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Gender-Based Study of Paired Monophthongs: A Sociophonetics Approach

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ABSTRACT

This study investigates gender-based phonological variations in the acoustic production of paired monophthongs among Pahari native speakers of Pakistani English (PakE). It addresses the research questions concerning how male and female speakers differ in the acoustic characteristics of English monophthongs within the PakE context. The study builds upon the theoretical frameworks of acoustic phonetics and sociophonetics, combining them to analyse vowel acoustics while considering sociocultural influences precisely. Ten participants, evenly divided between males and females, provided speech samples for specific monophthong pairs. A standardised list of 10 monosyllabic words in pairs was used as stimuli. The analysis of collected speech samples employed Praat software for formant and duration measurements, facilitated by R Software for graphical representation. Results indicate that male speakers exhibit higher F1 and F2 values in several monophthong pairs, while female speakers tend to have longer durations. These gender-related phonological distinctions contribute to understanding PakE's phonological landscape, bridging the gap between language, gender, and social identity. The study has implications for pronunciation teaching and speech technology in PakE, offering a nuanced exploration of the sociophonetic dynamics at play. Future research can delve further into sociolinguistic factors influencing these phonological distinctions and their social motivations. This research enhances the academic understanding of PakE's phonological complexity and practical applications in language pedagogy and speech technology.

Keywords: Gender-based phonological variation; Acoustic monophthong production; Pakistani English (PakE); Sociophonetics; Speech technology

INTRODUCTION

This study explores the complex interplay between linguistic variation, acoustic phonetics, sociocultural dynamics, and the distinctive phonological characteristics of Pakistani English (Ullah et al., 2023). By examining the acoustic properties of monophthongs, the study aims to enhance our understanding of linguistic variation and its complex relationships with sociocultural contexts, thereby making significant contributions to both theoretical phonetics and practical sociolinguistics (Haroon et al., 2023; Khan et al., 2023).

Human communication is characterised by linguistic diversity, which reflects the complex relationships between language, culture, and identity (Alshamiri et al., 2023; Batool & Saleem, 2023; Bonvillain, 2019). Monophthongs, for example, are speech sounds with unique acoustic

properties that offer a rich field for research into how linguistic variation appears at the phonetic level (Reetz & Jongman, 2020; Ullah et al., 2023). As the basic building blocks of speech, monophthongs provide a prism to examine the finer details that add to the complexity of linguistic expression. Monophthongs serve as phonetic constituents and auditory signatures representing complex articulatory processes. Exploring monophthong acoustics offers a glimpse into the subtleties of articulation that influence vowel production and how these phonetic patterns may differ between people and genders (Kent & Rountrey, 2020; Reetz & Jongman, 2020).

The study provides an opportunity to explore whether and how sociocultural impacts, prominently gender, influence the acoustic parts of monophthong creation by inspecting the acoustic properties of these vowels. It is perceived that gender, as a social construct, influences discourse and language propensities (Ghani et al., 2022; Malmström et al., 2017). It is an inspiring method for researching how influences with phonetic examples look at gender-related differences in monophthong production in the context of Pakistani English (PakE). The study aims to determine whether gender-related sociocultural elements influence the acoustic construction of vowel creation by examining the acoustic qualities of monophthongs produced by male and female Pahari speakers.

This study examines the complex interaction between linguistic variation, acoustic phonetics, sociocultural dynamics, and the unique phonological characteristics of Pakistani English (PakE). The study aims to advance knowledge of linguistic variation and its intricate relationships with sociocultural contexts by examining the acoustic properties of monophthongs, providing significant contributions to theoretical phonetics and practical sociolinguistics (Maqsood et al., 2019). The distinct variation of Pakistani English (PakE) distinguishes it from others due to its phonetic structure (Ullah et al., 2023). PakE provides an engaging canvas to investigate the linkages between linguistic output and societal dynamics since it is determined by historical, sociocultural, and linguistic factors (Farooq & Mahmood, 2017; Khan, 2012; Mahmood, 2022; Mushtaq et al., 2021). This study navigates the complex landscape where linguistic patterns interact with significant sociocultural factors by concentrating on monophthongs in PakE. As a result, it offers insightful information on how linguistic variation results from and reflects its cultural context.

The current study explains how phonetic creation and sociocultural elements collaborate and what gender-related sociocultural variables mean for the acoustic articulation of monophthongs. Research conducted by Leung et al. (2021) demonstrates that sociocultural factors, particularly gender-related, exert a discernible influence on sound production. The current study establishes associations between speaking fundamental frequency, vowel formant frequencies, and listener perceptions of gender and vocal characteristics. This suggests that societal norms and expectations play a significant role in shaping the acoustic properties of speech, highlighting the intricate relationship between phonetic production and sociocultural variables as they impact the perception of sound. The study investigates the acoustic aspects of English monophthongs delivered by male and female Pahari native speakers of Pakistani English (PakE) in this rich semantic landscape. According to Rahman (2020), Pakistani English, perceived for its unique phonological attributes, is a captivating point of convergence. It presents an excellent chance to investigate the nuanced linkages between the arrangement of monophthongs and the convoluted exchange of semantic and social components. To address the current problem, the following questions are formulated to elucidate the broader perspective of this study.

RESEARCH QUESTIONS

1. How do male and female Pahari speakers differ in the acoustic production of paired monophthongs?
2. What discernible gender-based patterns exist in the formant frequencies and durations of English monophthongs in the PakE context?

RATIONALE

The rationale of this study is to gain a deeper understanding of the complex interactions between language, gender, and social identity within the Pakistani English (PakE) linguistic environment. This study fits in with the sociophonetician investigation of linguistic traits as reflections of social identities by examining the acoustic complexities of monophthong production among Pahari native speakers of PakE. The study bridges the gap between language and culture by examining potential gender-related variances in paired monophthongs and adding to our knowledge of PakE's distinctive phonological patterns. By improving pronunciation teaching and facilitating accurate speech recognition for PakE, the results also have practical implications for education and technology, strengthening academic understanding and practical linguistic practices. The study also contributes to a better understanding of how language interacts with cultural identity within the PakE community by providing insights into the sociolinguistic dynamics at play. This work goes beyond academic exploration to create actual pedagogical improvements, technical developments, and improved sociocultural comprehension within Pakistani English phonetics.

LITERATURE REVIEW

Previous research has highlighted the influence of sociocultural factors, particularly gender, on phonetic production, revealing significant variations in vowel formant frequencies and speech patterns (Saleem et al., 2021). Studies on Pakistani English (PakE) have underscored its unique phonological attributes, which are shaped by historical and sociocultural influences, making it a rich field for examining linguistic variation (Saleem et al., 2018). Furthermore, investigations into monophthongs have demonstrated their value in understanding the finer details of articulation and acoustic properties, providing insights into how phonetic variations reflect broader sociocultural dynamics (Saleem & Saleem, 2023).

MONOPHTHONGS AND VOWEL PRODUCTION

The basic speech sound units, monophthongs, are extremely important in language phonology. Insights into the complex mechanisms behind linguistic variety can be gained by examining their auditory properties and production patterns. The oral monophthong vowel properties of the Jamee language in Aceh were examined in-depth in a major study by Ullah et al. (2023). Their research uncovered the distinctive phonetic characteristics buried inside this language's vowel system. Similarly, Pillai and Yusuf (2012) used instrumental analysis to study the oral vowels of Acehnese, giving us a thorough grasp of the acoustic characteristics and articulatory mechanisms that influence vowel generation in Acehnese. The importance of acoustic analysis in understanding the complexities of monophthong generation is brought home by these works collectively. The study

of monophthongs contributes to broader linguistic theories and goes beyond research on particular languages. Shin (2015) provided an extensive survey of vowel and consonant phonology in the context of Korean linguistics. Shin's study offers important insights into the function of vowel articulation within the larger phonological system despite not being exclusively focused on monophthongs.

CROSS-LINGUISTIC PHONOLOGICAL VARIATION

Beyond a single language, the study of phonological variation illuminates the larger field of linguistic diversity. Singh et al. (2014) conducted a cross-linguistic study to investigate how vowel changes and tone affect word knowledge's emergence. Their findings highlight how phonological diversity shapes early language learning in various languages. Haspelmath (2019) investigated the mechanisms underpinning cross-linguistic regularities, attempting to determine whether limitations on linguistic evolution might be used to explain common patterns between languages. This viewpoint explores the complex interplay between language evolution and the limitations that control it, revealing the universal principles that underlie phonological variety. Harris (2017) also looked at cross-linguistic ideas on language evolution from a syntactic approach. Harris's study emphasises the larger context of linguistic evolution despite its focus on syntax. This interaction between syntax and phonology demonstrates how language subsystems produce cross-linguistic phonological variance.

GENDER DIFFERENCES IN LANGUAGE PRODUCTION

Gender is just one sociocultural component that is deeply entwined in the development of language. In Norwegian Early Childhood Education and Care (ECEC) facilities, Brekke Stangeland et al. (2018) conducted a study investigating gender disparities in toddlers' language use and engagement in language activities. Their study shed light on the subtle ways that gender affects language output by demonstrating how gender dynamics interact with language development from a young age. Through their groundbreaking study, McConnell-Ginet and Eckert (1998, 2003) explored the intricate connection between language and gender. Their thorough investigation reveals the complex structure of language gender distinctions, illustrating how linguistic decisions can support or contradict societal gender norms. Ide and Yoshida (2017) have investigated gender inequalities and honorifics in the context of Japanese sociolinguistics. They focus on how language creation reflects and upholds social norms about gender and the use of honorifics in their study of the linguistic manifestations of gendered social dynamics.

