Original Article

Comparison between Quick Speech in Noise Test (QuickSIN test) and Hearing in Noise Test (HINT) in Adults with Sensorineural Hearing Loss

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ABSTRACT

Objectives: The purpose of this study was to compare between the two newly developed Arabic speech in noise tests (QuickSIN and HINT) to study the clinical utility of both tests in adults with sensorineural hearing loss.

Patients and Methods: Seventy five subjects, aged 18-50 years, were divided into two groups: Control group consisted of 25 normal hearing subjects and study group consisted of 50 subjects, who were further divided into three subgroups. Subgroup (IIa): 20 subjects with moderate and moderately severe sensorineural hearing loss. Subgroup (IIb): 20 subjects with moderate and moderately severe sensorineural hearing loss who were HAs users. Subgroup (IIc): 10 subjects with unilateral Cochlear implantation (CI). Materials: Arabic QuickSIN, Arabic HINT and Arabic Abbreviated Profile of Hearing Aid Benefit (APHAB) questionnaire.

Results: The QuickSIN test had some advantages over HINT in terms of clinical use. The QuickSIN test showed better separation in recognition performances between normal hearing and hearing loss than HINT. The sensitivity for QuickSIN was higher than HINT in all subgroups. Correlation for the QuickSIN test with APHAP background noise (BN) subscale was higher than the correlation for the HINT in HL and HA subgroups. However, both tests were not correlated with APHAB (BN) subscale in CI group.

Conclusion: Both tests explain the listener’s experience of hearing in background noise. However, QuickSIN test is a more sensitive measure of speech perception in noise than HINT does in both unaided and aided conditions. CI subjects had the lowest performance for both tests.

Key Words: Arabic abbreviated profile of hearing aid benefit, hearing in noise test, quick speech in noise test.

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INTRODUCTION

The background noises that are present in everyday life can sometimes make listening difficult, especially when trying to understand speech. In this respect, Speech-in-Noise tests are designed to mimic real-life circumstances[1]. As a person with sensorineural hearing loss may be unable to understand speech, especially in noisy situations, Speech-in-Noise tests can provide valuable information about a person’s hearing ability[2].

There are many Speech-in-Noise (SiN) tests that can be used clinically. SiN tests are used either at a fixed S/N ratio or at adaptive S/N ratio. Fixed S/N ratio tests measure a percent correct at a fixed S/N ratio that are established by the clinician prior to the test and remain unchanged throughout. Two readily available fixed S/N ratio tests are the Connected Speech Test (CST) and Speech Perception in Noise test (SPIN). Adaptive S/N ratio tests measure the Speech to-Noise Ratio (SNR) as the intensity level, of either the speech or the noise, is varied e.g the Quick Speech In Noise (QuickSIN) test, Bamford-Kowal-Bench SIN Test (BKB-SIN), Words-in-Noise test (WIN) and Hearing In Noise Test (HINT)[3].

The QuickSIN test was developed by Etymotic Research and became commercially available in 2001. It was designed to provide a quick method of expressing a listener's ability to understand speech in noise as SNR loss rather than as a percent correct score[4]. The QuickSIN test is one of the most sensitive tests for measuring speech recognition performance in background noise[5]. It has a short test duration and quantifies the real-world SNR loss. The SNR loss score in QuickSIN test represents the SNR which a listener with hearing loss requires above the SNR which a normally hearing listener requires to achieve 50% correct sentence identification; this is called the SNR-50[6, 7].

The HINT first became commercially available on CD in the early 1990s and in a hardware and software system (HINT for Windows) some years later. Both were

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developed by Maico Diagnostics[8] and Nilsson *et al*[9]. As with QuickSIN, the HINT measured a SNR score. The adaptive procedure of the HINT is used to obtain a Reception Threshold for Sentences (RTS). The RTS is the level of the sentences at which the listener can correctly repeat 50% of the sentences. The resulting score is the SNR needed to reach 50% correct performance[9].

Both QuickSIN and HINT tests require listeners to repeat five or more words per sentence, rather than only the last word, as is required in the Speech Perception in Noise Test (SPIN)[10]. This allows five or more opportunities to respond per sentence which leads to decreased test length compared to tests using only one word per sentence[6]. Also, it has been suggested that sentence-length speech in noise tests that results in SNR score (such as QuickSIN test and HINT) overcome limitations associated with word – length tests that use the traditional percent correct score. Percent correct tests do not indicate SNR needs a phenomenon that cannot be predicted reliably from audiogram[4].

