Development and Standardization of Sentences for Quick Speech in Noise Test in Malayalam

by Author Unnamed

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Abstract

The present study aimed to develop and standardize sentences for quick speech in noise test in Malayalam language for children and adults. A total of 500 Malayalam words were selected and evaluated for familiarity. Using 300 most familiar words, 150 syntactically and semantically correct sentences were constructed. These sentences were familiarized again by five qualified speech language pathologists. 105 most familiar sentences were carefully chosen and randomly assigned to 15 lists of seven sentences each. A four talker speech babble was added to these sentences at different SNR levels, from +5 to -10 dB SNR in 2.5 dB steps. The speech babble was added in such a way that the first sentence in each list had maximum SNR and last sentence had minimum SNR. The speech perception in noise ability was assessed on 120 normal hearing participants (60 adults and 60 children). The perceptual SNR-50 was calculated for each list, based on the perceptual scores obtained by each participant, separately for children and adults. Statistical analysis revealed that the perceptual scores for some lists were found to be significantly different from other lists, and hence, those lists were excluded from the final test. After removing these lists, seven lists were selected for children and adults, separately. The mean identification score (SNR-50) was -4.671 dB for children and -6.357 dB for adults. Reliability and validity results showed that the test is reliable and valid to assess speech perception in noise abilities in children as well as in adults.

Keywords: *Speech perception in noise; sentence list; SNR 50; SNR loss.*

Background

In everyday life, the identification of speech signals rarely occurs in optimum listening situations. Such identification often takes place in conditions that adversely affect one's ability to correctly identify speech stimuli. For instance, background noise or hearing impairment can impair the recognition of speech signals. Under such situations, listeners require more (cognitive) effort to identify the target signal (Hervais-Adelman, Carlyon, Johnsrude, & Davis, 2012; Mishra, Stenfelt, Lunner, Rönnberg, & Rudner, 2014; Rönnberg, Rudner, Foo, & Lunner, 2008; Rudner, Foo, Rönnberg, & Lunner, 2009).The listener's ability to understand speech in noisy background is challenging for individuals with hearing impairment. Identifying speech perception abilities in noise may help healthcare professionals to design appropriate therapeutic protocol for auditory training. Assessment of listeners' ability to identify speech in noisy situations had received significant research attention in the past few decades.

The standard audiometric test battery does not measure or predict the ability to understand speech in noise (Killion & Niquette, 2000). An ideal speech perception test should provide accurate prediction of the listener's ability in diverse listening environment. This lead to the development of speech in noise tests. Speech-in-noise measures gained important position in the audiological test battery. One of the most commonly used such test is speech in noise (SIN) test. SIN test helps to identify the difficulty in understanding speech in noise, and describe the amount of difficulty as well as the subsequent benefit provided by amplification devices (Bray & Nilsson, 2002). Hearing in Noise Test (HINT) is another such test (Nilsson, Soli, & Sullivan, 1994), which uses sentences in continuous speech spectrum shaped noise and an adaptive procedure that gives the signal to noise ratio (SNR) required for

50% correct identification of the sentences (SNR-50). A potential limitation of these tests to assess speech perception in noise abilities is that they are too time consuming and the scoring of these tests are difficult (Killion, Niquette, Gudmundsen, Revit, & Banerjee, 2004).

Killion and his colleagues at Etymotic Research (Killion et al., 2004) developed Quick speech perception in noise test (Quick SIN) with the aim to estimate SNR loss in 1-2 minutes, and which is easy to administer and score. The test comprised of IEEE sentences, divided into 12 lists, which were presented to individuals with normal hearing and hearing impairment along with four talker speech babble as noise at different SNR levels. The speech babble was added to the sentences in such a way that the first sentence in each list had maximum SNR and the last sentence in each list had minimum SNR. A series of experiments were conducted to ensure list equivalency. The authors claimed that each list can be used to measure SNR loss in individuals with normal hearing sensitivity and hearing impairment with 95% confidence.

