Research Article

Translation and Adaptation of the North Wind and the Sun Passage for Persian: A Phonetically Balanced Passage for the Persian Language

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Short running title: Translation and Adaptation of the North Wind…

Highlights:
- The Persian NWS passage maintains phonetic balance for accurate speech assessments
- Expert validation confirms linguistic accuracy, ensuring clarity in Persian speech
- Enables cross-linguistic phonetic analysis and supports hearing aid validation

ABSTRACT
Background and Aim: Standardized speech passages are essential tools in audiological assessments, particularly for verifying hearing aid performance and evaluating speech perception. To ensure linguistic and cultural relevance, these passages must be adapted to reflect the phonetic characteristics of the target language. This study focused on the translation and phonological adaptation of the North Wind and the Sun (NWS) passage into Persian, aiming to provide a linguistically balanced and culturally appropriate stimulus for use in speech-based verification protocols.

Methods: The NWS passage was translated into Persian with targeted phonetic and syntactic adjustments to ensure phoneme balance and linguistic coherence. Phoneme frequencies were compared to reference Persian studies, and expert reviewers evaluated clarity, naturalness, and content validity using Content Validity Ratio (CVR) analysis. Revisions were made based on feedback to optimize semantic integrity and phonetic distribution.
Results: The translated NWS passage contained 558 phoneme occurrences, with /a/ as the most frequent (63 times), aligning with Persian speech studies. The phoneme distribution stayed within the ±1 SD range, confirming linguistic consistency. Expert evaluations yielded a CVR of 0.85, surpassing the 0.78 threshold, validating its relevance for speech research. The Face Validity Ration (FVR) of 4.7 affirmed clarity, phonetic balance, and natural fluency in Persian speech assessments.
Conclusion: The translated NWS passage maintains phonetic balance with Persian linguistic norms, ensuring accuracy in speech mapping and verification of hearing aids. Its adaptability for phonetic research and hearing aid validation highlights its relevance for Persian-speaking populations and cross-linguistic comparisons.
Keywords: Hearing loss; speech perception; phonetics; hearing aids

Introduction

Hearing loss is a global health issue affecting millions, with a 56.1% increase expected by 2050, affecting 2.45 billion people globally [1]. Using hearing aids is a primary intervention for hearing loss, significantly improving the quality of life and communication skills [2].

Hearing aid verification is crucial for ensuring they function as intended and meet user requirements [3]. Selecting appropriate stimuli, such as speech-like noise, speech-modulated noise [4], or continuous discourse, helps measure cortical auditory-evoked potentials and event-related potentials by providing a realistic and engaging stimulus that elicits meaningful cortical responses, facilitating better assessment of auditory processing, especially in clinical settings [5], while spectral differences and stimulus duration can affect measured gain [6, 7].

The native language of speakers is crucial in hearing aid verification, as it allows for tailoring settings to specific phonetic and linguistic characteristics [8]. The speech intelligibility index varies across languages, and language-specific adjustments may be necessary for grammatical structures [8, 9].

The International Speech Test Signal (ISTS) is a tool for evaluating hearing aid performance, sound quality, and simulating real-world situations [10]. It was developed using the North Wind and the Sun (NWS) passage. Since 1912, linguists have contributed phonetic transcriptions of the passage in different English dialects, including Californian [11], Southern Michigan [12], Tyneside British English [13], and RP British English [14], making it a valuable tool for speech research. It tells the story of a contest between the NWS regarding their abilities to remove a traveler's cloak [15].

The NWS passage, used for phonetic assessments, has several limitations, including the absence of specific phonemes like /ʒ/, missing initial and medial /z/, and limiting the representation of dark /l/ [15]. Additionally, the omission of diphthongs and triphthongs impacts vowel analysis, especially in received pronunciation speakers [15]. High lexical repetition also limits phonetic diversity, reducing opportunities to observe speech variations [11]. The Persian language has significant structural differences compared to English, including fewer vowels, consonants, and tense/lax vowel distinctions [16]. Syllable structure and stress patterns differ, requiring modifications for natural fluency [17]. Persian uses a lower fundamental frequency in formal registers, affecting intonation patterns [18]. The average reading rate in Persian reading-style speech is five syllables per second [19, 20], requiring refinements in translation to preserve intonational meaning. Translating The NWS into Persian is essential for effective linguistic analysis and comparison.

The study aimed to culturally and phonologically adapt the NWS passage through phonemic transcription for use in ISTS-based stimuli, ensuring linguistic inclusivity in audiology research, improving global applicability of standards, and promoting equity in hearing healthcare services.