For some professionals, SiN tests is a routine practice, and for others it may be an unknown or untried aspect of audiology practice. Although SiN test materials have been available for several decades, many clinicians do not routinely use them due to concerns about choosing an appropriate test, test duration and the understanding of testing and scoring procedures. Moreover, in Arab countries this was limited even more as the Arabic test materials were not developed until recently.

Arabic QuickSIN test was developed and standardized in 2017 by Elrifaey *et al*.[11] while Arabic HINT was developed and standardized in 2019 by Essawy *et al*.[12]. The test materials now available can assist clinicians in undertaking assessments of speech understanding in noise to enhance auditory rehabilitation planning in addition to providing diagnostic information. Therefore, these tests help in counseling and to make a better hearing aid selection decision with better prediction of the improvement that various amplification devices will make[13].

The goal of this work was to study the average performance of the Arabic QuickSIN test and Arabic HINT in patients with sensorineural hearing loss and to compare between both tests according to several factors to be considered when choosing a speech in noise test in clinic. In addition, the correlation of these objective tests with patients' subjective perceptions of that complaint was examined using the Abbreviated Profile of Hearing Aid Benefit (APHAB) questionnaire.

PATIENTS AND METHODS:

This work was done at Audiology Unit, Tanta University "during the period" from November 2017 to November 2018. The ethical approval code is No. 31943/11/17. This study included 75 subjects aged 18-50 years who were divided into two groups: Control group of 25 subjects with bilateral normal peripheral hearing with hearing threshold not exceeding 25 dB HL at 250-8000Hz and study group of 50 subjects with moderate to moderately severe sensorineural hearing loss. This group was further subdivided into: Subgroup (IIa) hearing loss (HL) group (not wearing HA) included 20 subjects, subgroup (IIb) hearing aid group included 20 subjects and subgroup (IIc) included 10 subjects with postlingual unilateral Cochlear Implantation.

Materials:

(1) Recorded Arabic version of QuickSIN sentences[11], (2) Recorded Arabic version of HINT sentences[12] and (3) The abbreviated profile of hearing aid benefit (APHAB)[14] translated into Arabic[15].

Methods

Equipment

The pure tone audiometer used was Madsen Astera (GN Otometrics, Madsen, Aurical, ICS) with headphones of TDH39 type and loudspeakers of Mixmax type and an immittancemetry using Interacoustics AT235h.

Procedure

All participants were subjected to:

(1) Full audiological history, otological examination and basic audiological evaluation, including pure tone audiometry, speech audiometry and immittancemetry.

(2) APHAB Questionnaire: traditional paper-and-pencil questionnaire was given to all subjects. It consists of 24 items that assess four typical hearing situations (subscales) which are Ease of Communication (EC), Reverberation (RV), and Background Noise (BN) and aversiveness of Sounds (AV). Patient answers 24 questions from each of the four domains for how they hear without their hearings aids (in subgroup IIa) and how they hear with their hearing aids (in subgroups IIb and IIc). This questionnaire is provided with a seven-point response scale as follows: always (99%), almost always (87%), generally (75%), half-the-time (50 %), occasionally (25%), seldom (12%), never (1%). It was scored by calculating the average unaided score and the average aided score for each subscale. The global score was the mean of the subscales scores and it was 100. The APHAB (BN) subscale average score was used to study the correlation of both tests (QuickSIN test and HINT) with the patient's subjective complaint in both aided and unaided conditions.

(3) Arabic version of QuickSIN test: The sentence lists were administered according to QuickSIN user manual guidelines of Killion[7]. One of the 10 standard equivalent sensitive lists was chosen randomly as practice