Wilson, McArdle and Smith (2007) measured the sensitivity of Quick SIN test in identifying speech recognition performances in background noise. 24 listeners with normal hearing and 72 listeners with sensorineural hearing loss were compared for 4 speech-in-noise protocols, viz., BKB-SIN (Bamford-Kowal-Bench Speech-in-Noise test), HINT (Hearing In Noise Test), Quick SIN (Quick Speech In Noise test), and WIN (Word In Noise test). The researchers reported that Quick SIN and WIN materials are more sensitive measures of recognition performance in background noise than are the BKB-SIN and HINT materials. Duncan and Aarts (2006) conducted a study to determine the HINT and QuickSIN test performance in young adults with normal hearing, and to comment on the clinical utility of both the tests. The researchers concluded that there is no statistically significant difference between the responses obtained from both the tests. They further stated that QuickSIN has some advantage over the HINT in terms of its clinical usage.

Sharma, Tripathy and Saxena (2016) critically appraised the HINT, QuickSIN, BKB-SIN, LiSN-S (Listening in Specialized Noise-Sentences), and WIN test. They found that QuickSIN is maximally reliable and valid tool to assess speech perception in noise abilities. The reviewers also reported that participant responsiveness is best for QuickSIN with least item/instrument bias. Lee and Yi (2017) reviewed the performances of HINT, QuickSIN and Matrix test in terms of test procedure, norms, and interpretation. They reported that procedure and interpretation is easy for QuickSIN test, however, HINT and Matrix test has various multi-lingual versions, but multi-language stimulus material is less available for QuickSIN.

The need of multi-lingual material for the quick speech in noise test lead the researchers to develop material for quick speech in noise test in Mandarin (Zhou et al., 2017) and Persian(Shayanmehr, Tahaei, Fatahi, Jalaie, & Modarresi, 2015) languages. Among Indian languages, sentences for quick speech in noise test has been developed in Kannada (Avinash, Meti, & Kumar, 2010) and Oriya (Hota, Dutta, & Chatterjee, 2014) languages. No availability of such test material in Malayalam language created the need of the present study. Malayalam (a Dravidian language) is official language of the south Indian state of Kerala and union territories of Lakshadweep islands and some parts of Puducherry. With more than 37 million native language speakers (Campbell & Gordon, 2008), Malayalam is 26th largest language of the world (based on the number of native speakers). A total of 2.28% of the Malayalam speaking population being disabled, among which, 0.45% of the total population is hearing impaired. Thus, quick speech in noise test has a wide scope of practice in native

Malayalam speakers. Considering the same, the present study is designed to develop and standardize sentences for quick speech in noise test in Malayalam language.

Materials and Method

Participants

A normative research design was adapted and 120 participants with normal hearing sensitivity (PTA≤15 dBHL, SRT±10 dB of PTA; SIS≥90%;re. ANSI S3.21, 2009) were selected for the present study. The participants were divided into two groups. Group 1 consisted of 60 children within the age range of 8-12 years and group 2 consisted of 60 adults within the age range of 18-25 years. All the participants had normal auditory processing abilities as assessed using Screening Checklist for Auditory Processing (SCAP) (Muthuselvi & Yathiraj, 2010) for the participants of group 1 and Screening Checklist for Auditory Processing in Adults (SCAP-A) (Ramya & Yathiraj, 2014) for the participants of group 2. None of the participant reported of any neurological, psychological, visual or behavioral problems. All the participants were native Malayalam speakers. The study had been approved from the institutional ethical board to test human participants and an informed written consent was obtained from each of the participant before commencement of the study.

Preparation of Test Stimuli

A total of 500 common words of approximately similar length in Malayalam language were selected. These words were taken from Malayalam government school textbooks. The words were given to 10 native Malayalam speakers who were primary school teachers. The teachers were asked to rate each word on a five point familiarity rating scale (Vagias, 2006). Only those words with familiarity rating of '4' or more (familiar to highly familiar) were selected. 300 such words were finally selected. The school teachers were then asked to construct 150 sentences (five key words each) using these 300 words. All the sentences were semantically and syntactically correct. The 150 sentences were given to 5 native Malayalam speakers, who were qualified speech language pathologists to rate them for familiarity on a five point rating scale (Vagias, 2006). The sentences with the rating of 4 or more (familiar to highly familiar) were selected for the final list. Thus, a total of 105 sentences with maximum familiarity were selected as final stimuli. The 105 selected sentences were randomly assigned to 15 lists of seven sentences each.

