



Exploring English Monophthongs' Formants of Punjabi Speakers in Punjab, Pakistan

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ABSTRACT

This study discovers the formants of Punjabi speakers living in western Punjab, Pakistan and their relative position in a trapezium while articulating English cited words. English is a lingua franca while Punjabi is one of the local languages of India and Pakistan spoken in upper western Punjab, a province of Pakistan and Eastern Punjab, a part of India. The F1 and F2 (Formant 1 & Formant 2) determine the position of a monophthong (vowel) in a trapezium. Data were collected from twenty (20) Male participants from Lahore and Faisalabad, two major cities of Pakistan and were asked to articulate one hundred and twenty English cited words carrying all English monophthongs. The data was analyzed by measuring the Formant values (F1 and F2) of every single word articulated by twenty (20) Punjabi Male speakers. The Values in Hertz were changed into Bark Scale and Euclidian method was used to measure the distance of monophthongs articulated by Male participants living in Lahore and Faisalabad to determine the difference between two dialects of Punjabi language. Both the groups were also compared through co-relative t-test. The results showed that t value is 0.58, df=11 and $P > 0.955$ which is much higher than 0.05, so it can be concluded that these two cities' speakers utter the English cited words in the same way.

1 Introduction

Punjabi is the language of 92,722,200 people in the world (Lewis, Paul, Simons, & Fennig, 2017). The Punjabi can be divided into Eastern and Western Punjabi (Lewis, Paul, Simons, & Fennig, 2017) as it is spoken in Eastern Punjab which is in India and the Western Punjab which is a province of Pakistan. This study is delimited to the Western Punjab which is the most populated, but area-wise, second largest province of Pakistan (Pakistan Bureau of Statistics, 2017). The study was further delimited to the two major cities of Punjab, Lahore and Faisalabad to determine the impact of their mother tongue Punjabi on English. English and Urdu are used as a second language by these Punjabi speakers in western Punjab and parents also urge their children to speak Urdu and English at home (Riaz, 2015). Though they speak English and Urdu at home, Punjabi language reflection can easily be observed while speaking English or Urdu. This study explores how the Punjabi speakers articulate the English cited words in Lahore and Faisalabad and is there any difference between the articulation? The formants of Punjabi speakers while articulating/pronouncing cited words of English words were highlighted in this study.

The Britishers left English as their legacy in the Indo-Pak region (Philip Durkin, 2014) and replaced Persian and Arabic with English during their rule (Spear, 1938). Since the independence of Pakistan, English is the official language of Pakistan (Pakistan & Government of Pakistan, 2012). While Punjabi is a local language of Punjab and influenced English especially in terms of phonology as one of the regional languages of Pakistan (John, 2015). The British phonetician, David Deterding (1990) explored the formants of the vowels of Standard Southern British English cited words in a study. In his second study, he compared the formants of the vowels of Standard Southern British English cited words with the formants of the vowels of Standard Southern British English connected speech (Deterding, 1997) while American English vowels characteristics were discovered by James Hillenbrand (James Hillenbrand et al., 1995).

The Punjabi speakers articulate English words differently, not only from native speakers but also from the speakers of other local languages in Pakistan i.e. Pashto, Saraiki, Sindhi and Baluchi which are major local languages of Pakistan (Farooq, 2014). This study highlights the formants of monophthongs of Punjabi speakers which articulating English cited words.

2 Methodology

One hundred and twenty (120) words were selected carrying all English monophthongs and twenty (20) Punjabi speakers from western Punjab (10 each from Lahore and Faisalabad) were asked to articulate those words. The recordings were made by using the AUDACITY Version 2.2.2 (a recording software) and SONY ECM CS-3 MIC to avoid the surrounding noise. The AUDACITY version 2.2.2 was used to record the audio sounds at 44100 Hertz and files were saved as WAV files as PRAAT manipulates WAV files well (Boersma, 2001) as compared to other formats due to the quality of WAV files. The participants were selected by using the snowball sampling method. Every participant was graduate at least supposing the point that graduates can pronounce the English words correctly as they study the English language for fourteen years in Pakistan (Rahman, 1999). Male and female sound boxes, oral cavities are different physiologically and anatomically (Biemans, 2000), so the study was delimited to male Punjabi speakers only.

