

A Comparative Study: Acoustic Analysis of English and Pashto Vowels Produced by the Native Speakers of Pashto

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ABSTRACT

This study aims to investigate the acoustic properties of the native Pashto and English vowels spoken in District Mianwali. The main purpose of the study is to pin down the similarities and dis similarities in acoustic properties of both the languages vowels. The study adopts a quantitative approach. The participants of the study are selected by convenient based sampling and then categorized into two groups (Group A and Group B). The data was collected through two stimuli, lists of words (Pashto and English). The analysis is carried by applying the speech learning model (SLM). The present study shows that Pashto and English have different number of vowels and these are in dissimilar position on their respective inventories. The comparison of acoustic properties of English vowels with Pashto speakers' acoustic properties proves that these are significantly dissimilar from each other. An analysis of vowels produced by the native speakers of English shows that out of eleven vowels of English, /i:/, /e/ and /ɒ:/ are like Pashto vowels and F1 for /ɪ/ and /ɑ:/ of English are like L1 Pashto vowels. F1, F2 for /u:/ and duration values of the vowel /æ/ are also like the native English speakers' corresponding vowels. In addition, F1 for vowel /æ/, F2 for vowel /ʊ/, /æ/ and /ɑ:/ of Pashto learners are neither like L1 Pashto nor like native speakers of English. This work will initiate further linguistic investigations on Pashtoon learners of English. The study concludes that the SLM is valid for the context of English L2 speakers in acquisition of some of the vowels but the model does not account for some dimensions of acquisition of some other vowels of English by Pakistani learners who speak Pashto as L1.

1. Introduction

Pashto is one of the old languages of the Indo-European family. On the basis of its current Writing style, Hallberg (1992) claimed that Pashtu language is 2500 years old. It descends from the Iranian branch of the Indo-European Language Family (Tegey & Robson, 1996). Other major languages close to Pashto are Persian, Kurdish, Balochi and Tajik. All these languages are spoken in different areas of Pakistan, Afghanistan, and Iran. Table 1.1 exhibited the major branches of the Indo-European language, with one or two important languages from each sub-division below.

Table 1.1:Indo-European Language Family.

Celtic	Germanic	Italic	Hellenic	Baltic	Salvic	Indic	Iranian
Welsh	English German	Italian French	Greek	Latvian Lithuanian	Russian Polish	Hindi Urdu	Persian Pashto

As it is evident in the table above, Pashto is less related to English as compared to Italian or French (Tegey & Robson 1996). In addition, although it is written in a different type of Arabic alphabets, however, Pashto is not even related to Arabic language (Tegey & Robson, 1996). It can be considered as one of the most conservative languages of the Iranian family as it retains some archaic elements that the other sister languages have lost (Tegey & Robson, 1996). For instance, ergative constructions, gender system in nouns, and. the retroflex consonants are present in Pashto only whereas other Iranian languages have lost these elements to a great extent. The absence of retroflex consonants in other Iranian languages supports the linguists' claim that Pashto belongs to the Eastern Iranian family of languages (Williams, 2010). Further, Pashto shares a great part of its vocabulary with Dari (Persian). It is due to the fact that Pashtoons and Dari speakers are neighbours for centuries. Both languages heavily borrowed from Arabic

(Tegey & Robson, 1996). Other than that, Pashto also shares some linguistic characteristics with the Indic languages.

Moreover, Pashto has dialects and sub-dialects like any other languages. The three major dialects of Pashto language are the Kandahar or western dialect, the Kabul or central dialect and the Ningrahar or Eastern dialect (Tegey & Robson, 1996). The Kabul dialect is spoken in Kabul, Logar, Ghazni, and Parvan provinces of Afghanistan. The Kabul dialect heavily borrows from Persian, while the Eastern dialect (spoken mostly in Pakistan) borrows from Urdu and English. The dialectal differences between these dialects are minor. Phonological differences are the main differences among these dialects. The Pashtu dialect spoken in District Mianwali is a sub dialect of Kandahar dialect which is also known as North Westren (Central) dialect of Pashtu (Khan, 2011).

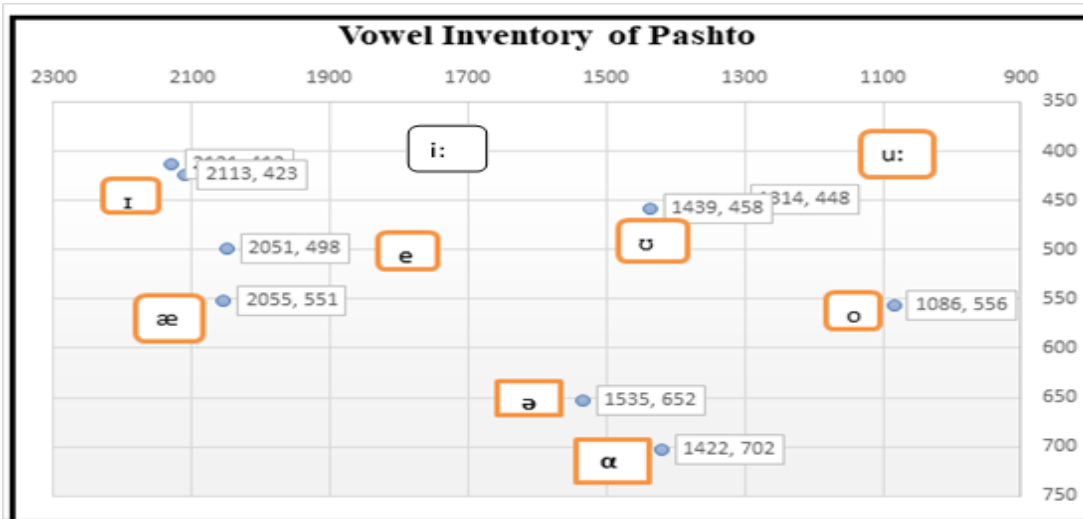
1.1.Pashto Vowels

As for as the quantity and quality of Pashto vowel sounds are concerned, there is no overall agreement observed among the studies over a variety of vowel inventories. These inventories are based on different dialects of Pashto. For example, the vowel inventory of Hallberg (1992) is based on the Yousafzai dialect of Pashto. According to this inventory, there are nine vowel sounds in Yousafzai dialect of Pashto. However, Rehman (2012) found eleven vowels in the Yousufzai dialect during the acoustic analysis of Pashtu vowels. This difference appeared because of the absence of minimal pairs for the two of the vowels in the Yousafzai dialect.

Additionally, the inventory based on the combination of Kandahar and Kabul dialects consists of seven vowels (Levi, 2004).

Penzl (1955) and Bell and Saka (1983) also found seven Pashto vowels whereas Tegey and Robson (1996) included nine vowels in their vowel inventory. Tegey and Robson (1996) research was based on the central dialect of Pashto. The Central dialect of Pashto comprised nine oral vowels. Khan (2011) argued that the difference of opinion on the number of vowels is due to the difference of quality in two low vowels /ɑ:/ and /æ / in their suggested inventories. The vowel inventory based on the acoustics frequencies of F1 and F2 of Pashto of Yousaf zai dialect is taken from Riaz & Rehman (2011).

Figure 1.1: Vowels Chart of Pashto



Source: Riaz & Rehman (2011)

Above chart shows that in Pashto, there are total nine oral vowels. In these nine oral vowels of Pashto, five are long and four are short. In oral vowels of Pashto, vowel [i:], [o], [ɑ:], [u:], [e],

[ɪ] and [æ] can occur at initial middle, and final positions of words however, short vowels [ə] and [ʊ] can only occur at initial and middle positions of words (Khan, 2011).