Recording the Stimuli

A native female Malayalam speaker with normal voice characteristics was selected to record the test stimulus. A calibrated microphone connected to a personal computer installed with the Praat software (version 5.3.53) was used for recording and saving the stimulus. The microphone was kept at 10 cm away from the mouth of the speaker. The sampling rate for recording was set as 44100 Hz. The speaker was requested to utter each of the sentences in the sentence lists at comfortable pitch and loudness and normal rate of speech. The entire recording was carried out in a sound treated room. All the 105sentences were recorded and saved separately on the personal computer in .wav format. The recorded sentences were analysed perceptually by the examiner to ensure that the recording is clear and intelligible. The recorded sentences were also analysed acoustically and any extra duration in the beginning and end of the sentences were edited using Praat software. The intensity of each of the recorded sentence was normalized to 70 dB SPL using Praat software.

Adding Noise to Signal

A four-talker speech babble of 2 minutes was recorded using the Praat software. The procedure of recording speech babble was adapted from the study of Killion et al. (2004). Four-talker babble was used as it represents realistic simulation of a social gathering. The recording was carried out in a classroom situation where four native Malayalam speakers were made to sit in a circular manner with omni-directional microphone placed in the centre. The approximate distance between the microphone and each of the speaker's mouth was 30 cm. The speakers were asked to read different Malayalam newspaper articles simultaneously. They were requested to maintain normal conversational speech loudness and rate of speech. The recorded speech babble was saved in the personal computer in .wav format. The intensity of the recorded speech babble was also normalized to 70 dBSPL using Praat software.

All the sentences in 15 sentence lists were added with speech babble at different SNR levels. Seven SNR values from +5 dB SNR to -10 dB SNR in 2.5 dB steps had been considered. The speech babble was added in such a way that the first sentence of each list had the maximum SNR (+5 dB) and the last sentence of each list had minimum SNR (-10 dB). All the seven sentences in each list, thus, were at different SNR levels. The procedure of adding speech babble to the signal was adapted from the study of Jain, Nataraja and Nair (2014, 2015). The speech babble was added using the Matlab software (ver. R2017a). Each of the fifteen lists developed had seven sentences, one sentence at each SNR of 5, 2.5, 0, -2.5, -5, -7.5 and -10dB.

Procedure

The test was conducted in a sound treated room with adequate illumination. The participants were made to seat comfortably. The sentences of each list were randomly presented to each participant through the personal computer routed via a calibrated audiometer with standard headphones (TDH 39). The stimuli were presented binaurally. The participants were instructed to listen to the sentences carefully and repeat each word in the sentence. The participant responses were recorded using audio recorder for further analysis.

Scoring

As each sentence consisted of five key words, a score of '1' was given for each key word repeated correctly, and each incorrectly repeated word was scored '0'. A score of 0.5 was given for partially correct responses. The responses were considered as partially correct only if there was any morphological and/or inflectional error. Remaining all errors were considered as incorrect responses only. Thus, a maximum score of 35 was given for each list. All 15 lists of sentences were presented to each participant to obtain their perceptual scores.

Data Analysis

The SNR-50 value for each participant across each list was estimated using non-linear logistic regression. The responses for each list was analysed for normalcy using Shapiro-Wilk test for normalcy. The data was normally distributes across each list, and hence, parametric statistics was used. The equivalency of responses across lists was measured using repeated measures analysis of variance with Bonferroni's post hoc analysis. Test-retest reliability was also measured using repeated measures ANOVA. The re-testing was done only for 15 adults and 15 children due to time constrains and availability of the participants. The re-testing was carried out after three months of the original testing; to ensure that the participant is not habituated with the test stimuli. Split half reliability was measured using one way ANOVA. Internal validity among the lists were carried out by measuring the difference in the SNR-50 values obtained for each list with that of mean overall SNR-50 values measured together for all the lists.

RESULTS

Calculation of SNR 50

The correct identification of key words in each sentence was noted separately for each participant. SNR 50 value was calculated for each of the 15 lists using logistic regression analysis, for each participant. Figure 1 is showing the mean SNR-50 value for each list, for the participants of both groups.

