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Diphthongs of Pakistani English: An acoustic study

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Abstract- The slogan that English is the language of those who speak it, has changed the whole spectrum of English studies. It led to the concept of World Englisheswith the idea of many non-native varieties of English. The current study is an acoustic investigation into the diphthongs of Pakistani English (PakE) with the question whether PakE has different set of diphthongs from Standard British English (SBE). The study explored the number of diphthongs of PakE, and any changes in the realization of diphthongs as compared to SBE. The participants (25 male and 25 female), with Punjabi as their L1,were chosen from among the undergraduates of English studies of University of Sargodha Pakistan. The word list containing diphthongs (adapted from Well's Lexical set) was prepared and the participants were asked to speak each word using a carrier phrase 'please say _____ loudly'. The sounds were recorded using high-tech equipment of 'VoV' FM Radio station of the University. Praat was used for acoustic analysis. Formant frequencies F1 and F2 were measured at two different positions (i.e. onsetand offset) of each sequence to observe trajectory of each vowel. The duration of the vowel tokens was also recorded. The formant frequencies and the duration were statistically processed applying ANOVA usingTukey's HSD Test to examine whether the differences of F1 at onset and offset and F2 at onset and offset, are significant. The findings revealed that PakE speakers realized only six diphthongs i.e. /iə/, /eə/, /uə/, /ɔi/, /ai/ and /au/. Two diphthongs i.e. /ei/ and /əu/ were monophthongised, as no glide or trajectory was observed on the Praat spectrogram, and they were articulated in relatively less amount of time as compared to other vowels. Hence, it is concluded that PakE is a different variety of non-native Englishes with its unique characteristics.

Key words: **PakE, diphthongs, Praat, acoustic analysis, formant frequencies, Tukey's HSD test.**

I. INTRODUCTION

Pakistani English (PakE) is one of the non-native varieties of Asia Englishes with its idiosyncratic features and characteristics particularly at the levels of phonology (Mahboob&Ahmar, 2004; Hickey, 2005;Mesthrie& Bhatt, 2008) and vocabulary(Bilal, et al 2012; Baumgardner, 1993;Tallat, 1993, 2002, 2003). Unlike native Englishes, it is a syllable-timedlanguage due to the influence of local languages ((Mahboob&Ahmar, 2004; Hickey, 2005). Words form local languages are borrowed and these loan-words have become part of the vocabulary (Baumgardner, 1993; Farid, 2004, Bilal et al, 2012). Cultural and religious terms along with festival names etc have made their way in the local variety of English (Kennedy 1993a, 1993b). Syntax of PakE is unique (Baumgardner, 1993; Anwar, 2007). A few researchers have tried to prove that PakE, a new variety of non-native Englishes, is in the making (Khan, 2012; Sheikh, 2012; Farid, 2004;Tallat, 2002, 2003) with its distinct features of pronunciation, spellings, grammar, semantics, etc. Discussing the overwhelming influence of Urdu, it is concluded that English in Pakistan is under the process of 'Uduization' (Ahmad & Ali 2014; Baumgardner, et al., 1993;Tallat, 2002, 2003). The current study is one such attempt to strengthen the idea and the process of identification of PakE as an independent variety of English by looking into phonological features of the local variety.

II. LITERATURE REVIEW

PakE is a relatively less explored variety, particularly at the levelofphonology, as compared to native varieties of English or even a few of the non-native dialects including Indian English, Nigerian English etc. Yet a few scholars have attempted to investigate various phonological features of PakE. Intheir exploration, Mesthrie and Bhatt (2008) have concluded that PakE consists of six vowels. Bilal, Mahmood and Saleem (2011a) have probed into the acoustic features of front vowels of PakE and came up with their findings that there are four front vowels. Central vowel phonemes of the local variety have been examined by Bilal et al. (2011b). Mahmood and Farooq (2018), Bilal, et al (2021,2011a, 2011b, 2011c, 2011d), Abbasi, et al (2018a, 2018b) have come up with their conclusions that vowels of PakE have some idiosyncratic features. Mahmood and Farooq (2017, 2018) have examined the variety to conclude the

features of diphthongs and triphthongs of PakE. Almost all the researchers have conducted acoustic analysis of the vowels using Praat.

