ISSN Online: 3006-4708
ISSN Print: 3006-4694

SOCIAL SCIENCE REVIEW ARCHIVES
https://policyjournalofms.com

Acoustic Analysis of Vowel Variation in Pakistani English Speakers

Umar Riaz [a], Anam Ikhtiar [b], Zeeshan Haider [c], Humaira Salik [d], Husnain Ali [a*]

[a] Institute of Language and Literature, Riphah International University, Islamabad, Pakistan. Chumariaz2@gmail.com
[b] Fulbright foreign language teaching assistant at Hamilton Lugar School of Global and International Studies, Indiana University, Bloomington, USA. anam.ikhtiar@fulbrghtmail.org
[c] National University of Modern Languages, Islamabad, Pakistan. Shaanjatt0222@gmail.com
[d] Riphah International Islamic University, English Department, Lahore, Pakistan, Healthcare Department, NHS UK. humairasalk786@gmail.com
[a*] Anglia Ruskin University, Cambridge. Husnainali8632@gmail.com
***Corresponding author:** Husnain Ali

DOI: https://doi.org/10.70670/sra.v3i4.1213

Abstract
This study investigates the acoustic characteristics of vowel variation in Pakistani English (PakE) speakers by analyzing formant frequencies (F1 and F2) of selected monophthongs. The aim is to explore how native language interference and regional backgrounds influence English vowel production. Twenty educated Pakistani speakers from different provinces participated in the study. The vowel sounds /iː/, /ɪ/, /e/, /æ/, /ʌ/, /ɑː/, /ɒ/, /ɔː/, /uː/, and /ʊ/ were analyzed acoustically using Praat software. The findings revealed systematic deviations from Standard British English (SBE) vowel targets, particularly in front vowel raising and back vowel centralization. These variations reflect the influence of L1 phonological structures and socio-linguistic factors, contributing to the formation of a distinct Pakistani English variety. The study adds to the growing body of phonetic research on South Asian Englishes.

Keywords: Acoustic phonetics, vowel variation, Pakistani English, formant analysis, sociophonetics.

1. Introduction

English has assumed a central role in Pakistan as a second language and as a medium of communication in multiple institutional domains (Haidar and Fang 2019). It is not merely a foreign language but an essential component of the country's socio-educational and administrative fabric. English is widely used in education, the judicial system, the civil bureaucracy, and the media, reflecting its position as a language of prestige and power (Ormrod 2003). As a result, a distinct localized variety, known as Pakistani English (PakE)**,** has gradually evolved. This variety exhibits unique phonological, lexical, syntactic, and pragmatic characteristics shaped by Pakistan's multilingual and multicultural context (Sadiq, Nadeem et al. 2024).

Pakistani English has emerged through sustained contact between English and indigenous languages such as Urdu, Punjabi, Sindhi, Pashto, Balochi, and Saraiki, among others. These languages possess different phonological inventories and articulatory settings compared to Standard British English (SBE), which serves as the primary educational model in Pakistan (Afsar and Kamran 2011). Consequently, when speakers of these regional languages acquire English, they transfer certain segmental and suprasegmental features from their native phonological systems, leading to a localized

accent. This process, known as language transfer or cross-linguistic influence**,** is a natural outcome of second language acquisition and has contributed to the phonetic distinctiveness of PakE (Afsar and Kamran 2011).

Phonetic variation is a key indicator of how new English varieties emerge and stabilize. The **vowel system**, in particular, plays a crucial role in defining accent and intelligibility (Sharma 2005). Vowels are inherently variable because they are influenced by the articulatory habits and auditory perception of the speakers. The realization of vowel sounds depends on multiple acoustic and physiological parameters, including tongue height, tongue advancement, lip rounding, and vocal tract resonance. These articulatory configurations directly influence the **first (F1)** and **second** (F2) formant frequencies**,** which serve as acoustic correlates of vowel quality. In phonetic studies, F1 corresponds inversely to vowel height (i.e., high vowels have low F1 values, and low vowels have high F1 values), while F2 corresponds to vowel frontness or backness (i.e., front vowels have high F2 values, and back vowels have low F2 values). These measurable parameters provide a scientific means to analyze and compare vowel production across dialects and varieties (Adank, Smits et al. 2004).