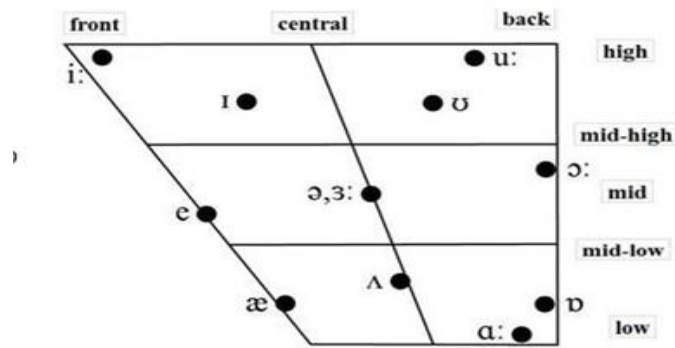
1.2.English Vowels

English is the lingua franca in the world of today (Dewey, 2007, Seidlhofer, 2004). Apart from the two canonical varieties i.e. British and American, English language is now having as many varieties as its speakers. Our focus in this study is, however, on oral monophthongs of British variety (RP). British English has twelve oral (monophthong) vowels namely /i:/, /ɪ/, /e/, /æ/, /ʊ/, /u:/, /ə/, /ɒ/, /ɜ:/, /ɑ:/, /ʌ/ and /ɔ/. Out of these, seven vowels are long/tense and five are short/lax. Out of these, four are front, five back and three central vowels. Vowels /i:/ and /ɪ/ are high-front vowels but Vowel /i:/ in word like 'see' is typically 50% longer than its counterpart lax vowel /ɪ/. However, in some varieties of English like (Australian, Northern) vowel /i:/ is realized not as a pure monophthong because in production of this vowel, tongue tends to lower and is centralized due to which this vowel is heard as /ii/ (Roach, 1997). Besides, mid-high vowel /e/ in word like 'pet' was found earlier in all varieties of English. However, today most Southern British English speakers use this particular vowel in words like 'fair' 'bear' and 'bare' (Lodge, 2009). In prior form of the RP, these words would have a diphthong /eə/. In addition to this, for different varieties of English, the actual quality of this vowel varies. For example, mid-front /e:/. The Scottish, Irish and Northern varieties have this particular vowel in words like 'day'. Many languages of the world do not differentiate between long vs. short vowels. For example, in Northern Irish and Scottish English, pairs of words like 'rowed' /rɔ:d/ 'road' /rɒd/ or 'daze' /des/ and 'days' /de:z/ are homophones (Roach, 1997).

Vowels are shaped in a different way due to the regional origin of the speakers. For Example, In the RP, the word 'book' is uttered with the short-high-back rounded /ʊ/ but for many speakers of northern part of England and Scotland, the same word is pronounced with long-high-back /u:/ (Lodge, 2009). English front vowel /æ/ in words like 'bag' is considered long and lowest front vowel. Front vowels /i:/, /e/ and /æ/ are in close position to each other on the inventory (Roach, 1997).

In comparison to Pashto Central vowels English has three central vowels. Out of these vowels /ɜ:/ in word like 'girl' is considered long and mid high. The vowel in word like 'girl' does not exist in Pashto language. The remaining two vowels /ʌ/ in word like 'hut' and /ə/ in word like 'about' are short vowels in English and Pashto. In some areas of England, there are words which have vowel /ʌ/ replaced by the vowel /ʊ/ (Roach, 1997). Moreover, English has five back vowels. Two of them are high vowels. One of the two vowels namely /u:/ in words like 'root' is long or tense and the other namely [ʊ] in words like 'shoe' is 'lax' or short. The vowel [ɒ] in words like 'pop' is mid-high and [ɔ] in words like 'saw' is a back-mid-low vowel. Vowel [ɑ:] in word like 'car' is considered on low back long vowel. Figure 1.2 shows vowel inventory of English.

Figure 1.2: Inventory of English Vowels taken from Roach (2004)



English Vowels (Roach, 2004, p242)

1.3. Frame Work of the Study

This study follows the prediction of Speech Learning Model (SLM) described by Flege (1995) to assess the L2 learner's acquisition. In general, the speech learning model is concerned with ultimate attainment of L2 pronunciation, and studies using its framework have generally focused on experienced learners, who have spoken the L2 for many years. This study also documents the learner's approximate *initial state*, which may or may not grasp the model's supposition that an L2 learner begins with only L1 perceptual categories.

An important prediction of the Speech Learning Model relevant to this study is that L2 learners are able to understand differences based on dialect or idiolect or vocal organs (Flege, 1992, pp.593-594). The SLM predicts that if a learner perceives some phonetic difference between two sounds, s/he may develop two separate phonetic representations for the two sounds in her/his L2 phonemic inventory.

We can contextualize the predictions of models of second language acquisition with the current study. According to Brown (1998, 2000) if the relevant feature is active in the L1 of learners, the L2 contrast may be acquired easily. In Pashto, the phonological features are active. In other words, the feature model predicts that Pashto learners of English may not face any big difficulty in acquisition of English Phonological constituents.

Finally, the SLM predicts that if L2 learners perceive the sounds of L2 as different, they can acquire these sounds. Pashto learners of English can easily discriminate phonological vowels of English on account of positive transfer from the L1. Thus, the SLM also predicts learning of English vowels for Pashto learners of English. In the light of these predictions it is hypothesized that Pashto learners of English may acquire English sounds with relative ease. The current study aims to test this hypothesis.

According to this model, the acquisitions of similar sounds are difficult in comparison to dissimilar sounds. The SLM categorizes all L2 sounds into three different groups such as 'New', 'Identical' and 'Similar'. New sounds are not found in the native speakers' language, identical sounds are acoustically same as the sound in the L1 and similar sounds are close yet not identical to sound in the L1. According to this model, for L2 speakers, new and identical sounds are easier than the 'Similar' sounds. Speakers pronounce L2 identical sounds in a native like manner, if L2

sound is similar to a sound in the L1. The learner will perceive it as part of the existing phonemic category with little modification. In a case if L2 sound does not correspond to the L1 phonetics category, the learner will create a new category. The reasons for selecting this model is that it concerned with ultimate attainment of L2 pronunciation, and have generally focused on experienced bilinguals, who have spoken the L2 for many years. This study also documents the learner's approximate *initial state*, which may or may not grasp the model's supposition that an L2 learner begins with only L1 perceptual categories.

Before going to analyze the acoustics properties of English vowels it is mandatory to analyze the acoustics properties of Pashto vowels thus, the study intends to achieve the following objectives:

- To identifying the acoustic properties (Duration, Formant patterns and acoustic space) of vowel of Pashto Language.
- To find out the differences in acoustic properties of English vowels produced by Pashto speakers.
- To investigate the problems of acquisition of English vowels by adult Pashto speakers based on the predictions of Speech Learning Model.

2. Literature Review

Lodge (2009) classified vowels sound on the quadrilateral in three dimensions, e.g. height of the tongue, frontness/backness and with orientation of position of lips. According to Ladefoged (2003), acoustic analysis explores visual representation of sound waves properties like, formants frequencies, durations and vibration patterns. Based on these properties, vowels' characterization in terms of their respective inventories is possible. The classifications of vowels using spectrographic analysis are supported by better evidences. It is considered better method for the identification of vowel on their respective inventory. Besides, Delattre (1964) illustrated that vowels in the vocal track are modified by means of adjusting the position of the tongue. He indicated that the role of F1 and F2 in distinguishing the vowels is crucial. F1 corresponds inversely to tongue height and F2 values of vowels is related directly to tongue frontness/backness (Delattre, 1964).

Previous studies (Gass & Selinker, 2001; Flegeet *al.*, 1995b) illustrated that speakers with varying L1 background pronounce vowels differently whereas Gimson (1970) and Flegeet *al.* (1995b) argued that bilingual speakers face problems while pronouncing English vowels. The difference in their pronunciation can be observed by comparing acoustic characteristics like vowel duration, space and formant frequencies of L1.

