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Feasibility of the Speech Intelligibility Index in Turkish-speaking Adults with Sensorineural Hearing Loss

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ABSTRACT

Objective: The speech intelligibility index (SII) quantifies the proportion of speech that is audible to a listener. Its predictive accuracy is based on the acoustic and phonetic properties of the language it uses. Our study evaluated the feasibility of using the English-based SII for Turkish-speaking individuals with sensorineural hearing loss, comparing younger and older adults.

Methods: In this retrospective cross-sectional study, 161 participants (68 younger adults and 93 older adults) with bilateral sensorineural hearing loss were included. Hearing thresholds, word recognition scores (WRS), and SII values were analyzed. Non-parametric statistical analyses, including the Wilcoxon signed-rank test for paired comparisons, Mann-Whitney U test for group differences, Spearman's rank correlation for associations, and Fisher Z-test with bootstrap analysis to compare correlation coefficients were conducted to evaluate differences and relationships among audiological measures.

Results: Significant positive correlations were found between SII and WRS in both age groups (r=0.73 for younger adults; r=0.65-0.70 for older adults). Older adults had higher high-frequency thresholds and lower WRS ($p<0.001$), but no age-related differences were observed in SII or the pure-tone average.

Conclusion: The English-based SII can be used as a provisional tool for Turkish speakers, but age-related and frequency-specific variations highlight the need for a language-specific model.

Keywords: Speech intelligibility index, sensorineural hearing loss, age factors, Turkish language, word recognition, pure-tone average

INTRODUCTION

Speech intelligibility refers to a listener's ability to perceive speech under specific listening conditions and is often assessed as a measure of speech comprehension. It depends on the spectral and temporal characteristics of speech (1,2), the level of background noise (3), the dynamic range of the speech spectrum (4), the listener's hearing capacity (5), and the fundamental features of the target language (6). The speech intelligibility index (SII) quantifies weighted audibility across frequency bands at a given signal-to-noise ratio by using language specific band importance functions (BIF) and band audibility functions (7,8). Essentially, the amount of speech information accessible to the auditory system is determined by how much of the speech spectrum rises above the listener's hearing thresholds.

Language-specific differences determine the frequency weighting that forms the foundation of SII predictions. Languages vary in the extent to which they rely on particular bands, leading to distinct BIF profiles (6,9). For example, Korean places greater emphasis on lower bands than English and Mandarin do (10). Specifically for Turkish, agglutinative suffixation and vowel harmony increase the functional load of low-to-mid vowel energy, whereas English places greater weight on high-frequency consonantal cues (11-14). For instance, the high frequency /s/, which encodes plurality and possession in English, has no direct morphological counterpart in Turkish, which may shift band importance toward lower bands (10,15). This suggests that information may be concentrated in bands dominated by vowel energy rather than by high-frequency frication. Consistent with this linguistic profile, Turkish long-term average speech spectra (LTASS) indicate relatively elevated

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low-to-mid-frequency bands, providing an acoustic basis for reweighting band importance toward these frequencies (11). Taken together, these linguistic and acoustic features motivate a redistribution of band-importance toward lower frequencies and provide a principled rationale for deriving Turkish-specific BIFs.

The predictive validity of the SII is modulated by age-related factors. Although the SII demonstrates robust associations with speech recognition outcomes in both normal-hearing and hearing-impaired populations, prediction accuracy diminishes systematically in older listeners (16,17). This decline reflects age-related suprathreshold auditory deficits, particularly degraded temporal processing and difficulty understanding speech in noise (18,19). Notably, these age-dependent effects remain observable when language-specific weightings are applied, highlighting the need to account for both linguistic characteristics and age-related changes in auditory processing when making SII-based predictions (20).

In clinical practice, modern hearing aid analyzers compute SII with English-based parameters. Recent speech intelligibility studies have examined metrics for assessing communicative ability or simulated hearing loss in Turkish (21,22). However, these studies do not permit the development of a clinically usable model that predicts speech perception by estimating SII from audiometric data. Therefore, the aim of this preliminary study was to determine how the English-based SII differs among Turkish individuals and to explore its relationship with word recognition score (WRS), hearing thresholds, and pure tone averages (PTA) in Turkish-speaking older and younger adults.