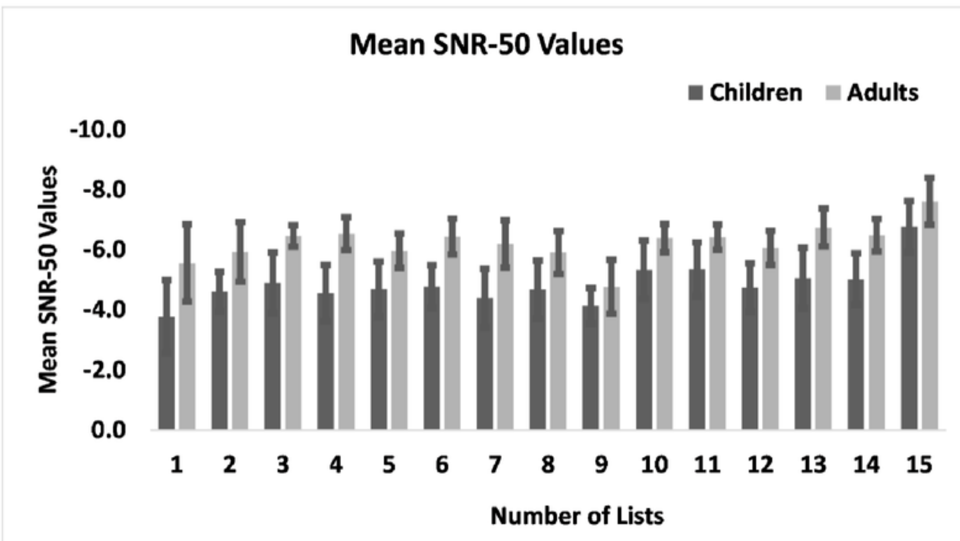

Figure 1: The mean overall speech recognition scores for children and adults.

Equivalency of the sentence lists

A repeated measure analysis of variance with Bonferroni's multiple pairwise comparisons were used to compare the perceptual SNR-50 scores between each list, for both group of participants, separately. This was done to see the equivalency of the perceptual responses obtained for lists in normal hearing adults and children. Results showed a significant difference between perceptual scores obtained for each list [F (14, 1624) = 61.76; p<0.001], for children. These results indicated that out of 15 lists, some lists were easy and resulted in significantly higher scores while some lists were difficult and resulted in significantly lower scores. It was found that list number 10, 11, 14 and 15 were relatively simpler and hence had better perceptual SNR-50 scores. List number 1, 8 and 9 were relatively hard to perceive and resulted in poorer SNR-50 scores. Hence, these lists were excluded from the further analysis. Repeated measures ANOVA was again done with SNR-50 scores of the remaining lists as the factors. The results indicated that there was no statistically significant difference between perceptual SNR-50 scores for any of the remaining seven lists [F (1, 59) = 2.85; p>0.05].

The perceptual SNR-50 responses obtained for each list was compared with that of another for adults as well. The results revealed that list number 13 and 15 were relatively simpler and hence had better perceptual SNR-50 scores. List number 1, 2, 5, 8, 9 and 12 were relatively hard to perceive and resulted in poorer SNR-50 scores. These lists were thus excluded from the analysis. Repeated measures ANOVA indicated that there was no statistically significant difference between perceptual SNR-50 scores for any of the remaining seven lists [F (1, 59) = 3.61; p>0.05]. Thus seven lists were selected separately for children (list number 2, 3, 4, 5, 6, 7, and 12) and adults (list number 3, 4, 6, 7, 10, 11 and 14). The mean SNR-50 scores for these sentences were plotted in Figure 2. These lists are provided in the Appendix. It may be noted that list no. 3, 4, 6 and 7 are common for both children and adults whereas the other lists are different for the participants of both the groups.

