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RESEARCH PAPER

Gender Differences in English Vowel Production by Pashto Speakers

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ABSTRACT

This study explores gender-based differences in the production of six English vowels—/iː/, /ɪ/, /æ/, /ɑː/, /ʌ/, and /uː/—by native Pashto speakers. It aims to analyze the acoustic characteristics of these vowels and assess whether typical vowel contrasts are distinctly produced. Recognizing the phonological differences between Pashto and English, and physiological gender-based speech variations, this research applies a quantitative approach to assess vowel production patterns. Ten undergraduate students from the University of Buner uttered a minimal pair word list three times. Their utterances were recorded and analyzed using Praat software, focusing on vowel duration and the first two formants (F1 and F2). Quantitative data analysis revealed that male speakers produced longer vowels with lower formants, while female speakers showed shorter durations and higher F1 and F2 values. Despite these differences, both groups maintained clear vowel distinctions. It is recommended to examine the pronunciation of English diphthongs by Pashto speakers in order to identify and analyze the specific challenges they encounter.

KEYWORDS Acoustic Analysis, Duration, Formant Frequencies, Pashto Speakers, Vowels

Introduction

There are many reasons to study speech acoustically, in speech acoustics, the acoustic signals help in making relationship of speech production with speech perception. For this, the acoustic analyses provide information about the speakers' intent and listeners' perception of the produced acoustic signals. The advancements in computer science has made acoustic research easier relatively due to various acoustic software in terms of time and resources. The availability of numerous quantitative theories has made the analysis of acoustic data easier in terms of speech articulation and perception. The acoustic signals are the natural input for the studies of speech analyses. The theoretical knowledge and the use of technology has together opened new doors in the fields of acoustics. The acoustic data has potential to help in conducting the research on speech related issues. The acoustic data provide ways to deal by assessing and managing the language issues.

Over the years, language sounds have been focused by many researchers (e.g., Hillenband et al., 1995; Keerio et al., 2014; Nishi et al., 2008; Rehman, 1991) to characterize them from various perspectives by using various methods and procedures. The work of previous researchers has been focused either on looking for the common linguistic features across languages or on phonetic characteristics of a language. In this regard, either the physical properties of speech sounds have been studied or the relationship of physical properties of speech with its production and perception have been the focus. There are number of reasons to study the speech sounds under the standards of acoustic phonetics. These include, the knowledge about the ways by which speech is generated and the role of vocal tract and other resonating bodies in the propagation of speech, development of artificial speech articulation systems, and the speech recognition features (Ansarin 2004; Lee, 1992). Therefore, the vowel phonemes due to their constant acoustic intents have been focused more as compared to consonantal phonemes (Kent, 2002; Moore, 2003).

English language is the medium of world business and the international trade (Ku & Zussman, 2010). English has been the language of researches in science and technology. Therefore, English has been the most focused language in the work of past researchers in the field of acoustic phonetics. The phonemic inventory of English on the patterns of native and the non-native speakers has been studied on different aspects of acoustic phonetics (e.g., Chen, 2001; Deterding, 2003; Maxwell, 2009; Peterson, 1952).

According to past researchers, the speakers of Asian languages, in their production of English as a second language, show phonetic inaccuracies (Flege, 1989; Pittman & Ingram, 1992; Wang, 1983; Yang, 1996). The extent of phonetic inaccuracies in second language is related to the length of exposure to a particular language or the age in which second language is learned (Johnson & Newport, 1991). The reasons for phonetic inaccuracies are the differences in the segmental and suprasegmental features of languages (Cheng, 1987; Flege et al. 1997; Os, 1985).

To the extent of my review of literature, the research on acoustic analysis of English vowels produced by Pashto speakers has not been conducted to compare male and female speakers' articulations. In this manner, data collection was done from the native speakers of Pashto language to explore the acoustic characteristics of vowel phonemes in their use of English language. The current research work presents the acoustic analysis of English vowel sounds produced by the Pashto speakers.