METHODS

Participants

In this retrospective, cross-sectional study, data were obtained from the medical records of patients who visited the clinic between 2022 and 2023. Ethical approval for the study was obtained from the İstanbul Medeniyet University Göztepe Training and Research Hospital Clinical Research Ethics Committee (decision no: 2021/0596, date: 24.11.2021) before data collection.

A total of 202 patient records were initially reviewed. Of these, 41 records were excluded because they did not meet the inclusion criteria. The sample consisted of 161 individuals, including 80 females and 81 males, ranging in age from 16 to 95 years [mean age 63.5 years, standard deviation (SD)=18.6 years]. A total of 322 hearing test results (ears) were collected, including the pure tone average, speech recognition threshold (SRT), and WRS.

The participants were categorized into two age groups: younger adults (aged below 65 years) and older adults (aged 65 years and above). The younger adult group consisted of 68 participants (38 women, 30 men) with a mean age of 45.99 years (SD=14.63 years), while the older adult group included 93 participants (42 women, 51 men) with a mean age of 76.58 years (SD=6.84 years).

All participants were confirmed to have sensorineural hearing loss, with no individual exhibiting an air-bone gap of more than 10 decibel (dB) hearing level at any frequency. The inclusion criteria were as follows: absence of audiological findings suggestive of retrocochlear pathology, such as asymmetric hearing loss or disproportionately poor word-recognition scores relative to the degree of hearing loss; absence of conductive pathology; and hearing and behavioral thresholds obtained at all frequencies. Individuals who did not meet these criteria were excluded. Therefore, criterion-based convenience sampling was employed in this study.

Sample size calculation was performed using G*Power software to ensure sufficient statistical power for the analyses. The calculation was based on a two-tailed Fisher Z-test to compare two independent Pearson correlation coefficients, with an expected effect size q=0.6, an alpha error probability of 0.05, and a power of 0.95. The analysis indicated a required total sample size of 152 participants, with 76 per group. The actual sample size in this study (322 ears, corresponding to 161 participants) exceeds this requirement, ensuring robust statistical power for the planned analyses.

Procedures

For each ear of the patients, air conduction hearing thresholds at 250 Hz, 500 Hz, 1 kHz, 2 kHz, 4 kHz, 6 kHz, and 8 kHz, four-frequency PTA (500 Hz-4 kHz), SRTs and WRS which are from using Turkish monosyllabic word recognition test (TMWRT) were obtained. TMWRT was a standardized, phonetically balanced single-syllable speech recognition test developed for Turkish (23).

To determine the SII scores, an Audioscan Verifit hearing aid analyzer was used. Air conduction hearing thresholds for each patient were entered into the software. Unaided SII values were calculated for each ear assuming a nominal speech input level of 65 dB sound pressure level (SPL). Calculations were performed using the Audioscan Verifit Speechmap module, which implements the ANSI/ASA S3.5-1997 1/3-octave band method with standard English BIF weights. The calculation excluded the 160 Hz band and did not incorporate masking effects. The SII scale ranges from 0.0 to 1.0.

Statistical Analysis

All statistical analyses were conducted using the R statistical software (version 4.3.1). Descriptive statistics provided an initial overview of data distribution. We assessed normality using the Shapiro-Wilk test; normality was confirmed only for hearing thresholds at 2,4,6, and 8 kHz. Therefore, non-parametric tests were used. Using the Wilcoxon signed-rank test, we compared, between ears, hearing thresholds at each frequency and PTA, WRS, SRT, and SII. Spearman's rank correlation was employed to assess the relationships between variables. The strengths of the correlation coefficients were interpreted according to Evans (24): $r<0.20$ as very weak, 0.20-0.39 as weak, 0.40-0.59 as moderate, 0.60–0.79 as strong, and $r \geq 0.80$ as very strong. Mann-Whitney U tests were performed to examine differences in WRS, SRT, and PTA between younger and older adults. To investigate whether the correlation between the SII and WRS differs between younger and older adults and whether the relationships of both the SII and WRS with hearing thresholds across frequencies vary between these age groups, Fisher Z-tests with bootstrap analysis were employed.