Although the British model of pronunciation has traditionally been considered the target norm in Pakistan, local realizations deviate considerably from it (Ghafoor, Shahzadi et al. 2024). Prior studies have reported centralization of front vowels**,** fronting of back vowels**, and** reduction in vowel length contrasts among Pakistani speakers. Such variations can be attributed to the phonetic characteristics of Urdu and other regional languages, which possess fewer vowel distinctions than English. For instance, Urdu lacks the tense-lax contrast that exists in English (/iː/ vs. /ɪ/, /uː/ vs. /ʊ/), leading to partial mergers or approximations in PakE. Similarly, the low vowel /æ/ in English is often realized as a more central or open sound [a], reflecting influence from local vowel inventories.

In addition to phonological factors, sociolinguistic elements—such as region, gender, education, and exposure to English media—play a pivotal role in shaping pronunciation patterns (Faheem, Danish et al. 2024). Urban speakers with higher exposure to English may produce vowels closer to international norms, whereas rural or regionally influenced speakers tend to display greater deviation. Therefore, PakE is not homogeneous but rather a continuum of speech patterns reflecting varying degrees of localization and identity expression. The study of these patterns can reveal not only linguistic but also social and cultural dimensions of Pakistani English.

From an academic standpoint, research on the acoustic properties of PakE vowels remains limited (Abbasi, Channa et al. 2018). While several descriptive studies have explored pronunciation trends qualitatively, quantitative acoustic analysis—involving the measurement of formant frequencies—has not been extensively conducted. Such an analysis is essential for empirically validating claims about vowel variation and for situating PakE within the broader framework of World Englishes. By using software such as Praat for acoustic measurement, researchers can obtain objective, replicable data that illustrate how Pakistani speakers realize English vowel categories compared to established SBE targets.

Given this context, the present study seeks to explore and quantify the acoustic variation of English vowels produced by Pakistani speakers. The primary focus is on identifying systematic deviations from Standard British English and examining the underlying linguistic and social factors contributing to these shifts. Specifically, the study aims to:

1) Measure the formant values (F1 and F2) of selected English vowels produced by Pakistani speakers;
2) Compare these values with Standard British English reference data; and
3) Interpret the observed variations in relation to first language influence and sociophonetic identity.

This research is significant for several reasons. First, it provides empirical evidence for the ongoing phonetic evolution of Pakistani English, thereby contributing to the documentation and recognition of PakE as a legitimate variety of English. Second, the findings can have pedagogical implications for English language teaching in Pakistan, where pronunciation instruction often follows British

models without considering local realities. Finally, this study offers insights into how acoustic phonetics can serve as a tool to understand broader processes of linguistic nativization, identity construction, and language change in postcolonial contexts (Alshehri and AlShabeb 2023).

In conclusion, vowels are central to speech intelligibility, and their acoustic realization reveals the extent to which speakers' phonological backgrounds shape their production of English sounds. By systematically analyzing formant values, this study aims to contribute to the growing body of phonetic and sociolinguistic research that examines how English continues to evolve in multilingual societies such as Pakistan. The findings are expected to highlight both the diversity and distinctiveness of Pakistani English, reinforcing its status as a dynamic and evolving linguistic variety within the global English spectrum.

The objectives of this study are:

1. To measure and compare the formant values (F1 and F2) of English vowels produced by Pakistani speakers.
2. To identify patterns of variation and regional influences.
3. To interpret these findings in light of L1 phonological transfer.

2. Literature Review

Research on English phonetics in postcolonial contexts has established that new English varieties undergo systematic phonological and phonetic modifications as they adapt to local linguistic ecologies. In South Asia, English has evolved in contact with diverse indigenous languages, resulting in distinct regional accents and speech patterns. Previous studies on South Asian English varieties (Deterding, 2013; Mesthrie & Bhatt, 2008) have demonstrated that vowel systems in Indian, Sri Lankan, and Pakistani Englishes are shaped by the phonological structures of local languages. These shifts are not random but represent a process of **nativization**, whereby English phonology becomes localized to reflect speakers' native articulatory norms and socio-cultural identities.

In the context of Pakistani English (PakE)**,** several scholars have explored its distinctive phonological characteristics. Rahman (1990) provided one of the earliest comprehensive descriptions of PakE, identifying features such as the centralization of front vowels**,** the fronting of back vowels, and a general tendency toward vowel reduction. Similarly, Mahboob (2003) emphasized that PakE vowels are typically less tense than their British counterparts, reflecting both phonetic simplification and **cross**-linguistic influence from Urdu and Punjabi. These local languages do not possess certain English vowel contrasts, such as /ɒ/ versus /ɔː/ or /æ/ versus /ʌ/, resulting in mergers or approximations in Pakistani English pronunciation. For instance, many Urdu or Punjabi speakers produce /æ/ as [a], shifting it toward the center of the vowel space, while /ɒ/ and /ɔː/ are often realized as near-identical back rounded vowels.