Research Questions

The present study is an acoustic analysis of diphthongs of PakE. Previous researches on vowels of PakE have documented several features, yet the current research is unique in the sense that it examines the diphthongs of PakE with the idea of finding number of diphthongs. The study aims at finding the answers to the questions given below:

1. Does PakE have any diphthongs?If yes, how many diphthongs are there in PakE?
2. Do they behave like their British counter-parts? Or Are they different enough in number or realisation to declare PakE a different variety of English?

III. MATERIALS AND METHODS

Participants

To minimize the diversity of the participants and to obtain reliable results, the selection procedure of the participants was well-thought out and meticulous. Fifty participants (twenty five male and twenty five female) were chosen from the undergraduate students of English studies.They were interviewed face to face prior to their selection to determine the following variables:

1. All the participants should have Punjabi as their L1.
2. All the participants should be fluent in English.
3. All the participants should have been exposed to English since their pre-schooling.

Selection of Words

Following word list was adapted form Well's lexical set for the analysis.

Face	/ei/	Price	/ai/		
Choice	/ɔi/	Goat	/əu/		
Mouth	/au/	Near	/iə/		
Square	/eə/	Your	/uə/		

Recordings

Recordings were made in the soundproof chamber of 'VoV' FM Radio Station of University of Sargodha using hi-tech apparatus. The participants were asked to speak each word separately using the carrier phrase 'please say _____ loudly'. The recordings were listened to immediately to ascertain if they are audible and clear.

Procedure

The required segment from the whole recorded sound clip was elicited using Praat. The total vowel tokens amounted to three hundred, i.e. one hundred and fifty for male sounds and one hundred and fifty for female sounds. For each diphthong, a total of fifty sound segments (i.e. twenty five for male and twenty five for female) were analysed. The first two formants F1 and F2 were measured for each vowel at two different positions. First measurement was taken at onset position and the second at offset position. The idea was to observe the trajectory, as the diphthongs show a glide. The durational properties of the vowels were also recorded. Formants F1 and F2, measured at onset position were compared with those measured at offset position. Finally, the statistical test (ANOVA along with Tukey's HSD test) was performed to see whether the difference in the values of F1 at onset and offset and of F2 at onset and offset is significant.

Analysis

Analysis for male speakers and female speakers was made separately to precisely conclude the phonological patterns of the articulation of diphthongs by Pakistani speakers of English.

Male Speakers

Each of the diphthongs was analysed separately. First the three centring diphthongs were processed and then the rising diphthongs.

Centring Diphthong /iə/

The vowel was articulated as a diphthong as there was visible glide on the spectrogram. Statistical analysis revealed that the formant values also showed significant variation. The average F1 at onset remained 300Hz while at offset, it remained 410Hz, while the average F2 at onset and offset remained 2700Hz and 1900Hz respectively. The average duration of articulation recorded was 0.49 seconds. Fig 1 below show the formant movement.

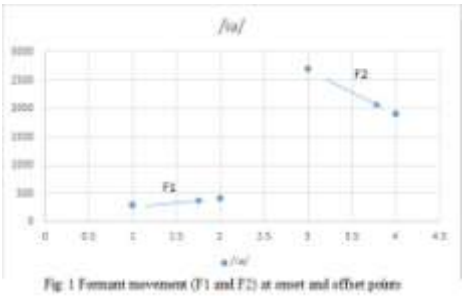


Fig. 1 Formant movement (F1 and F2) at onset and offset points

Centring Diphthong /eə/

The vowel was realised as a diphthong by male speakers. The acoustic analysis showed a visible glide on the Pratt spectrogram. The average formant frequencies for F1 and F2 remained 500Hz and 2800Hz at onset and 550Hz and 2100Hz atoffset respectively. Statistical analysis showed the difference between the formants at onset and at offset is significant. Average duration of articulation of the diphthong was 0.53 seconds. Fig 2 below show the formant movement of F1 and F2 at onset and offset points.

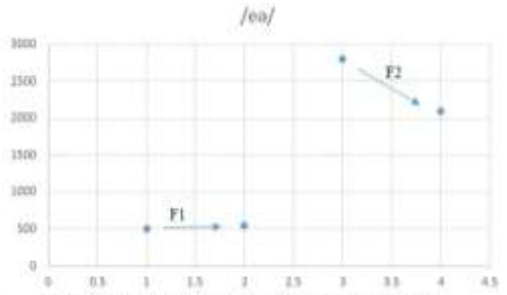


Fig 2 Formant movement (F1 and F2) at onset and offset points

Centring Diphthong /uə/

The vowel behaved as a centring diphthong. Statistical analysis showed that the difference between formant frequencies at onset and offset positions is significant. The spectrogram display also showed a visible glide. The formant frequencies for the diphthong remained 380Hz and 590Hz for F1 at onset and offset respectively. For F2, the frequencies remained 1000Hz and 1700Hz on onset and offset positions. Figure 3 below shows the formant movement at onset and offset points. The average time calculated for the articulation of the vowel was 0.51seconds.