RESULTS

The study analyzed two groups of participants with hearing loss: younger adults (aged 32-64 years) and older adults (aged 65-95 years). The variables examined included hearing thresholds, PTA, SRTs, WRSs, and SII values. Analyses were conducted at the ear level. To assess the assumption of independence, we first tested for systematic right-left differences and found no statistically significant differences for SII, PTA, or WRS between ears (p>0.05). We then analyzed within-subject, ear-to-ear correlations and observed very strong correlations for SII, PTA, and WRS, with correlation coefficients (r) ranging from 0.85 to 0.95.

Hearing Thresholds Across Age Groups

Table 1 provides detailed descriptive statistics and compares hearing thresholds between groups across frequencies. Mann-Whitney U tests revealed significant age-related differences in the high-frequency range (4000-8000 Hz) in both ears (p<0.05), with increased thresholds in older adults. For example, at 8000 Hz, the threshold value was approximately 14 dB higher in the right ear (p<0.001) and 15 dB higher in the left ear (p<0.001), compared to the younger adult. In Figure 1, the mean hearing threshold values, with SDs, are plotted for both ears across frequency levels for younger and older adults.

PTA, SRT, and SII

The descriptive statistics for the audiological variables, including PTA, SRT, WRS, and SII values, are summarized in Table 2. The data are presented separately for younger and older adults, as well as for the right and left ears.

Comparison of Audiological Measures Between Ears and Age Groups

The Wilcoxon signed-rank test showed no difference between the right and left ears for hearing thresholds and PTA, WRS, SRT, and SII values (p>0.05). Mann-Whitney U tests were performed to examine differences in WRS, SRT, PTA, and SII between younger and older adults. WRS and SRT results revealed statistically significant differences. Younger adults demonstrated higher WRS (right ear: p<0.001; left ear: p<0.001) and lower SRT (right ear: p<0.001; left ear: p<0.001) than older adults. However, no significant differences were observed between younger and older adults in PTA or SII measures (p>0.05).

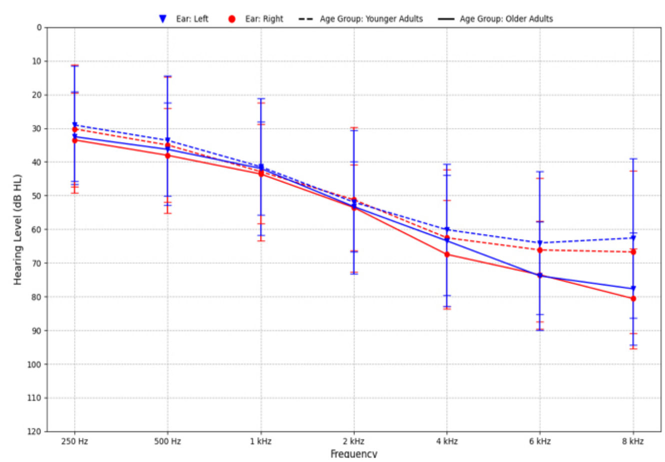

Figure 1. Mean and standard deviation of hearing thresholds by frequency and age group

Table 1. Hearing thresholds across frequencies: descriptive statistics and inter-group comparison