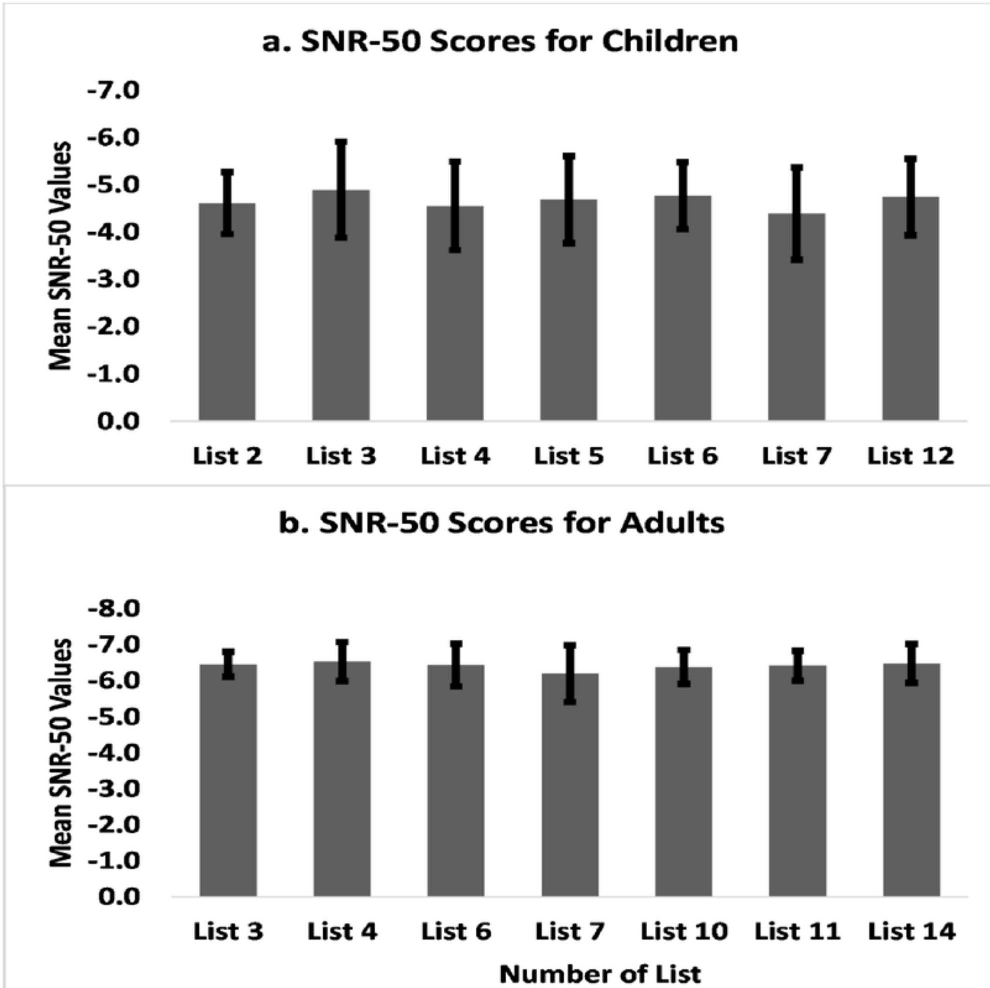

Figure 2: The mean SNR-50 scores for finally selected lists a. for children; and b. for adults.

SNR loss

As a preliminary analysis, the SNR loss obtained by adults and children with normal hearing on the seven equivalent lists was calculated. Procedure recommended by Tillman and Olsen (1973) was adopted to calculate the SNR loss. They have described a method to calculate the SNR loss for spondee words based on the total number of correctly repeated words. In this 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. They recommended use of 2 dB steps and 2 words per step. If the audiometer has only 5 dB steps, the corresponding method would be to use 5 words per step and 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 will be the spondee threshold. The Quick SIN Malayalam has five key words per step and SNR was reduced in 2.5 dB steps. The highest SNR tested was 5 dB. So 5 + 1.25 = 6.25 minus the total number of words repeated correctly will give SNR 50. Since SNR 50 for adults with normal hearing obtained in the present study was -6.357 dB and for children was -4.671 dB, the SNR loss can be calculated using the following formula.

For adults, SNR loss = 6.25-(-6.357)-total number of words correct.

For children, SNR loss = 6.25-(-4.671)-total number of words correct.

Reliability of the Responses

In the quest to assess whether the sentences are reliable to test the speech perception in noise ability of children and adults, split-half reliability and test-retest reliability measures were carried out. Split-half reliability was measured using independent sample t-test. It was done by dividing the responses of 60 participants in each group randomly into two sets of 30 participants each. The comparison within group revealed no statistically significant difference between the two set of participants ($t = 5.17$; $p<0.01$). Test-retest reliability was measured using paired sample t-test. The re-testing was done only for 15 adults and 15 children due to time constrains and availability of the participants. The re-testing was done 3 months after the original testing to avoid habituation effect. The results revealed no statistically significant difference between trails for both children and adults (t = 7.89; p>0.05), indicating that the responses were consistent across time.