This research mainly focuses the acoustic features of English vowels produced by Pashto speakers. The acoustic properties are the cues to the perception of a speech sound. However, to reveal the acoustic cues for the English vowel sounds produced by Pashto speakers of different gender, this study has been conducted to meet the objectives of the study; to explore the acoustic characteristics of English vowels produced by Pashto speakers and to examine, if there is any contrast between the typical vowel pairs produced by Pashto speakers.

Moreover, this research study is the acoustic analysis of English vowels produced by Pashto speakers. It focuses the quality and the length of the vowels sounds. For quality, spectrographic representation of the produced English vowels was examined to measure first two formant frequencies (F1 and F2). For length, the duration of the produced vowels was measured form the spectrographic outcome. Further, this study is delimited to ten native speakers (5 males and 5 females) of Pashto language.

Literature Review

Language is a combination of sounds and those sounds combine together to form words and then words form phrases and sentences which make complete linguistic expressions. A language is compulsory aspect of human life which is very much important for the communication. Although, without any language, communication is possible like animals and birds do not have any language but they use sounds through which they convey messages. Even after birth, a child uses different sounds and gestures to express his needs to his mother. In case of human languages, a linguistic expression is very important. In spite of the fact that language is important for communication, there are two ways to communicate, either by oral communication or written communication, where oral communication is primary and writing is secondary aspect of a language. Each sound in a language is represented by a symbol which is called an alphabet and sometimes single alphabet represents more than one sound in a language depending on the structural constraints of the language.

Today, linguists emphasize on the importance of sounds. Sounds are important unit of any language and they have a logical connection with the meanings and perception (Ohala et al., 1997). The branch of linguistics that deals with the production and physical properties of sounds is called phonetics (Stevens, 2000). The sound production process involves the organs that are present in our vocal tract like teeth, lips, jaws, tongue and other regions of our oral cavity. With the combination of one another, different types of sounds are produced.

Phonetics is the basic and important science of any language which then leads to the phonology, morphology and semantics. Phonetics is a vast field of linguistics which deals from the production of sounds to the perception of sounds which is based on the physical characteristics of speech sounds which is the subject of acoustic phonetics. The three main branches of phonetics are: Articulatory Phonetics, Auditory phonetics and Acoustic Phonetics.

Articulatory phonetics is the sub branch of linguistics which deals with the production of speech sounds using the speech organs that are present in the vocal tract (Ogden, 2009). In the process of production of sounds, different articulators are involved and with combination of each other, these articulators can produce multiple sounds of a language (Smalley, 1963). The production of sound is not only depending upon the articulators a normal human being has, but it also utilizes the energy that is coming from the lungs and the manner that how different sounds are produced with the help or articulators.

The perception of a speech sound is the subject of auditory phonetics. In auditory phonetic, the phoneticians find how the sounds are perceived and how they are produced to assist the listeners to perceive that speech sounds easily (Ashby, 2011). The perception and production of sounds gained very much importance in the study of speech sounds of any language (Koerich, 2006, Leather, 1999, Wode, 1999). Auditory phonetics plays an important role in the study of any language because perception leads to interpretation and understanding of how sounds are put together to form meaningful words. Over the past few years, several studies have been conducted to address the difficulties faced by the non-native speakers while speaking second language (e.g., Best & Strange, 1992; Fledge & Eefting, 1987; MacKain et al., 1981; Yamada, 1995).

Acoustic phonetics is the study of physical characteristics of speech sounds. In acoustic phonetics, the speech which is abstract is made to measure by its waveform, frequency, intensity, amplitude and duration. The history of acoustic phonetics date back to 1830 but spectrographic analysis is the recent invention of acoustic phonetics which help phoneticians and linguists to explore physical qualities of sounds of languages around the world. Rousselot (1846-1924) was considered as the father of experimental phonetics and contributed a lot in the field of acoustic phonetics. Later on, different linguists introduced different methods of analyzing speech sounds of languages which helps researchers to explore the characteristics of sounds that are particular and common to world languages (e.g., Olson & Hispania, 2014; Martinez & Rufiner, 2000; Nilsonne, 1987; Park & Sim, 2003, Schalling & Hammberg, 2007).