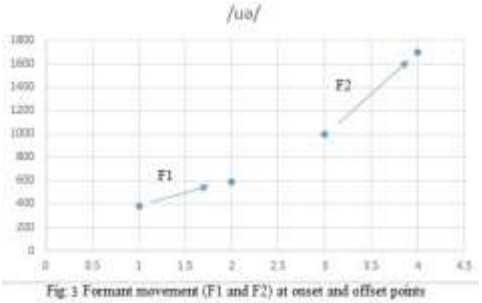


Fig. 3 Formant movement (F1 and F2) at onset and offset points

sClosing Diphthong /ai/

The analysis of this token showed that it was articulated as a closing diphthong. The Praat spectrogram exhibited a glide. The statistical analysis showed that the difference between F1 at onset and offset and F2 at onset and offset is significant. The mean values of first formant F1 remained 700Hz and 460Hz at onset and offset points, and for F2, the values remained 2000Hz and 2900Hz at onset and offset points. The figure below (Fig 4) show the trajectory movement of the formants. The average duration of articulation calculated was 0.58 seconds.

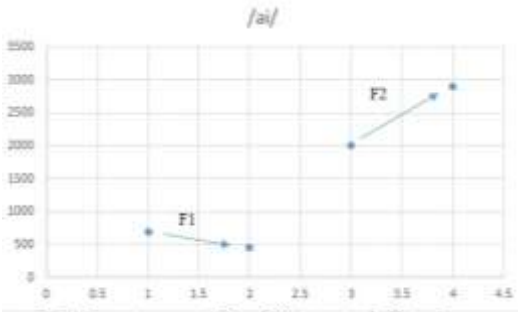


Fig 4 Formant movement (F1 and F2) at onset and offset points

Closing Diphthong /ei/

This vowel behaved differently, as it was not articulated as a diphthong. The duration and the formant frequencies exhibited that it was articulated as a monophthong. No glide was visible on the spectrogram and the duration of articulation was much less as compared to other diphthongs. Statistical analysis also showed that the difference between F1 at onset and offset, and F2 at onset and offset is insignificant. The average formant frequencies for F1 at onset and offset were 460Hz and 470Hz respectively, while for F2 they remained 2900Hz and 2885Hz at onset and offset points respectively. The average duration of the realisation of the vowel was 0.34 seconds. The figure below (Fig 3) shows no trajectory or formant movement of F1 and F2 at onset and offset points.

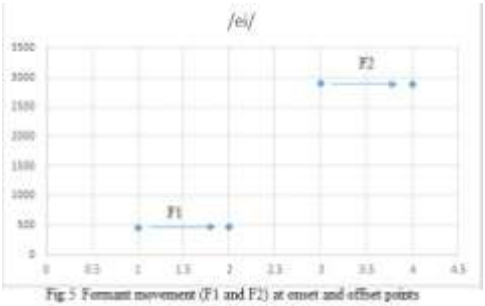


Fig 5 Formant movement (F1 and F2) at onset and offset points

Closing Diphthong /ɔi/

Formant frequencies for the vowel remained 600Hz and 450Hz for F1 at onset and offset points, while for F2, they remained 1500Hz and 2600Hz at onset and offset points respectively. Tukey's HSD test showed that the difference between the values of F1 at onset and offset and of F2 at onset and offset remained significant. Praat picture also showed trajectory in the formant movement. The average duration of articulation remained 0.57 seconds. The figure (Fig 6) shows the formant movement of F1 and F2 atonset and offset positions.