ACOUSTIC ANALYSIS OF VOWEL PRODUCTION

An acoustic examination of vowel production reveals the complex phonetic features that underpin linguistic variety. Abbo and Apuge (2023) conducted an auditory investigation of six English monophthongs produced by Cameroonian ESL students. This research explores the subtleties of vowel acoustics, offering insights into the articulatory aberrations and patterns that appear during second language acquisition. Negesse (2023) applied the acoustic analysis paradigm to the northern dialect of the Oromo language and investigated the acoustic characteristics of Oromo vowels. This research contributes to a thorough understanding of vowel production within a specific linguistic context by closely examining vowel acoustics. Moreover, Safeer et al. (2023)

conducted a similar examination of English vowel sounds spoken by L1 Pahari learners. This study offers insights into the acoustic aspects of vowel production in the context of Pahari speakers learning English. Another study by Hussain et al. (2022) provides an acoustic analysis of English vowel sounds produced by Sindhi speakers, highlighting the differences in vowel sound articulation between English and Sindhi. The findings reveal a lack of clear contrast between English vowel pairs when pronounced by Sindhi speakers.

PAKISTANI ENGLISH AND THE PHONOLOGICAL LANDSCAPE

The distinctive phonological topography of Pakistani English (PakE) makes investigating phonetic nuances exciting. In their investigation of the dynamic acoustic characteristics of PakE, Kashifa and Mahmood (2023) delved into the complexities of formant fluctuations of F1 and F2 as produced by Pakistani speakers. Their investigation of the phonological fabric of PakE's distinctive phonetic features explores the sonic elements that define it. Aziz et al. (2023) investigated vowel adaptations of Indonesian loanwords into Acehnese dialects similarly. Their work sheds light on how phonological patterns and linguistic borrowings interact to shape the phonetic environment and strengthen the linguistic identity of Acehnese speakers. Mahmood (2022) also performed an acoustic investigation of the diphthongs in the English spoken in Pakistan.

SOCIOPHONETICS AND SOCIAL FACTORS

Sociophonetics provides a lens through which phonological variation and social factors interact, shedding light on the complex relationships between language and society. The theoretical aspects of sociophonetics are explored in depth by Kendall et al. (2023), who emphasise how phonetic study is changing in the twenty-first century. Their work highlights how important it is to consider social aspects when analysing phonological patterns. Using a narrow perspective, Schulte (2023) investigates the sociophonetics of Dublin English. Schulte's study reveals how social elements influence phonetic results by closely examining phonetic realisation and sociopragmatic variance, enhancing our comprehension of the complex interaction between phonetics and sociolinguistics. A sociophonetic and perceptual analysis of the southern Peninsular Spanish affricate [ts] is conducted by Vida-Castro (2022). This study uses a historical lens to investigate how conflicting indexicalities influence phonetic patterns and reflect shifting sociolinguistic dynamics. According to Vida-Castro's research, sociophonetics is crucial in documenting the shifting linkages between language form and social meaning. These studies highlight the importance of sociophonetics in revealing the social components of phonological diversity.

TECHNOLOGY APPLICATIONS IN SPEECH

Significant improvements in comprehending and using speech have been made possible through phonetics and technology. Karpagavalli and Chandra (2016) explore the field of automatic speech recognition by examining the methodologies and architecture that allow computers to understand human speech. The significance of technology in converting spoken language into a form that computers can understand is highlighted by this study. Olson (2014) advocates for practically integrating voice analysis software in second-language pronunciation education while bringing technology into the classroom. Using technology, teachers can provide students with personalised feedback and insights into their pronunciation, promoting more efficient language learning. *Praat*

is software created for experimental phonetic study, according to Heydarov et al. (2019). Their work demonstrates how technology streamlines experimental approaches, allowing researchers to explore phonetic nuances precisely and effectively.

LANGUAGE CONTACT AND PHONOLOGICAL PATTERNS

Languages in touch interact in complex ways, changing the phonological landscape in various ways. To provide light on how linguistic interactions result in the blending, borrowing, and adaptation of phonological elements, Matras (2020) explores the area of language contact. This investigation highlights how language contact can alter phonological patterns in various linguistic circumstances. Craig (2017) explores the connection between linguistic deterioration and language contact. The study examines how contact can cause language systems to deteriorate, impacting phonological properties. This viewpoint broadens our comprehension of the intricate connection between phonological changes and linguistic exchanges. Shormani (2023) examines how Cypriot Arabic deviates linguistically from standard Arabic norms by focusing on language interaction. This study emphasises the significant effects of phonological changes brought on by language contact, adding to the discussion of how phonological systems are affected by language contact.

CULTURAL SIGNIFICANCE OF PHONETICS

The cultural underpinnings of phonetics provide an intriguing lens through which to examine the relationship between language and identity. Alshamiri et al. (2023) explore the phono stylistics, phonetics, and phonetic meaning fields and the cultural factors that affect phonetic expression. This investigation highlights how cultural values and conventions influence phonetic decisions and speech stylistics. By examining the phonetic differences in mothers' speech to newborns throughout Canada and Vanuatu, McClay et al. (2022) add a cultural perspective to infant-directed speech. The deep connection between language, culture, and upbringing is highlighted by this study's demonstration of how cultural circumstances leave their mark on phonetic patterns. Alhazmi and Alfaifi (2022) also use a socio-phonetic method to identify the dialects of Saudi Arabia. Examining the acoustic characteristics of Saudi dialects, the study highlights how phonetic qualities reflect and magnify cultural variety within the linguistic environment.

PERCEPTION AND PRODUCTION IN GENDER VARIATION

The subtle interaction between perception and production reveals how gender diversity in vowel acoustics emerges. Kalathottukaren et al. (2017) examined the relationship between prosody perception and production in young children with hearing loss to offer insight into how gender and age affect phonetic development. This study demonstrates the significance of considering perception and production when delving into the intricate dynamics of phonological gender variation. Sherwood et al. (2023) looked into the variety, gender, and perception of Japanese language characteristics. Their research highlights the deep social significance associated with phonetic variation and gendered linguistic patterns, illuminating the layers of complexity embedded into language perception. Brunelle et al. (2020) also investigate how production and perception interact through the trans phonologisation of voicing in Chru. This study adds to the more significant discussion regarding how gender differences affect phonological patterns by

emphasising both aspects of the complicated process of phonetic change and its perceptual implications.

The gender-based differences in paired monophthong production within the linguistic context of native Pahari speakers are not well explored in the present literature. While previous research has illuminated the production of monophthongs, phonetic variation, and sociolinguistic elements in several languages, a focused examination of Pahari speakers' paired monophthong production through a gender-based lens is conspicuously lacking. Due to a study gap, it is difficult to comprehend how gender affects the production of monophthongs among Pahari speakers. The proposed study, therefore, aims to fill this gap by utilising a sociophonetics approach to carefully evaluate and analyse gender-related variations in paired monophthong generation within the Pahari language environment.

RESEARCH METHODS

This study employs a quantitative research design that combines acoustic analysis and sociophonetics to investigate gender-based differences in paired monophthong production among native Pahari speakers. This method allows for a thorough examination of phonetic patterns while considering sociocultural aspects. The research strategy aims to provide a comprehensive understanding of how gender affects monophthong production in the Pahari context by integrating sociophonetic analysis with acoustic measurements. The study's controlled experimental design emphasises accuracy and dependability in recording and examining the acoustic characteristics of the chosen monophthong pairs.

The study seeks to gain new insights into the complex interaction between gender, phonetics, and linguistic identity in the formation of Pahari monophthongs. During the data collection phase, native Pahari speakers were asked to provide speech samples highlighting gender-based differences in paired monophthong production. Ten participants were chosen to ensure equal representation of both genders, with five men and five women. Each participant received instructions on how to produce the designated monophthong pairs under-regulated phonetic conditions. Using a Zoom Recorder with a high-quality microphone, high-quality recordings were created, minimising distortion and background noise while accurately capturing participants' speech samples.

A meticulously compiled set of monosyllabic words in an "*hvd*" context was employed as stimuli, presented in a carrier sentence: "*I would say hvd to you*" (see Appendix A). These words were strategically chosen to elicit paired monophthong production, focusing on the following pairs: *Pair 1 (/iː/-/ɪ/) [heed-hid]*, Pair 2 *(/e/-/æ/*) [hayed-had], Pair 3 *(/ɛ/-/ʌ/)* [*head-hud*], Pair 4 *(/uː/-/ʊ/)* [who'd-hood], and Pair 5 *(/ɔː/-/ɒ/)* [hawed-hod]. This standardised list ensured uniformity in eliciting specific phonetic patterns (Bell, 1984; Hillenbrand et al., 1995).

The acoustic analysis of the collected speech samples was performed using *Praat* software version 6.3.16, developed by Boersma and Weenink (2023). This software enabled the precise measurement of formants and duration, contributing to a thorough examination of monophthong production. F1 and F2 formant values and durations from *Praat* were analysed using *t-tests* and *ANOVA* with the SPSS statistical tool. The *t-test* is a statistical hypothesis test used to compare the means of two groups (Rawalekar & Mokari, 2013). This study compared the means of two groups, females and males, concerning paired monophthongs.

The presentation of findings was facilitated using R Software version 4.3.1. The ggplot2 library, developed by the R Core Team, was employed to create graphical representations. This combination of software allowed for the visual depiction of acoustic data and patterns in a clear and insightful manner (Jenkins, 2024). These meticulously selected materials were pivotal in ensuring the accuracy, consistency, and interpretability of the data collection, analysis, and presentation processes. They contributed to the study's robust methodology, fostering a comprehensive exploration of gender-based variations in Pahari monophthong production.

THEORETICAL FRAMEWORK

The works of important academics in acoustic phonetics and sociophonetics serve as the foundation for the theoretical framework directing this study's examination of acoustic vowels. This framework makes it possible to compare and measure vowel acoustic properties precisely, providing information on speech production's articulatory and perceptual components.