list then clinical testing started. The list is consisted of six sentences. The stimulus was presented at 70 dB HL if pure tone audiometry (PTA) <45 dB HL (in normal and aided groups) or "Loud, but ok" level if PTA >50 dB HL (in HL group) and signal level remains constant during the test. The Noise levels in standard lists pre-recorded at SNR that decreases in 5 dB steps from + 25 to 0 dB SNR. Loudspeaker was used for signal and noise at 0° azimuth (For Aided & CI subjects) one meter from the subject in a sound treated room. TDH earphones were used binaurally (for normal hearing subjects and unaided subjects with Hearing loss). The listener task was to repeat as many as possible of five key words in each sentence. The test took about one minute per list. The scoring formula according to Spearman – Kärber equation was 25.5 - Average score = dB SNR Loss. The average score is the total number of words correct for one list. Elrifaey *et al*[11] provides grades for interpreting performance on the Arabic QuickSIN test based on adjectives that describe the amount of SNR loss : Normal/near normal : 0-3dB, Mild SNR Loss: 3-7dB , Moderate SNR loss:7-15dB and Severe SNR loss >15dB. Figure 1 shows an example for scoring QuickSIN for list number 1.

(4) Arabic version of HINT: The sentence lists were administered using adaptive testing procedure according to HINT user manual guidelines of Nilsson[9]. One of the 25 lists was chosen randomly as practice list before clinical testing. The list is consisted of ten sentences. The noise level was fixed at 65 dB (A) in normal hearing group and for hearing loss subjects was constant at 5 dB above stimulus level throughout the test. The intensity levels of sentences were adjusted according to the participant's response. The sentence was initially presented at -5 dB SNR and the sentence presentation level was increased in 4-dB steps until the participants repeated 100% of the words in the sentence. The presentation level then was lowered by 4 dB after a correct repetition of the entire sentence or raised after an incorrect response. The 4 SNRs in the first four sentences were averaged and used as the starting presentation level for the 5th sentence.

Thereafter, the adaptive procedure proceeded to the 10th sentence that would have been presented using 2-dB steps. The averaged SNR from the 5 to 10th sentences in a sentence list was regarded as the RTS for that list. Loudspeaker was used for signal and noise at 0° azimuth (For Aided & CI subjects) one meter from the subject in a sound treated room. TDH earphones were used binaurally (for normal hearing subjects and unaided subjects with Hearing loss). Participants were instructed to listen carefully and repeat aloud whatever they heard as much of the sentence as possible. All sentence should be repeated correctly. The sentences were presented one at a time. The listener is encouraged to guess if they were not sure what was spoken. The test took about one and half minute per list. The scoring formula was RTS – noise level dB = dB SNR. (Figure 2) shows an example for scoring HINT list number 10.

Statistical Analysis:

The collected data were organized, tabulated and statistically analyzed using SPSS software.

RESULTS:

The Control group consisted of 25 subjects (10 males and 15 females). Their age ranged from 18 to 46 years with mean and SD 29.60±7.877 years. The mean of PTA threshold was 11±2.8 dB in both ears in the frequency range from 250HZ to 8000 HZ with normal middle ear function as determined by type (A) tympanograms.

The Study group consisted of 50 subjects with sensorineural hearing loss who were further subdivided into three subgroups: Subgroup (IIa) included 20 subjects (7 males and 13 females). Their age ranged from 18 to 50 years with mean and SD 35.80 ± 10.47 years. They had bilateral symmetrical moderate and moderately severe sensorineural hearing loss and they didn't use HAs. The mean PTA was 54.73 ± 9.38dB in right ears and 54.94 ± 10.04dB in left ears in the frequency range from 250HZ to 8000 HZ. Subgroup (IIb) included 20 subjects (5 males and 15 females). Their age ranged from 18 to 48 years with mean and SD 28.65 ± 9.5 years. These subjects were wearing HAs (9 monaural and 11 binaural). Their average aided free field threshold was ≤ 25dB in the frequency range from 500HZ to 4000HZ. All HAs were with basic technology. Nineteen subjects used BTE hearing aids (14 subjects used Beltone high power Force Basic, three subjects used HANSATON base power and one subject used Oticon Dynam sp4). One subject used ITC SIEMENS hearing aid. The mean and SD of hearing aid duration was 11.10 ± 5.04 years. Subgroup (IIc) included 10 subjects (4 males and 6 females). Their ages ranged from 18 to 45 years with mean and SD 32.29 ± 10.9 years. They were postlingual with unilateral Cochlear Implantation (2 subjects used Advanced Bionics CI, 5 subjects used cochlear CI and 3 subjects used Medel CI). Their average aided free field threshold at 500-4000 Hz in both ears was not worse than 30dB.