Methods

This study involves translating the fable NWS from English into Persian, incorporating phonetic modifications to enhance linguistic coherence. The original passage, extracted from the International Phonetic Alphabet (IPA) book, underwent a thorough phonetic analysis to optimize the phoneme balance. Drawing from a reference book [21], the adaptation of the NWS passage into Persian involved deliberate refinements in lexical choice and syntactic structure to meet phonotactic norms and achieve phoneme balance. Selected words maintained semantic

clarity while incorporating less common Persian phonemes such as /ʒ/, /z/, and voiced fricatives. Furthermore, sentence patterns were reshaped to follow the Persian subject-object-verb order and maintain a rhythmic syllable flow, ensuring natural prosody and an even distribution of phonemes throughout the text. Throughout the process, phonemes were represented using IPA, adhering to Martin's framework to maintain phonetically balanced speech materials [22]. To achieve phoneme equilibrium, the phoneme frequency in the translated passage was compared to previous Persian language studies. We utilized available Persian phonetic studies, which were the only accessible research examining phoneme frequency distribution, including the works of Movalelli [23], Mosleh [24], Eslami et al. [25], Mohamadi et al. [26], and Adel Ghahraman et al. [27] These studies provided essential reference points for assessing phoneme balance and linguistic consistency within Persian speech. The average frequency for each phoneme and Standard Deviation (SD) was calculated, with ±1 SD values determined to establish an acceptable range. Necessary modifications were made by selecting and adjusting words and phrases to fine-tune phoneme distribution while preserving semantic accuracy and fluency.

A panel of five expert speech therapists, three linguists, and five audiologists, all native speakers of Persian, evaluated the translated and phonetically balanced NWS to ensure its appropriateness for Persian-speaking populations. This assessment examined clarity, naturalness, and linguistic suitability, establishing Face Validity Ratio (FVR) through expert judgment. The comprehensiveness and representativeness of the NWS content were also reviewed, and content validity was verified by determining whether the translation sufficiently encompassed Persian speech sounds and linguistic features relevant to speech perception. Content validity was further examined using a 3-point Likert scale (1=not relevant, 2=relevant, 3=highly relevant), with the Content Validity Ration (CVR) computed for each item. A threshold of 0.78 indicated sufficient content validity [28], ensuring items above this criterion were suitable for Persian speech perception evaluation. Additionally, experts verified that the vocabulary was linguistically accessible, maintaining semantic integrity while optimizing phonetic balance. Feedback was systematically integrated, and revisions were made to refine the clarity and validity of the NWS adaptation. This study was approved by the Institutional Ethical Review Board (Approval Code: IR.IUMS.REC.1402.988).

Results

In the translated NWS, a total of 558 phoneme occurrences were analyzed. The most frequent phoneme in the translated passage is /a/ (63 occurrences), aligning with findings in other studies [28-30], which emphasize its high prevalence in Persian speech processing and recognition tests (Table 1).

The phoneme frequency falls within the ±1 SD range of prior studies for the majority of phonemes, confirming phonetic consistency with Persian linguistic norms. This alignment suggests that the translated NWS maintains phoneme balance, making it a suitable speech sample for perceptual and phonetic evaluations. The distribution pattern of key phonemes supports natural speech representation, ensuring applicability for speech recognition, acoustic analysis, and phonetic assessments in Persian-speaking populations (Figure 1).

Expert evaluations revealed that the overall average CVR for the NWS translation was 0.85, indicating a high level of relevance in assessing speech perception among Persian-speaking populations. This score exceeds the recommended threshold of 0.78, indicating that the translated passage effectively represents the phonetic and linguistic structures necessary for valid speech assessment. Additionally, the average FVR was 4.7, indicating that experts considered the translated materials to be exceptionally natural, clear, and contextually appropriate for Persian speakers. This high rating indicates that the phonetic modifications integrated into the translation maintain fluency and intelligibility, ensuring alignment with spoken Persian norms while preserving semantic integrity.

The combination of high CVR and FVR values confirms the NWS translation's linguistic accuracy, phonetic balance, and perceptual suitability, reinforcing its applicability for standardized speech assessments among Persian-speaking individuals.

Discussion

The findings of this study demonstrate that the phoneme distribution in the translated NWS passage closely aligns with standard Persian, suggesting that the adapted passage maintains the phonetic characteristics necessary for speech perception assessments in Persian-speaking populations. The methodology used to achieve phonetic balance ensured a natural speech flow while preserving semantic integrity. The analysis of phonetic distribution confirmed that most phonemes fell within the range of ±1 SD compared to previous Persian studies, reflecting a

balanced linguistic representation. Maintaining phonetic stability is critical for minimizing potential distortions in speech assessments. The CVR score of 0.85 indicates that most items were considered highly relevant for evaluating speech perception in Persian. The FVR score of 4.7, which reflects high clarity and naturalness, further supports the passage's suitability for Persian-speaking populations.