Since the basic purpose of acoustic linguistics is to study the physical properties of sounds and the relationship of these properties to the speech signals. A great number of linguistics talked about the acoustic variations and the features of speech sounds of different languages that how a speech sound is transmitted in the form of waves and how the fluctuations of air particles cause the difference in the quality and properties of sounds (e.g., Birjandi & Nodoushan, 2005; Bussmann, 2006; Crystal, 2003; Finch, 2005; Ladefoged, 2000; Malmkjar, 2006; O`Connor, 1973; Roach, 2000; Stranzy, 2005).

Acoustic analysis of speech samples is an imperative phenomenon which can be done using different computer programs and which helps in determining different features in numerous settings. In acoustic research studies, there are multiple parameter that are essential to be kept in mind before conducting any fruitful experiment. Amir and Wolf (2009) conducted a research on the validity of different computer programs that can help a linguist to analyze speech samples. The research study shows that it is very important to use an authentic tool for the speech sample analysis because different programs have different attributes based on different algorithms which sometime give different and inaccurate results. Concerning the effectiveness of analysis tools, PRAAT which is an open computer software program has been used in this study for the analysis of data.

The characteristics of males and female are different very important in differentiating the both living beings. Not only their physical characteristics but certain other traits are also different from each other. From the perspective of language, the speech of both genders is different on the basis of multiple factors even the way of speaking is also different (Oh, 2011). In acoustic studies researchers studied language samples of both genders to see the differences in the speech of male and female and the results shows that there is a clear difference between the speech of males and females.

One of the main reasons to study the gender as a variable in acoustic studies that they differ in frequencies and pitch and the frequency difference is considered as the major difference between the speech of male and female (Gilbert & Weismer, 1974). The normal frequency range of male speech is 120 Hz and 200 Hz for female speech but they can vary through the age (Takeuta et al., 1972). A number of acoustic studies has been done to see the cross-linguistic differences of male and female speech and the vowel formants are considered to be higher for females (Hillenbrand et al., 1972; Pepiot, 2009). Some of acoustic studies states that the range of F0 is larger for females than of males (Simpson, 2009). Few of the acoustic studies concluded that these differences are basically on the basis of biological factors like focal folds of male beings are denser and bigger and vibrate more slowly than females (Kahane, 1978). Due to these reasons, in the current study, the focus of the acoustic differences of vowels is also based of gender to that whether the vowels spoken by females is different than males or not.

Theoretical Framework

Furthermore, the current study adopts Fant's Source-Filter Theory or Source-Filter Theory (1960) as a theoretical framework to gain insightful measurement of the vowels. This theory describes the speech sound and its production in terms of sound energy source and sound filtering effects. Fant states, 'speech wave is the response of the vocal tract filter systems to one or more sound sources' (1960, p. 15).

Material and Methods

This study is an acoustic analysis of English vowel sounds in the speech of Pashto speakers. Therefore, the nature of this study is both descriptive and analytical. In descriptive, it focusses on by introducing vowel characteristics such as formants and durations, and in analytical, it focusses on comparing vowel features across speakers. To meet the objective of the study, the data were collected from Pashto native speakers of different gender. Moreover, the quantitative approach is adopted to analyze the acoustic data by using an acoustic software PRAAT version 6.4.30 (Boersma & Weenink, 2025).

Furthermore, for the acoustic analysis, the data was recorded from 10 participants (5 males and 5 females) in district Buner KP Pakistan. The speech samples of the participants were collected in University of Buner. The word list given in Table 1 was presented to the speakers and they articulated the words. All the participants articulated the word list thrice and their responses were recorded. All the participants' native language was Pashto and were studying BS English at University of Buner.

The speech sample used in this study was the list of six monosyllabic words in CVC context. These vowels include /iː/, /ɪ/, /æ/, /ɑː/, /ʌ/, /uː/ as given below in Table 1. The structure of the words was restricted to CVC in which these vowels occur.

Table 1
Wordlist containing vowel sounds in CVC context

Vowel	Word
/ɪ/	Bit
/iː/	Beat
/æ/	Bat
/ɑː/	Bart
/ʌ/	But
/uː/	Boot

Results and Discussion

The analysis of the data has been done by measuring the acoustic features (formant frequencies and the duration) of vowels. It in, all the recorded tokens were analysed acoustically and their spectrograms were taken for measuring their frequencies. Then, the differences in formant frequencies and the vowel length were identified based on gender differences.

