.5	1.8	1.5	1.3	1.1	1.0	1.0	0.9	0.8

When comparing HFE and HFE-LP conditions for a patient with ski-slope loss, one might well accept an 80% confidence level (one in five chance of being wrong), and consider anything less than 1.5 dB as not practically significant. In this case, Table 4 indicates that three lists in each condition would suffice. This will typically take six minutes, which is relatively small compared to the time often taken fighting feedback. (A relaxed criterion of 1.8 dB would require only two lists in each condition, or four minutes of testing). If the test results indicate that high-frequency emphasis which ends at about 2.5 kHz gives as good or better scores, the clinician can abandon the feedback fight without guilt.

12. Appendix A

CATEGORIES OF LOUDNESS

7. Uncomfortably Loud
6. Loud, But OK
5. Comfortable, But Slightly Loud
4. Comfortable
3. Comfortable, But Slightly Soft
2. Soft
1. Very Soft

Valente and Van Vliet (1997)

13. Appendix B

TECHNICAL NOTE: CROSSTALK

In Lists 24-35, the target speech and the babble are recorded on separate channels, but a small amount of interchannel crosstalk (-65 dB) exists on the QuickSIN recording. Under normal conditions none of these levels will be audible, but during silent periods on the sentence channel, a faint babble can sometimes be heard in the background. None of these crosstalk levels will affect normal usage of these lists.

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