The influence of the first language (L1**)** on English pronunciation in multilingual contexts has been widely documented in second language acquisition literature (Flege, 1995; Jenkins, 2000). According to Flege's Speech Learning Model, adult learners tend to perceive and produce foreign sounds through the filter of their native phonological categories. This often results in phonetic transfer, whereby speakers substitute unfamiliar English vowels with the closest equivalents from their L1. In the Pakistani context, Urdu and Punjabi both have relatively smaller vowel inventories (approximately 7–8 monophthongs), compared to the 12–14 monophthongs of Standard British English (Wells, 1982). This structural mismatch contributes to the neutralization **of tense-lax** distinctions and the centralization of high and low vowels among Pakistani speakers.

In terms of methodology, acoustic phonetic research offers an objective approach to examining such variations. Studies employing acoustic analysis (Hickey, 2004; Ladefoged & Johnson, 2011) have shown that formant frequencies (F1 and F2**)** serve as reliable indicators of vowel quality, allowing researchers to map subtle variations in vowel height and frontness. Acoustic techniques have been extensively applied to analyze other varieties of English, including Indian English (Wiltshire, 2005),

Nigerian English (Jowitt, 2010), and Singapore English (Deterding, 2007). These investigations demonstrate that English vowels, when spoken in different sociolinguistic environments, shift in systematic and measurable ways due to local articulatory habits and sound inventories.

Despite the growing body of work on World Englishes, Pakistani English remains underrepresented in detailed acoustic phonetic research. Most available studies (e.g., Rahman, 1990; Mahboob, 2003; Mehmood, 2015) have focused on qualitative descriptions of pronunciation or sociolinguistic perspectives rather than quantitative acoustic analysis. There is limited data on formant frequency measurements**,** especially across different Pakistani regions and speaker groups. Consequently, there exists a clear gap in understanding the precise acoustic realization of English vowels in Pakistan, as well as the extent of deviation from Standard British English norms.

Furthermore, as English continues to serve as a marker of social class, education, and prestige in Pakistan, examining its phonetic variation holds **sociophonetic** significance**.** Vowel variation not only reflects the interaction between phonetic systems but also indexes speakers' social identities and degrees of linguistic exposure. The study of PakE vowels, therefore, contributes to both **linguistic** and social dimensions of English language research, offering insights into how a non-native variety stabilizes over time through consistent and predictable patterns of variation.

In summary, prior research underscores that vowel systems in non-native Englishes are highly susceptible to local linguistic influences. However, Pakistani English remains insufficiently documented through acoustic phonetic methods. The present study addresses this gap by employing formant-based acoustic analysis to quantify vowel variation among Pakistani English speakers. By comparing their vowel formant values with Standard British English targets, this research seeks to provide empirical evidence of the ongoing phonetic and sociolinguistic evolution of Pakistani English, situating it firmly within the global framework of World Englishes.

3. Methodology

3.1 Participants

Twenty (20) Pakistani speakers (10 male, 10 female) aged between 20–30 years participated. All were postgraduate students with at least 10 years of English education.

3.2 Materials

Vowel	Word Example	IPA
/iː/	heed	/hiːd/
/ɪ/	hid	/hɪd/
/e/	head	/hed/
/æ/	had	/hæd/
/ʌ/	hud	/hʌd/
/ɑː/	hard	/hɑːd/
/ɒ/	hod	/hɒd/
/ɔː/	hoard	/hɔːd/
/uː/	who'd	/huːd/
/ʊ/	hood	/hʊd/

3.3 Procedure

The data-collection procedure was designed to ensure high-quality recordings and acoustic precision. Each participant was invited individually to a soundproof room in order to minimize ambient noise and external interference. The participants were comfortably seated in front of a desktop computer equipped with a studio-quality condenser microphone (sampling rate = 44.1 kHz, 16-bit resolution) connected through an external audio interface to guarantee consistent sound quality. Before the recording session began, participants were informed about the objectives of the study and were given

clear instructions on how to pronounce each item on the reading list. They were encouraged to speak naturally but clearly, maintaining a moderate pace and neutral intonation.

The stimulus material consisted of a set of monosyllabic English words in the /hVd/ frame (e.g., heed, hid, head, had, hod, hood, who'd), representing the major English vowel categories. Each word was displayed on the computer screen and read aloud three times to obtain reliable average measurements. The order of the items was randomized to avoid any sequential or anticipatory effects. Recordings were automatically stored and labeled using the Praat software interface. During the session, the researcher monitored the waveform visually to ensure proper amplitude and to avoid clipping or background noise. After the session, the recordings were reviewed for clarity; any samples affected by hesitation, mispronunciation, or distortion were discarded and rerecorded when necessary.