Frequency (Hz) Mean		Younger adults (n=68)						Older adults (n=93)						Between-group difference
		Median	SD	Min-max	95% CI lower	95% CI upper	Mean	Median	SD	Min-max	95% CI lower	95% CI upper	p-value	
250 Hz	R	30.22	25	19.07	5-90	25.51	34.99	33.49	30	13.92	10-85	30.75	36.50	0.037
	L	29.06	25	17.56	0-80	24.85	33.67	32.53	30	13.30	5-75	29.94	35.26	0.050
500 Hz	R	35.00	30	20.26	10-100	30.20	40	38.06	35	13.91	15-100	35.32	41.07	0.043
	L	33.62	30	19.15	5-90	29.77	38.67	36.29	35	13.83	10-70	33.38	39.08	0.073
1000 Hz	R	42.90	40	20.44	5-100	37.72	47.35	43.60	45	14.73	15-95	40.53	46.77	0.411
	L	41.45	40	20.24	10-105	36.98	46.61	41.94	40	13.85	15-80	39.14	44.73	0.379
2000 Hz	R	51.23	50	21.48	10-115	45.88	56.32	53.55	55	12.80	20-80	50.91	56.29	0.179
	L	51.96	50	21.30	10-115	47.79	57.94	53.28	55	13.40	25-90	50.43	56.02	0.236
4000 Hz	R	62.54	60	20.34	20-120	57.50	67.79	67.47	65	16.13	30-110	64.03	70.85	0.048
	L	60.14	60	19.52	15-120	56.17	65.43	60.14	60	19.52	15-120	63.44	69.30	0.005
6000 Hz	R	66.16	65	21.25	20-120	60.73	70.58	73.55	75	16.01	25-110	70.05	76.61	0.006
	L	64.06	65	21.15	15-120	60.14	69.70	73.87	75	16.12	35-110	70.64	77.25	0.002
8000 Hz	R	66.74	70	24.16	5-120	60.59	71.90	80.59	80	14.80	45-115	77.41	83.54	<0.001
	L	62.61	65	23.68	5-120	57.42	68.30	77.69	75	16.63	30-120	74.40	81.18	<0.001

R: Right ear, L: Left ear, Mean: Average, Median: Middle value, SD: Standard deviation, Min-max: Minimum-maximum values, CI: Confidence interval, p-value: Significance level

Table 2. Descriptive statistics of PTA, SRT, WRS, and SII values in younger and older adults

R		PTA		SRT		WRS		SII	
		L	R	L	R	L	R	L	
Younger adults	Mean	47.72	47.24	44.93	45.59	70.35	70.50	0.38	0.38
	Median	45.00	43.75	40.00	40.00	72.00	76.00	0.38	0.39
	SD	17.25	16.74	16.63	15.75	20.19	18.71	0.26	0.24
	Min-max	23.75-100	23.75-105.00	25.00-95.00	25.00-95.00	8.00-100.00	16.00-96.00	0.00-0.82	0.00-0.79
Older adults	Mean	50.67	49.45	52.37	50.91	59.53	60.13	0.30	0.31
	Median	51.25	48.75	50.00	50.00	60.00	64.00	0.27	0.31
	SD	11.93	10.95	13.68	13.12	17.70	18.20	0.20	0.19
	Min-max	27.50-87.50	27.50-80.00	25.00-95.00	20.00-85.00	0.00-92.00	0.00-92.00	0.00-0.73	0.00-0.72

R: Right ear, L: Left ear, Mean: Average, Median: Middle value, SD: Standard deviation, Min-max: Minimum-maximum values, PTA: Pure-tone average, SRT: Speech reception threshold, WRS: Word recognition score, SII: Speech intelligibility index

Correlations Between PTA, WRS, and SII

Spearman's rank correlation was used to examine the relationship between WRS and SII for both younger and older adults. A strong positive correlation was observed between WRS and SII in younger adults for the right ear (r=0.73, p<0.001) and the left ear (r=0.73, p<0.001). Similarly, older adults showed strong positive correlations for the right ear (r=0.65, p<0.001) and the left ear (r=0.70, p<0.001). The relationship between PTA and SII was also examined. In younger adults, very strong, statistically significant negative correlations between PTA and SII were observed in both the right (r=-0.95, p<0.001) and left (r=-0.95, p<0.001) ears. Older adults exhibited very strong negative correlations in both the right (r=-0.93, p<0.001) and left (r=-0.94, p<0.001) ears. Scatterplots with locally estimated scatterplot smoothing curves visually confirmed trends in the relationships between the SII and the WRS, and between the SII and the PTA. The relationship between SII and WRS (Figure 2) showed a positive trend, suggesting that higher SII values correspond to improved word recognition performance in both younger and older adults. In contrast, the relationship between SII and PTA (Figure 3) exhibited a negative, indicating that increased PTA values were associated with reduced SII.