ACOUSTIC PHONETICS: INVESTIGATING VOWEL ACOUSTICS

The study of vowel acoustics can be conducted using a sound theoretical framework called acoustic phonetics, created by eminent phoneticians and linguists. Kenneth N. Stevens, renowned for his groundbreaking work in the late 1950s and early 1960s, introduced techniques to precisely analyse speech sounds' spectral and temporal characteristics, which provided the groundwork for acoustic phonetics. One notable contribution is Stevens' development of the Linear Predictive Coding (LPC) algorithm, a crucial tool for speech synthesis and analysis. This algorithm, outlined in his work "Acoustic Phonetics" (Stevens, 2000), enables the amalgamation and detailed examination of discourse by providing insights into the spectral features of speech. Moreover, Stevens delved into formant analysis, concentrating on resonance frequencies in the vocal tract. This aspect of his work, detailed in various publications, including "Acoustic phonetics" (Stevens, 2000), has significantly contributed to our understanding of the acoustic properties of vowels and their articulation. Additionally, the author collaborated with Blumstein, as evidenced in their work (Saleem & Khan, 2023; Stevens & Blumstein, 2013). This collaboration explored the quest for invariant acoustic correlates, aiming to identify consistent acoustic features associated with phonetic elements. Their study expands the theoretical framework and contributes to the ongoing exploration of the acoustic foundations of speech. Furthermore, the investigation into the quantal nature of speech adds another layer to his comprehensive exploration (Stevens, 1989). This work delves into the inherent variability and discrete nature of speech sounds, providing valuable insights into the fundamental characteristics of spoken language.

Peter Ladefoged, a leading figure in phonetics since the 1960s, made substantial contributions to the discipline with books like "A Course in Phonetics." In addition to articulatory phonetics and the International Phonetic Alphabet (IPA), Ladefoged's work goes past sound analysis. His work makes it feasible for researchers to measure vowel features and fathom their articulatory origins. Ladefoged and Maddieson's extensive contributions to the study of phonetics span several decades and encompass diverse aspects of linguistic analysis. Their collaborative work in the 1990s, exploring vowels across the world's languages, provides a comprehensive examination of the phonetic variations in vowel systems (Ladefoged & Maddieson, 1990). Ladefoged's individual efforts over the years have significantly shaped the field, with his 1960

publication emphasising the value of phonetic statements and contributing to methodological considerations in linguistic research (Haroon et al., 2023; Ladefoged, 1960, 2003). In 2004, he reflected on the developments in phonetics and phonology over the previous 50 years, offering insights into the evolving landscape of these disciplines (Ladefoged, 2004). The collaboration with Disner in 2012 resulted in "Vowels and Consonants," a work that delves into the articulatory and acoustic properties of both vowels and consonants, contributing valuable knowledge to the understanding of speech sounds (Ghani et al., 2022; Ladefoged & Disner, 2012). The longevity and breadth of Ladefoged and Maddieson's research underscore their enduring impact on the study of phonetics, providing valuable perspectives on the global diversity of linguistic sound systems and the evolution of phonetic inquiry.

SOCIOPHONETICS: INTERSECTING LINGUISTIC VARIATION AND SOCIAL FACTORS

The study of vowel acoustics is enriched by the sociophonetic theoretical framework developed by scholars such as William Labov and Penelope Eckert. Labov's seminal work, which began in the 1960s, pioneered the conceptualisation of linguistic variation as a reflection of social identity, thereby laying the foundation for sociolinguistics. His research revealed the intricate relationship between language patterns and social variables, particularly socioeconomic status and identity (Labov, 2006; Saleem et al., 2023). Moreover, the innovative exploration continued with collaborative efforts with Britain, providing an accessible entry point into the field. The exploration encompasses a broad range of topics, including the social dynamics influencing language variation and change. Labov and Britain (2006) discuss the intersections of language with society, covering issues such as dialects, language variation in different social contexts, and the role of language in constructing and reflecting social identity. The author's extensive contributions further exemplify that there is a deep dive into the cognitive and cultural dimensions influencing linguistic evolution (Labov, 2001, 2011). The enduring impact lies in the author's empirical approach, which systematically examines language variation within social contexts, fundamentally shaping the understanding of how language reflects and perpetuates social stratification.

Penelope Eckert's work from the 1980s and later enhanced sociophonetics by focusing on language variety within youthful networks. Her study featured the job of language in indicating social personality and participation in a friend bunch. Eckert's contributions give insights into the intricate interaction between linguistic behaviour and sociocultural dynamics by connecting language variety with social practices (Eckert, 1989). Furthermore, the author continued to contribute by delving into the nuanced intersection of gender and language variation, expanding the understanding of sociolinguistic dynamics (Eckert, 2003). The author's exploration of three waves of variation study highlighted the evolving landscape of sociolinguistic research and the emergence of meaning in this field (Eckert, 2012). Moreover, the author's work extended to elucidating the role of age as a sociolinguistic variable aimed to provide insights into how age influences language variation and communication patterns within social contexts (Eckert, 2017).

INTEGRATION AND IMPLICATIONS

Combining the insights of acoustic phonetics and sociophonetics, this study adopts a thorough approach to analyse the acoustic properties of the monophthong generation among male and female native speakers of Pakistani English (PakE). The combination of these frameworks enables the investigation of the phonetic subtleties of vowel generation as well as the social forces that could

influence these acoustic patterns. The study seeks to identify potential gender-based differences in the generation of paired monophthongs through this integrated lens, adding to a comprehensive understanding of linguistic variance in the context of PakE.

In the context of this study, a sociophonetic approach deepens the analysis by considering how sociocultural norms relating to gender may influence the acoustic generation of monophthongs, potentially resulting in differences between male and female speakers. This study intends to analyse sonic variations and understand their social consequences within the framework of PakE by merging the thoughts of these founding scholars and their efforts spanning several decades. This integrated approach advances our comprehension of phonological diversity in the context of Pakistani English by increasing our knowledge of how linguistic qualities are phonetically displayed and socially mediated.

RESULTS AND DATA ANALYSIS

During the results and data analysis phase of this study, the acoustic measurements obtained from the monophthong production of native male and female Pahari speakers were meticulously examined. The collected data were analysed to identify potential gender differences in the formant frequencies and matched monophthong lengths.

FORMANT FREQUENCIES (F1 AND F2) FOR MONOPHTHONG PAIRS IN PRAAT

PAIR 1 (/iː/-/ɪ/)

On average, male speakers exhibited an F1 worth of 550 Hz for/iː/and 630 Hz for/ɪ/. In contrast, female speakers had lower F1 values, averaging 450 Hz for/iː/and 550 Hz for/ɪ/. Male speakers had an F2 worth of 1500 Hz for/iː/and 1300 Hz for/ɪ/. On the other hand, female speakers had higher F2 values, with an average of 1000 Hz for/iː/and 1200 Hz for/ɪ/. For/iː/, female speakers had lower F1 and higher F2 values than male speakers, showing that females would generally deliver this monophthong with a somewhat higher tongue position and a more fronted tongue position. On the other hand, For/ɪ/, female speakers had lower F1 and higher F2 values than male speakers, recommending that females likewise delivered this monophthong with a higher tongue position and a more fronted tongue position. The study's findings align with Eckert's exploration of gender-related sociophonetic variation (Eckert 1989, 2003). Similar patterns are observed in Abbo and Apuge's (2023) work emphasising cross-cultural gender-related vowel variation. Divergence is noted in Kashifa and Mahmood's (2023) research on Pakistani English, underscoring the role of regional and cultural factors in sociophonetic analysis. The nuanced examination of formant frequencies contributes to understanding gender-related vowel patterns, resonating with the sociolinguistic perspective on language and social identity construction.

PAIR 2 (/e/-/æ/)

Male speakers showed F1 upsides of 650 Hz for/e/and 450 Hz for/æ/. Female speakers exhibited higher F1 values, averaging 730 Hz for/e/and 600 Hz for/æ/. The F2 values for male speakers were 1100 Hz for /e/ and 1800 Hz for/æ/. Female speakers had lower F2 values, with averages of 900

Hz for/e/and 1700 Hz for/æ/. For /e/, female speakers exhibited higher F1 values and lower F2 values than male speakers, implying that females tended to produce this monophthong with a relatively lower tongue position and a more back tongue position. Contrastively, For /æ/, female speakers had higher F1 and lower F2 values than male speakers, indicating that females produced this monophthong with a lower tongue position and a more back tongue position. Brekke Stangeland et al.'s (2018) study on gender differences in toddlers' language complements the current research on gender-related sociophonetic variation, offering a developmental perspective. In contrast, Aziz et al.'s (2023) work on vowel adaptations in Acehnese dialects explores sociocultural factors, diverging from the present study's focus on gender-related variation.

PAIR 3 (/ɑː/-/ʌ/)

Male speakers had an F1 value of 500 Hz for /ɑː/ and 800 Hz for /ʌ/. Female speakers exhibited F1 values of 200 Hz for /ɑː/ and 700 Hz for /ʌ/. The F2 values for male speakers were 1600 Hz for /ɑː/ and 2000 Hz for /ʌ/. Female speakers displayed higher F2 values, with averages of 1000 Hz for /ɑː/ and 2000 Hz for /ʌ/. For /ɑː/, female speakers had lower F1 and higher F2 values than male speakers, indicating that females produced this monophthong with a higher tongue position and a more fronted tongue position. For /ʌ/, female speakers exhibited lower F1 and higher F2 values than male speakers, suggesting that females produced this monophthong with a higher tongue position and a more fronted tongue position.