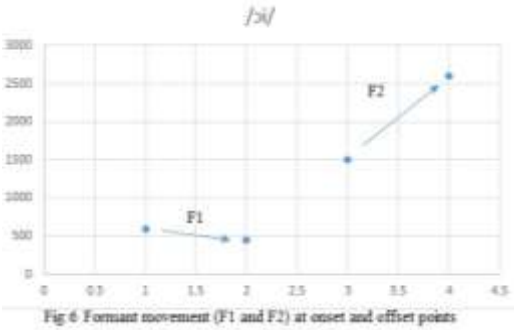


Fig 6 Formant movement (F1 and F2) at onset and offset points

Closing Diphthong /əu/

Like /ei/ which did not behave like a diphthong, /əu/ also realised itself as a monophthong. There was no glide or trajectory visible on the spectrogram showing any formant movement (Fig 7). Statistical analysis also showed that there is no significant difference between the values of F1 at onset and offset and those of F2 at onset and offset points. The durational properties of the vowel also showed that it took much shorter than the other diphthongs. The average duration of the articulation of this vowel was 0.30 seconds. The average formant frequencies remained 500Hz and 510Hz for F1 on onset and offset respectively, while for F2, the values remained 800Hz and 790 Hz at onset and offset points.

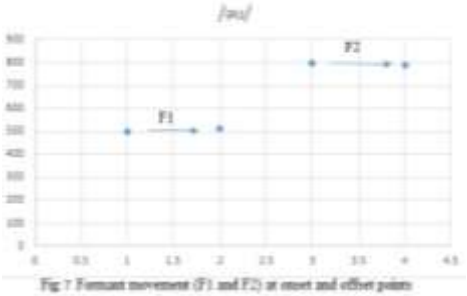


Fig 7 Formant movement (F1 and F2) at onset and offset points

Closing Diphthong /au/

The vowel realised itself as a diphthong closing to /u/. The average formant measurement remained 500Hz and 350Hz of F1 atonset and offset points. The formant values ofF2 remained 1900Hz and 1000Hz atonset and offset respectively. The average duration of articulation remained 0.5 seconds. The statistical analysis showed that there is significant difference between the values of F1 at onset and offset, andof F2 at onset and offset. The figure below (Fig 8) shows the formant movement of F1 and F2 atonset and offset points.

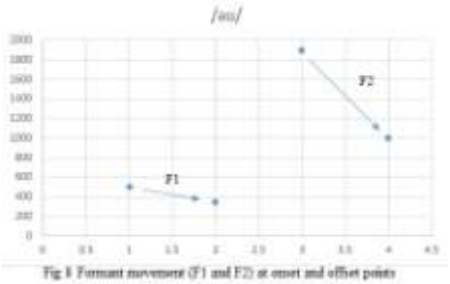
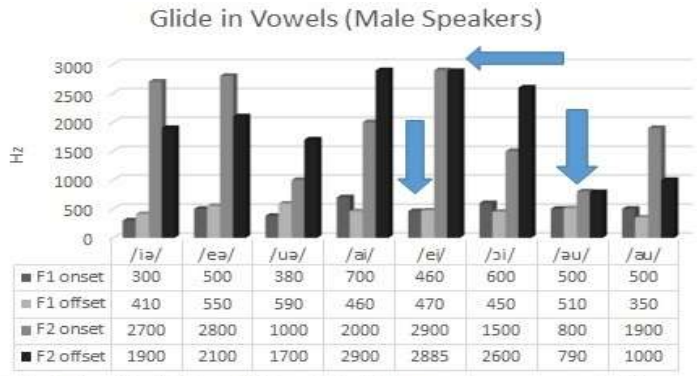


Fig 8 Formant movement (F1 and F2) at onset and offset points

The analysis of the vowel tokens of male speakers show that PakE has six diphthongs. There are three centring diphthongs, i.e. /iə/, /eə/ and /uə/ and three closing diphthongs, i.e. /au/, /ai/ and /ɔi/. The two closing diphthongs of SBE i.e. /əu/ and /ei/ are articulated as monophthongs by Pakistani speakers.The articulation of these vowel tokens do not show any glide or trajectory on the spectrogram. The following graph (Fig 9) shows the difference in the formants of F1 at onset and offset and of F2 at onset and offset points of all the vowel tokens.



	/iə/	/eə/	/uə/	/ai/	/ei/	/ɔi/	/əu/	/au/
F1 onset	300	500	380	700	460	600	500	500
F1 offset	410	550	590	460	470	450	510	350
F2 onset	2700	2800	1000	2000	2900	1500	800	1900
F2 offset	1900	2100	1700	2900	2885	2600	790	1000

Fig 9: Graphic display of F1 and F2 of the vowels on onset and offset representing glide. Arrows show tokens with no glide.

They are also short in duration as compared to other diphthongs. Following (Fig 10) is the graphic display of the comparison of duration of articulation of all the eight tokens.