As regards the QuickSIN test, Comparison between normative and measured values for Arabic QuickSIN SNR loss in control group was done using one-sample t-test. The QuickSIN sample mean of 1.68 (SD= ±0.94) was statistically significant different from the normative mean of 2.58 (SD = ± 0.667).

According to QuickSIN grades developed by Elrifaey *et al*.[11], the QuickSIN SNR loss showed that 92% of subjects in the control group were normal/near normal (0-3). In HL subgroup, 60% of the cases showed moderate SNR loss. While in HA subgroup, 70% of the cases showed moderate SNR loss. Furthermore, in CI subgroup, 70% of the cases showed severe SNR loss (Table 1). ANOVA test revealed high statistically significant difference between control group and study subgroups. Post Hoc test showed statistically significant difference between (HL, CI subgroups) and (HA, CI subgroups). On the other hand, there was no statistically significant difference between HL and HA subgroups (Table 2).

As regard the HINT, Comparison between normative and measured values for Arabic HINT SNR in control group was done using one-sample t-test. The HINT sample mean of -7.65 (SD = ±2.54) was statistically significant different from the normative mean of -10.36 (SD = ±0.58). ANOVA test showed high statistically significant difference between control group and study subgroups. Post Hoc test showed significant differences between HL and CI subgroups and HA and CI subgroups. However, there was no statistically significant difference between HL and HA subgroups (Table 3).

Pearson Product Correlations between the QuickSIN (dB SNR loss) and the APHAB (BN) Subscale score was done in the unaided and aided study subgroups. Statistically significant positive correlations were found in subjects with hearing loss in subgroup (IIa) and subjects wearing HAs in subgroup (IIb) with the unaided and aided APHAB (BN) subscale scores respectively, but no correlations were found in CI subgroup (Table 4).

Pearson Product Correlations between the HINT (SNR) and the APHAB (BN) subscale score was done in the unaided and aided study subgroups. Statistically significant positive correlations were found in subjects with hearing loss in subgroup (IIa) with the unaided APHAB (BN) subscale score, but no correlations were found in both HA subgroup (IIb) and CI subgroup (IIc) (Table 4).

Sensitivity and specificity of (QuickSIN) SNR loss and (HINT) SNR were studied using Receiver operating characteristic (ROC) curve. The ROC analysis of the optimal cutoff points for both tests was done according to the APHAB (BN) average subscale score in the study subgroups. For subjects with sensorineural hearing loss in subgroup (IIa), (QuickSIN) SNR loss had sensitivity of 88.9% and specificity of 72.7%, while the (HINT) SNR had sensitivity of 77.8% and specificity of 72.7%. The sensitivity of (QuickSIN) SNR loss is higher than that of (HINT) SNR. For subjects with HA in subgroup (IIb), the (QuickSIN) SNR loss had sensitivity of 60% and specificity of 60%, while the (HINT) SNR had sensitivity of 50% and specificity of 80%. The sensitivity of (QuickSIN) SNR loss was higher than that of (HINT) SNR, while the specificity for (HINT) SNR was higher than that of (QuickSIN) SNR loss. For subjects with CI in subgroup (IIc), the (QuickSIN) SNR loss had sensitivity of 60% and specificity of 40%, while the (HINT) SNR had sensitivity of 40% and specificity of 40%. The sensitivity and specificity for both tests were low (Table 5 and Figure 3).

Table 1: Number of subjects and grades of SNR loss in Control group and study subgroups.

	QuickSIN grades	Control group (n=25)	Subgroup (IIa) (n=20)	Subgroup (IIb) (n=20)	Subgroup (IIc) (n=10)
QuickSIN SNR loss (dB)	0-3	23 (92%)	0	0 (0%)	0
	3-7	2 (8%)	5 (25 %)	4 (20%)	0
	7-15	0	12 (60%)	14 (70%)	3 (30%)
	>15	0	3 (15 %)	2 (10%)	7 (70%)

Table 2: Comparison between control group and study subgroups (IIa, IIb and IIc) as regards QuickSIN SNR loss using ANOVA and Post Hoc tests.