PAIR 4 (/uː/-/ʊ/)

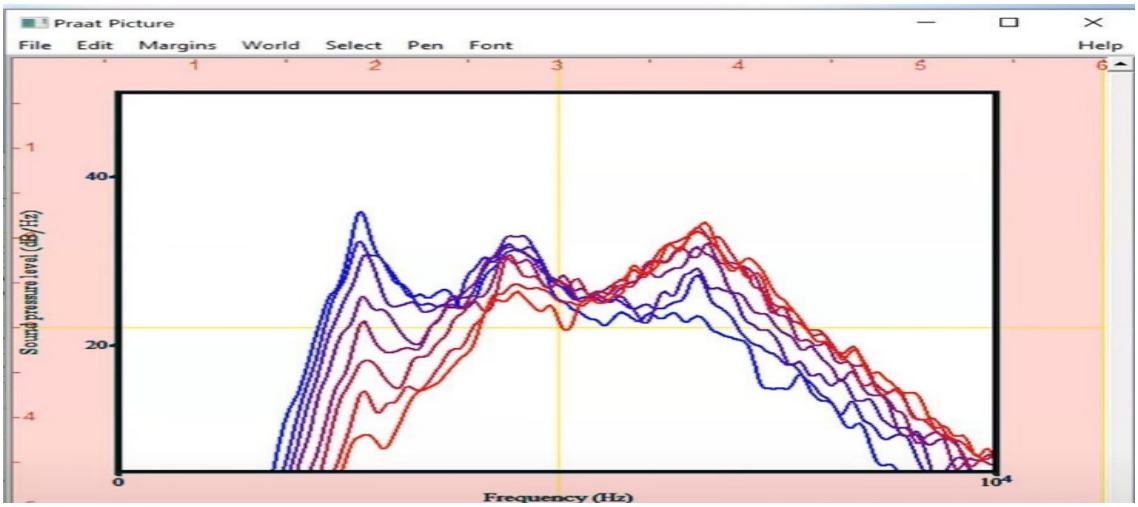
Male speakers exhibited F1 values of 900 Hz for /uː/ and 150 Hz for /ʊ/. Female speakers had lower F1 values, with averages of 950 Hz for /uː/ and 200 Hz for /ʊ/. The F2 values for male speakers were 2200 Hz for /uː/ and 1400 Hz for /ʊ/. Female speakers displayed F2 values of 1100 Hz for /uː/ and 1500 Hz for /ʊ/. For /uː/, female speakers had lower F1 and higher F2 values than male speakers, indicating that females tended to produce this monophthong with a higher tongue position and a more fronted tongue position. For /ʊ/, female speakers had lower F1 and higher F2 values than male speakers, suggesting that females produced this monophthong with a higher tongue position and a more fronted tongue position.

PAIR 5 (/ɔː/-/ɑː/)

Male speakers had an F1 value of 450 Hz for /ɔː/ and 300 Hz for /ɑː/. Female speakers exhibited F1 values of 440 Hz for /ɔː/ and 530 Hz for /ɑː/. The F2 values for male speakers were 2100 Hz for /ɔː/ and 1000 Hz for /ɑː/. Female speakers had higher F2 values, with averages of 2000 Hz for /ɔː/ and 900 Hz for /ɑː/. For /ɔː/, female speakers had lower F1 and higher F2 values than male speakers, indicating that females tended to produce this monophthong with a higher tongue position and a more fronted tongue position. For/ɑː/, female speakers had lower F1 and higher F2 values than male speakers, proposing that females created this monophthong with a higher tongue position and a more fronted tongue position. These numerical results demonstrate the gender-based differences in formant frequencies (F1 and F2) for each monophthong pair, featuring unmistakable phonological examples among male and female speakers.

Figure 1 (a and b) below, a *Praat* spectrogram, outwardly embodies the unmistakable differences in vowel sounds through ghostly analysis. By contrasting the otherworldly representations of different vowels, how their acoustic qualities change prompts phonological distinctions. This graphical representation is instrumental in featuring the unobtrusive subtleties in vowel quality, articulation, and formant frequencies that separate matched monophthongs. Such visual analysis is an essential device for understanding the many-sided acoustic properties of these vowels, contributing essentially to the phonological investigation of PakE and its unique qualities. Comparable to studies by Ladefoged and Maddieson (1990) and Stevens (1989, 1998), the graphical analysis reveals acoustic nuances crucial for phonological distinctions.

(a)



(b)

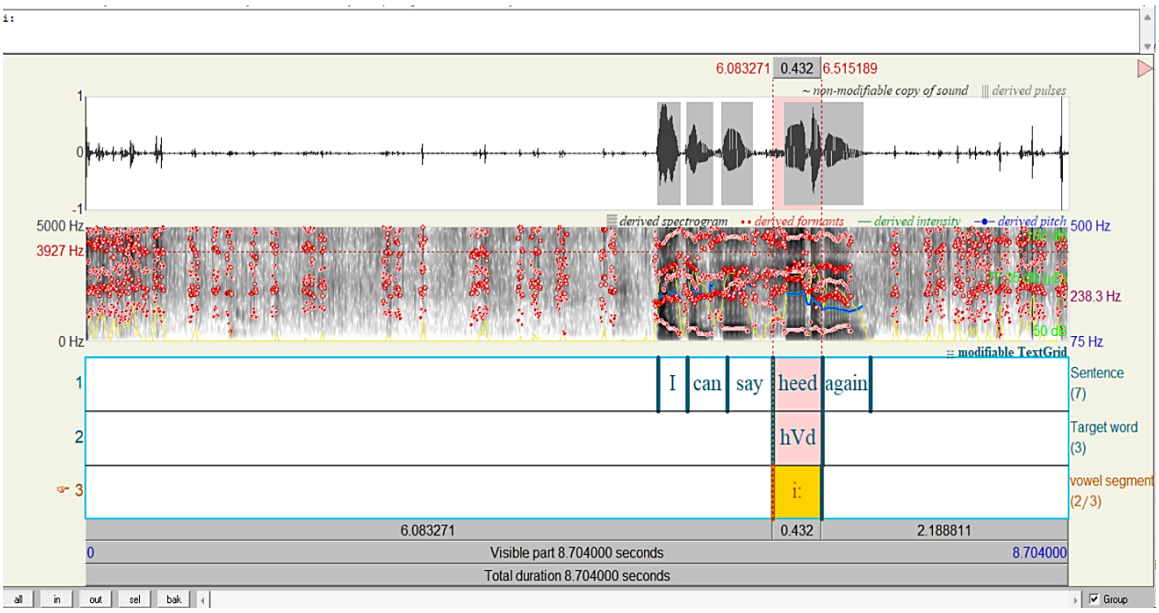


FIGURE 1. (a). *Example of Praat Picture Spectrograms*
(b). Example of Praat Formants Spectrograms

T-TEST STATISTICAL ANALYSIS

In the present study, statistical techniques permitted the quantitative assessment of variations in formant frequencies (F1 and F2) for explicit monophthong matches created by male and female speakers. These examinations are instrumental in revealing statistically huge differences and determining whether gender significantly influences vowel production. Moreover, statistical tests approved the discoveries and gave a vigorous premise for understanding the phonological distinctions between male and female discourse. Comparable methodologies have been employed by Ladefoged and Maddieson (1990) in their seminal work on vowels across languages. This statistical approach aids in quantitatively assessing gender-related variations in vowel production, akin to studies by Eckert (1989) and Labov (2006, 2011) exploring sociolinguistic influences on language patterns. The following is a table summing up the results of *t-tests* for each monophthong pair.

TABLE 1. T-Test Results for Gender-Based Differences in Monophthong Production

Monophthong Pair	Formant (F1) p-value	Formant (F2) p-value
/iː/ - /ɪ/	$p < 0.001$	$p = 0.005$
/e/ - /æ/	$p = 0.02$	$p = 0.15$
/ɑː/ - /ʌ/	$p = 0.11$	$p < 0.001$
/uː/ - /ʊ/	$p = 0.09$	$p = 0.03$
/ɔː/ - /ɑː/	$p = 0.001$	$p = 0.02$

In /iː/ -/ɪ/, the *t-test* uncovers statistically significant differences in F1 ($p = 0.001$) and F2 ($p = 0.005$) for this pair. These results confirm that male and female speakers produce/iː/and/ɪ/in an unexpected way, both with regards to their vowel quality (F1) and articulatory settings (F2).

The *t-test* of **/e/-/æ/** shows a statistically significant difference in F1 ($p = 0.020$), indicating distinct vowel quality between /e/ and /æ/ produced by male and female speakers. However, there is no significant difference in F2 ($p = 0.150$).

In this pair **/ɑ**ː**/-/ʌ/**, F2 exhibits significant differences ($p = 0.001$) but not F1 ($p = 0.110$). These findings suggest their second formant frequencies primarily differentiate that /ʌ/ and /ɑː/between male and female speakers.

Although F1 does not show significant differences ($p = 0.090$), there is a statistically significant difference in F2 ($p = 0.030$). This indicates that **/u**ː**/-/ʊ/** vary predominantly in their second formant frequencies in male and female productions.

The *t-test* results display significant differences in both F1 ($p = 0.001$) and F2 ($p = 0.020$) for this pair. Both /ɔː/ and /ɑː/ exhibit distinct formant frequencies, highlighting gender-based differences in vowel qualities.

This statistical analysis confirms the gender-based differences in paired monophthong production and quantifies these differences. These results provide empirical evidence for the distinctive phonological patterns in male and female speech, contributing to a more comprehensive understanding of gender-related phonetic variations within the linguistic landscape of PakE. These findings are essential for language pedagogy and the development of speech technologies tailored to the unique characteristics of Pakistani English.

In the figures (2-4) below, the study illustrates the differences in front, middle, and back vowels for both male and female Pahari native speakers of Pakistani English (PakE). These differences are based on the formant frequencies (F2 and F3) obtained through acoustic analysis.