It is observed that L2 learners face difficulties in distinguishing and producing non-native vowels. Previous comparative acoustic studies conveyed and tried to solve the problems in acquisition of target L2 vowels. For L2 learners, variability in vowel quality, vowel deletion, labialization and vowel-laxing in word-final position are main modification in vowel related phenomena (Lodge, 2009). For instance, Gottfried (1984) studied American English vowels spoken by L2 learners of French speakers. All vowels were embedded in a CVC context and pronounced by two groups (L1 French and L2 learners of English). The results indicated that native French speakers were more perfect in pronouncing French vowels as compared to American English learners of French. The study also verified that the native French speakers were better in discriminating French vowels than the American English learners of French (Gottfried, 1984). Polka (1995) also found contrastive dissimilarity between high front and back vowels of German language. The researcher argued that the monolingual Canadian English speakers exposed native like performance for the German tense vowel contrast /u:/-/y/. But for the lax contrast /ʊ-/y/, their performance is not satisfactory. This difficulty was attributed to

differences in English speakers' assimilation of the German vowels to English vowel categories. Same effect has been found in Spanish learners of English in discrimination of English /i:/- /ɪ/. One of the reasons can be the lack of such a contrast in their L1, and having a single vowel category in the F1/F2 vowel space occupied by the two English vowels (Flege et al., 1997). The shift in vowel quality is inspected in number of contexts. The phenomenon is also observed in other languages like some varieties of Mexican (Disner, 1980). However, in Colombian Spanish mid vowels are raised in diphthong formation (/e.o/ > /jo/). In addition, Disner (1980) also investigated mid-vowel variation in Dominican Spanish. Similarly, Park (1997) explored the Australian English vowel spoken by Male NI (North Indian) speakers. Spectrogram for such vowels, like /æ/, /i:/ and /ɑ:/ on the basis of their acoustic properties emerged in different vowel patterns. The difference in vowel pattern suggested the possibility that it can be a separate variety of Indian English. Flege et al. (1997) highlighted the speaker's first language (L1) affected construction and perception of English as a second language (L2). They have argued that these effects were experience dependent. In the same fashion, Baker, et al. (2002) analyzed English vowels spoken by L1 English and L1 Korean Bilingual speakers. It was found that L2 vowels of late bilinguals were influenced by the L1 system while the influence was bidirectional for early bilinguals. At the segment level, L2 learners usually shift the L1 sound system into L2 speech. There is no commonly accepted techniques to determine 'New' or 'Similar' sounds. And there is no commonly accepted techniques for measuring the distance between sounds of two languages in order to determine 'new' 'similar' sounds existed. Flege (1987) suggested a "phonetic symbol" criterion. Similar L1 and L2 sounds are represented by the same IPA symbol, even if they have some statistically significant audible differences. An example of a similar sound is Pashto /i:/ and English /i:/ . Though the Pashto /i:/ differs from its English counterpart still the same phonetic symbol is used for both (Vergun, 2006). Fleged (1995) also argued that similar vowels are perceived equivalent to the existing phonetic category. This practice asserts that Speech Learning Model's prediction of new category formation for similar vowels is blocked by equivalence classification. As for as vowels of Pashto are concerned, it has nine vowels sounds. In comparison to English language, vowels /ɜ:/ (in word 'girl') and /ɔ/ (in word like 'college') do not exist in Pashto language. Similarly, the vowel /ʌ/ (in word like 'cut') does not exist in Pashto language. This is one of the difficulties Pashto speakers face in producing certain English vowels because these are not found in their native languages. Second, the most crucial difficulty in pronouncing the sounds in target language is the differences in acoustic space. The dissimilarity in acoustic space in native and target language acoustic space directs the mispronunciation of vowels.

3. Research Methodology

The target population for this research was Pashto L1, and English L2 Speakers. Total thirty (15x2=30) participants were chosen for this study, and then categorized into two groups. The selection of the participants was based on the stratified convenient sampling. In each group, numbers of the participants were fifteen. In selecting participants, primary focus was given to their native language. All the participants used for the current research were male which can be one of the limitation of the present study.

1.1. Participants

Group A consists of monolinguals Pashto speakers having no formal education. They belonged to District Mianwali. Moreover, their age range was between 20-25 years. Group B consists of L1 Pashto speakers and L2 learners of English. They were bilingual and having college level

education. All speakers of this group were also from District Mianwali and their age range was between 20-25 years.

3.2. Stimuli

Total two stimuli lists were designed in monosyllabic words for the two groups. In each stimuli list, vowels were placed at the medial position of the words. In each word, a target vowel was presented after the voiceless plosives stop. Following are the list of words which were incorporated in the stimuli.

Table 3.1: Pashto Vowels

Vowel	Word	Meaning
/i:/	/ki:r/	Sweet
/ɪ/	/kɪɾ/	Left side
/e/	/kes/	Warm cloth
/ə/	/kəl/	To cut
/u:/	/ku:ɾ/	Deaf
/ʊ/	/kʊl/	Powder
/æ/	/kæp/	Powder
/ɑ:/	/kɑ:t/	camp bed
/o/	/kor/	Home

In Pashto, there are nine oral monophthongs (Kamal, 2011). The above stimuli list was designed for Group ‘A’. All vowels were in CVC context after the voiceless-velar (Plosive) stop /k/.

Table 3.2: English Vowels

Vowel	CVC	Word
/i:/	/hi:d/	Heed
/ɪ/	/hɪd/	Hid
/e/	/hed/	Head
/æ/	/hæd/	Had
/ɑ:/	/hɑ:d/	Hard
/ɔ:/	/hɔ:d/	haw'd
/ɒ/	/hɒd/	Hod
/u:/	/hu:d/	who'd
/ʊ/	/hʊd/	Hood
/ʌ/	/hʌd/	Hud
/ɜ:/	/hɜ:rd/	Heard

The above stimuli list (Table: 3.2) adopted from Wells (1962) was selected for Group B. In English, there are twelve oral monophthongs. Central vowel /ə/ in word like ‘about’ did not include in the stimuli list. For the reason [ə] does not exist in the stressed syllable of English word (Roach, 1997; Lodge, 2009). Total forty five (3 repetitions* 15 participants) tokens for each vowel were recorded by using Praat software¹ version 4.4.13.

3.3. Reliability Test Results

A Cronbach’s alpha reliability test was applied on the data to determine the level of reliability. The following tables show group wise result.

Table 3.3: The reliability results of Group A

Vowels	F1	F2	Duration
/i:/	.943	.943	.780
/ɪ/	.821	.860	.667

¹ A speech processing tool which creates a spectrogram from the wave files sound wave. It is designed by Boersma and David Weenink (1999) (University of Amsterdam). This software can record sounds and display acoustic properties (voicing, formants, time duration etc).

/e/	.732	.396	.964
/u:/	.807	.894	.562
/ʊ/	.328	.938	.954
/æ/	.827	.835	.446
/ɑ:/	.919	.990	.934
/o/	.768	.865	.966

The above table shows the reliability coefficient and it is above .7 in most cases which denotes 70 percent reliability (consistency) (Larson-Hall, 2010). In only three cases the reliability is below the cut of point .7. For instance, the reliability coefficient for F1 of short /ʊ/ and duration of mid vowel /æ/ is .44 and .32 respectively. Twenty-one results out of twenty-four are reliable. Thus the results have sufficient reliability.

Table 3.4: The reliability results of L2 learners of English

Vowels	F1	F2	Duration
/i:/	.920	.987	.972
/ɪ/	.881	.984	.928
/e/	.879	.987	.353
/æ/	.984	.967	.814
/ɑ:/	.978	.991	.801
/ɔ:/	.892	.888	.982
/o/	.982	.988	.976
/ʊ/	.969	.988	.994
/u:/	.987	.979	.745
/ʌ/	.992	.995	.767
/ɜ:/	.920	.989	.951

Larson Hall (2010) denoted reliability of the data results by mentioning co-efficient values above the level of .600 in ‘good shape’. However, from below .500 level shows reliability of the data results in ‘poor shape’. The reliability coefficient for Duration of short [e] is .353. Out of 33 cases in the above table, only one value for vowel shows poor reliability. Remaining 32 values are above the cut of point of .700 which is good according to Larson-Hall (2010).

4. Data Analysis

Data analysis is presented in two main parts. The first part on the one hand shows the acoustic properties of oral vowels. Average frequencies and time duration of vowel sounds are presented in tabulated form. Graphical representations differentiate a vowel from its adjacent vowel. This section recognizes vowel space on the basis of their results uttered by two groups (A-B). Further, their relevant inventories provide notion for the placement of vowels. On the other hand, part two analyzes the data according to the predictions of SLM. The focus of this section is on acoustic characteristics of Pashto and English vowel system produced by groups A and B.