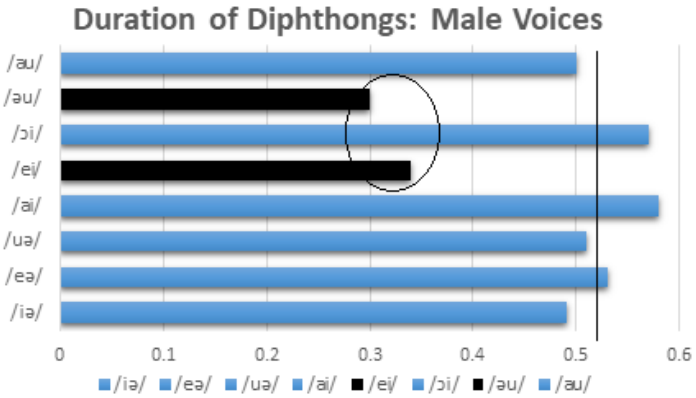


Fig 10: The black bands show that /əu/ and /ei/ are much shorter in length as compared to other diphthongs.

Female Speakers

Owing to differences in vocal cavities of male and female, causing differences in formant frequencies, separate analysis of the voice tokens of male and female speakers was planned to reach certain adequate conclusions. The process of analysis remained same as was adopted for the male speakers.

Centring Diphthong /iə/

Like their male counter parts, female speakers articulated it as a centring diphthong. Praat picture on the spectrogram showed a visible glide. The formant values of F1 were 400Hz and 620Hz at onset and offset points while of F2, they were 2950Hz and 620Hz at onset and offset points. Tukey's HSD test also ascertained that the difference of the formants of F1 on onset and offset and of F2 on onset and offset is significant. The duration of articulation was 0.58 seconds. The figure below (Fig 11) represents the formant movement (F1 and F2) atonset and offset points of the segment analysed.

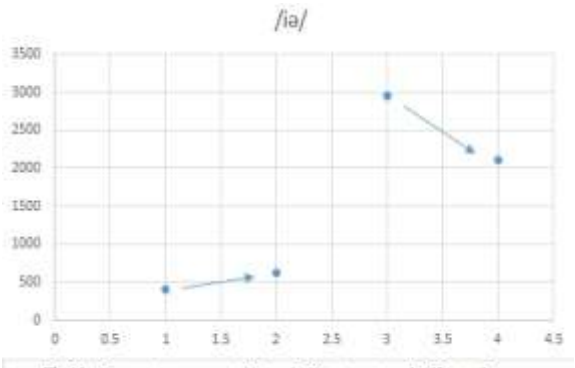


Fig 11: Formant movement (F1 and F2) at onset and offset points

Centring Diphthong /eə/

The female speakers did realise it as a centring diphthong. The duration of articulation remained 0.57 seconds. The spectrographic representation on Praat showed a visible glide of the formants. Tukey's HSD statistical analysis confirmed that the formant values of F1 and F2 on onset and offset positions are significantly different. The formant frequencies offirst formant F1 remained 590Hz and 670Hz at onset and offset points, while forthe second formant F2, the formant frequencies remained 3100Hz and 2300Hz. The figure below (Fig 12) shows the formant movement of F1 and F2 atonset and offset points.

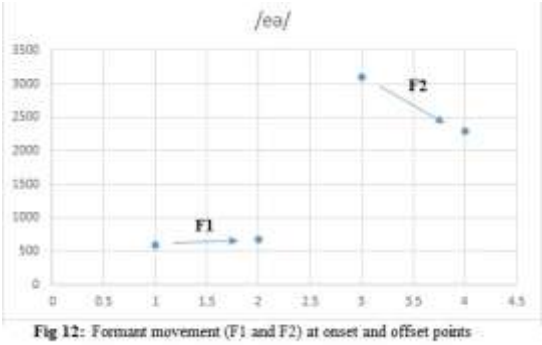


Fig 12: Formant movement (F1 and F2) at onset and offset points

Centring Diphthong /uə/

The female speakers showed no difference from male speakers in the articulation of this vowel. They articulated it as a centring diphthong. Tukey'sHSD statistical analysis showed that the difference between formant frequencies of F1 and F2 at onset and offset positions is significant. The spectrogram display also showed a visible glide and trajectory of the formants. The formant frequencies for the diphthong remained 450Hz and 650Hz for F1 at onset and offset respectively. For F2, the frequencies remained 1200Hz and 2000Hz atonset and offset positions. The average time calculated for the articulation of the vowel was 0.60 seconds. The figure (Fig 13) below displays the formant movement of F1 and F2 at onset and offset points.