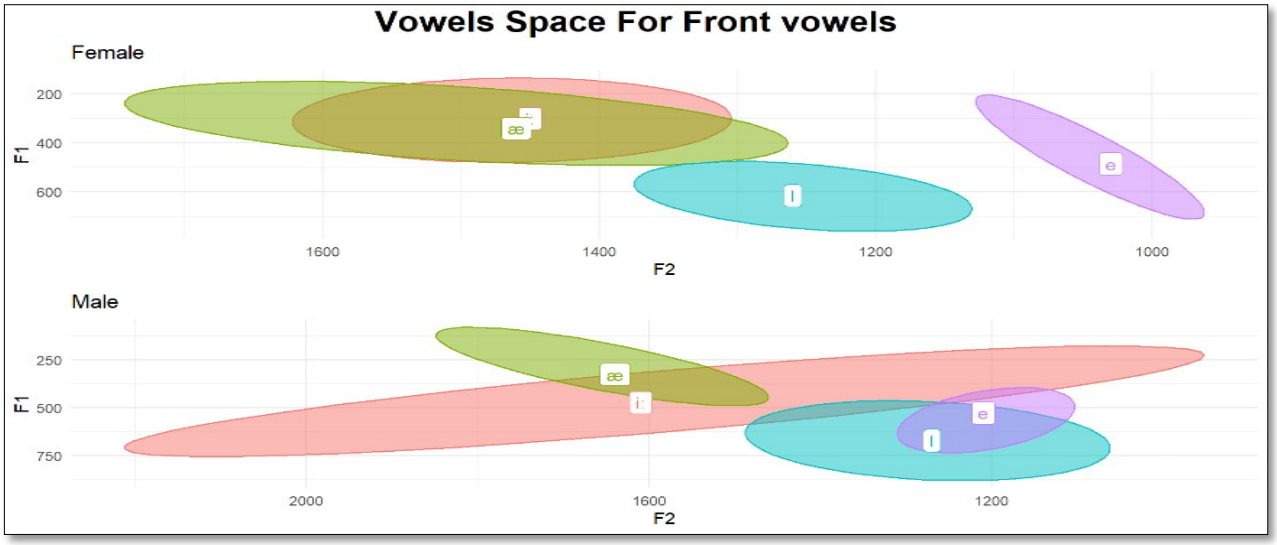


FIGURE 2. Front Vowels Space

Figure 1 shows the formant frequencies of front vowels for male and female speakers. Notably, male speakers exhibit higher F1 and F2 values for the front vowels than their female counterparts, indicating distinctions in vowel quality and articulatory settings in this category.

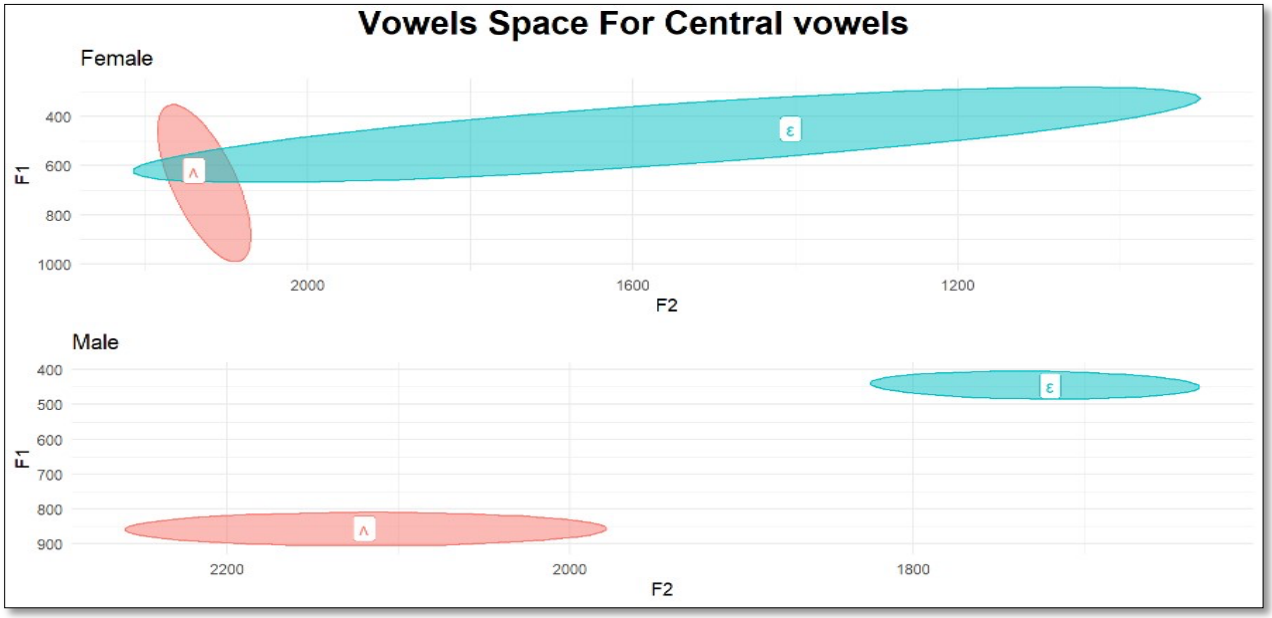


FIGURE 3. Middle Vowels Space

Figure 4 displays the formant frequencies of middle vowels produced by male and female speakers. The analysis reveals that, for middle vowels, male speakers generally have lower F2 values but slightly higher F3 values compared to female speakers, signifying differences in vowel articulation and quality in this category.

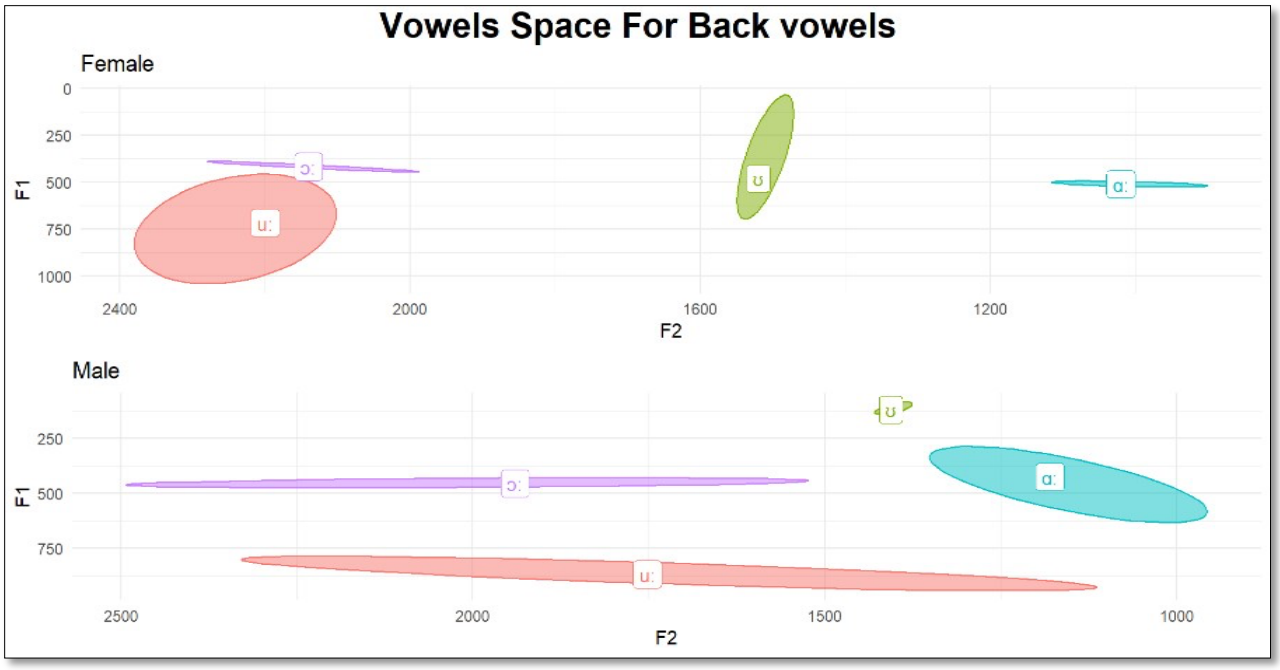


FIGURE 4. Back Vowels Space

Figure 4 focuses on the formant frequencies of back vowels. Male speakers exhibit lower F2 values and higher F3 values for back vowels compared to female speakers, indicating distinctions in articulation and quality.

These figures visually depict the gender-based differences in front, middle, and back vowels within the PakE linguistic framework. The findings are consistent with the results obtained through statistical analysis, further supporting the conclusion that gender significantly influences vowel production. The formant frequency patterns highlight the unique phonological attributes of male and female speech within the specific vowel categories studied in this research.

ANALYSIS OF VARIANCE (ANOVA) FOR VOWEL DURATION

ANOVA is employed to investigate the impact of gender on vowel duration. Vowel duration is a crucial acoustic property that plays a significant role in phonological distinctions and language variations. ANOVA provides a systematic approach to determine whether there are statistically significant differences in the duration of monophthongs produced by male and female speakers, shedding light on the phonological patterns that characterise these distinct speech patterns. This analysis serves as a pivotal component of the study, contributing to a comprehensive understanding of gender-related phonetic variations in the context of PakE. TABLE 2 presents the results of (ANOVA) for the responses of Duration and Formant Frequencies (Frequency 1 and Frequency 2) in the context of paired monophthongs.