The Formants F1 and F2 of every single Monophthong were measured through spectrogram by using PRAAT (6.0.43 version) in Hertz.

3 Bark Scale

The measurements in Hertz were converted into the Bark Scale introduced by Zwicker (1961), and later modified by Zwicker & Terhardt (1980).

The conversion equation from Hertz to Bark is as under:

$$Z = 13 \arctan(0.00076F) + 3.5 \arctan(F/7500)^2$$

4 Euclidian distance measurements

The means of Bark frequencies were calculated from the centroid of each group and a difference was measured through Euclidian distance method of each monophthong from the centroid of each group in a trapezium through the Euclidian distance equation.

5 Euclidian distance equation

In the following equation, “*d*” is the distance between the two points “*p*” and “*q*”.

$$d(p, q)^2 = (q_1 - p_1)^2 + (q_2 - p_2)^2$$

6 *The population of the study*

Twenty (20) participants were asked to pronounce ten (10) English cited words for every single monophthong. Out of these twenty participants, ten (10) were from Lahore while other ten (10) were the permanent resident of Faisalabad city. It means every single participant pronounced 120 words in total while all the participants pronounced 6000(six thousand words) in total. All 6000 (Six thousand) words were analysed separately to complete this study.

7 *Sample of the study*

All twenty (20) participants were selected as the sample of this study.

8 *Monophthongs*

All monophthongs of English language were selected for this study as follows:

/ɪ/, /ʊ /, /ʌ /, /ɒ/, /ə/, /e/, /æ/, /i:/, /u:/, /ɑ:/, /ɔ:/, /ɜ:/

9 *Data Analysis*

Ten (10) English words were selected against each monophthong as follows:

Table 1

Ten (10) selected cited words carrying each English monophthong (Sajid-us-Salam, 2019)

Sr #	Vowel	Words
1	/ɪ/	Honest, forbidden, baggage, become, behave, bin, bit, build, chick, cottage
2	/ʊ /	Book, cook, could, foot, full, pull, rook, should, took, wolf
3	/ʌ /	Wonderful, among, blood, brother, bug, bun, but, company, country, cousin
4	/ɒ/	Block, body, bother, bottle, box, comma, cot, dog, dolmen, hop
5	/ə/	Honour, accept, answer, apartment, atom, balance, banal, banana, bosom, calendar

Sr #	Vowel	Words
6	/e/	November, anyone, bell, bread, breakfast, breath, cheque, debt, eleven, head
7	/æ/	Challenge, axe, bank, black, calculate, candle, captain, cat, dam, gnat
8	/i:/	Agree, bean, belief, believe, breathe, cede, ceiling, cheap, cheek, cheese
9	/u:/	Bamboo, root, boot, booty, brew, bruise, bruit, brutal, brute, chew
1	/ɑ:/	March, aunt, bar, barn, carp, cart, draught, guard, hard, heart
1	/ɔ:/	Adorn, audience, awful, awkward, ball, bawdy, board, born, bought, call
1	/ɜ:/	Bird, burden, burly, burn, burst, circuit, colonel, curl, courtesy, curtain

10 Recordings

Recordings were made by using the AUDACITY Software version. 2.2.2 at 44100 HZ which is a default setting to record human sounds by AUDACITY developers by using SONY ECM CS-3 microphone which is considered a good quality microphone available in market to minimize the role of error / surrounding noise(s) while recording sounds of the participants.

11 Results and Discussion

Ten (10) words were selected against each monophthong (Table 1) and these were asked to articulate by twenty (20) Male Punjabi speakers in total. Out of these twenty Male Punjabi speakers, ten (10) were from Lahore while other (10) were the residents of Faisalabad. Formant 1(F1) and Formant 2 (F2) of each word of each participant were measured in a spectrogram through PRAAT.