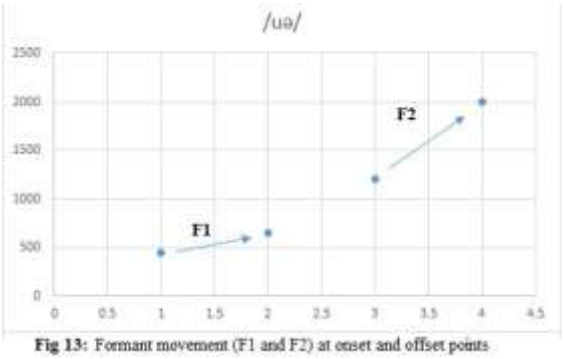


Fig 13: Formant movement (F1 and F2) at onset and offset points

Closing Diphthong /ai/

The mean values of first formant F1 remained 740Hz and 510Hz at onset and offset points, and for F2, the value remained 2200Hz and 3100Hz at the same points. The average duration of articulation calculated was 0.62 seconds. The analysis of the vowel token showed that it was articulated as a closing diphthong. The Praat spectrogram exhibited a glide. Tukey'sHSD Test ascertained that the difference between F1 at onset and offset and F2 at onset and offset is significant. The following figure (Fig 14) displays the formant movement of F1 and F2 at onset and offset positions.

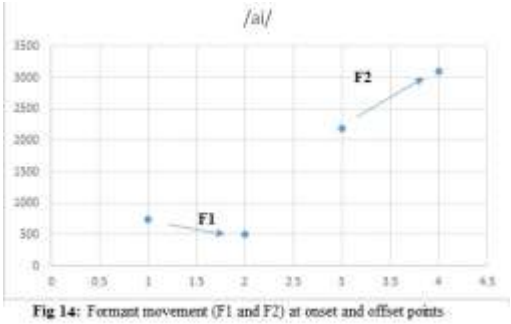


Fig 14: Formant movement (F1 and F2) at onset and offset points

Closing Diphthong /ei/

It was observed in the analysis of the speeches of male speakers that the vowel was not articulated as a diphthong. The female speakers displayed the same pattern of articulation. The duration and the formant frequencies established that it was articulated as a monophthong. There was no trajectory or glide visible on the spectrogram and the duration of articulation was much less as compared to other diphthongs. Tukey's HSD statistical test also showed that the difference between values of F1 at onset and offset, and of F2 at onset and offset is insignificant. The average formant frequencies of F1 at onset and offset were 530Hz and 530Hz respectively, while for F2 they remained 2980Hz and 2960Hz at onset and offset points respectively. The average duration of the realisation of the vowel was 0.39 seconds. The figure below (Fig 15) showsflat formant movement of F1 and F2 at onset and offset points.

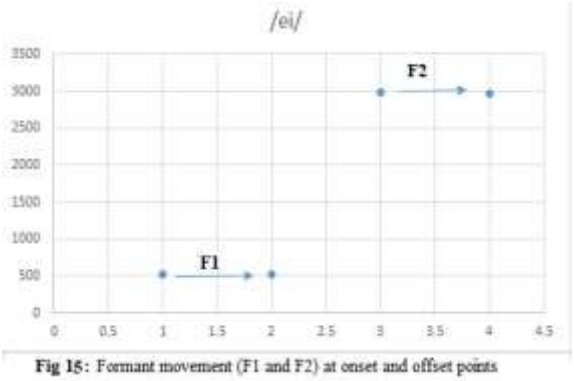


Fig 15: Formant movement (F1 and F2) at onset and offset points

Closing Diphthong /ɔi/

The vowel was articulated as a rising diphthong. Formant frequencies for the vowel remained 700Hz and 550Hz for F1 atonset and offset points, while for F2, they remained 1900Hz and 2850Hz atonset and offset points respectively. Statistical test ascertained that the difference between frequencies of F1 at onset and offset and of F2 at onset and offset positions remained significant. Praat picture also showed trajectory in the formant movement. The average duration of articulation remained 0.57 seconds. The figure below (Fig 16) shows the formant movement of F1 and F2 atonset and offset positions.