All the three responses of five male respondents were acoustically analysed and their averages were taken (5 respondents x 3 responses= 15 tokens) that are shown in the Table 2 below. It shows the results of durations and formant frequencies; F1 and F2 respectively.

Table 2
Average of male respondents' responses

Vowel	Duration	F1	F2
/ɪ/	146	355	1893
/iː/	244	251	2266
/æ/	238	385	2065
/ɑː/	251	492	923
/ʌ/	128	478	1008
/uː/	242	330	770

The above analysis was done acoustically using Praat and values were noted focusing the spectrograms. These are the results of all five male speakers who articulated each word thrice and every token was analysed separately. Then, the average of three token was taken and presented in the table 2 respectively. In it, the duration of vowels was measured in millisecond (ms), and the values of F1 and F2 were noted. F1 shows tongue height of tongue, and F2 shows front and back of tongue. In these analyses, every word having the targeted vowel had three tokens and had given the same consideration and acoustic analysis, but for visual representation, only two spectrograms were given below in Figure 1 and 2 of /ɪ/ and /i:/.

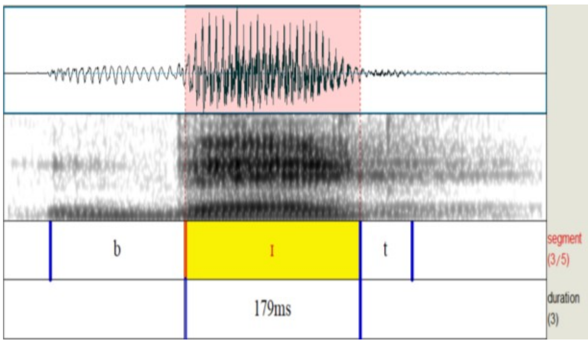

Figure 1: Spectrogram of /ɪ/

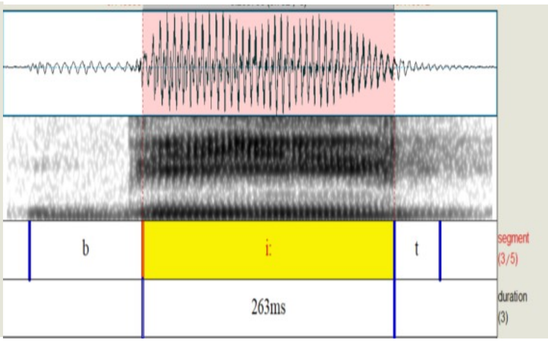

Figure 2: Spectrogram of /i:/

These spectrograms show the features of vowels such as short vowel /ɪ/ and its long counterpart /i:/produced my male native Pashto speaker. The given spectrograms show the wave form at top, followed by spectrographic representation. The two tiers show the segments with marked boundaries and duration of the vowels. In these, the short vowel has 179ms and long one has 263ms.

The above analysis contains six English vowels such as /ɪ/, /iː/, /æ/, /ɑː/, /ʌ/, and /uː/ and analyzed acoustically by measuring their acoustic properties in terms of duration, first formant (F1), and second formant (F2) frequencies. These features help us understand how vowels are produced in the mouth and how they differ from one another.

Starting with duration, it's clear from the data that some vowels take longer to pronounce than others. For example, the vowels /iː/, /ɑː/, and /uː/ had the longest durations, all above 240 milliseconds, which tells us they are tense vowels—these are usually produced with more muscular effort and take a bit longer to say. In contrast, the vowels /ɪ/, /æ/, and /ʌ/ were noticeably shorter, especially /ʌ/, which was the briefest at just 128 milliseconds. These are called lax vowels, and they're typically shorter and less tense in pronunciation.

Next, we looked at the first formant, or F1, which helps us understand how high or low the tongue is during vowel production. A lower F1 means the tongue is higher up in the mouth. According to the data, /iː/ had the lowest F1 (251 Hz), showing it's the highest vowel in the group, while /ɑː/ had the highest F1 (492 Hz), meaning it's the lowest. The other vowels fell somewhere in between, with /ʌ/ and /æ/ also showing relatively high F1 values, suggesting that they are produced with a lower tongue position.