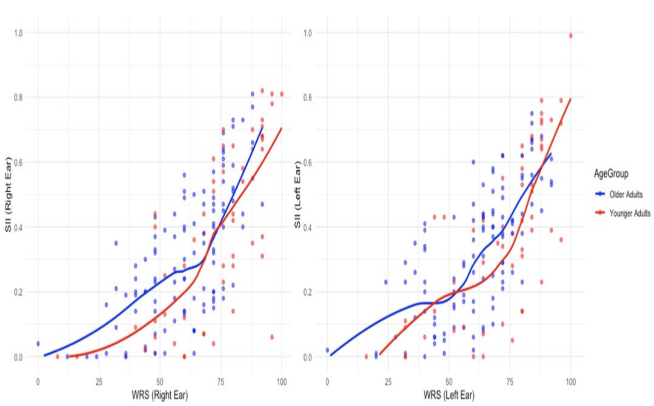

Figure 2. Relationship between SII and WRS with LOESS curves
SII: Speech intelligibility index, WRS: Word recognition score, LOESS: Locally estimated scatterplot smoothing

Frequency-specific Correlations

Table 3 summarizes Spearman's rank-order correlation coefficients (r) between hearing thresholds at various frequencies and WRS and SII in both younger and older adults. The analysis revealed significant correlations across all examined frequencies, highlighting age-dependent differences in these relationships. For younger adults, hearing thresholds showed very strong negative correlations with WRS and SII, particularly at lower frequencies (e.g., 1000 Hz: r=-0.914 for WRS-left and r=-0.89 for SII-right; p<0.001). Similarly, older adults exhibited significant correlations,

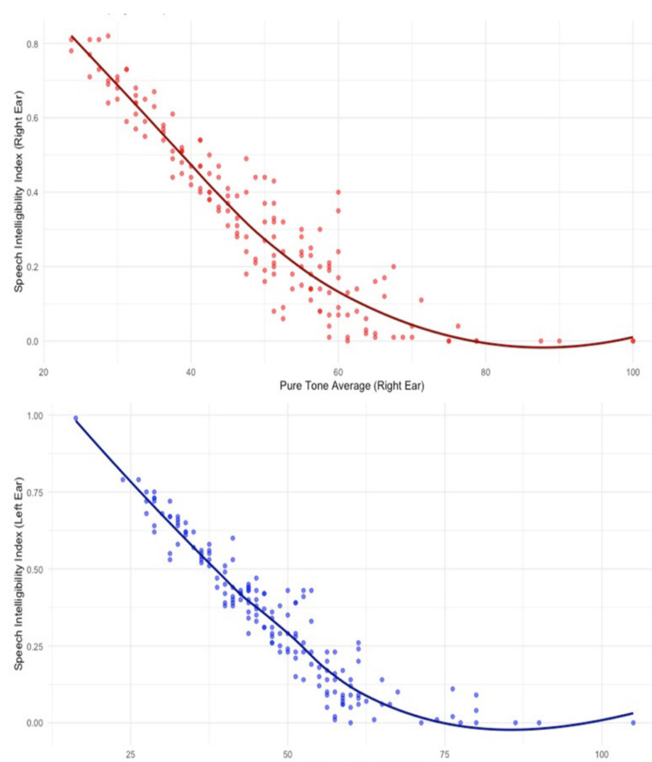

Figure 3. Relationship between SII and PTA with LOESS curves
SII: Speech intelligibility index, PTA: Pure tone averages, LOESS: Locally estimated scatterplot smoothing

Table 3. Spearman's rank-order correlations (r) between hearing thresholds at various frequencies and speech understanding measures