To the best of our knowledge, there are only a limited number of studies in the Persian language that have systematically employed phoneme frequency analysis to guarantee phoneme balance. This limited foundation constrained our ability to incorporate broader dialectal diversity and large-scale phoneme distribution analysis in the present study. Among these studies, Movalelli developed a lipreading test for hearing-impaired adults, emphasizing phoneme recognition through visual cues. Their study underscored the necessity of ensuring that the phonemes included in the test were well-represented to avoid biases in the lipreading task [23]. Similarly, Mosleh created a speech recognition test for Persian-speaking adults, focusing on phoneme intelligibility and the acoustic properties of speech. Their approach similarly utilized phoneme frequency analysis to ensure that no phoneme was disproportionately represented, thus ensuring a more accurate measure of speech recognition abilities in the Persian language [24]. Adel Ghahraman et al. focused on the development of a speech recognition test for young Persian-speaking children. They used phoneme frequency analysis to design stimuli that were linguistically appropriate for children aged 4 to 6 years. This age-specific approach highlights the importance of phoneme balance in ensuring that assessments are both developmentally appropriate and reliable [27]. Eslami et al. provided a detailed statistical analysis of the phoneme frequency distribution in Persian, offering valuable insights into the natural phonetic structure of the language. Their work helped establish a phoneme distribution model that informed the creation of balanced speech stimuli, providing the foundation for speech assessment tools that truly reflect natural speech patterns [25]. In a similar vein, Mohamadi et al. developed a standardized Persian speech sample specifically for evaluating acoustic parameters in voice disorders. Their approach incorporated phoneme balance to ensure that the sample accurately represented the phonetic diversity needed for clinical assessments of voice disorders [26].

All of these studies highlight the importance of phoneme frequency analysis in developing assessments. Phoneme balancing is crucial for developing speech tests that yield accurate, valid, and sensitive measurements [29]. These studies enhance the accuracy of speech assessments across various groups and reduce the likelihood of biased results by ensuring that all phonemes are accurately represented.

In our study, we have similarly prioritized phoneme balance in developing the Persian version of the NWS passage for use in hearing aid verification assessments. This approach ensures that the adapted passage is suitable for constructing speech stimuli that reflect the phonetic characteristics of Persian. Clinically, the passage can be filtered and modified to match different hearing loss profiles, such as high-frequency loss, low-frequency loss, or flat audiograms, allowing for a tailored evaluation of speech perception and hearing aid performance. These applications enhance the reliability and ecological validity of speech-based assessments for Persian-speaking individuals.

Similar efforts in other linguistic contexts further support the importance of developing language-specific speech-like stimuli. Lee et al. demonstrated that ISTS does not accurately reflect Korean acoustic properties, reinforcing the need for native-language verification tools [30]. Similarly, Habasińska et al. found that PSTS was better suited for Polish speakers, as it ensured phonetic consistency that was absent in ISTS [31]. Vinodhini and Geetha further underscored the potential limitations of ISTS in Indian languages, advocating for localized speech stimuli in hearing aid assessments [32]. These findings emphasize the need for language-specific verification methods to enhance audiological evaluation precision and improve hearing aid programming accuracy. The observed differences underscore the limitations of using multilingual or non-native stimuli in hearing aid verification.

Conclusion

The Persian translation of north wind and the sun passage serves as a phonetically balanced passage that incorporates a diverse range of speech sounds, reflecting natural Persian phonetic patterns. It can assess pronunciation, articulation, and phoneme distribution across various languages. It is also valuable for creating speech stimuli for phonetic research, mapping and verifying hearing aids. Additionally, the translated passage can be converted into an audio signal, weighted by frequency based on the type and degree of hearing impairment. This approach is highly beneficial for real-ear measurements used in verification of hearing aids. Future research could examine comparisons across multiple languages to explore how phonetic adaptations influence patient satisfaction with hearing aid amplification and improve speech comprehension ability.

Ethical Considerations

Compliance with ethical guidelines

The study was approved by the Ethics Committee of Iran University of Medical Sciences under the Code No. IR.IUMS.REC.1402.988.

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Authors' contributions

SE: Study design, data acquisition, and manuscript drafting; NR: Study design, supervision, result interpretation, and critical manuscript revision; SJS, and FT: Result interpretation and manuscript revision; MB: reviewing the final manuscript.

Conflict of interest

The authors declare no conflict of interest.