To control for coarticulatory effects from surrounding consonants, formant measurements were taken at the temporal midpoint of the vowel segment, where articulatory stability is highest. Each vowel token was manually segmented in Praat by marking its onset and offset in the waveform and spectrogram view. Ethical guidelines were observed throughout the process; participants gave informed consent, and their recordings were anonymized for analysis. This systematic and controlled recording procedure ensured that the acoustic data were consistent, comparable, and suitable for subsequent quantitative analysis.

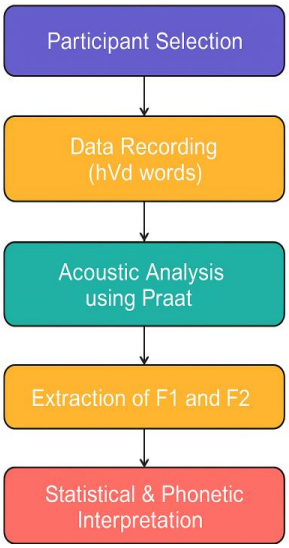
3.4 Data Analysis

The recorded vowel samples were analyzed acoustically using Praat (Boersma & Weenink, 2022). The first two formant frequencies—F1 and F2—were extracted at the midpoint of each vowel to represent its height **and** frontness/backness, respectively. For every speaker, three repetitions of each vowel were measured and averaged to minimize measurement error. The resulting formant values were then grouped according to **gender**, recognizing that male and female speakers typically exhibit systematic differences in vocal-tract length and resonance patterns, which affect raw formant frequencies.

Prior to statistical comparison, the raw F1 and F2 data were normalized using the Lobanov method, which reduces inter-speaker variability and allows for more accurate comparison across individuals. The normalized data were then plotted on a vowel space chart, with F1 on the vertical axis and F2 on the horizontal axis, providing a visual representation of each vowel's relative position. These measurements were compared with Standard British English (SBE) reference values reported in Wells (1982) and Deterding (1997) to identify systematic deviations in vowel quality among Pakistani speakers.

Descriptive statistics, including mean values, standard deviations, and ranges, were computed separately for male and female participants. In addition, independent-sample t-tests were performed to determine whether observed differences between Pakistani English and SBE vowel realizations were statistically significant. The analysis further examined patterns of centralization, fronting**, and** lowering to identify possible phonetic tendencies characteristic of Pakistani English.

Finally, the acoustic data were interpreted within a phonological and sociophonetic framework. The results were compared across gender groups and cross-referenced with previous literature on South Asian English varieties. This comprehensive approach, combining objective acoustic measurement with comparative interpretation, enabled a detailed understanding of how Pakistani speakers realize English vowels and the extent to which their productions diverge from SBE norms. The findings from this analysis form the empirical foundation for the discussion of vowel variation presented in the subsequent section.



4. Results and Discussion

4.1 Formant Comparison Table (Mean Values in Hz)

Vowel	F1 (PakE Male)	F2 (PakE Male)	F1 (SBE Male)	F2 (SBE Male)	Shift Pattern
/iː/	310	2150	300	2300	Slightly centralized
/ɪ/	420	1850	390	1990	Lower and backer
/e/	510	1800	470	1900	Lowered
/æ/	710	1600	660	1700	Centralized
/ʌ/	680	1350	640	1400	Stable
/ɑː/	730	1200	700	1150	Slightly fronted
/ɒ/	600	1000	570	950	Stable
/ɔː/	520	1050	490	950	Raised
/uː/	330	950	320	870	Slightly fronted
/ʊ/	400	1100	380	1000	Fronted

4.2 Interpretation

The acoustic analysis reveals clear and systematic deviations in vowel production among Pakistani English (PakE) speakers when compared with Standard British English (SBE) norms. The front vowels (/iː/, /ɪ/, /e/, /æ/) exhibit a noticeable tendency toward centralization, suggesting strong **first-**language (L1) influence, particularly from Urdu and Punjabi phonological systems. In these native languages, the vowel space is more compact, and distinctions between tense and lax vowels are less pronounced. As a result, Pakistani speakers tend to produce /iː/ and /ɪ/ closer to a mid-front position, reducing the contrast between these two vowels. Similarly, /e/ and /æ/ are often realized as centralized or slightly lower variants, resulting in a narrower front-vowel dispersion compared to SBE.