4.1. Pashto Oral Monophthongs

The selected parameters for acoustic analysis are vowel duration and the formant frequencies (F1, F2). Table 4.1 shows mean vowel duration and the formant frequencies (F1, F2) of Pashto vowels spoken by the native speakers. The measurements of three tokens of each participant are also averaged.

Table 4.1: F1 and F2 (in Hz) for Pashto vowels

Vowels	F1	Std. Deviation	F2	Std. Deviation	Vowel Duration	Std. Deviation
/i:/	298	(34.92)	2078	(80.68)	201	.01826
/ɪ/	421	(51.96)	1962	(64.65)	92	.00526
/e/	505	(35.12)	1836	(58.29)	155	.03231
/u:/	357	(29.57)	1075	(73.45)	226	.01718
/ʊ/	487	(20.55)	1141	(91.20)	139	.04385
/æ/	590	(44.04)	1701	(46.59)	233	.01994

/ɑ:/	695	(44.70)	1174	(105.85)	255	.02958
/o/	524	(23.96)	1031	(71.60)	236	.03430

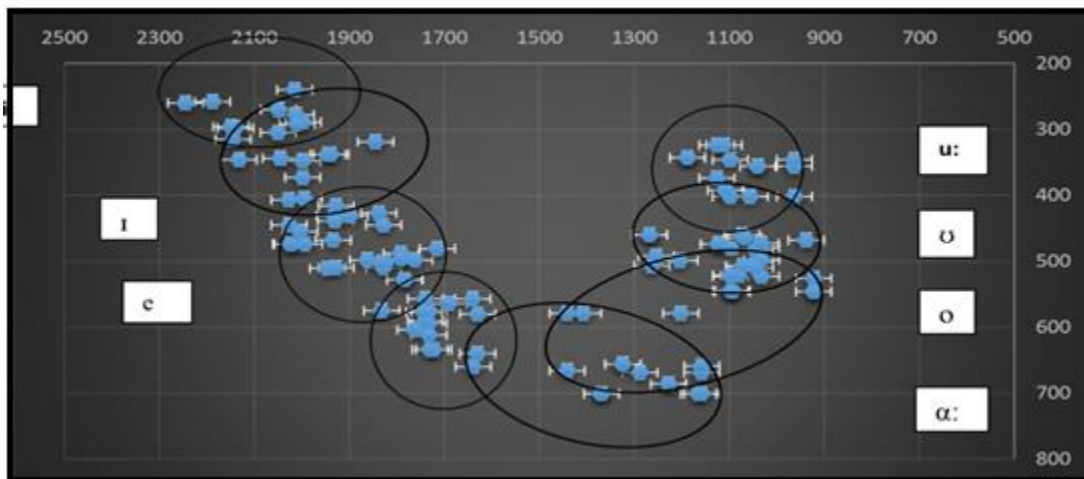
The data given in table 4.1 show that there are total nine vowels in Pashto in which five vowels are long and three are short. The longest vowel in Pashto is [ɑ:] (255 ms). Vowels [ɪ], [ʊ], and [e] are short vowels. The duration values of the short vowels are below 110 milliseconds. The shortest vowel in Pashto is [ɪ] (92 ms). The highest F1 695(Hertz) is noted for vowel [ɑ:] and lowest F1 298 (Hertz) is eminent for front-high Vowel [i:]. Moreover, the highest F2 2078 (Hertz) is noted for high vowel [i:] and lowest F2 1031 (Hertz) is noted for back Vowel [o]. Additionally, the table 4.1 also illustrates the average duration of each short and long vowels. The average duration of long and short vowels is in range of 92 ms to 255ms. The data further express the increase in length with vowel openness. /æ/ has 233 ms duration that is longer than that of two other long / i:/ and /u:/. A significant difference in terms of duration is found between long and short vowels, but no significant difference is found within long vowels and same is for the short vowels with each other.

Table 4.1 further illustrates that, for front vowels, F1 turns out to be lower as the obstruction in the oral cavity increases. As /i:/ is the front vowel, it has the lowest F1 and highest F2. First formant frequency increases gradually as the tongue position gets lower for front vowels i.e. F1 of front-high vowel /i:/ is 298 Hz, whilst F1 of front-mid vowel /æ/ is 590 Hz In case of the back vowels, F1 reduces by height of the tongue for example, low back long vowel /ɑ/ has 695 Hz, while long high-back /u:/ has 357 Hz. In contrast to F1, /i:/ has the greatest F2 and /u:/ has the lowest F2 values. This proposes that high vowels hold low F1 and low vowels contain high F1 values. Table 4.1 exhibits the utmost separation between F1 and F2 with the front vowels.

4.1.1. Vowel space

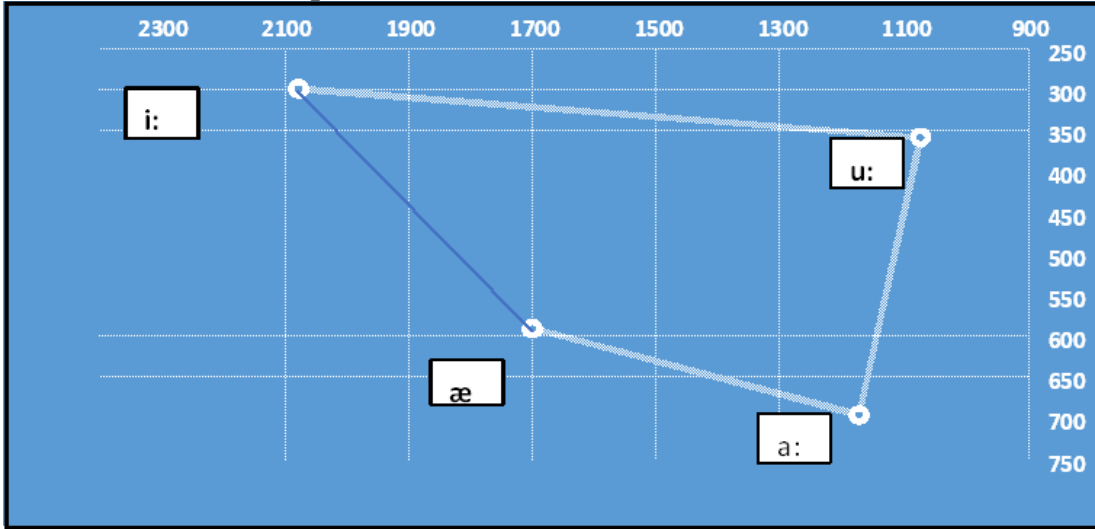
This sub section shows the vowel scheme that was generated on the basis of Plotted Formant frequencies. Figure 4.1 displays the tokens of Pashto vowels. It also specifies the vowel region on the formant chart.

Figure 4.1: Formant Chart of Pashto vowels



In figure 4.1, Pashto vowels are plotted on the basis of average obtained frequencies of each participant of Group A. It also identifies the range of occurrences of Pashto oral vowels. Figure 4.2 informs about the acoustic vowel space in Pashto vowels. Acoustic vowel space was also generated based on four extreme vowels' measured formants frequencies. On the chart, F2 is placed on the horizontal axis and F1 is on the vertical axis.