The second formant, F2, tells us whether the vowel is made at the front or the back of the mouth. A high F2 means the tongue is pushed forward, and a low F2 means it's pulled back. Here, /iː/ once again stood out with the highest F2 (2266 Hz), showing it's a very fronted vowel. /æ/ and /ɪ/ also had high F2 values, which fits their status as front vowels. On the other hand, /uː/ had the lowest F2 (770 Hz), which tells us it's produced far back in the mouth. /ɑ:/ and /ʌ/ also showed low F2 values, supporting their classification as back or central vowels.

Looking at each vowel pair more closely helps highlight their differences. The first pair, /ɪ/ and /i:/, shows a clear contrast in all three areas: /i:/ is longer, higher, and more fronted than /ɪ/. This reflects the common tense-lax distinction found in many varieties of English. The second pair, /æ/ and /ɑ:/, may seem similar in length, but their formant patterns show that /æ/ is a front vowel while /ɑ:/ is back and lower. The third pair, /ʌ/ and /u:/, also shows clear differences: /u:/ is longer and more back and high, while /ʌ/ is shorter and more central.

After analyzing the productions of male speakers, the same process was done on the responses of female speakers and the duration and values of F1 and F2 were taken. The obtained values were shown in Table 3 below.

Table 3
Averages of female respondents' responses

Vowel	Duration	F1	F2
/ɪ/	133	455	1942
/i:/	205	298	2062
/æ/	215	460	2004
/ɑ:/	249	525	1140
/ʌ/	145	477	1247
/u:/	210	370	1156

As noted above for male speakers, this analysis was done acoustically using Praat and values were noted focusing the spectrogram for female speakers. All the process was done here and spectrograms were taken as given below in Figures 3 and 4.

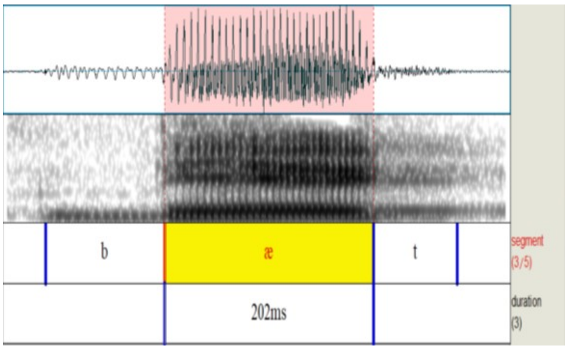

Figure 3: Spectrogram of /æ/

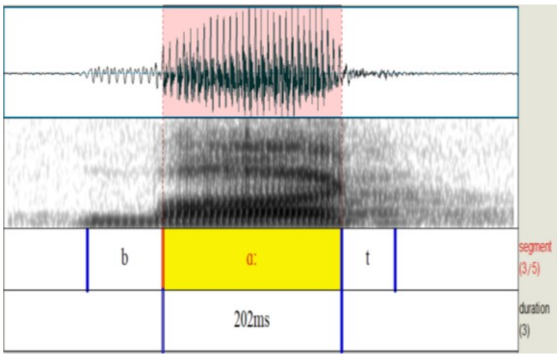

Figure 4: Spectrogram of /ɑ:/

As noted above that Figure 1 and 2 were taken from the responses of male speakers, these spectrograms shown in Figure 3 and 4 were taken from the responses of female speakers that carry /æ/ and /ɑ:/. Similarly, the spectrograms show the waveform, spectrographic representation, segments and their duration.

This section presents the acoustic analysis of six English vowels i.e., /ɪ/, /i:/, /æ/, /ɑ:/, /ʌ/, and /u:/, produced by female speakers which is based on their duration and formant frequencies (F1 and F2). These values offer important insights into how the vowels are produced and perceived, especially when examining contrasts in vowel quality related to tongue height, frontness or backness, and tenseness.