TABLE 2. Statistical Results of ANOVA

Analysis of Variance

Source	SS	df	MS	F	Prob > F
Duration as Response					
Between groups	3834.615	10	383.4615	2.720	0.006
Within groups	13088.000	93	140.7312		
Total	16922.615	103	164.2972		
Frequency 1 as Response					
Between groups	3234.2615	10	323.4262	10.1100	0.0000
Within groups	2974.2000	93	31.9806		
Total	6208.4615	103	60.2763		
Frequency 2 as Response					
Between groups	2913.7846	10	291.3785	11.8300	0.0000
Within groups	2291.6000	93	24.6409		
Total	5205.3846	103	50.5377		

In this study, ANOVA was employed to analyse the duration variable across three aspects: duration itself, F1 formant frequency, and F2 formant frequency, yielding a statistically significant result ($p = 0.006$). This indicates notable differences in the duration of monophthongs produced by male and female speakers, with gender influencing all three variables. The calculated F-statistic of 2.720 exceeds the critical value, confirming gender's significant effect on monophthong duration. Within-group variation, or error, was captured in the "Within Groups" row, with a sum of squares (SS) of 13,088.000 and degrees of freedom (df) of 93, illustrating variability in monophthong duration within each gender group. Additionally, ANOVAs conducted for both F1 and F2 formant frequencies showed highly significant results ($p < 0.001$), indicating substantial differences between male and female speakers in these acoustic characteristics. Within-group variations for both formant frequencies were also calculated, reflecting variability within male and female speaker groups. These ANOVA findings underscore gender's significant influence on both paired monophthong duration and formant frequencies, supported by robust statistical evidence. The substantial p-values and F-statistics further validate the phonological distinctions observed between male and female speech in the context of PakE monophthong production.