12 Data analysis of the Punjabi Speakers from Lahore

The mean of F1 and F2 of each monophthong of all the ten (10) Punjabi speakers from Lahore was calculated which is in Table 2 as under:

Table 2

Formant 1 (F1) and Formant 2 (F2) values of all monophthongs of Punjabi Speakers from Lahore in Hertz.

Punjabi Speakers from Lahore		
Vowel	F1* (Hertz)	F2** (Hertz)
/ɪ/	448.74	1852.74
/ʊ/	420.26	1215.26
/ʌ/	633.72	1214.88
/ɒ/	598.72	1032.92
/ə/	574.12	1525.26
/e/	600.26	1790.56
/æ/	720.78	1633.58
/i:/	379.88	2099.4
/u:/	498.88	1419.62
/ɑ:/	73.03	118.022
/ɔ:/	625.18	1138.88
/ɜ:/	572.22	1323.74

*F1=Formant 1 & F2=Formant2

The above values in Hertz were converted/ changed into Bark Scale suggested by Zwicker & Terhardt, (1980) by applying the following equation:

$$Z=13\arctan(0.00076F)+3.5\arctan(F/7500)^2$$

The converted values in Bark are as under in Table 3.

Table 3

Punjabi Speakers from Lahore F1 and F2 values' conversion from Hertz to Bark

Vowel	F1 (Hertz)	F2 (Hertz)	F1 (Bark)	F2 (Bark)
/ɪ/	448.74	1852.74	4.28314	12.5929
/ʊ/	420.26	1215.26	4.02975	9.78157
/ʌ/	633.72	1214.88	5.85957	9.77853
/ɒ/	598.72	1032.92	5.5732	8.71408
/ə/	574.12	1525.26	5.36585	11.2928
/e/	600.26	1790.56	5.58558	12.367
/æ/	720.78	1633.58	6.54662	11.7677
/i:/	379.88	2099.4	3.66216	13.4148
/u:/	498.88	1419.62	4.72491	10.8219
/ɑ:/	73.03	118.022	6.6182	9.62143
/ɔ:/	625.18	1138.88	5.78877	9.34912
/ɜ:/	572.22	1323.74	5.35261	10.3498

The centroid point of Punjabi speakers from Lahore was measured and distance of each monophthong from the centroid was calculated through the Euclidian method by applying the following equation:

$$d(p, q)^2 = (q_1 - p_1)^2 + (q_2 - p_2)^2$$

Table 4

Distance from the Centroid of Punjabi Speakers from Lahore

Vowel	F1 (Hertz)	F2 (Hertz)	F1 (Bark)	F2 (Bark)	Distance from the Centroid
/ɪ/	448.74	1852.74	4.28314	12.5929	0.39358
/ʊ/	420.26	1215.26	4.02975	9.78157	0.23933
/ʌ/	633.72	1214.88	5.85957	9.77853	0.24931
/ɒ/	598.72	1032.92	5.5732	8.71408	0.2683
/ə/	574.12	1525.26	5.36585	11.2928	0.54019
/e/	600.26	1790.56	5.58558	12.367	0.37228
/æ/	720.78	1633.58	6.54662	11.7677	0.21567
/i:/	379.88	2099.4	3.66216	13.4148	0.17857
/u:/	498.88	1419.62	4.72491	10.8219	0.37408
/ɑ:/	73.03	118.022	6.6182	9.62143	0.32229
/ɔ:/	625.18	1138.88	5.78877	9.34912	0.37689
/ɜ:/	572.22	1323.74	5.35261	10.3498	0.32571

In Table 4, the distance of each monophthong of Punjabi Speaker from Lahore was measured from the centroid calculated by Euclidian distance method.

13 Descriptive Statistics of the Punjabi Speakers from Lahore

Table 5

Descriptive Statistics of Punjabi Speakers from Lahore

Punjabi Speakers form Lahore	
Mean	0.321349
Standard Error	0.028587
Median	0.323999
Mode	#N/A
Standard Deviation	0.099028
Sample Variance	0.009806

The mean of all the monophthongs of Punjabi speakers from Lahore is 0.321349 while median value is 0.323999, while none of the monophthongs has the same difference from the centroid as Mode is (Not Applicable). The standard deviation of 0.099028, while standard error is 0.028587 which both are very minute.