	Younger adults								Older adults							
	WRS				SII				WRS				SII			
	Right		Left		Right		Left		Right		Left		Right		Left	
	(r)	(p)	(r)	(p)	(r)	(p)	(r)	(p)	(r)	(p)	(r)	(p)	(r)	(p)	(r)	(p)
250 Hz	-0.699	<0.001	-0.694	<0.001	-0.65	<0.001	-0.64	<0.001	-0.75	<0.001	-0.7	<0.001	-0.7	<0.001	-0.68	<0.001
500 Hz	-0.780	<0.001	-0.755	<0.001	-0.74	<0.001	-0.72	<0.001	-0.919	<0.001	-0.87	<0.001	-0.88	<0.001	-0.82	<0.001
1000 Hz	-0.920	<0.001	-0.914	<0.001	-0.89	<0.001	-0.88	<0.001	-0.921	<0.001	-0.938	<0.001	-0.89	<0.001	-0.92	<0.001
2000 Hz	-0.866	<0.001	-0.853	<0.001	-0.84	<0.001	-0.81	<0.001	-0.825	<0.001	-0.776	<0.001	-0.8	<0.001	-0.77	<0.001
4000 Hz	-0.514	<0.001	-0.592	<0.001	-0.47	<0.001	-0.56	<0.001	-0.486	<0.001	-0.367	<0.001	-0.45	<0.001	-0.35	<0.001
6000 Hz	-0.431	<0.001	-0.498	<0.001	-0.42	<0.001	-0.45	<0.001	-0.268	0.009	-0.313	0.002	-0.25	0.013	-0.29	0.009
8000 Hz	-0.406	<0.001	-0.439	<0.001	-0.39	<0.001	-0.42	<0.001	-0.098	0.348	-0.231	0.026	-0.1	0.340	-0.2	0.045

WRS: Word recognition score, SII: Speech intelligibility index, r: Spearman's correlation coefficient, Right: Right ear, Left: Left ear, p: p-value

with notable differences at higher frequencies where correlations were generally weaker (e.g., at 8000 Hz: r=-0.406 for WRS-right in younger adults versus r=-0.098 in older adults, p<0.05). Figure 4 illustrates the frequency-specific Spearman correlations for WRS and the SII across younger and older adults.

Comparison of Correlation Strength Between Younger and Older Adults

The Fisher Z-test was conducted to compare the strength of correlations between the SII and WRS across younger and older adults, examining whether the relationship differed significantly between the two age groups. Because of the non-normal distribution of our data, a bootstrap analysis was also performed to estimate non-parametric confidence intervals (CI) for differences between correlations. The results revealed no statistically significant differences in the correlation between the SII and WRS for younger and older adults in either the right ear (Z=0.86, p>0.05) or the left ear (Z=0.30, p>0.05). When comparing WRS and SII between younger and older adults across frequency-specific hearing thresholds, the Fisher Z-test identified significant differences at 500 Hz for both WRS (Z=3.3, p=0.005) and SII (Z=2.613, p=0.045). However, the bootstrap analysis for this frequency did not support this finding, as the 95% CI included zero (CI: -0.2528 to 0.3097). For the remaining frequencies, the differences between the groups were also not statistically significant (p>0.05).

DISCUSSION

In this study, we examined the feasibility of using the English-based SII among Turkish-speaking individuals with sensorineural hearing loss the results showed significant correlations between SII and WRS, and between SII and PTA and hearing thresholds at individual frequencies, in both younger and older adults.