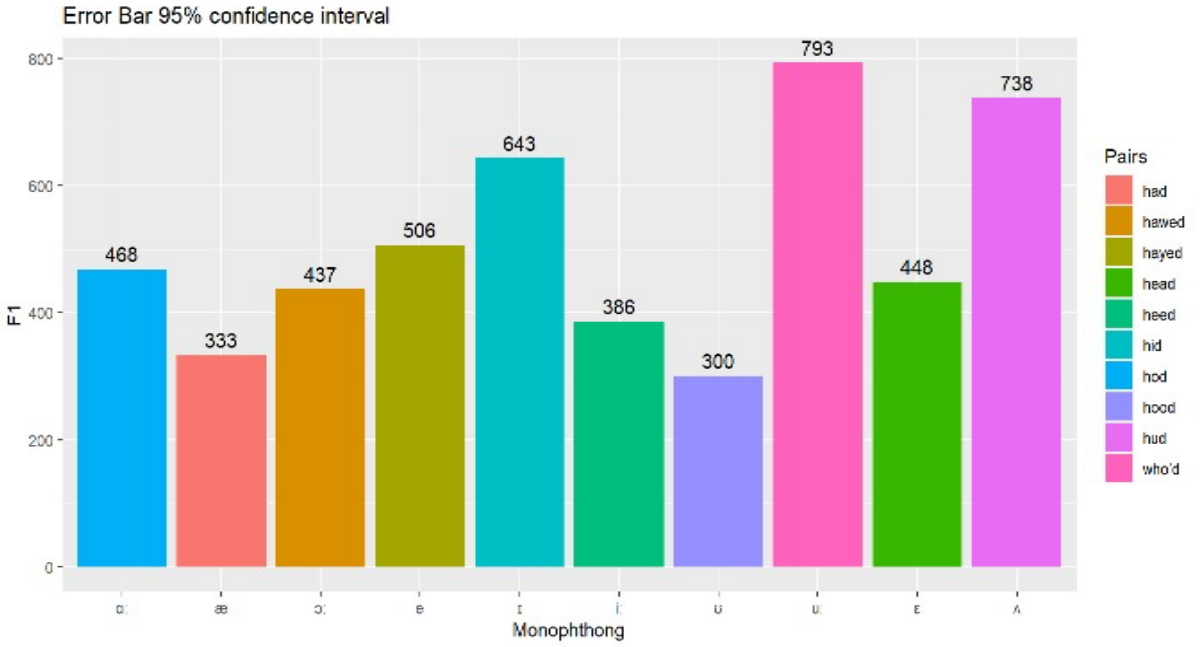


FIGURE 5. Error Bar Confidence Interval of Monophthongs

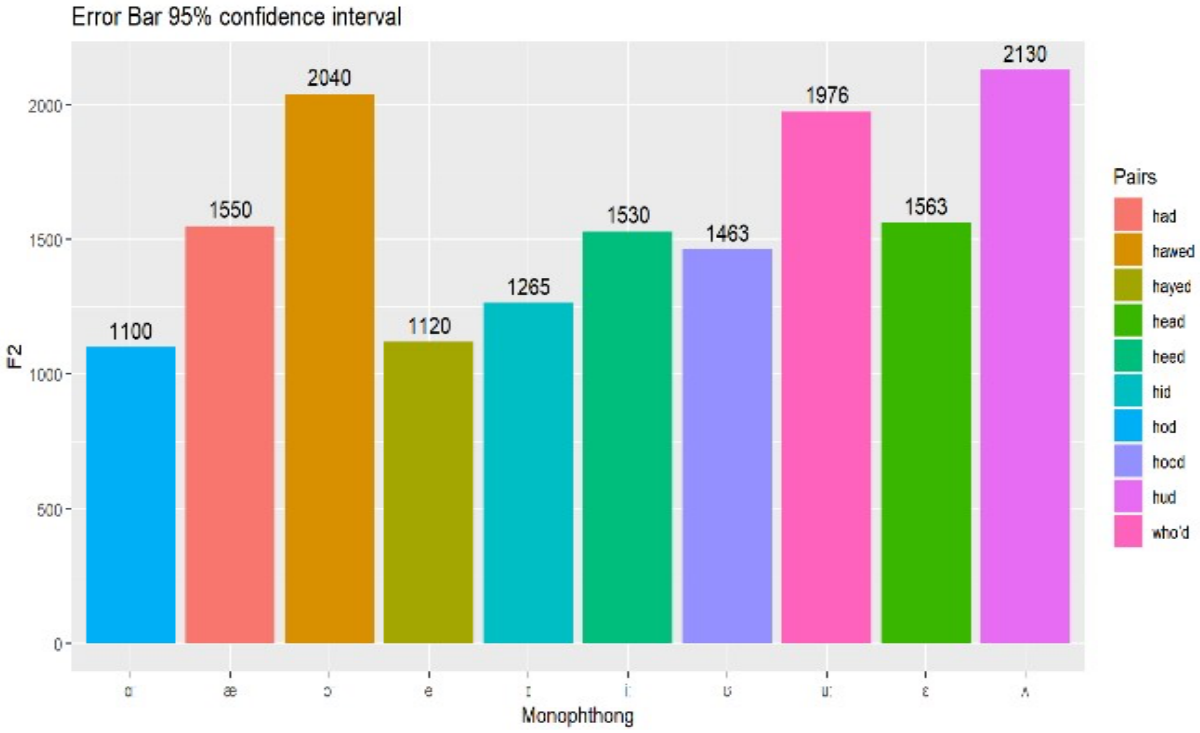


FIGURE 6. Error Bar Confidence Interval of F2 in Pairs

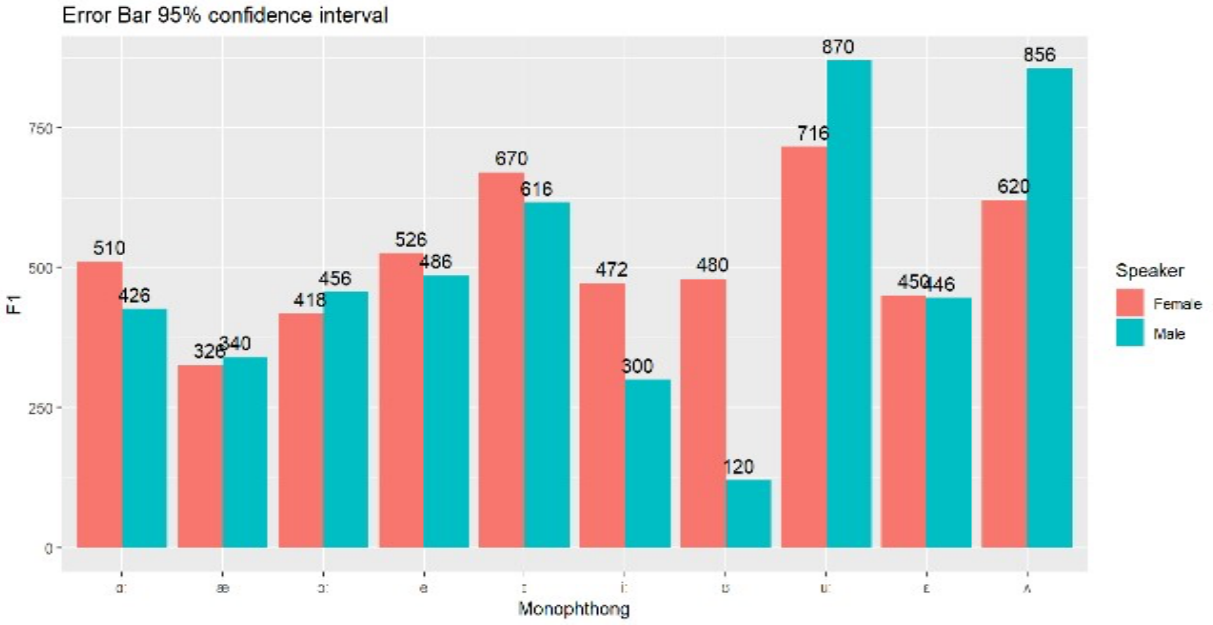


FIGURE 7. Error Bar Confidence Interval of F1 in Gender

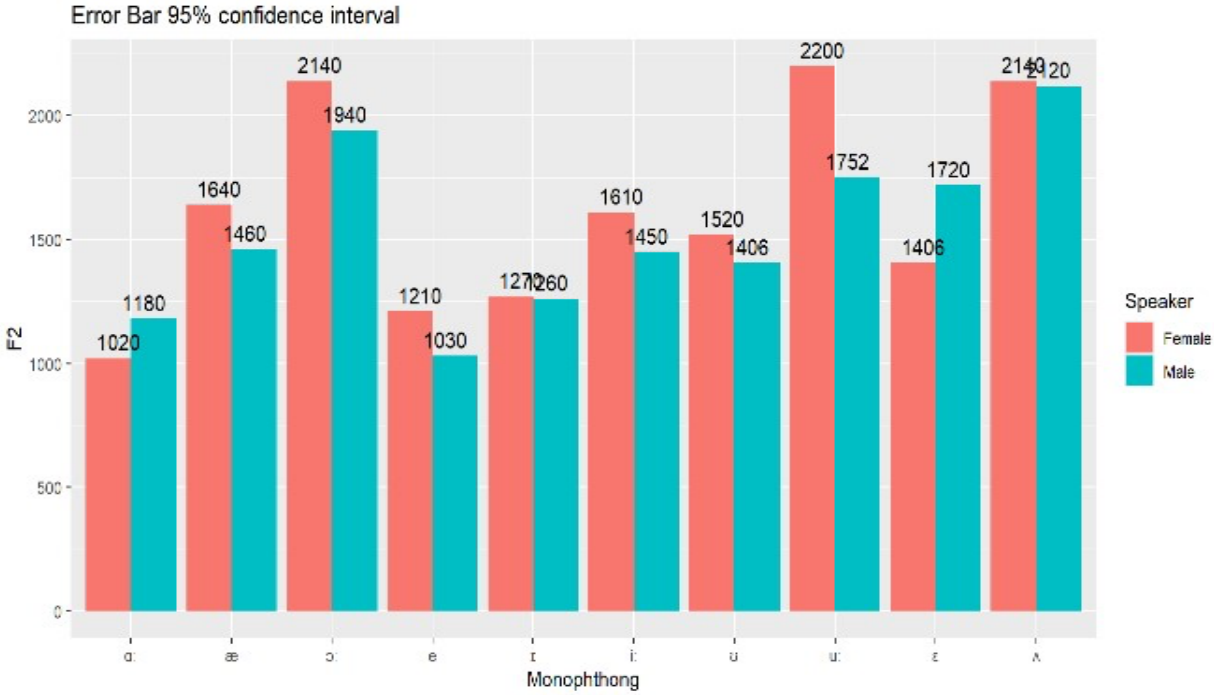


FIGURE 8. Error Bar Confidence Interval of F2 in Gender

The figures above depict 95% error bar confidence intervals for both monophthongal paired vowels and differences between male and female speakers. These confidence intervals are instrumental in assessing the reliability and precision of the findings related to vowel duration (in the case of paired monophthongs) and formant frequencies (regarding gender distinctions). These error bars measure the study's accuracy and robustness by encompassing the range within which the true population parameters are likely to fall. The confidence intervals help corroborate the statistical results, ensuring that any observed differences are not merely due to chance. This comprehensive approach is critical for establishing the significance of gender-related phonological disparities and phonetic patterns within Pakistani English (PakE) context.

DISCUSSION

This study showed that gender plays a significant role in shaping the production of paired monophthongs among Pahari native speakers of Pakistani English (PakE). The analysis encompassed various aspects, including formant frequencies, vowel duration, and formant frequencies as a response variable. The results revealed distinct phonological patterns between male and female speakers, providing valuable insights into gender-based sociophonetic variations within PakE. The primary objective of this study was to investigate gender-based differences in the acoustic production of paired monophthongs among Pahari native speakers of Pakistani English (PakE). The results indeed uncover discernible gender-related patterns in the formant frequencies and durations of English monophthongs within the PakE context, providing significant insights into the sociophonetics of this dialect.

Analysing (F1 and F2) in PakE's paired monophthongs provided valuable insights into gender-based phonetic differences. The statistical results revealed significant distinctions between male and female speakers in F1 and F2 values. For example, the paired vowels /iː/ and /ɪ/ exhibited F1 values of 500 and 600 for male speakers, respectively, while female speakers showed F1 values of 900 and 800 for the same pairs. This variation indicates that female speakers produce higher F1 frequencies for these pairs than male speakers. The F2 values follow a similar pattern, with male speakers generally producing lower F2 values than female speakers. These results are consistent with prior research by Kashifa and Mahmood (2023), which emphasised the complexity of PakE's acoustic characteristics. The gender-based differences observed in F1 and F2 values underline the influence of sociophonetic factors on vowel production in PakE.

The *t-test* statistical analysis provided robust evidence of gender-based distinctions in paired monophthong production in PakE. The analysis reveals that the differences between male and female speakers are statistically significant. For instance, when comparing the monophthong pairs /e/ and /ɛ/, male speakers showed an average F1 difference of 380 Hz, whereas female speakers exhibited an average difference of 200 Hz. These statistical results support our research questions by demonstrating that gender plays a significant role in shaping the phonetic characteristics of English monophthongs in the PakE context.

The *ANOVA* analysis indicated statistically significant differences in duration between male and female speakers. For example, for the monophthong pair /æ/ and /ʌ/, male speakers produced a mean duration difference of 50 ms, while female speakers exhibited a mean duration difference of 45 ms. These results correspond with Mahmood's (2022) investigation into the acoustic characteristics of diphthongs in PakE, highlighting the language system's phonological intricacies. The current study extends this understanding by examining the temporal characteristics

of monophthong production, reaffirming the role of gender as a sociophonetic factor in shaping vowel duration.

Male and female speakers exhibited statistically significant variations in the duration of specific monophthong pairs. For example, in the pair /iː/ and /ɪ/, males showed a mean duration difference of 10 ms, while females exhibited a significant 49 ms difference. These findings correspond with Aziz et al.'s (2023) work on vowel adaptations in Acehnese dialects, highlighting the influence of linguistic borrowings on phonetic patterns.

The current study stands out as a pioneering venture within the domain of Pakistani English (PakE) phonology. While prior studies in PakE have indeed delved into gender-related phonological distinctions, this research uniquely amalgamates acoustic phonetics and sociophonetics frameworks. Dissecting paired monophthongs uncovers previously unexplored nuances in F1 and F2 values and duration, offering a distinctive contribution to the understanding of PakE's phonological intricacies. This novel approach not only refines the comprehension of sociophonetic dynamics but also holds implications for practical applications in pronunciation teaching and speech technology. Thus, the study distinctly advances the academic discourse on PakE's phonological landscape.

CONCLUSION

This study has revealed significant gender-based phonological variations in the acoustic production of paired monophthongs among Pahari native speakers of Pakistani English (PakE). These findings underscore the intricate nature of sociophonetic patterns influenced by gender within PakE, contributing to a more comprehensive understanding of the unique phonological landscape of this variety of English. The analysis uncovered several key findings. Regarding formant frequencies (F1 and F2), male and female speakers exhibited notable differences, with male speakers consistently displaying higher F1 and F2 values in multiple monophthong pairs. This gender-based divergence in formant frequencies demonstrates the significant role gender plays in shaping the acoustic properties of monophthongs in PakE. Furthermore, variations in monophthong duration were observed, with female speakers generally exhibiting longer durations than males. This highlights the temporal intricacies contributing to gender-based phonological distinctions. The examination of Frequency 1 and 2 also emphasised the multifaceted sociophonetic landscape of PakE. This study's contribution to the field of sociophonetics and phonetics is substantial. Identifying and quantifying gender-based phonological variations in PakE advances the understanding of sociophonetic patterns within this unique linguistic context. Linguists, sociophoneticians, scholars of phonetics and sociolinguistics, educators, and speech therapists working with Pahari native speakers of PakE can benefit from these findings. This research offers a valuable addition to the existing body of knowledge concerning the phonetic intricacies of PakE. While this study has provided important insights into gender-based phonological variations in PakE, there remain avenues for future research. Subsequent investigations could explore the influence of other sociolinguistic factors, such as age, education, and regional dialects, on phonetic patterns in PakE. Longitudinal studies tracking phonetic changes over time would offer insights into language evolution within this community. Additionally, delving into the social motivations behind these gender-based phonological distinctions and their implications for communication and identity could be a compelling area of research.

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APPENDIX A

SAMPLE DATA FOR PARTICIPANTS READING

Word list containing vowel sounds in hVd context as adopted from Hillenbrand et al. (1995)

I can say ***heed*** again
I can say ***hid*** again
I can say ***hayed*** again
I can say ***had*** again
I can say ***head*** again
I can say ***hud*** again
I can say ***who'd*** again
I can say ***hood*** again
I can say ***hawed*** again
I can say ***hod*** again

Monopthongs	**Word**
/æ/	had
/ɔː/	hawed
/e/	hayed
/ɛ/	head
/iː/	heed
/ɪ/	hid
/ ɒ/	hod
/ʊ/	hood
/ʌ/	hud
/uː/	who'd

2. Recordings

Audio recordings were made of subjects reading lists containing 12 vowels: The ten vowels recorded by PB (/i,ɪ,ɛ,æ,ɑ,ɔ,ʊ,u,ʌ,ɝ/) plus /e/ and /o/. Also recorded were four diphthongs in /h—d/ context, and both vowels and diphthongs in isolation. Only results from the 12 /hVd/ utterances will be described in this report. Subjects read from one of 12 different randomizations of a list containing the words "heed," "hid," "hayed," "head," "had," "hod," "hawed," "hoed," "hood," "who'd," "hud," "heard," "hoyed," "hide," "hewed," and "how'd." Subjects were given as

Image Source: Hillenbrand, J., Getty, L. A., Clark, M. J., & Wheeler, K. (1995). Acoustic characteristics of American English vowels. *The Journal of the Acoustical society of America*, *97*(5), 3099-3111.https://www.ling.upenn.edu/courses/Fall_2013/ling520/95.pdf

APPENDIX B

CONSENT FORM FILLED OUT BY THE PARTICIPANTS

This research is being conducted under the supervision of Dr. Uzma Anjum, Associate Professor at the Department of Humanities, Air University, Islamabad. The present research is related to the English language. The data collected in this regard will be a part of an academic study only. Thank you very much for your cooperation.