14 Data analysis of the Punjabi Speakers from Faisalabad

The mean of F1 and F2 of each monophthong of all the ten (10) Punjabi speakers from Lahore was calculated which is in Table 6 as under:

Table 6

Formant 1 (F1) and Formant 2 (F2) values of all monophthongs of Punjabi Speakers from Faisalabad in Hertz

Vowel	F1 (Hertz)	F2 (Hertz)
/ɪ/	447.88	1845.14
/ʊ/	413.8	1231.52
/ʌ/	635.88	1228.5

Vowel	F1 (Hertz)	F2 (Hertz)
/ɒ/	600.74	1046.9
/ə/	558.54	1594.22
/e/	601.08	1786.12
/æ/	719.2	1642.38
/i:/	388.12	2091.66
/u:/	479.32	1411.04
/ɑ:/	73.148	116.398
/ɔ:/	616.04	1094.6
/ɜ:/	578.74	1276.04

The above values in Hertz were converted/ changed into Bark Scale suggested by Zwicker & Terhardt, (1980) by applying the following equation:

$$Z=13\arctan(0.00076F)+3.5\arctan(F/7500)^2$$

The converted values in Bark are as under in Table 7:

Table 7

Punjabi Speakers from Faisalabad F1 and F2 values' conversion from Hertz to Bark

Vowel	F1 (Hertz)	F2 (Hertz)	F1 (Bark)	F2 (Bark)
/ɪ/	447.88	1845.14	4.27683	12.569981
/ʊ/	413.8	1231.52	3.9716161	9.8550868

Vowel	F1 (Hertz)	F2 (Hertz)	F1 (Bark)	F2 (Bark)
/ʌ/	635.88	1228.5	5.8770811	9.8549496
/ɒ/	600.74	1046.9	5.5898753	8.8031043
/ə/	558.54	1594.22	5.2359171	11.59589
/e/	601.08	1786.12	5.5927446	12.34635
/æ/	719.2	1642.38	6.5343087	11.803559
/i:/	388.12	2091.66	3.7373188	13.39181
/u:/	479.32	1411.04	4.5534112	10.778546
/ɑ:/	73.148	116.398	6.6370469	9.5096151
/ɔ:/	616.04	1094.6	5.7146394	9.0828504
/ɜ:/	578.74	1276.04	5.4072747	10.109052

The centroid point of Punjabi speakers from Faisalabad was measured and distance of each monophthong from the centroid was calculated through the Euclidian method by applying the following equation:

$$d(p, q)^2 = (q_1 - p_1)^2 + (q_2 - p_2)^2$$

Table 8

Distance from the Centroid of Punjabi Speakers from Faisalabad

Vowel	F1 (Hertz)	F2 (Hertz)	F1 (Bark)	F2 (Bark)	Distance from the Centroid
/ɪ/	447.88	1845.14	4.27683	12.569981	0.33951
/ʊ/	413.8	1231.52	3.9716161	9.8550868	0.47722

Vowel	F1 (Hertz)	F2 (Hertz)	F1 (Bark)	F2 (Bark)	Distance from the Centroid
/ʌ/	635.88	1228.5	5.8770811	9.8549496	0.2081
/ɒ/	600.74	1046.9	5.5898753	8.8031043	0.19356
/ə/	558.54	1594.22	5.2359171	11.59589	0.40143
/e/	601.08	1786.12	5.5927446	12.34635	0.36822
/æ/	719.2	1642.38	6.5343087	11.803559	0.236
/i:/	388.12	2091.66	3.7373188	13.39181	0.20133
/u:/	479.32	1411.04	4.5534112	10.778546	0.41334
/ɑ:/	73.148	116.398	6.6370469	9.5096151	0.34735
/ɔ:/	616.04	1094.6	5.7146394	9.0828504	0.45475
/ɜ:/	578.74	1276.04	5.4072747	10.109052	0.23489

In Table 8, the distance of each monophthong of Punjabi Speaker from Lahore was measured from the centroid calculated by Euclidian distance method.