In terms of duration, the vowels behave much as expected. The long vowels: /i:/, /ɑ:/, and /u:/ have durations of 205 ms, 249 ms, and 210 ms, respectively. These values are noticeably longer than their corresponding short or lax counterparts. For instance, /ɪ/ is much shorter at 133 ms, and /ʌ/ is 145 ms. Interestingly, /æ/ appears relatively long at 215 ms, even though it is traditionally categorized as a short vowel; this could suggest variability depending on speaker or context, or the influence of dialectal factors. Overall, the length contrast reflects the typical tense-lax vowel distinction found in English, where tense vowels are longer and more stable in articulation, while lax vowels are produced more quickly and often with less precision.

Looking at the first formant (F1), which relates to vowel height (with lower F1 values indicating higher tongue positions), the results show that /iː/ has the lowest F1 at 298 Hz, confirming its status as a high vowel. /uː/ follows with a slightly higher F1 of 370 Hz, also marking it as a high vowel, but produced at the back of the mouth. On the opposite end, /ɑː/ shows the highest F1 at 525 Hz, which aligns with its description as a low vowel. /æ/ (460 Hz) and /ʌ/ (477 Hz) also appear relatively low, but not as much as /ɑː/. These values reflect a clear contrast in tongue height among the vowels.

Turning to the second formant (F2), which indicates the frontness or backness of the tongue (with higher values pointing to a fronted articulation), /iː/ and /æ/ have the highest F2 values e.g., 2062 Hz and 2004 Hz respectively, placing them clearly in the front region of the vowel space. /ɪ/ also shows a relatively high F2 (1942 Hz), though slightly less fronted than /iː/. In contrast, the vowels /ɑː/, /ʌ/, and /uː/ all display significantly lower F2 values such as 1140 Hz, 1247 Hz, and 1156 Hz, respectively, indicating that they are articulated towards the back or center of the mouth. These results are consistent with traditional vowel classifications, showing clear differences along the front-back dimension.

Examining the individual vowel pairs gives us a clearer picture of these contrasts. In the first pair, /ɪ/ and /iː/, the differences are marked across all three parameters. /iː/ is longer, higher (lower F1), and slightly more fronted (higher F2) than /ɪ/, aligning with the typical tense-lax contrast. The second pair, /æ/ and /ɑː/, shows a strong contrast in backness and height. /æ/ is a front, mid-low vowel with an F2 of 2004 Hz, whereas /ɑː/ is low and back, with the highest F1 (525 Hz) and much lower F2 (1140 Hz). The third pair, /ʌ/ and /uː/, is particularly interesting. While /uː/ is clearly a high back vowel, as shown by its low F1 (370 Hz) and low F2 (1156 Hz), /ʌ/ is more central, being slightly lower and somewhat less back (F1: 477 Hz, F2: 1247 Hz). Their duration difference also reinforces the tense-lax distinction between them.

After analysing the data and puting the resutls in Tables 2 and 3 respectively, the comparison were done by finding out similarities and differences in responses. This was done putting all the values in Table 4 which presents the characteristic of each vowels uttered by different speakers.

Table 4
Comparison of male and female respondents' responses

Vowels	Duration of Males	Duration of Females	F1 (Males)	F1 (Females)	F2 (Males)	F2 (Females)
/ɪ/	146	133	355	455	1893	1942
/iː/	244	205	251	298	2266	2062
/æ/	238	215	385	460	2065	2004
/ɑː/	251	249	492	525	923	1140
/ʌ/	128	145	478	477	1008	1247
/uː/	242	210	330	370	770	1156

This study investigated the articulation of six English vowels e.g., /ɪ/, /iː/, /æ/, /ɑː/, /ʌ/, and /uː/ by analyzing and comparing the acoustic responses of male and female speakers. The focus was on three key phonetic features: vowel duration, and the first and second formant frequencies (F1 and F2), which relate to vowel height and frontness, respectively. While both speaker groups followed the expected vowel patterns, some differences emerged that reflect broader trends commonly observed in gender-based phonetic variation.