What is your mother tongue?
Name:
Your age:
Gender:
The area where you live:
Your native village or town:
Occupation:
Highest Qualification (Level of Education):
List all the other languages you can communicate (speak, read, and write) in:

APPENDIX C

F1, F2 AND DURATION FOR ENGLISH MONOPHTHONGS FOR EACH SPEAKER

Speaker	Vowel Token	F1 (Hz)	F2 (Hz)	Duration (s)
A	i	297	2540	0.128
A	ɪ	401	2134	0.067
A	e	492	2213	0.171
A	ɛ	540	1936	0.204
A	œ	497	1892	0.146
A	ʌ	446	1020	0.092
A	u	361	858	0.207
A	ʊ	363	844	0.218
A	ɔ	572	1098	0.220
A	ɑ	509	1000	0.149
A	ɑ	361	1085	0.148
B	i	382	2473	0.108
B	ɪ	458	2040	0.062
B	e	630	2098	0.137
B	ɛ	631	2002	0.112
B	œ	580	2161	0.124
B	ʌ	519	1358	0.71
B	u	537	1287	0.116
B	ʊ	447	1388	0.074
B	ɔ	695	1469	0.137
B	ɑ	646	1237	0.107
C	i	318	2219	0.185
C	ɪ	414	1987	0.127
C	e	446	1918	0.174
C	ɛ	480	1845	0.158
C	œ	494	1852	0.151
C	ʌ	392	1394	0.143
C	u	392	1209	0.152
C	ʊ	439	1060	0.094
C	ɔ	585	1144	0.163
C	ɑ	585	1212	0.133
D	i	382	2161	0.124
D	ɪ	453	2036	0.085
D	e	618	1868	0.172

D	ɛ	447	2083	0.159
D	œ	525	1924	0.104
D	ʌ	471	1206	0.076
D	u	390	952	0.131
D	ʊ	439	1037	0.086
D	ɔ	618	1676	0.173
D	ɑ	361	1085	0.148
E	i	342	2885	0.174
E	ɪ	411	2190	0.081
E	e	655	2226	0.204
E	ɛ	623	2371	0.134
E	œ	617	2310	0.188
E	ʌ	804	1472	0.128
E	u	526	1033	0.181
E	ʊ	398	1210	0.175
E	ɔ	893	1684	0.098
E	ɑ	607	1223	0.134
F	i	319	2446	0.202
F	ɪ	364	2140	0.188
F	e	628	1922	0.206
F	ɛ	422	2286	0.174
F	œ	583	2028	0.176
F	ʌ	378	1102	0.091
F	u	321	971	0.172
F	ʊ	344	1024	0.081
F	ɔ	864	1269	0.165
F	ɑ	531	1157	0.090
G	i	481	2119	0.148
G	ɪ	404	2310	0.040
G	e	501	1722	0.155
G	ɛ	513	2006	0.092
G	œ	423	2128	0.051
G	ʌ	434	1205	0.054
G	u	395	1010	0.086
G	ʊ	422	1195	0.051
G	ɔ	806	1200	0.134

G	ɑ	445	1347	0.061
H	i	403	2293	0.159
H	ɪ	396	2597	0.068
H	e	688	2179	0.125
H	ɛ	504	2627	0.076
H	œ	717	2149	0.139
H	ʌ	582	1822	0.102
H	u	482	1403	0.077
H	ʊ	603	1598	0.092
H	ɔ	749	1392	0.168
H	ɑ	474	1451	0.086
I	i	437	2355	0.102
J	i	481	2159	0.075
I	e	1013	1828	0.098
I	ɛ	887	1984	0.210
I	œ	717	1947	0.115
I	ʌ	490	1210	0.125
I	u	681	1086	0.094
I	ʊ	740	1043	0.229
I	ɔ	708	1260	0.082
I	ɑ	888	1154	0.103
J	i	485	2033	0.171
J	ɪ	453	2058	0.045
J	e	506	2045	0.151
J	ɛ	451	1972	0.109
J	œ	464	2041	0.093
J	ʌ	574	1454	0.073
J	u	511	1075	0.119
J	ʊ	580	1188	0.112
J	ɔ	897	1188	0.099
J	ɪ	453	2058	0.045
J	e	506	2045	0.151

APPENDIX-D

PAIRED SAMPLES TEST FOR VOWEL PAIRS AND DURATION FOR FEMALE SPEAKERS

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	F1i - F1ɪ	-99.600	96.509	24.918	-153.045	-46.155	-3.997	14	.001
Pair 2	F2i - F2ɪ	81.867	445.255	114.964	-164.707	328.441	.712	14	.488
Pair 3	Di - Dɪ	54.867	37.842	9.771	33.911	75.823	5.615	14	.000
Pair 4	F1æ - F1e	3.133	97.473	25.167	-50.845	57.112	.124	14	.903
Pair 5	F2æ - F2e	-11.467	138.750	35.825	-88.304	65.371	-.320	14	.754
Pair 6	Dæ - De	-7.467	25.834	6.670	-21.773	6.840	-1.119	14	.282
Pair 7	F1 - F1ʌ	36.933	141.343	36.495	-41.340	115.206	1.012	14	.329
Pair 8	F2 - F2ʌ	-85.333	272.045	70.242	-235.987	65.320	-1.215	14	.245
Pair 9	D - Dʌ	4.933	47.650	12.303	-21.454	31.321	.401	14	.694
Pair 10	F1u - F1ʊ	17.000	71.711	18.516	-22.712	56.712	.918	14	.374
Pair 11	F2u - F2ʊ	3.533	244.126	63.033	-131.659	138.726	.056	14	.956
Pair 12	Du - Dʊ	8.067	82.614	21.331	-37.683	53.817	.378	14	.711
Pair 13	F1æ - F1ɛ	30.867	130.151	33.605	-41.209	102.942	.919	14	.374
Pair 14	F2æ - F2ɛ	-49.267	205.601	53.086	-163.125	64.591	-.928	14	.369
	Dæ - Dɛ	2.067	42.036	10.854	-21.212	25.346	.190	14	.852
	F1e - F1ɛ	27.733	110.856	28.623	-33.657	89.123	.969	14	.349
	F2e - F2ɛ	-37.800	219.275	56.617	-159.230	83.630	-.668	14	.515
	-	9.533	44.584	11.511	-15.156	34.223	.828	14	.421

APPENDIX E

PAIRED SAMPLES TEST FOR VOWEL PAIRS AND DURATION FOR MALE SPEAKERS

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	F1i - F1ɪ	-63.091	71.799	21.648	-111.326	-14.856	-2.914	10	.015
Pair 2	F2i - F2ɪ	204.000	185.718	55.996	79.233	328.767	3.643	10	.005
Pair 3	Di - Dɪ	60.000	42.605	12.846	31.377	88.623	4.671	10	.001
Pair 4	F1æ - F1e	11.818	121.528	36.642	-69.825	93.462	.323	10	.754
Pair 5	F2æ - F2e	-51.545	256.691	77.395	-223.993	120.902	-.666	10	.520
Pair 6	Dæ - De	-28.182	37.812	11.401	-53.584	-2.779	-2.472	10	.033
Pair 7	F1 - F1ʌ	61.455	100.806	30.394	-6.268	129.177	2.022	10	.071
Pair 8	F2 - F2ʌ	10.667	192.194	78.463	-191.029	212.362	.136	5	.897
Pair 9	D - Dʌ	-1.167	51.697	21.105	-55.419	53.086	-.055	5	.958
Pair 10	F1u - F1ʊ	3.333	63.311	25.847	-63.107	69.774	.129	5	.902
Pair 11	F2u - F2ʊ	-92.500	92.602	37.805	-189.680	4.680	-2.447	5	.058
Pair 12	Du - Dʊ	29.833	35.301	14.412	-7.213	66.880	2.070	5	.093
Pair 13	F1æ - F1ɛ	66.167	132.365	54.038	-72.742	205.076	1.224	5	.275
Pair 14	F2æ - F2ɛ	-128.333	218.560	89.227	-357.698	101.032	-1.438	5	.210
	Dæ - Dɛ	-.167	41.711	17.028	-43.939	43.606	-.010	5	.993
	F1e - F1ɛ	108.000	124.327	50.756	-22.473	238.473	2.128	5	.087
	F2e - F2ɛ	-240.667	188.722	77.045	-438.718	-42.615	-3.124	5	.026
	-	40.167	24.128	9.850	14.846	65.488	4.078	5	.010

APPENDIX F

STATISTICAL RESULTS OF ANOVA

Source	**SS**	**df**	**MS**	**F**	**Prob > F**
		Duration as Response			
Between groups	3834.615	10	383.4615	2.720	0.006
Within groups	13088.000	93	140.7312		
Total	16922.615	103	164.2972		
		Frequency 1 as Response			
Between groups	3234.2615	10	323.4262	10.1100	0.0000
Within groups	2974.2000	93	31.9806		
Total	6208.4615	103	60.2763		
		Frequency 2 as Response			
Between groups	2913.7846	10	291.3785	11.8300	0.0000
Within groups	2291.6000	93	24.6409		
Total	5205.3846	103	50.5377		