Validity of the Test Stimuli

Internal validity was measured to find whether the stimuli is reliable enough to assess the speech perception in noise abilities. Internal validity among the lists were carried out by measuring the difference in the SNR-50 values of each list with that of mean overall SNR-50 values measured together for all the lists for each subject. The mean SNR-50 was measured for seven selected lists and the SNR-50 value for each list was subtracted from the mean SNR-50 value. This was done for each participant separately. The difference SNR-50 values were tabulated and compared with each other using repeated measures ANOVA. The results revealed no statistically significant difference between the 'difference SNR-50 values' for any list for adults [$F(1, 59) = 0.593$; $p>0.05$] and children [$F(1, 59) = 0.013$; $p>0.05$]. The difference SNR-50 values were similar for each list and minimally deviant from the mean SNR-50 values. These results indicate that the selected lists are internally valid, and thus, the responses obtained by presenting these lists should be consistent.

Discussion

The present study was designed to develop sentence material for quick speech in noise test in Malayalam language. Although there are a few materials available in other languages like English, Persian, Mandarin, Kannada and Oriya, those cannot be used to test the speech perception abilities in native Malayalam speakers due to linguistic constrains. Absence of such material in Malayalam language crafted the need for the present study. It is noteworthy that, quantifying an individual's ability to understand speech in noisy condition in terms of SNR helps in the hearing aid fitting process as it reflects the real world performance of the individual. The strategies and features which would maximize the performance in the test can be opted by the hearing care professional during the hearing aid fitting which would likely improve the comfort of listening and consequently the hearing aid success ratio. Further, it may assist in identifying auditory processing deficits, as speech perception in noise is compromised in such individuals. However, this requires a well-furnished and standardized test material. Hence, care was taken throughout the study to ensure that the test material is homogenous and yields reliable and valid results.

Consequently, the present study was carried out in four phases and the sentences in the present study underwent rigorous selection criterion. The initial 15 lists of sentences each for adults and children were shortlisted to seven based on the SNR-50 values to maintain homogeneity across the lists. The strength of the study lies not only to the development and standardization of the test material, but also with reference to the development of separate test material for children and adults. Since, the abilities and needs of children and adults are different, it has been recommend for using different stimulus material while testing children and adults. Further, the tests retest reliability, split half reliability and internal reliability measures of the developed material was also carried out which yielded affirmative results in terms of validity of the developed material.

The present test not only identified the SNR-50 values for children and adults, but also suggested measures to calculate SNR loss, based on the procedure recommended by Tillman and Olsen (1973). Knowing the SNR, loss makes it possible for the hearing professional to recommend the appropriate technology (e.g., omni-directional microphones, directional microphones, array microphones, and close-talking FM microphones) required for listener to function in commonly encountered noisy situations. Standardized tests like speech recognition thresholds or speech identification scores available for measurement of speech understanding do not reflect the real world performance of individuals with hearing impairment. Thus, speech in noise tests were designed, as they are more accurate predictor of speech understanding in everyday living situations. But the potential limitation of such tests lies in their complexity in measuring speech perception abilities and difficulty in scoring. Killon et al. (2004) suggested Quick speech in noise test in English, which was designed to assess speech perception abilities in 1-2 minutes, with good accuracy. This measure is popular among the audiologists, and that is the reason of developing the sentence material for quick speech in noise test in various languages. With the development of sentence material in Malayalam language, as mentioned in the present research study, the authors expect that the material will be useful for audiologists and other related professionals to assess speech perception abilities in the relevant population.

Conclusion

It can be concluded that with the decrease in SNR, the speech identification scores decreased. This was seen for both normal and hearing impaired participants. There was also a significant difference between the SNR 50 obtained for children and adults. Adults scored better than children indicating their better speech perception in noise ability. In the present study the authors had developed separate test lists for children and adults though some lists are common. The lists developed for children and adults showed good equivalency. The test materials had good test retest reliability and good internal validity. It is capable to differentiate between normal and hearing impaired based on SNR loss. It can also be used in the assessment of individuals with central auditory processing disorders.

References

ANSI S3.21. (2009). ANSI/ASA S3.21-2004 (R2009) Methods Manual Pure-Tone Threshold Audiometry. Retrieved May 15, 2017, from http://webstore.ansi.org/RecordDetail.aspx?sku=ANSI%2FASA+S3.21-2004+(R2009)

Avinash, M. C., Meti, R. R., & Kumar, A. U. (2010). Development of sentences for quick speech-in-noise (QuickSin) test in Kannada. *Journal of Indian Speech and Hearing Association*, *24*, 59–65.

Bray, V., & Nilsson, M. (2002). What digital hearing aids can do: Another perspective. *The Hearing Journal*, *55*, 60–61.

Campbell, L., & Gordon, R. G. (2008). Ethnologue: Languages of the World. *Language*, *84*, 636–641.