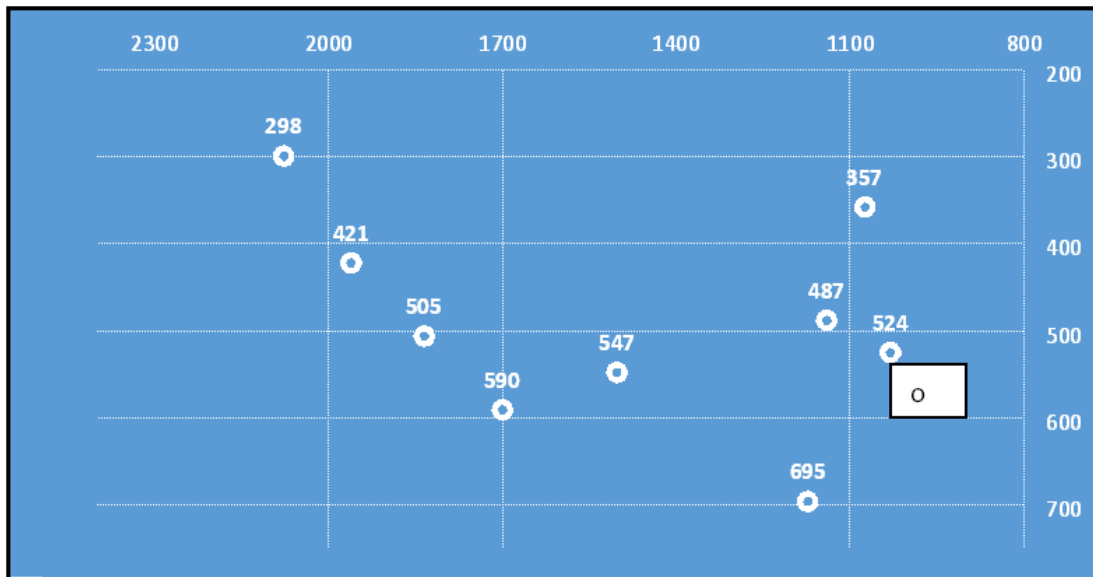
Figure 4.2: F1-F2 acoustic space for Pashto Vowels



As it is observed, the short vowels are slightly lowered and centralized. In contrast to their corresponding short vowels, long vowels are dispersed peripherally inside vowel space.

4.1.2 Vowels Token of Pashto Speakers

Figure 4.3: Pashto vowels inventory



Above chart is arranged to resemble the vowel quadrilateral of Pashto. On the edges of quadrilateral, vowel signs show the Cardinal vowels whereas, dots show the token of Pashto vowels.

Vowel	Word	Meaning
/i:/	/ki:r/	Sweet
/ɪ/	/kɪɾ/	Left side
/e/	/kes/	Warm cloth
/ə/	/kəl/	To cut
/u:/	/ku:ɾ/	Deaf
/ʊ/	/kʊl/	Powder
/æ/	/kæp/	Powder
/ɑ:/	/kɑ:t/	camp bed
/o/	/kor/	Home

Pashto vowels have three sets of front vowels: a close-front, mid-front and low-front. It has two high front vowels: long /i:/, in words like ‘/ki:r/’ and short vowel /ɪ/ in words like ‘/kɪɾ/’. One mid-vowel /e/ in words like ‘/kes/’ and one low-front /æ/ in words like ‘bag’. These vowels differ in length as well as in quality. English vowel /i:/ in words like ‘feet’ exist in Pashto language. For the group A, this similar vowel is articulated in a dissimilar way. The differences lie in their position of occurrences. While in articulation of the vowel, for both speakers position of the tongue is in the close-front position of the mouth which causes the position of lips open or spread. In addition to this, groups A designate the vowel /ɪ/ somewhat lowered, backward and short in length to its corresponding long vowel /i:/. Duration of short vowel /ɪ/ demonstrate, that /ɪ/ is approximately fifty-sixty percent shorter than its corresponding long vowel /i:/. As displayed vowel /e/ in English words like ‘pet’ is spoken on the same height of the tongue position by the group A. Second formant frequency of vowel /u:/ pronounced by the group A is 1075Hz. The variation anticipated that vowel /u:/ in English words like ‘pool’ uttered on backward position than the vowel spoken by the group A.

This next section of the study investigates how Pashto learners of English speakers (Group B) pronounced English vowels. Particularly, this sub section provides an acoustic explanation of English vowels spoken by Bilingual speakers (Pashto) to answer the second research question: what are the differences in acoustic properties of English vowels produced by Pashto L1 speakers (Bilingual)? All English vowels tokens were analyzed in English words by group B. All English vowels frequencies are presented in a tabulated form. Further, obtained frequencies are compared with standard frequencies of English vowels. Each vowel is exhibited in the first column, against the average acoustic properties for each vowel as given.

4.2. English Oral Monophthongs

English language has eleven oral monophthongs. Out of twelve, seven vowels are long and five are short. The table below compares three acoustic properties of English vowels spoken by the group B to the standard properties of RP Vowels measured by Wells (1962). The aim of the comparison is to find out the potential acoustic differences for the same vowels. Table 4.2 also demonstrates English vowels which have greater differences among frequencies and misidentified by Pashtoon learners of English in the group B of the study. In order to comprehend these particulars vowels, obtained acoustic properties (F1, F2, and Dur) for each vowel is shown below in table 4.2.

Table 4.2: F1, F2 (in Hertz) and Duration (in millisecond) of English Vowels.

Standard RP

Group B

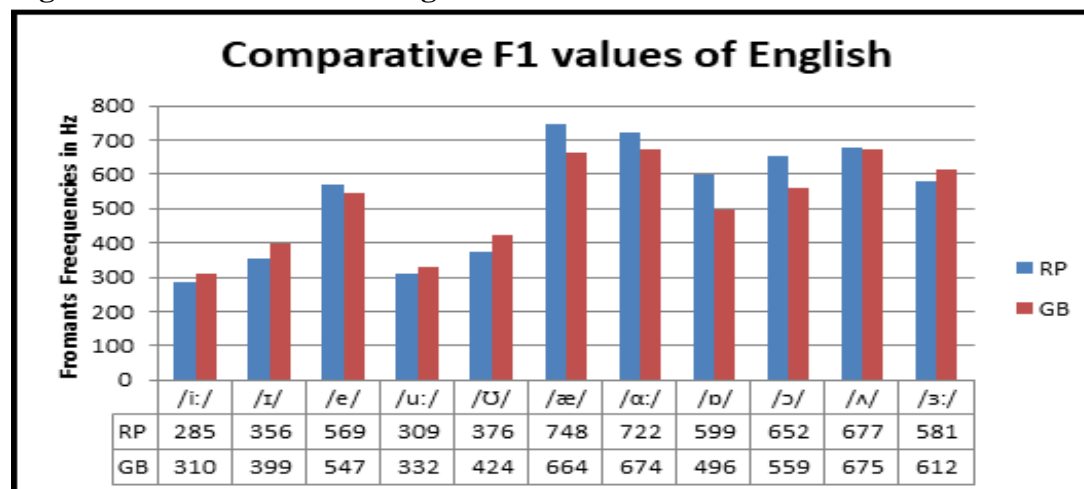
Vowels	F1	F2	Duration	F1	Std. Deviation	F2	Std. Deviation	Duration	Std. Deviation
/i:/	285	2373	293	310	(34.76)	2078	(144.02)	229	.02969
/ɪ/	356	2098	139	399	56.97)	1850	(208.69)	106	.01317
/e/	569	1965	170	547	(81.49)	1748	(130.36)	141	.00929
/u:/	309	939	294	332	(84.43)	904	(69.62)	237	.01896
/ʊ/	376	950	142	424	(58.17)	1124	(85.78)	158	.05722
/æ/	748	1746	210	664	(83.99)	1625	(104.65)	200	.02201
/ɑ:/	722	1236	335	674	(64.58)	1175	(67.90)	239	.02546
/ɒ/	599	891	178	496	(53.79)	998	(78.55)	241	.04616
/ɔ/	652	997	283	559	(88.48)	1144	(122.76)	228	.01192
/ʌ/	677	1083	148	675	(42.29)	1165	(57.95)	126	.03586
/ɜ:/	581	1381	261	612	(35.17)	1309	(91.41)	245	.02539

Table 4.2 denotes standard pronunciation by the native English speakers and Pashtoon learners of English. The durational difference of long /i:/ between the group B and native English speakers is of 60m/sec. Similarly, all vowels F1 and F2 values are different from the native speakers of English. Most importantly, the group B speakers' F2 values of vowel /i:/ 2078 Hz, /ɔ/ 1144 Hz, F1 values of /ʌ/ 675 Hz and /ɜ:/ 612 Hz in comparison to the native speakers values are significantly different. Based on these results, it can be claimed that these vowels are misidentified by the group B.