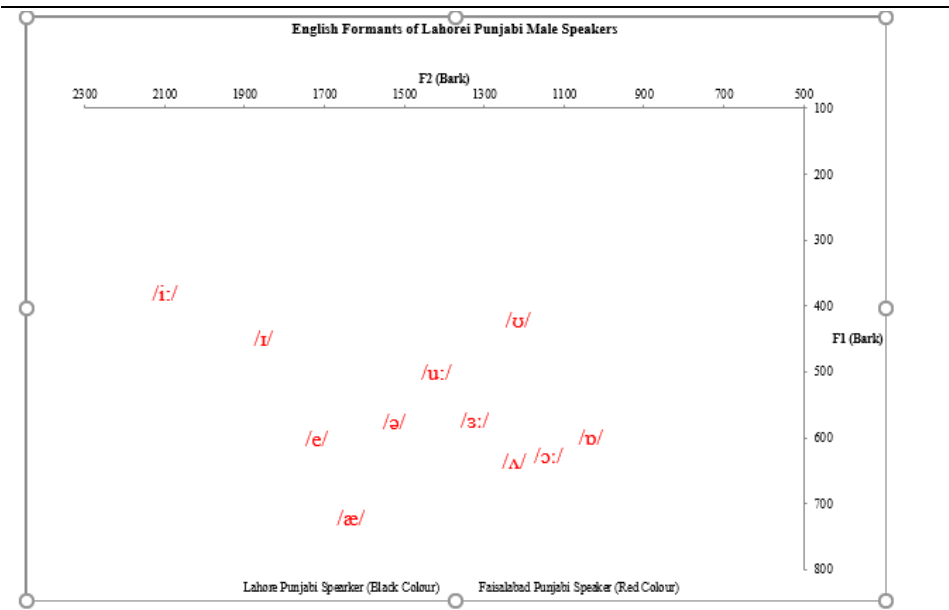


Figure 11.1 Lahori Punjabi Male Speakers’ Trajectory

15 Descriptive Statistics of the Punjabi Speakers from Faisalabad

Table 9
Punjabi Speakers from Faisalabad

Punjabi Speakers from Faisalabad	
Mean	0.322975
Standard Error	0.029957
Median	0.343429

Punjabi Speakers from Faisalabad

Mode	#N/A
Standard Deviation	0.103773
Sample Variance	0.010769

The mean of all the monophthongs of Punjabi speakers from Faisalabad is 0.322975 while median value is 0.343429, while none of the monophthongs has the same difference from the centroid as Mode is (Not Applicable). The standard deviation of 0.103773, while standard error is 0.010769 which both are very minute.