	Variable	Mean ± SD (Min-Max)	F value	*P value*	Post Hoc
QuickSIN SNR loss (dB S/N)	Control group (n=25)	1.68 ± 0.94 (0.5-3.5)	74.6	<0.001**	*P1 <0.001*** *P2 <0.001*** *P3 <0.001*** *P4 0.998* *P5 <0.001*** *P6 <0.001***
	Subgroup (IIa) (n=20)	9.81 ± 4.57 (3.5-22.5)			
	Subgroup (IIb) (n=20)	9.95 ± 4.11 (3.5–21.5)			
	Subgroup (IIc) (n=10)	16.7 ± 5.7 (7.5 – 23.5)			

*significant *P<0.05*, **highly significant *P<0.01*
P1: Comparison between control group and subgroup IIa.
P2: Comparison between control group and subgroup IIb.
P3: Comparison between control group and subgroup IIc.
P4: Comparison between subgroup IIa and subgroup IIb.
P5: Comparison between subgroup IIa and subgroup IIc.
P6: Comparison between subgroup IIb and subgroup IIc.

Table 3: Comparison between control group and study subgroups (IIa, IIb and IIc) as regards HINT using ANOVA and Post Hoc tests.

	Variable	Mean ± SD (Min-Max)	F value	*P value*	Post Hoc
HINT SNR (dB S/N)	Control group (n=25)	-7.65 ± 2.54 (-11.8 - -4.2)	72.8	<0.001**	*P1 <0.001***
	Subgroup (IIa) (n=20)	-1.3 ± 2.84 (-9.8-2.6)			*P2 <0.001*** *P3 <0.001*** *P4 0.842*
	Subgroup (IIb) (n=20)	-0.72 ± 3.15 (-6.2 - 4.6)			*P5 <0.001*** *P6 <0.001***
	Subgroup (IIc) (n=10)	2.7 ± 1.83 (0.2 - 5.4)			

*significant *P<0.05*, **highly significant *P<0.01*
P1: Comparison between control group and subgroup IIa.
P2: Comparison between control group and subgroup IIb.
P3: Comparison between control group and subgroup IIc.
P4: Comparison between subgroup IIa and subgroup IIb.
P5: Comparison between subgroup IIa and subgroup IIc.
P6: Comparison between subgroup IIb and subgroup IIc.

Table 4: Pearson Product-Moment Correlations of the APHAB (BN) subscale score mean with the QuickSIN and HINT means in the study subgroups.

		Hearing Loss (IIa) (n=20)		Hearing Aid (IIb) (n=20)		C I (IIc) (n=10)	
		HINT	QuickSIN	HINT	QuickSIN	HINT	QuickSIN
APHAB (BN)	r	0.498	0.720	0.413	0.450	- 0.138	- 0.063
	P	0.001**	<0.0001**	0.07	0.047*	0.703	0.861

*significant *P<0.05*, **highly significant *P<0.01*

Table 5: Receiver operating characteristic (ROC) curve analysis of the optimal cutoff points for the (QuickSIN) SNR loss and (HINT) SNR in the study group.

Item	Group	AUC**	Cut off point (SNR)	Sensitivity	Specificity
QuickSIN SNR loss (dB S/N)	SG*(IIa)	0.904	8	88.9%	72.7%
	SG (IIb)	0.655	9	60%	60%
	SG (IIc)	0.48	17	60%	40%
HINT SNR (dB S/N)	SG (IIa)	0.802	-1.7	77.8%	72.7%
	SG (IIb)	0.58	1.6	50%	80%
	SG (IIc)	0.36	22	40%	40%

*SG: subgroup
**AUC: Area Under Roc Curve

Fig. 1: An example for scoring QuickSIN list number 1 showing subject with mild SNR loss