4.2.1. Comparison of F1 of English vowels

The figure 4.4 below depicts the comparison of F1 values of English vowels spoken by the native speakers and the Pashtoon learners of English.

Figure 4.4: F1 Values of English Vowels



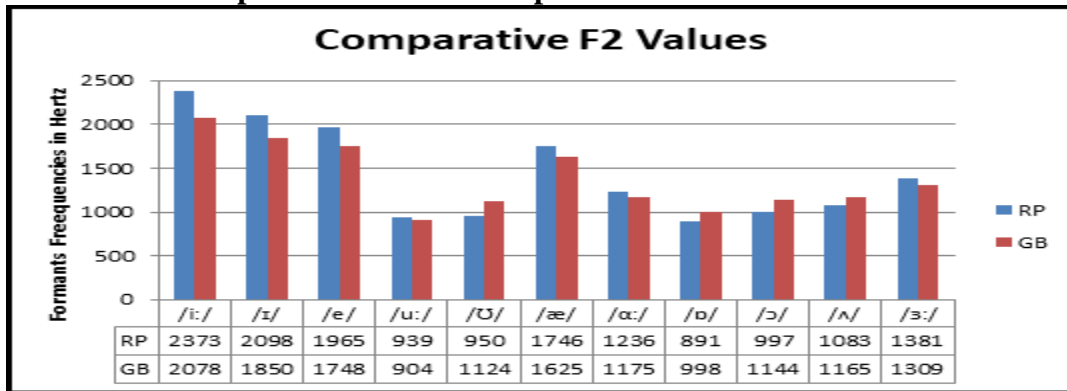
Note: For high vowels bar is lowered conversely to this, for low vowels bars is higher.

Figure 4.4 denotes all English high vowels spoken by the Pashto speakers in comparison to RP vowels that were found lowered. Moreover, the difference in the high front vowels is an adequate amount in comparison to the back-high vowels /u:/ and /ʊ/. English central vowel /ɜ:/ in words like 'furr' does not exist in Pashto speaker's native language. Due to the absence of this vowel in their native language, the group B speakers misidentify this particular vowel. Above bar /ɜ:/ indicates, that for group B speakers, this particular vowel is tend to be lowered and more retract towards vowel /ɑ:/. Conversely to this, in comparison to RP, another central vowel /ʌ/ spoken by the group B is in higher position. Similarly, English long back /ɒ/ in words like 'pot' spoken by RP speakers is lowered in position as compared to the vowel spoken by the group B.

In addition, all English low vowels /æ/, /ɔ/ and /ɑ:/ in English words like ‘bag’ ‘paw’ and ‘cat’ are also higher in position than the vowels spoken by the group B speakers.

4.2.2 Comparison of F2 of English vowels

Figure 4.5: shows Comparison of F2 of Group B and RP

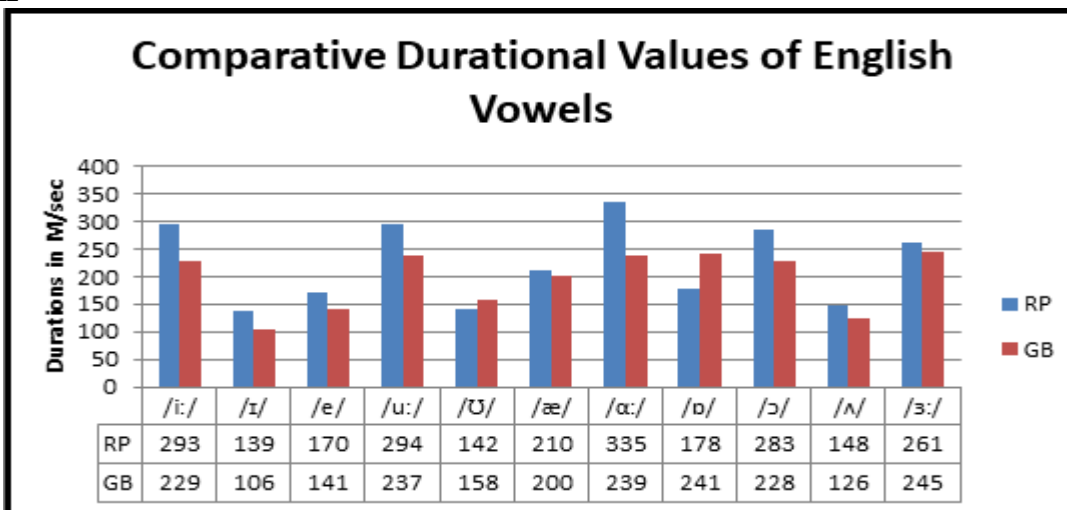


NOTE: Above graph shows that for the front vowels bar is high and for the back vowels bar is lowered.

For group B, all front vowels of English are in the backward position in comparison to vowels spoken by the native RP speakers. Vowel /ɜ:/ in words like ‘girl’ spoken by the group B is on the backward position than the vowel spoken by the native English speakers. In addition to this, English vowel /ɑ:/ in words like ‘car’ spoken by RP speakers is on the forward position than the vowel spoken by the group B speakers. For RP speakers’ mid-low back /ɔ/ and mid-high /ʊ/ are backward in comparison to group B. As results indicate, bilingual subjects tend to articulate fine approximation of most of RP vowels when there is close or equivalent vowel exist in their L1. However, their attempts at articulation of vowels /ɜ:/, /ʌ/, /ɔ/ and /ɪ/ tend to create confusion.

4.2.3. Comparative duration of English vowels

Figure 4.6: comparison of duration of English vowels spoken by the speakers of group B and RP



(Note: The above graph is arranged according to RP vowels duration where shorts vowels are shown on the right side of the chart and long vowels are shown on the left side of the chart.)

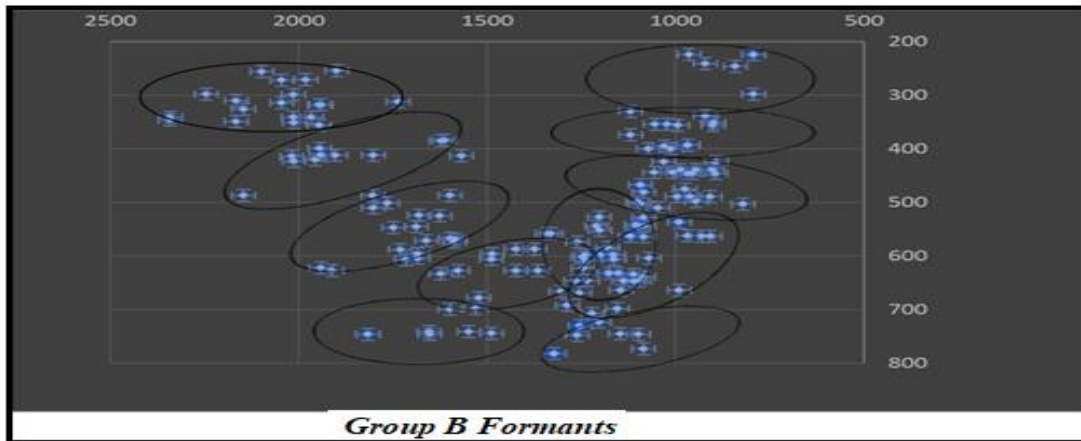
Graph 4.6 indicates that all RP vowels in comparison to the group B tokens have the longer duration. However, English vowels spoken by the speakers of group B show significant difference among them. Results also show that all English vowels spoken by the group B are

clearly differentiated in term of their tense-lax distinction. However, short back /ʊ/ is not always clearly differentiated by the speakers of group B.

4.2.4. Comparison of English Vowel Space

In below charts, English vowels are plotted on the basis of average obtained frequencies of Group B. It also identifies the range of occurrences of English oral vowels on the quadrilaterals for both groups.