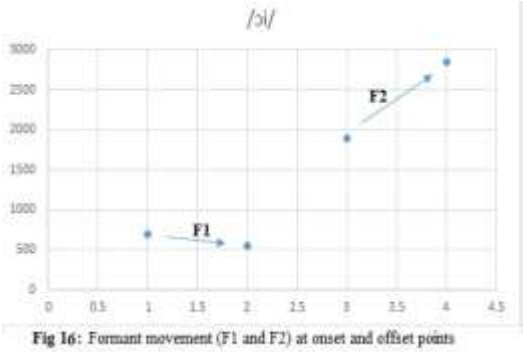


Fig 16: Formant movement (F1 and F2) at onset and offset points

Closing Diphthong /əu/

The male speakers articulated this vowel as a monophthong, the female speakers were no different. Like /ei/ which did not behave like a diphthong, /əu/ was also realised as a monophthong. There was no glide

or trajectory visible on the spectrogram showing any formant movement. Statistical analysis also showed that there was no significant difference between the values of F1 at onset and offset and those of F2 at onset and offset points. The durational properties of the vowel also showed that it took much shorter than the other diphthongs. The average duration of the articulation of this vowel was 0.30 seconds. The average formant frequencies remained 550Hz and 565Hz for F1 at onset and offset respectively, while for F2, the values remained 930Hz and 935 Hz at onset and offset points. The following figure (Fig 17) displays the formant movement.

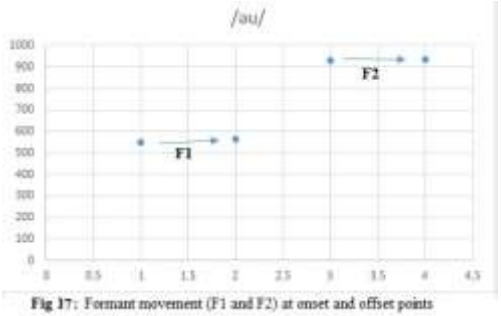


Fig 17: Formant movement (F1 and F2) at onset and offset points

Closing Diphthong /au/

The female speakers realised the vowel as a closing diphthong. The average formant measurement remained 570Hz and 370Hz for F1 atonset and offset points. The formant values for F2 remained 1900Hz and 1000Hz atonset and offset respectively. The average duration of articulation remained 0.63 seconds. The statistical analysis showed that there was significant difference between the values of F1 at onset and offset, and of F2 at onset and offset. The figure below (Fig 18) shows the formant movement of F1 and F2 on onset and offset points.

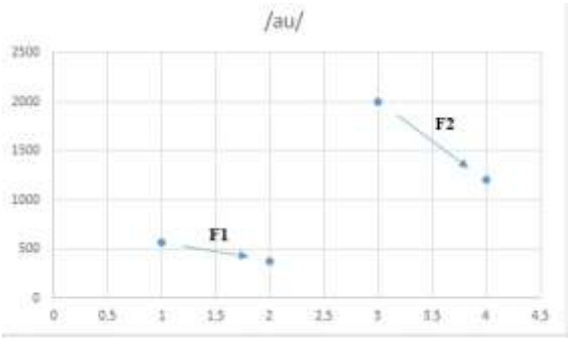
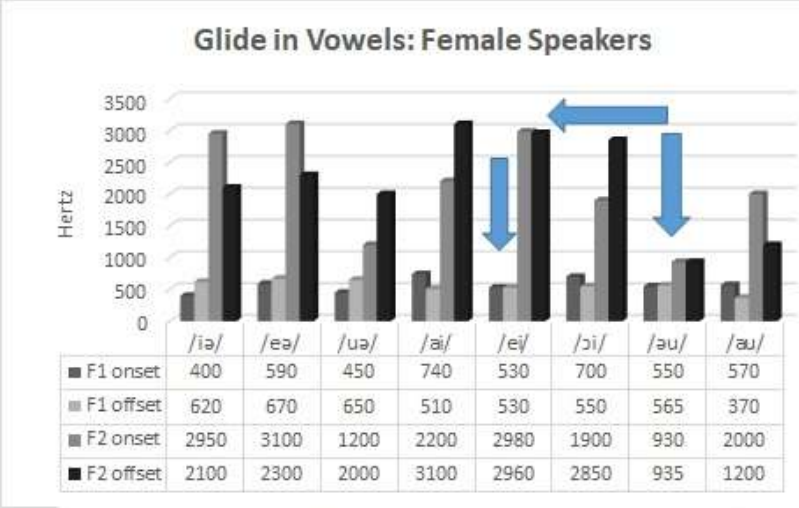