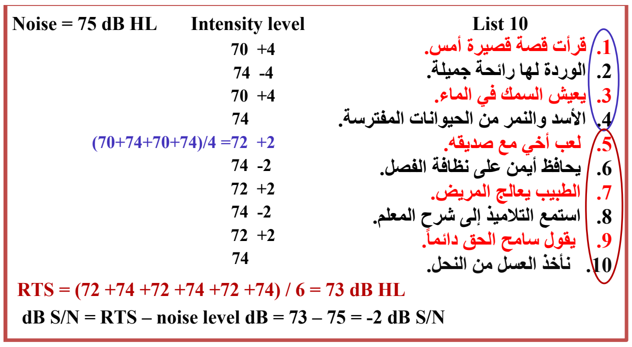

Fig. 2: An example for scoring HINT list number 10

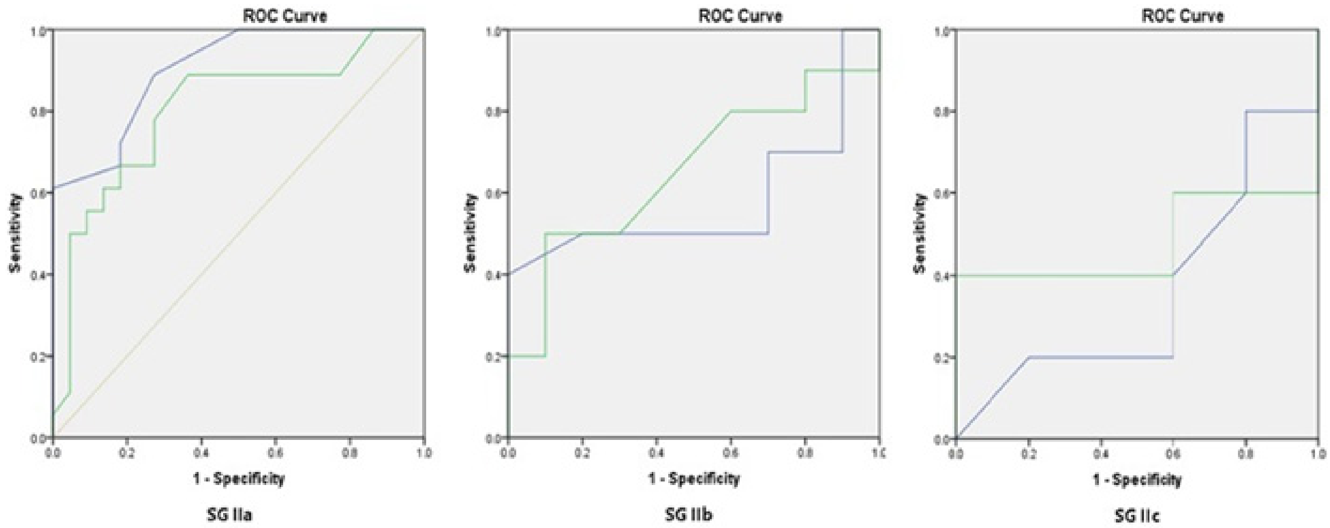

Fig. 3: ROC curves of (QuickSIN test) and (HINT) in comparison to the mean of (BN) subscale of APHAB questionnaire in subgroup (IIa, IIb & IIc).

DISCUSSION

The most common complaint from people with sensorineural hearing loss and with traditional hearing aids is the difficulty to understand speech in noise[16]. The present study was designed to study the newly developed Arabic version of QuickSIN test and Arabic version of HINT in adults with sensorineural hearing loss and to compare between the performances of both tests according to several factors to consider when selecting a speech in noise test.

QuickSIN test vs. HINT according to set-up requirements, ease of administration, scoring technique and test time Audio-vestibular medicine physicians often select a speech in noise test based on availability, ease to administer the test, time required in running the test, test materials and simplified scoring technique[17].

In this study, the QuickSIN surpasses the HINT in terms of set-up requirements, ease of administration, and scoring technique. Although both tests used sentences as a test material, in the Arabic HINT, correct response of a sentence was based on 100% correct repetition by the listener[9,12], which made it difficult for them. In contrast, the Arabic QuickSIN was scored depending on the number of target words (5 words) which should be correctly repeated for each sentence[7,11]. Accordingly, response burden was greater for Arabic HINT than Arabic QuickSIN test.

On the other hand, according to test materials, Arabic HINT sentences was taken from children books at first grade reading level or from equivalent sources of uniform sentence lengths of three to six words[12] while, Arabic QuickSIN sentences comprise words that are typically not highly predictable from the surrounding context. The sentences were designed to have few contextual cues to aid in understanding[7, 11].

According to test time , administration of QuickSIN test list required one minute, while administration of HINT test list required one and half minute[18]. Accordingly, QuickSIN test required shorter test duration than HINT did.

According to ease of administration, HINT used an adaptive method where SNR changed depending on the patient's response[9,12]. So, an increase or decrease in noise level was reflected by the change in the response from the listener in terms of correct or incorrect response While, QuickSIN used descending paradigm. SNR decreased as the test progressed[7,11] which were represented by low score every reduction in SNR.