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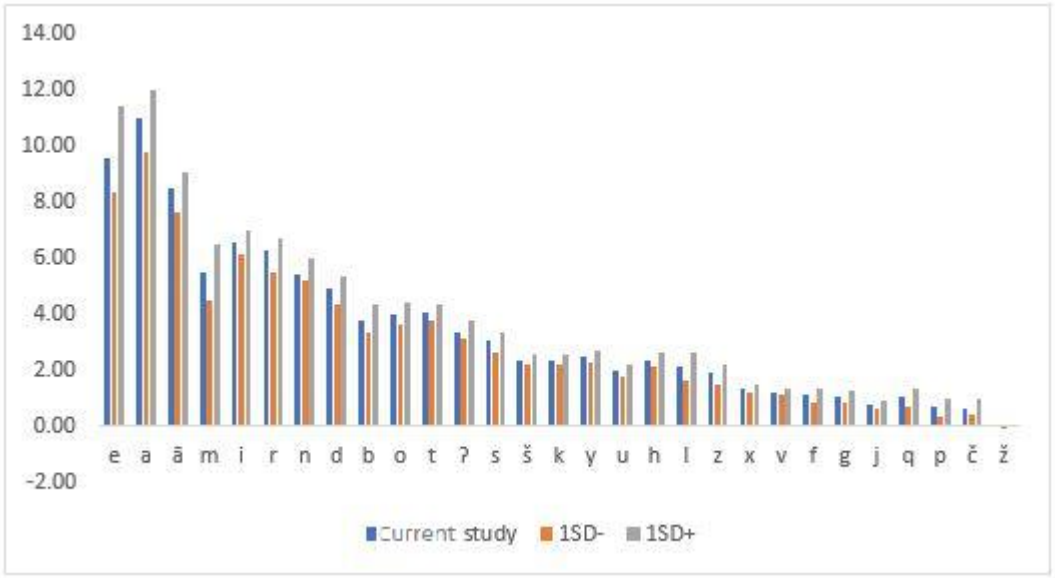

Figure 1. The mean phoneme frequency in the Persian "north wind and the sun" passage compared to ±1 SD from other studies in the Persian language

Table 1. Phoneme frequency in Persian language studies

Phonemes	Frequency in our study	Frequency in Mohamadi et al. [26]	Frequency in Mosleh [24]	Frequency in Eslami et al. [25]	Frequency in Movalleli [23]	Frequency in Ghahreman et al. [27]	Ave
e	9.54	11.30	10.39	7.90	8.58	11.16	9.87
a	11.00	11.20	10.81	9.50	12.47	10.39	10.87
ā	8.46	7.50	8.20	9.30	8.82	7.91	8.35
m	5.45	6.78	5.63	4.00	5.40	5.49	5.46
i	6.58	6.16	6.23	7.20	6.73	6.54	6.57
r	6.29	5.65	6.39	6.70	6.43	5.32	6.10
n	5.42	5.16	5.62	5.70	5.20	6.12	5.56
d	4.92	5.04	4.82	4.20	5.60	4.60	4.85
b	3.76	4.37	3.89	3.10	3.69	4.17	3.84
o	3.98	3.90	4.25	4.40	3.37	4.07	4.00
t	4.05	3.81	3.89	4.00	4.48	4.07	4.05
ʔ	3.31	3.11	3.30	3.20	3.64	3.87	3.42
s	3.07	2.83	2.72	3.50	3.23	2.63	2.98
š	2.36	2.68	2.36	2.10	2.31	2.45	2.38
k	2.34	2.64	2.15	2.30	2.27	2.52	2.38
y	2.48	2.56	2.75	2.20	2.41	2.47	2.48
u	1.96	2.25	2.03	1.90	1.64	2.15	1.99
h	2.35	2.19	2.73	2.20	2.27	2.61	2.40
l	2.13	2.04	1.88	3.00	1.59	2.13	2.13
z	1.92	1.80	1.86	2.40	1.63	1.53	1.84
x	1.35	1.40	1.39	1.10	1.49	1.39	1.35
v	1.21	1.34	1.31	1.10	1.10	1.37	1.24
f	1.15	1.12	1.08	1.50	0.88	0.94	1.10
g	1.05	0.90	1.05	1.40	0.85	0.96	1.03
j	0.78	0.69	0.82	1.00	0.60	0.76	0.77
q	1.02	0.63	1.00	1.50	0.96	0.94	1.01
p	0.70	0.51	0.60	1.20	0.47	0.57	0.67
č	0.66	0.42	0.82	0.40	1.00	0.88	0.70
ž	0.04	0.02	0.04	0.10	0.007	0.01	0.04

Ave; average of phoneme frequency in 5 previous studies