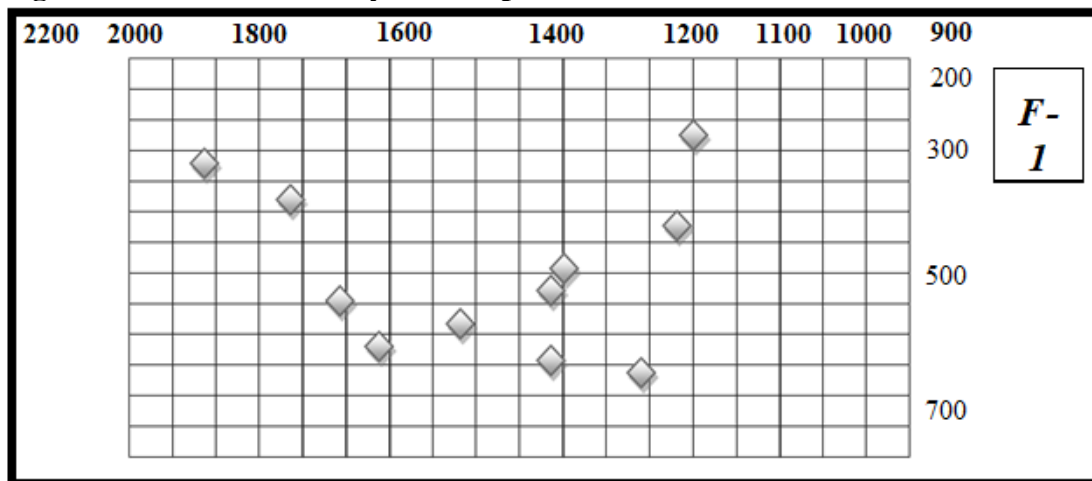
Figure 4.7: The formants chart of English vowels produced by Group B (Pashto Bilinguals).



4.2.5. English Vowels Inventories

This section displays definite place of English vowels on their respective inventories uttered by the group B. In order to pin down faithful position of the vowels, vowels are clearly separated among each other. These inventories are developed on the basis of the overall obtained mean F_1 - F_2 . Inventories screening the frequency of the first formant on the vertical axis plotted against the second formant on the horizontal axis for eleven English vowels.

Figure 4.8: Vowel inventory of Group B



This frequency chart forms the basis for developing the quadrilateral of English vowels spoken by the speakers of group B which is given above: The oral vowels of English in the light of the chart given above are described as under;

/i:/	Front	Close	Spread	Long
/ɪ:/	Front	Close	Spread	Short
/e/	Front	Half-Close	Spread	Short

/æ/	Front	Half-Open	Spread	Long
/ɔ/	Tend to lowered	Half-open	Spread	Long
/ɜ:/	Tends to backward	half-close	spread	long
/ʌ/	central	half-close	Neutral	short
/ɑ:/	Central	Open	spread	Long
/ɒ/	Back	Half-close	Rounded	Long
/ʊ/	Back	Close	Rounded	Short
/u:/	Back	Close	Rounded	Long

5. Analysis of data according to the predictions of SLM

This study follows Flege's (1995a) Speech Learning Model which hypothesizes that learners acquire L2 sounds depending on the concept of new or similar phonemes as compared with the L1 system. According to this model, acquisitions of similar sounds are difficult in comparison to new sounds. The SLM divides all L2 sounds into new, identical and similar. New and identical sounds are easier than 'similar' sounds (Flege, 1987). So, in order to develop hypotheses, a one-sample t-test was applied on values of F1, F2 and duration of Pashto vowels produced by the monolingual participants. T-test determines whether the formant values and duration of Pashto vowels are significantly different from the values of the corresponding English vowels or not. All those vowels of English which do not exist in L1 of the participants are classified as new for the bilingual participants of this study. If the formants and duration of L1 and L2 vowels were not significantly different from each other, the vowels were categorized as 'identical' and if the L2 vowels were found to be significantly different from the corresponding L1 vowels, they were categorized as 'similar'. The following tables show the results of t-tests. The values of English vowels were taken from Wells (1962).

Table 4.3: Comparison of Vowels of Pashto and English produced by the monolinguals

Vowels	F1		F2		Duration	
	T-Test	P-Value	T-Test	P-Value	T-Test	P-Value
/i:/	1.54	.146	14.15	.000	19.49	.000
/ɪ/	4.87	.000	8.502	.000	49.08	.000
/e/	6.55	.000	8.698	.000	2.19	.046
/u:/	6.75	.000	7.350	.000	18.62	.000
/ʊ/	20.60	.000	7.749	.000	.442	.665
/æ/	13.83	.000	3.397	.004	2.19	.046
/ɑ:/	5.44	.000	1.756	.101	10.91	.000
/ɒ/	32.29	.000	7.652	.000	7.87	.000

Table 4.3 shows results of eight oral vowels of Pashto and English. The results exhibit that Group A pronounces all vowels except /i:/, /ɑ:/ and /u:/ as significantly different from English speakers. It suggests that these vowels (i.e. /i:/, /ɑ:/, /ʊ/) of English are produced as if they are in category of identical vowel category. Based on these results, English vowels for Pashto speakers are classified in the following way;

Identical: vowel /i:/ (F1), /ɑ:/ (F2) and /ʊ/ (duration values)

Different: /ɔ/, /ɜ:/, /ʌ/

Similar: /ɪ/, /e/, /æ/, /ɑ:/, /ɒ/, /ʊ/, /u:/

The SLM predicts that identical vowels are easier, different vowels are difficult and similar vowels are extremely difficult for L2 in this current case learners. To evaluate the learner's production, English vowels were produced by Pashto English Bilinguals (Group B). T-tests were used to determine whether L2 learners of Pashto establish English-like or L1-like phonetic categories for English vowels. Below tables compare English vowels spoken by the group B in comparison to the native English vowels.

Table 4.4: English vowels in the speech of Pashto Bilinguals compared with English Monolinguals.

Vowels	F1		F2		Duration	
	T-Test	P-Value	T-Test	P-Value	T-Test	P-Value
/i:/	2.815	.014	7.926		8.339	.000
/ɪ/	2.950	.011	4.586	.000	9.704	.000
/e/	9.090	.000	6.435	.000	11.898	.000
/u:/	1.061	.307	1.914	.000	11.563	.000
/ʊ/	3.231	.006	3.374	.076	2.744	.016
/æ/	3.867	.002	4.451	0.005	1.676	.116
/ɑ:/	2.830	.013	3.525	.001	14.601	.000
/ɒ/	7.416	.000	5.301	0.003 .000	5.34	.000
/ɜ:/	3.472	.004	3.022	.009	2.420	.000
/ɔ/	8.485	.000	9.842	.000	6.105	.000
/ʌ/	.067	.947	2.595	.021	9.292	.000

This table demonstrates that out of the eleven vowels of English, three vowels are somehow produced like the native speakers of English by the speakers of Group B. It suggests that the speakers of group B uttered these vowels without any significant difference from the English speakers. Besides, Table 4.4 demonstrates that p-values in most of the cases is below .05 which denotes that the speakers of group B could not produce the vowels /ɜ:/ and /ɔ/ accurately. P-value of F2 for /ɜ:/ is .068 that indicates that speakers of group B uttered this particular vowel near to the native English speakers. For vowel /ɜ:/ mean of the group B and English vowel is the same. The significance level of the mean difference of Duration for /ɜ:/ is .936 and /æ/ is .174 which is also greater than .05.

Another t-test was applied to compare the vowels of English by bilingual participants with their L1 vowels. This test was only applied on those vowels which are common in L1 and L2. However, the participants could not produce accurately. The purpose of the t-test was to determine if the participants produce these vowels like their L1 vowels. The results of these tests are given in the table below.