In terms of duration, male speakers consistently produced longer vowels than female speakers across all six vowels. For example, the vowel /iː/ was produced with an average duration of 244 milliseconds by male speakers, compared to 205 milliseconds by female speakers. Similarly, /uː/ lasted 242 milliseconds in male speech, while it was slightly shorter in female speech at 210 milliseconds. Even the short vowels, such as /ɪ/ and /ʌ/, showed this pattern, with male durations slightly exceeding those of their female counterparts. This difference in vowel length may be attributed to physiological and anatomical factors as males typically have larger vocal tracts and slower speech rates, which may naturally result in longer durations.

When comparing F1 values, which indicate how high or low the tongue is during vowel production, it became clear that female speakers tended to have higher F1 values across most vowels. For instance, the vowel /æ/ had an F1 of 460 Hz in female speech compared to 385 Hz in male speech. This suggests that female speakers may articulate their vowels with a slightly more open mouth or lower tongue position. This trend is also visible in the vowels /ɪ/, /iː/, and /ɑː/, all of which showed higher F1 values for females than males. These results are consistent with what we know from acoustic phonetics: since women have shorter vocal tracts and smaller resonating cavities, their formant frequencies—especially F1—tend to be higher overall.

A similar pattern was found in F2 values, which relate to how front or back a vowel is articulated in the mouth. Generally, female speakers showed higher F2 values than male speakers. For example, /ʌ/ had an F2 of 1247 Hz in female speech, compared to 1008 Hz in male speech, and /ɑː/ showed 1140 Hz for females versus 923 Hz for males. These higher F2 values suggest that female speakers may produce vowels slightly more toward the front of the mouth, or that their shorter vocal tracts naturally raise the resonance frequencies. However, not all vowels followed this trend strictly. In the case of /iː/ and /æ/, the F2 values were slightly lower in female speakers, indicating that these front vowels might be articulated with slightly more retracted tongue positions by females in this dataset. These exceptions could be influenced by individual speech styles, dialectal background, or social factors affecting pronunciation.

Despite these subtle differences, both male and female speakers followed the same general pattern of vowel articulation. The tense-lax distinction was preserved, as was the relative positioning of vowels in the height and frontness dimensions. For instance, /iː/ consistently emerged as a high front vowel with low F1 and high F2, while /ɑː/ was the lowest and one of the most back vowels across both groups. Similarly, /uː/ was produced as a high back vowel by both males and females, though with slightly different acoustic values.

Furthermore, the obtained results were then used for generating the vowel chart that contains the uttered vowels both by male and female speakers. The generated vowel chart has been given below in Figure 5.