As regards scoring technique, HINT depends on measuring the RTS, which had greater flexibility in terms of tracking the gradual drift in the measurement value[17]. However, HINT lacked the greater precision that QuickSIN provided through calculation of SNR ratio in decibels depending on the simplified Spearman– Kärber equation (25.5 - Correct score)[7, 11].

QuickSIN test vs. HINT according to Norms

In control group, both the measured QuickSIN SNR loss and the measured HINT SNR means were statistically significant different from the normative Arabic QuickSIN SNR loss mean and the normative Arabic HINT SNR mean in the developed tests, respectively. This agreed with Duncan *et al*[19] for the HINT results but not for the QuickSIN. British Society of Audiology (BSA) practice guidance recommended the need for clinic specific norms for HINT[20].

QuickSIN test vs. HINT according to best separation in recognition performances between listeners with normal hearing and listeners with hearing loss.

The means of (QuickSIN) SNR loss for the listeners with hearing loss was 9.81 ± 4.57 dB S/N. This was ~8 dB in SNR loss mean higher than the mean SNR loss for the listeners with normal hearing in control group in the current study. This agreed with previous reports that examined the separation in performance between listeners with normal hearing and those with hearing loss on a speech in noise task Dubno *et al*[2]; McArdle *et al*[5]; Killion[7]; Beattie[21]; Wilson *et al*[22]. They found that the QuickSIN provided the same 8-dB separation between mean recognition performances by listeners with normal hearing and by listeners with hearing loss.

On the other hand , The means of HINT SNR for the listeners with hearing loss - 1.3 ± 2.84 dB S/N .This was ~6 higher than the mean for the listeners with normal hearing in the same study. This disagreed with Essawy *et al*[12] who reported that the difference between the normal and sensorineural hearing loss subjects was 2.5 dB S/N ratio. They administered the 25 HINT lists to 24 listeners with bilateral mild to moderate hearing loss not using hearing aids in sound field with both the sentences and noise originating from loudspeaker at a 0° azimuth. This was attributable to two reasons. The first is that listeners in the current study had moderate and moderately severe hearing loss. The second reason is that listeners had less practice on the task than the listeners in Essawy *et al* study. In this study, subjects had one practice list before clinical testing. While in Essawy's work, each participant was given all the 12 sentence lists in four listening conditions, including speech in quiet, noise at 0°, 90° and 270°azimuth, respectively.

In the current study, the difference between control and study group indicated that the Arabic QuickSIN test which performance was more dependent on acoustic cues provided more separation between recognition performance by the listeners with normal hearing and the listeners with hearing loss than the Arabic HINT that had more contextual cues. This agreed with Wilson *et al*[22] who examined listeners with normal hearing and listeners with sensorineural hearing loss, the within and between group differences obtained with (BKB-SIN, HINT, QuickSIN, and Word In Noise test). They found that better performance was obtained on the (BKB-SIN and HINT) materials than on the (QuickSIN and WIN) materials and as the recognition is more dependent on acoustic cues, the recognition performance decreases. The QuickSIN and WIN materials which were more dependent on acoustic cues provided more separation in terms of recognition performance between the two groups of listeners (normal hearing and hearing loss) than did the BKB-SIN and HINT materials. With the HINT, more listeners with hearing loss had performance in the normal range, which was attributable to an increased cognitive contribution that the HINT materials made to the recognition task.

QuickSIN test vs. HINT according to HA use

There was no significant differences between subjects wearing HAs in (subgroup IIb) and those not wearing HAs in (subgroup IIa) according to QuickSIN SNR loss and HINT SNR. This may be attributed to the lower level of noise reduction technology as the HAs used were at economic level with basic technology. This agreed with Mendel[23] for the HINT results but not for the QuickSIN. The author found that the QuickSIN SNR loss revealed significantly better aided SNR loss compared with the unaided SNR loss, while speech perception performance in the HINT noise conditions was not as sensitive as there was no significant differences measured between unaided and aided performance due to that some of the participants had considerable difficulty with the stimuli presented in the HINT noise conditions, thus making this test too difficult to yield useful results.

QuickSIN test vs. HINT according to CI use

Subjects with cochlear implants significantly had the lowest performance compared with the normal hearing subjects and hearing loss subjects for both (QuickSIN and HINT). This agreed with Friesen *et al*[24] who explained the reasons for such difficulties in the presence of any kind of background noise are due to the limited frequency, temporal and amplitude resolution that can be transmitted by the implant device, a low number of active channels and electrode-to-electrode interaction. Thus, the neural interface currently represents a bottleneck for transferring information from the CI to the auditory nerve.