The back vowels (/uː/, /ʊ/, /ɔː/) also display systematic variation. They appear to be fronted and less rounded, which may be attributed to lip rounding reduction and articulatory simplification. This fronting effect aligns with global tendencies observed in many English varieties but is further reinforced by the absence of rounded back vowels in Urdu and Punjabi, leading to a perceptible shift in acoustic space. The **low vowel /æ/**, in particular, demonstrates greater openness and centralization,

often merging acoustically with /ʌ/ for some speakers, thereby reducing the distinctiveness between these two categories.

Overall, these findings indicate that Pakistani English vowel production reflects a process of phonological adaptation and localization**.** The observed centralization and fronting patterns suggest that Pakistani speakers have developed a stable, intelligible vowel system that aligns with their **sociophonetic identity** and local linguistic norms. Rather than representing "errors" or "deviations," these shifts signify the natural evolution of PakE as a legitimate and contextually grounded variety of English, shaped by both articulatory tendencies and socio-cultural influences.

5. Conclusion

This acoustic study confirms that Pakistani English (PakE) speakers demonstrate systematic vowel variation when compared with Standard British English (SBE) norms. The analysis shows three major tendencies: the centralization of front vowels**, the** fronting of back vowels, and the reduction of vowel contrasts across several categories. These phonetic patterns are not random but reflect the influence of native languages such as Urdu and Punjabi, which shape the articulation and perception of English vowels in Pakistan. The results provide concrete acoustic evidence that English in Pakistan has undergone significant phonological adaptation, resulting in a localized and recognizable sound system.

Such features exemplify the **nativization process** through which PakE continues to evolve as a legitimate and stable variety of English within the framework of World Englishes. This emerging vowel system illustrates how linguistic contact, social identity, and educational exposure collectively contribute to shaping a unique Pakistani phonetic identity. Importantly, the findings challenge deficit-based perspectives on pronunciation differences, emphasizing instead that these variations represent natural linguistic evolution **and** cultural integration. To strengthen this line of inquiry, future research should incorporate a larger and more diverse sample, representing speakers from different regional, educational, and socio-economic backgrounds. Additionally, integrating sociophonetic variables such as gender, proficiency level, and language exposure will allow for a more nuanced and comprehensive understanding of vowel variation in Pakistani English.

References

Deterding, D. (2013). Misunderstandings in English as a Lingua Franca: An Analysis of ELF Interactions. De Gruyter Mouton.

Hickey, R. (2004). Legacies of Colonial English. Cambridge University Press.

Mahboob, A. (2003). The English Language in Pakistan. In World Englishes: Critical Concepts in Linguistics (Vol. 2).

Rahman, T. (1990). Pakistani English: Status, features and functions. World Englishes, 9(1), 83–94.

Wells, J. C. (1982). Accents of English. Cambridge University Press.

Mesthrie, R., & Bhatt, R. M. (2008). World Englishes: The Study of New Linguistic Varieties. Cambridge University Press.

Abbasi, A. M., et al. (2018). "An acoustic investigation of Pakistani and American English vowels." **8**(4): 115-124.

Adank, P., et al. (2004). "A comparison of vowel normalization procedures for language variation research." **116**(5): 3099-3107.

Afsar, A. and U. J. K. J. o. L. R. Kamran (2011). "Comparing Consonantal Phonemes of Pakistani Standard English with British Standard English." **14**(1).

Alshehri, A. and A. J. I. J. o. A.-E. S. AlShabeb (2023). "Exploring attitudes, identity, and linguistic variation among Arabic speakers: Insights from acoustic landscapes." **24**(2): 1-16.

Faheem, M., et al. (2024). "PRONUNCIATION PERSPECTIVES: HOW LOCATION SHAPES ENGLISH ACCENTS." **2**(4): 443-453.

Ghafoor, A., et al. (2024). "Exploring The Phonological Analysis of Vowels Sounds Among Speakers of Pakistani English." **3**(2): 311-322.

Haidar, S. and F. J. A. P. J. o. E. Fang (2019). "English language in education and globalization: A comparative analysis of the role of English in Pakistan and China." **39**(2): 165-176.

Ormrod, W. M. J. S. (2003). "The use of English: Language, law, and political culture in fourteenth-century England." **78**(3): 750-787.

Sadiq, S., et al. (2024). "Unraveling Lexical Mixing Patterns: A Comprehensive Morphological Evaluation of Pakistani English." **2**(2): 940-958.

Sharma, D. J. J. o. S. (2005). "Dialect stabilization and speaker awareness in non-native varieties of English 1." **9**(2): 194-224.