Duncan, K. R., & Aarts, N. L. (2006). A comparison of the HINT and Quick SIN tests. *Journal of Speech-Language Pathology and Audiology*, *30*, 86–94.

Hervais-Adelman, A. G., Carlyon, R. P., Johnsrude, I. S., & Davis, M. H. (2012). Brain regions recruited for the effortful comprehension of noise-vocoded words. *Language and Cognitive Processes*, *27*, 1145–1166.

Hota, P., Dutta, P., & Chatterjee, I. (2014). *Psychometric validation of speech perception in noise test material in Odia* (Master's Dissertation). West Bengal University of Health Science, Kolkata, West Bengal, India.

Killion, M. C., & Niquette, P. A. (2000). What can the pure-tone audiogram tell us about a patient's SNR loss?. *The Hearing Journal*, *53*. Retrieved from http://journals.lww.com/thehearingjournal/Fulltext/2000/03000/What_can_the_pure_tone_audiogram_tell_us_about_a.6.aspx

Killion, M. C., Niquette, P. A., Gudmundsen, G. I., Revit, L. J., & Banerjee, S. (2004). Development of a quick speech-in-noise test for measuring signal-to-noise ratio loss in normal-hearing and hearing-impaired listeners. *The Journal of the Acoustical Society of America*, *116*, 2395–2405.

Lee, J. H., & Yi, D. W. (2017). A comparison of adaptive Sentence-in-Noise tests. *Audiology and Speech Research, Audiology and Speech Research*, *13*, 9–18.

Mishra, S., Stenfelt, S., Lunner, T., Rönnberg, J., & Rudner, M. (2014). Cognitive spare capacity in older adults with hearing loss. *Frontiers in Aging Neuroscience*, *6*, 96.

Muthuselvi, T., & Yathiraj, A. (2010). Utility of the screening checklist for auditory processing (SCAP) in detecting (C) APD in children. *Student Research at AIISH*, *7*, 159–175.

Nilsson, M., Soli, S. D., & Sullivan, J. A. (1994). Development of the Hearing in Noise Test for the measurement of speech reception thresholds in quiet and in noise. *The Journal of the Acoustical Society of America*, *95*, 1085–1099.

Ramya, V., & Yathiraj, A. (2014). Screening Checklist for Auditory Processing in Adults (SCAP-A): Development and preliminary findings. *Journal of Hearing Science*, *4*, 33–43.

Rönnberg, J., Rudner, M., Foo, C., & Lunner, T. (2008). Cognition counts: a working memory system for ease of language understanding (ELU). *International Journal of Audiology*, *47 Suppl 2*, S99-105.

Rudner, M., Foo, C., Rönnberg, J., & Lunner, T. (2009). Cognition and aided speech recognition in noise: specific role for cognitive factors following nine-week experience with adjusted compression settings in hearing aids. *Scandinavian Journal of Psychology*, *50*, 405–418.

Sharma, S., Tripathy, R., & Saxena, U. (2016). Critical appraisal of speech in noise tests: a systematic review and survey. *International Journal of Research in Medical Sciences*, *5*, 13.

Shayanmehr, S., Tahaei, A. A., Fatahi, J., Jalaie, S., & Modarresi, Y. (2015). Development, validity and reliability of Persian quick speech in noise test with steady noise. *Auditory and Vestibular Research*, *24*, 234–244.

Tillman, T., & Olsen, W. (1973). Speech Audiometry. In *Modern developments in Audiology*. Academic Press.

Vagias, W. M. (2006). Likert-Type Scale Response Anchors. Retrieved August 21, 2017, from http://www.academia.edu/4384441/Likert-Type_Scale_Response_Anchors_Citation_Vagias_Wade_M._2006_._Likert-type_scale_response_anchors._Clemson_International_Institute_for_Tourism

Wilson, R. H., McArdle, R. A., & Smith, S. L. (2007). An evaluation of the BKB-SIN, HINT, QuickSIN, and WIN materials on listeners with normal hearing and listeners with hearing loss. *Journal of Speech, Language, and Hearing Research: JSLHR*, *50*, 844–856.

Zhou, R., Zhang, H., Wang, S., Chen, J., D, & Ren, A. (2017). Development and evaluation of the Mandarin Quick Speech-in-Noise Test materials in mainland China. *Journal of Phonetics & Audiology*, 1–8.

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