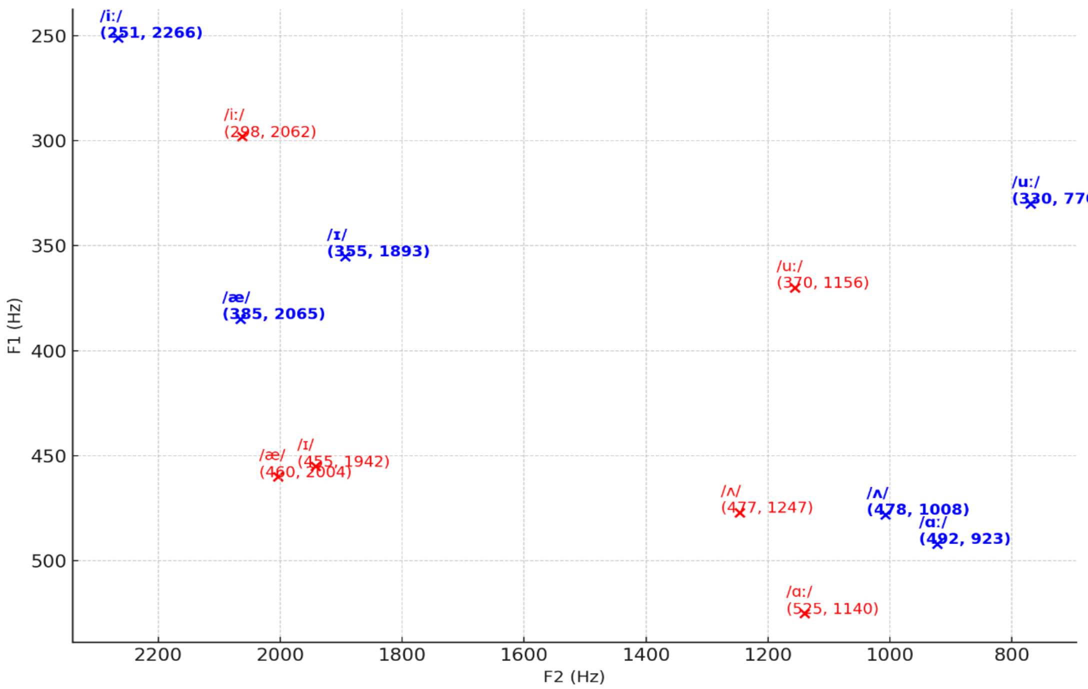

Figure 5: Vowel chart having both male and female speakers' responses

To visually represent the acoustic differences in vowel production between male and female Pashto speakers, a vowel quadrilateral chart was generated using the F1 and F2 values extracted from the recorded data. This chart plots six English monophthong vowels—/iː/, /ɪ/, /æ/, /ɑː/, /ʌ/, and /uː/—based on their formant frequencies. The values for male speakers were plotted in bold blue text, while those for female speakers were presented in normal red text to ensure clear differentiation. The F1 values (indicating vowel height) are represented on the vertical axis and the F2 values (indicating vowel frontness or backness) on the horizontal axis, following the traditional orientation of the vowel space. The chart demonstrates that male speakers generally produce vowels with lower F1 and F2 values, reflecting a relatively higher and more back articulation, whereas female speakers tend to show higher formant frequencies, which may be due to physiological differences such as shorter vocal tracts. This visual representation effectively supports the acoustic analysis by highlighting both the similarities and gender-based variations in the vowel systems of Pashto-speaking learners of English.

In conclusion, while the core structure of English vowels remained stable across genders, the acoustic data revealed some expected and meaningful differences. Male speakers generally produced longer vowels with lower formant frequencies, whereas female speakers produced vowels with shorter durations and higher F1 and F2 values. These variations reflect natural anatomical differences between the genders and align with patterns documented in phonetic literature. Importantly, the findings suggest that while physical differences influence the precise acoustic shape of vowels, the functional and phonological distinctions between vowels are consistently maintained across both male and female speech.

Conclusion

This study explored the acoustic characteristics of English monophthong vowels as produced by native Pashto speakers, with a focus on comparing the vowel productions of male and female participants. By examining six key vowels such as /iː/,

/ɪ/, /æ/, /ɑː/, /ʌ/, and /uː/, the research aimed to understand how vowel quality (in terms of formant frequencies) and vowel length (duration) may vary across gender. The data were collected in audio format from ten undergraduate students enrolled in the BS English program at the University of Buner. Each participant, five males and five females, was asked to read a word list containing the target vowels. The list was repeated three times by each speaker, and recordings were made.

The recordings were then analyzed using Praat, where vowel boundaries were manually marked to capture accurate acoustic measurements. For each vowel token, duration (in milliseconds), along with F1 and F2 values (in Hertz), were extracted. The findings revealed that while male and female speakers shared general patterns in vowel production—such as the distinction between tense and lax vowels—there were also noticeable differences. Male speakers tended to produce vowels with longer durations and lower formant frequencies, suggesting a relatively higher and backer articulation. In contrast, female speakers typically produced vowels with shorter durations and higher F1 and F2 values, indicating slightly more open and fronted articulation. These differences are consistent with established patterns in acoustic phonetics and can be largely attributed to physiological differences in vocal tract length and resonance properties.

Overall, the study highlights that although the Pashto-speaking participants exhibited a consistent understanding of English vowel contrasts, gender plays a significant role in shaping the precise acoustic realization of these vowels. These findings have important implications for second language phonetics and can contribute to the development of more nuanced pronunciation instruction for Pashto learners of English.

Recommendations

It is advisable to investigate how Pashto speakers articulate English diphthongs, with the aim of identifying and analyzing the particular difficulties they face. This comparative analysis can provide valuable insights into the phonetic differences between the two languages and support the development of more effective teaching strategies for improving English pronunciation among Pashto-speaking learners.

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