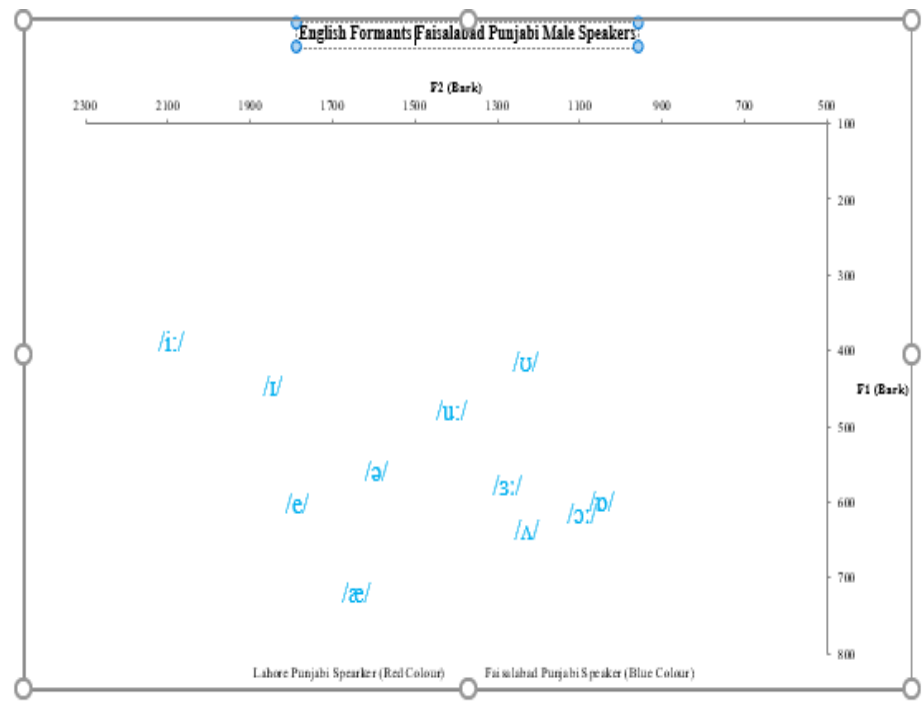


Figure 11.2 Punjabi Speakers’ trajectory from Faisalabad

16 *Comparison of the Punjabi speakers from Lahore and Faisalabad*

In Table 10, a comparison of monophthongs of Punjabi speakers of Lahore and Faisalabad is depicted. It can be observed that though there is a minute difference between the two groups of Punjabi speakers, but the difference is there.

Table 10

Comparison of Punjabi Speakers from Lahore and Faisalabad

Vowels	Speakers from Lahore	Speakers from Faisalabad
/ɪ/	0.39358	0.33951
/ʊ/	0.23933	0.47722
/ʌ/	0.24931	0.2081
/ɒ/	0.2683	0.19356
/ə/	0.54019	0.40143
/e/	0.37228	0.36822
/æ/	0.21567	0.236
/i:/	0.17857	0.20133
/u:/	0.37408	0.41334
/ɑ:/	0.32229	0.34735
/ɔ:/	0.37689	0.45475
/ɜ:/	0.32571	0.23489

The following vowel trajectory portrays that there is a vivid difference between /i/, /e/, /u:/, /ʊ/, /ɜ:/, /ɔ:/, /ə/, /ɒ/ while /ɪ/, /ʌ/ and /æ/ have a slight difference between the formants of Punjabi speakers from Lahore and Faisalabad while uttering cited English words.

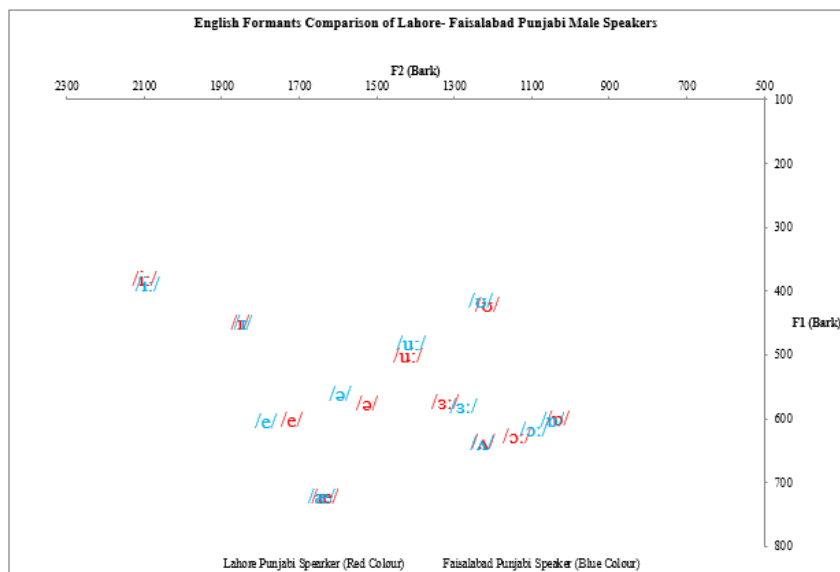


Figure 11.3 Comparison of Lahori and Faisalabad Punjabi Speakers' English formants

17 Comparison of means through correlated *t*-test

The mean of the Punjabi speakers from Lahore is 0.3213 and the standard deviation is 0.0993 while the mean of the Punjabi speakers from Faisalabad is 0.00377 and standard deviation is 0.2996 which indicates that Punjabi speakers from Faisalabad are more peripheral than Punjabi speakers from Lahore while uttering English cited words.