Fig 18: Formant movement (F1 and F2) at onset and offset points

The analysis of the vowels of female speakers show a similar pattern as compared to their male counter-parts. It is observed that female speakers of PakE articulated six diphthongs, i.e. three centring diphthongs (/iə/, /eə/ and /uə/) and three closing diphthongs (/au/, /ai/ and /ɔi/). The two closing diphthongs i.e. /əu/ and /ei/ were articulated as monophthongs. The graph below (Fig 19) shows the difference in the formant frequencies of F1 at onset and offset and F2 at onset and offset positions of all the vowel tokens. The arrow-heads point to two vowels that are monophthongised.



	/iə/	/eə/	/uə/	/ai/	/ei/	/ɔi/	/əu/	/au/
F1 onset	400	590	450	740	530	700	550	570
F1 offset	620	670	650	510	530	550	565	370
F2 onset	2950	3100	1200	2200	2980	1900	930	2000
F2 offset	2100	2300	2000	3100	2960	2850	935	1200

Fig19 Graphic display of F1 and F2 of the vowels on onset and offset representing glide. Arrows show tokens with no glide.

The two vowels that showed a different behaviour in formant movement, are also short in duration as compared to other diphthongs. Below (Fig 20) is the graphic representation of the comparison of duration of articulation of all the eight tokens as articulated by female speakers of PakE.

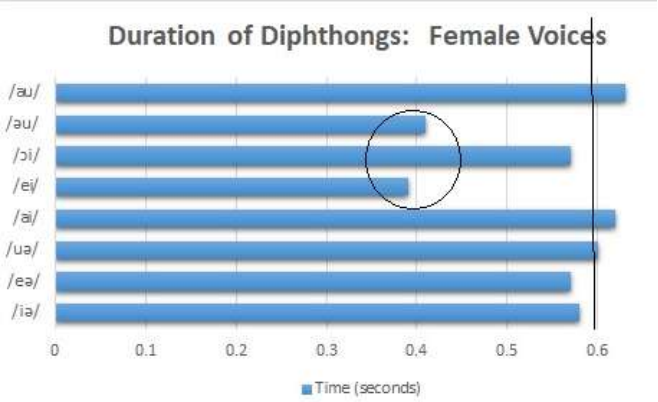


Fig 20: The black bands show that /əu/ and /ei/ are much shorter in length as compared to other diphthongs.

IV. DISCUSSION

Bothe male and female speakers articulated the diphthongs in a similar manner. Both have articulated three central diphthongs, i.e. /iə/, /eə/ and /uə/ and three closing diphthongs, including two closing to /i/, i.e. /ai/ and /ɔi/ and one closing to /u/, i.e. /au/.The two closing diphthongs of SBE i.e. /əu/ and /ei/ are not realised as diphthongs. Both the vowels are articulated without glide, i.e. as monophthongs. The pattern remained alike in male and female speakers of PakE. The difference between male speakers and female speakers is of duration of articulation, i.e. the female speakers articulated the six diphthongs longer than their male counter-parts. So it may be concluded that PakE has six diphthongs, further divided into three centring, two closing to /i/ and one closing to /u/. PakE follows Indian English in this particular aspect which has six diphthongs (Gargesh, 2004; Nihalani et al., 2004; Trudgill and Hannah, 2008) and the two diphthongs i.e. the face and goat diphthongs, show characteristics of monophthongs due to the influence of local languages (Maxwell, 2010). Other Asian varieties of English show a similar tendency where these two diphthongs are reported as monophthongs, including Singapore English (Wee, 2004; Deterding, 2007), Malaysian English (Hickey, 2005). Even other non-native varieties showed the similar tendency, eg. Nigerian English(Dyrenko& Fuchs, 2018).

To answer the question whether PakE can be called a different variety on the basis of these findings, we need to look at the linguistic variables that lead to cause a change in a particular variety. A variety may be

considered a variant or a different variety on the basis of number of phonemes, or the different realisation of phoneme(Barber et al, 2009; Cruttenden, 2008; Bauer, 2002). So PakE can be declared a different variety of non-native Asian Englishes on the basis of its differences in diphthongs, leading to variation in pronunciation. Thus, it can be concluded that PakE is a different variety of English with six diphthongs, unlike SBE which has eight diphthongs.

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