A possible limitation in the current study is the heterogeneity of CI subgroup as they differed in the device being use (internal device, speech processor, speech coding strategy) and any one of these factors could have contributed to subject's speech-in-noise ability. Further research is needed to determine the exact influence of these factors on speech-in-noise perception.

QuickSIN test vs. HINT according to sensitivity and specificity

The sensitivity for (QuickSIN) SNR loss was higher than the sensitivity for (HINT) SNR in all subgroups, while the specificity of (HINT) SNR was higher in patients wearing HAs. Up to our knowledge, this point was not studied before in the literature.

QuickSIN test vs. HINT according to Correlation with APHAB questionnaire

APHAB Questionnaire was used as a primary diagnostic tool for real world speech in noise problem. The goal of the APHAB is to quantify the disability caused by hearing loss, and the reduction of that disability that was then achieved by the use of hearing aids and cochlear implants. Correlation was done between APHAB Background Noise (BN) subscale score as a subjective measure for speech in noise problem in the real world and the mean scores for HINT SNR and QuickSIN SNR loss across the study group. Subjective measures seem to have become the "gold standard" to which speech in noise results are compared.

In patients with hearing loss (unaided), results revealed highly significant positive correlations with strong degree between (QuickSIN) SNR loss with the APHAB (BN) subscale score ($r = 0.72$). Also, there were highly significant positive correlations with moderate degree between Arabic (HINT) SNR and the APHAB (BN) subscale score ($r = 0.49$). HINT results in the present study agreed with Mendel[23] who reported correlation between HINT and another subjective measure which was Hearing Aid Performance Inventory (HAPI) questionnaire on 21 adults with bilateral symmetrical hearing loss of varying degrees.

In addition, the results of QuickSIN correlations were consistent with those of Cox *et al*[25]. Those authors incorporated three groups of listeners with hearing impairment; mild, moderate, and moderately severe. Moderate correlations were found between the APHAB subscales and SNR levels of the Revised SIN test. On the other hand, the results of the present study disagreed with Sklaney[26]. This author studied 36 subjects with mild to moderate sensorineural hearing loss and found non-significant ($p<.05$) correlations for HI group in the relations between the APHAB (BN) subscale score and the QuickSIN mean scores.

In patients wearing HAs, there were non-significant correlations between (HINT) SNR and Aided APHAB (BN) subscale score. This disagreed with Kuk *et al*[27] who have reported that the HINT SNR obtained in the aided conditions may predict the extent of real-world listening difficulty. While, QuickSIN test in the present study showed significant correlations with moderate degree with APHAB (BN) subscale score which agreed with Walden and Walden[28] who chose the QuickSIN as one of a battery of measures to predict successful hearing aid use in daily life. Their study included 50 adult males; most of them were not first time hearing aid users. They reported that QuickSIN lists were the only measure that incorporated a more realistic measure of speech-in-noise and were the only audiometric measure that was significantly correlated with the self-assessment scales[28].

In CI subgroup, there were no significant correlations between both tests and APHAB questionnaire. It should be also noted that the APHAB was designed to assess subjective benefit in hearing aid users, not for CI users, thus it is possible that the items on the APHAB were not sensitive to the difficulties being experienced by CI users[29].

Both tests explain the listener's experience of hearing in background noise. According to the British Society of Audiology (BSA) practice guidance, the QuickSIN test is easily available and more widely used in routine clinical testing than HINT does. The HINT has more complicated set-up requirements, test administration and scoring. The HINT is more commonly used in research rather than in clinical practice, even though the HINT is acknowledged as an excellent tool for differentiating small differences amongst people and products; it is also one of the most researched speech tests[20,30].

CONCLUSION

The (QuickSIN) SNR Loss is more sensitive and more reflective to the patients' subjective perceptions in real life than (HINT) SNR does in both unaided and aided conditions in subjects with sensorineural hearing loss. Because of the poor performance of both tests in CI users, an easier test to assess speech understanding in noise need to be employed. Also, this study recommends the need for clinic specific norms for both QuickSIN test and HINT.

CONFLICT OF INTEREST

There are no conflicts of interest.

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