Hearing Loss and Speech Intelligibility

A strong negative correlation between SII and PTA was observed. Correlations between the thresholds (250-2000 Hz) and both WRS and SII were particularly high (>0.75) but decreased with

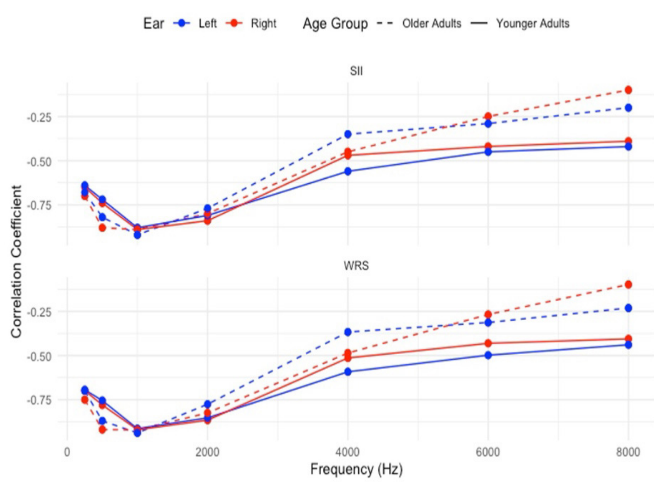

Figure 4. Frequency-specific spearman correlations of WRS and SII
WRS: Word recognition score, SII: Speech intelligibility index

increasing frequency. This is consistent with studies highlighting the critical role of this frequency range in SII and the association between this frequency range and elevated BIFs (15,25,26). Notably, the impact of language-specific characteristics on results is highlighted by differences in BIFs across languages (6,9,27). Similar to the differences observed in BIF, LTASS studies have revealed language-specific features, suggesting that frequency distributions may be influenced by the language's phonetic characteristics (11,28). These linguistic characteristics indicate that Turkish relies more heavily on low- to mid-frequency bands and less on high-frequency fricative information (e.g., /s/-like sounds). This interpretation is consistent with the frequency-specific patterns observed in our data.

Word Recognition and Speech Intelligibility

The findings of our study indicate that the English-based SII, despite lacking Turkish-specific BIF, retains robust sensitivity as a general measure of audibility. A strong positive correlation between SII and Turkish WRS in younger and older adults is consistent with previous studies confirming the predictive power of SII for speech recognition in both normal-hearing and hearing-impaired individuals (13,16,29). We also found strong relationships between WRS and frequency-specific thresholds, which suggest that SII derived from English may provide clinically meaningful estimates in the Turkish-speaking population. Although this confirms its utility as a functional baseline, the generalizability of English-based standards remains questionable. The concentration of information in the lower band in Turkish, driven by its LTASS and agglutinative structure, suggests frequency-dependent differences in SII-performance predictions compared with English. Factors such as Turkish vowel harmony, agglutinative structure, vowel-to-consonant frequency ratios, and phonetic characteristics may contribute to variations in SII values across specific frequency bands (11). Studies in other languages have shown that language-specific SII adaptations improve predictive accuracy (6,20,27). Although the English-based SII provides a functional baseline, we believe that developing Turkish BIFs would be a logical next step to enhance the precision of this metric within clinical protocols.

Effects of Age

Our results indicate that older adults exhibited significantly higher SRTs and significantly lower WRSs than younger adults. These findings are consistent with previous studies showing that progressive hearing loss and age-related changes in cognitive processes negatively affect speech-recognition performance (16-18). However, no significant differences in the PTA or the SII were observed between younger and older adults. One possible explanation for the lack of significant differences between the two groups is the homogeneity of participants' hearing loss and the reliance of PTA and SII results on average hearing thresholds. PTA and SII mainly reflect audibility; thus, compensatory effects across frequencies might mask the age-related differences in these summary measures. While the SII effectively quantifies audibility for speech intelligibility prediction, it does not fully account for suprathreshold deficits associated with aging, such as reduced temporal resolution and impaired speech-in-noise performance (17,30,31). A high SII value may therefore fail to capture these limitations. Consequently, the SII should be regarded primarily as an audibility index rather than a complete measure of intelligibility.

In both younger and older adults, strong positive correlations were observed between WRS and SII, and strong negative correlations between PTA and SII. However, the Fisher Z-test showed no statistically significant differences between the correlation coefficients of these measures specifically between PTA and either WRS or SII across the groups at any tested frequency. Although not statistically significant, the correlation coefficient for 500 Hz hearing thresholds was higher in older adults. However, this trend decreased with increasing frequency. These observations indicate that age-related changes in hearing, particularly in critical frequency regions, may contribute to reduced predictive accuracy of the SII in older adults. Previous literature suggests that the predictive accuracy of the SII may deteriorate with age (20,32), especially under challenging listening conditions (18). Future studies should consider the impact of these age-related differences on the development of Turkish-derived SII models.