Table 4.5: Comparison of paired vowels between Pashto Monolinguals and Pashto Bilinguals speakers

Vowels	F1		F2		Duration	
	T-Test	P-Value	T-Test	P-Value	T-Test	P-Value
/i:/-/i:/					-2.835	.013
/ɪ/-/ɪ/	1.143	.272	.000	1.000 .078	-8.841	.000
/e/-/e/	1.301	.214	1.901	.058	1.278	.222
/ʊ/ - /ʊ/	1.464	.165	2.064	.002	1.748	.102
/æ/ - /æ/	4.036	.001	3.873	.041		
/ɑ:/ - /ɑ:/	3.104	.008	2.248	.004	1.146	.271
/ɒ/ - /ɒ/	.746	.468	3.501	.299	527	.607
/u:/ - /u:/	1.645	.122	1.079		-3.454	.004

Table 4.5 postulates that Pashto vowel /i:/, /e/ and /ɒ/ are produced like Pashto vowels by the Pashto bilingual speakers. In addition to this, F1 for /ɪ/ and /ɑ:/ are also produced like L1 Pashto vowels. All these values are above the level of significance (0.05). However, F1, F2 for /u:/ and duration property of the vowel /æ/ is produced near to English native speakers and their values are not mentioned in the table. P-values of F1 for vowel /æ/, F2 for vowel /ʊ/, /æ/ and /ɑ:/ are neither like the L1 Pashto vowels nor like the native English vowels. Results suggest that they are in the direction towards English vowels. The following table summarized the result of English vowels produced by the speakers of group B.

Table 4.6: Results of Pashto Bilinguals

Sounds	F1	F2	Duration
/i:/	L1 like	L1 like	L1 like
/ɪ/	L1 like	L1 like	Different from L1&L2
/e/	L1 like	L1 like	L1 like
/u:/	Acquired	Acquired	Different from L1&L2
/ʊ/	Different from L1&L2	Different from L1&L2	L1 like
/æ/	Different from L1 & L2	Different from L1&L2	Acquired
/ɑ:/	L1 like	Different from L1&L2	L1 like
/ɒ/	L1 like	L1 like	L1 like.
/ɜ:/	Not acquired	Not acquired	Not acquired
/ɔ/	Not acquired	Not acquired	Not acquired
/ʌ/	Acquired	Not Acquired	Not Acquired

These results shown in the table partly support, and partly contradict the Speech Learning Model. The bilingual speakers of the study did not form a category for the new vowel /ɜ:/, /ɔ/ while according to the SLM, they should have formed category for new sounds. This may have been due to their beginner status in learning English, or it may be due to the local dialect. The previous studies conducted by Aoyama et al. (2004) and Flege (1987) are based on traditional method of new and similar vowel classification. These studies get their support from Speech Learning Model of Flege (1987). We must bear in mind that Flege (1987) claims “new category formation for similar vowel is not possible by equivalence classification due to the reason that the similar vowels are perceived to be equivalent to the existing phonetic category”. Flege’s (1987) claim is based upon the adult Dutch learners of English who could not show vital differences in the pronunciation of the similar vowels /ɪ/, /ʊ/, and /ʌ/ (beat, boot, cut). Another study of Flege (1992) also supports Speech learning Model on the basis of experienced and inexperienced German learners of English. The primary difference between the groups was exposure to the native English speakers. Both groups studied English in school for about the same period of time (inexperienced: 6.6 years; experienced: 7.6 years), but they spend different amounts of time in an English-speaking environment (inexperienced: 0.6 years; experienced: 7.5 years). As predicted in Speech Learning Model, no group was able to achieve the phonetic level of the native-English speakers. For example; in case of similar vowels /i:/ (beat) and /ɪ/ (bit). However, in case of vowel sound /æ/ (cat) for German experienced speakers did affect the pronunciation of above mentioned vowel. But the inexperienced group, was able to produce /æ/ near to the native speakers. This supports the evidence that experienced L2 learners can form new phonetic categories and eventually produce those sounds corresponding to the new category. Moreover, these studies also support the model’s claim that phonetic learning takes place in adulthood. The investigation into the acquisition pattern for the similar vowels also goes very close to Pashto language but at the same time at certain places it does not reach to the native level. Hence it is not possible to determine or speculate whether bilinguals (Pashto) are modifying their pronunciation of similar vowels or not. It has often been observed in this study through the analysis and comparison of vowels of different languages that Pashto speakers fail to attain the correct level of pronunciation and accent of those vowels which are absent in their L1,. Therefore, Pashto learners commits pronunciation mistakes in handling such vowels while speaking English.

5. Findings

This section reviews the findings and presents the possible implication of the research. And at the same time, it also reflects a look at L2 learners’ progress in attaining accuracy in English vowels. Hence it could be an idea for further research to focus L2 learners’ acquisition of English vowels.

Following are the finding of the current research;

1. The dialects of Pashto language have different number of vowels. Their acoustic analyses confirmed that Pashtoon learners of English in Group A pronounced their oral vowels in dissimilar position.
2. Results of duration values confirmed that in ‘Pashto’, /ɪ/ has the shortest vowel duration among short vowels of Pashto.
3. Acoustic analysis of English vowels confirmed that all English high vowels and central vowel /ɜ:/ spoken by the speakers of group B, in comparison to RP vowels, are in lowered position. The bilingual speakers of Pashto adopt almost comparable contour approach towards RP English vowels. There is minimal difference between vowels produced by both groups. English native speakers articulated vowels in wide constituency in comparison to the group B.
4. All English high vowels namely /i:/, /ɪ/, /ʊ/ and /u:/ spoken by the speakers of group B, in comparison to RP vowels, are in lowered position. The level of difference in high front vowels /i:/ and /ɪ/ is enough in comparison to back-high vowels /u:/ and /ʊ/.
5. All English Mid-Vowels except /ɜ:/ and low-vowels spoken by the group B are placed on higher position than the vowels spoken by RP speakers. However, vowels on back and central part of the inventory pose some serious problems, e.g. central vowel /ɜ:/, back vowel /ɔ/.
6. All front vowels and back vowel /ɑ:/ of English spoken by the speakers of group B are in backward position than the vowels spoken by the native RP speakers. The bilingual participants generally tend to articulate fine approximation (in term of their frontness/backness) to RP vowels when there is close or equivalent vowel in their L1. But the speakers of group B who attempted articulation of vowels /ɜ/, /ʌ/, and /ɔ/ and /ɪ/ tend to get confused. Their frequencies show that they merged into other vowels.
7. English vowels /ɜ:/ and /ɔ/ do not exist in the L1 of the speakers of group B. Due to the absence in their L1, the bilingual speakers have frequently faced difficulties in production of the vowel. These results exhibit that these vowels have lowered tendency and more retraction towards vowel /ɑ:/.
8. All RP vowels in comparison to the speakers of group B have the longer duration. English vowels spoken by the group B shown significant difference between each other. Results also show that all English vowels spoken by the bilinguals clearly differentiate in term of their tense-lax distinction. However, short back /ʊ/ spoken by native L1 speakers is not as much longer as uttered by the group B.
9. In the standpoint of SLM, for the speakers of group B results confirmed that vowels /i:/, /e/ and /ɒ/ are produced Like Pashto vowels. Moreover, F1 for /ɪ/ and /ɑ:/ are also produced like L1 Pashto vowels. However, F1, F2 for /u:/ and duration value of the vowel /æ/ is produced like English native speakers. Results also show F1 for vowel /æ/, F2 for vowel /ʊ/, /æ/ and /ɑ:/ are neither like L1 Pashto nor like the native English vowel.

6. Conclusion

This study performed acoustic analyses of the vowels of Pashto and English. The researcher has identified Pashto vowels through Praat software. The main focus of the study was on whether there is any similarity between English and Pashto vowels by applying the speech learning model of Flege (1995a). After the analysis, the results of the study partially confirm the SLM predictions. As some vowel sounds were new for the Pashto learners so these vowels were easy for them to learn and produce according to the predictions of SLM, while some sounds were similar and hence were difficult for the L2 learners to acquire the native like ability. Since the findings of the study highlighted the similarities and differences between the vowel system of

Pashto and English language, the study may prove helpful for course designers as well as teachers and English L2 learners. As the findings highlighted these facts, the study may be used as a guide by teachers of English to learners of Pashto. The results of the current study also suggested that the role and the characteristics of vowels in words is crucial. These segments (vowels) provided listeners with more prosodic information in words than do consonants (Polka, 1995). To be able to differentiate between disorders and typical differences in L2 learning language users must be aware of differences in languages. That will be helpful to determine discrimination difficulties in these L2 learners.

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