Table 11 Mean and Standard Deviation of the Lahore and Faisalabad Punjabi Speakers

Paired Samples Statistics				
	Mean	Std. Deviation	Std. Mean	Error
Speakers from Lahore	.3213	.09903	.02859	
Speakers from Faisalabad	.3230	.10377	.02996	

In the following table the significant value 0.955 and is much higher than 0.05, it indicates that both the groups are almost same and there is no significant difference between the Punjabi speakers while uttering English cited words.

Table 12 Paired Sample t-test Results

Paired Samples Test				
Paired Differences				
Mean	Std. Deviation	t	df	Sig. (2-tailed)
-.00163	.09698	-.058	11	.955

18 Conclusion

As the t value is 0.58, df=11 and $P > 0.955$ is much higher than 0.05 so it can be concluded that these two cities' speakers the English cited words in the same way with a slight difference which has been identified in the upper lines in the English vowels trajectory in figure 4.3. The vowel placement trajectory of Punjabi speakers from Lahore and Faisalabad while uttering cited English words clearly portrays that there is a noticeable difference between /i/, /e/, /u:/, /ʊ/, /ɜ:/, /ɔ:/, /ə/, /ɒ/ vowels while in vowels /ɪ/, /ʌ/ and /æ/ have a slight difference, but the distance from their centroid is almost the same in both the speakers.

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18. Transcription of the cited words

1. ʊnɪst, fə'brɪdn, 'bæɡɪdʒ, bɪ'kʌm, bɪ'heɪv, bɪn, bɪt
, bɪld, ʃɪk, 'kɒtɪdʒ
2. bʊk, kʊk, kʊd, fʊt, fʊl, pʊl, rʊk, ʃʊd, tʊk, wʊlf
3. wʌndəfʊl, ə'mʌŋ, blʌd, 'brʌðə, bʌg, bʌn, bʌt, '
kʌmpəni, 'kʌntri, 'kʌzn
4. blɒk, 'bɒdi, 'bɒðə, 'bɒtl, bɒks, 'kɒmə, kɒt, dɒg
, 'dɒlmən, hɒp
5. 'ʊnə, ək'sept, 'a:nsə, ə'pɑ:tmənt, 'ætəm, 'bælə
ns, bə'nɑ:l, bə'nɑ:nə, 'bʊzəm, 'kæləndə
6. nəʊ'vembə, 'enɪwʌn, bəl, brəd, 'breɪkfəst, brəθ,
ʃɛk, det, ɪ'levn, həd
7. 'ʃælɪndʒ, æks, bæŋk, blæk, 'kælkjʊleɪt, 'kændl,
'kæptɪn, kæt, dæm, næt
8. ə'grɪ:, bɪ:n, bɪ'li:f, bɪ'li:v, brɪ:ð, sɪ:d, 'si:lɪŋ, ʃɪ:p
, ʃɪ:k, ʃɪ:z
9. bæm'bu:, ru:t, bu:t, 'bu:ti, bru:, bru:z, bru:t, 'br
u:tl, bru:t, ʃu:
10. mɑ:ʃ, a:nt, bɑ:, bɑ:n, kɑ:p, kɑ:t, dra:ft, gɑ:d, hɑ:
:d, hɑ:t
11. ə'dɒ:n, 'ɔ:diəns, 'ɔ:fʊl, 'ɔ:kwəd, bɔ:l, 'bɔ:di, bɔ:
d, bɔ:n, bɔ:t, kɔ:l
12. bɜ:d, 'bɜ:dn, 'bɜ:li, bɜ:n, bɜ:st, 'sɜ:kɪt, 'kɜ:nl, kɜ:
:l, 'kɜ:tɪsi, 'kɜ:tn