Clinical Implications and Future Directions

The studies of English-based SII conducted with non-English-speaking participants are limited. One study by Figueiredo et al. (33) compared unaided and aided SII values in Portuguese-speaking children with respect to the degree and configuration of hearing loss. They found that the average thresholds at 2000 Hz and 500 Hz were significant predictors of SII 65 values. In another study, the same researchers demonstrated how SII values varied at different input levels in a similar sample (34). Although SII is an important indicator based on sample data, the fact that they did not evaluate its relationship with speech perception creates uncertainty about the extent to which the results might differ for this Portuguese-speaking population. Nigri and Iório (32) assessed the relationship between verified aided SII, based on the desired sensation level (DSL) formula, and WRS at 65 dB SPL in Portuguese elderly individuals over 60 years of age and found a weak linear correlation. In contrast to our study, they found a weak relationship between aided SII and WRS. A possible explanation is that using the DSL v5 prescriptive method uniformly for all participants and matching amplification targets to real-ear measurements likely increased SII scores significantly. Thus, the SII scores became more similar across participants, regardless of individual differences in speech recognition. This produced a ceiling effect, thereby attenuating the observed relationship between SII and WRS. None of these studies discussed the linguistic dependency of SII and its potential impacts on results.

The integration of English-based SII values into audiological assessment and hearing aid analysis tools raises questions about their practical utility for non-English-speaking populations. Our study has demonstrated that these values can provide significant predictive utility for Turkish-speaking individuals. Nevertheless, the age-related differences in correlation coefficients at specific frequencies suggest that a linguistically adapted model could offer even greater predictive accuracy, thereby providing a strong rationale for establishing a Turkish-specific standard. Future research should therefore aim to develop a Turkish-specific model, primarily by deriving key language-specific parameters, such as BIF and its associated transfer function.

Study Limitations

This study has several limitations. First, English-based SII calculations were applied to Turkish participants, thereby ignoring Turkish-specific differences that may affect the SII. However, the aim of this preliminary study was to discuss situations that may arise from this discrepancy and help establish SII standards. Second, the use of a 65-year cut-off, though common in audiological research, may introduce bias because of unequal group sizes and heterogeneous aging trajectories. Third, SII values were obtained at a fixed speech level (65 dB SPL), limiting the generalizability to real-world listening conditions. Additionally, due to the retrospective nature of the study design, heterogeneity among the obtained results may affect the outcomes despite the inclusion criteria we used. This should be taken into account. Lastly, analyses were conducted at the ear level to preserve clinically meaningful ear-specific variability. However, we acknowledge that ear level analyses may introduce within subject non-independence that can modestly reduce the effective sample size; therefore, p-values and CIs should be interpreted with this consideration in mind.

CONCLUSION

The SII, which is based on English, demonstrates clear, provisional usefulness for Turkish-speaking individuals and aligns well with WRS. However, reduced predictive accuracy among older adults and frequency-specific differences support the development of a Turkish-specific SII. Clinically, the current SII can be used for counseling and verification; however, caution is warranted in older adults and in high-frequency-weighted contexts.

Ethics

Ethics Committee Approval: Ethical approval for the study was obtained from the İstanbul Medeniyet University Göztepe Training and Research Hospital Clinical Research Ethics Committee (decision no: 2021/0596, date: 24.11.2021) before data collection.

Informed Consent: Retrospective study.

Footnotes

Author Contributions: Concept - A.A., M.E., M.T.K.; Design - A.A., M.E., M.T.K.; Data Collection and/or Processing - A.A., M.E., C.T.S.; Analysis and/or Interpretation - A.A., M.E., C.T.S., M.T.K.; Literature Search - A.A., M.E., C.T.S.; Writing - A.A.

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