

Long Vowels in Northeastern Pashto

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1 Introduction

This paper seeks to investigate the acoustic properties of long vowels in the Northeastern dialect of Pashto (/pəχto/). While seven phonemic vowels have been identified in the Pashto vowel inventory, the only vowel which featured a distinct phonemic contrast in terms of length is in the low /a/ vowel, where the short /a/ was notably more central, and the long /a/ was distinctly further back, and even lower than the short /a/ vowel. This paper will compare all other long and short vowels found in the Pashto data elicited with our consultant, and attempt to identify any other significant findings with regards to the long vowels in the Pashto language. All data that is referenced in this paper was annotated collectively in the classroom setting, and are mainly obtained from the Swadesh list and plural noun formation elicitation sessions.

2 Short Vowels

As mentioned before, it is commonly agreed upon that there are seven vowels in the Pashto vowel system (David & Brugman, 2014). Of the seven, six are short vowels, and one is a long vowel. Below is a scatter plot of short vowels extracted from the data collected from the Swadesh list, illustrating the six short vowels that are seen in the language. All formant values were obtained from the midpoint of the vowel.

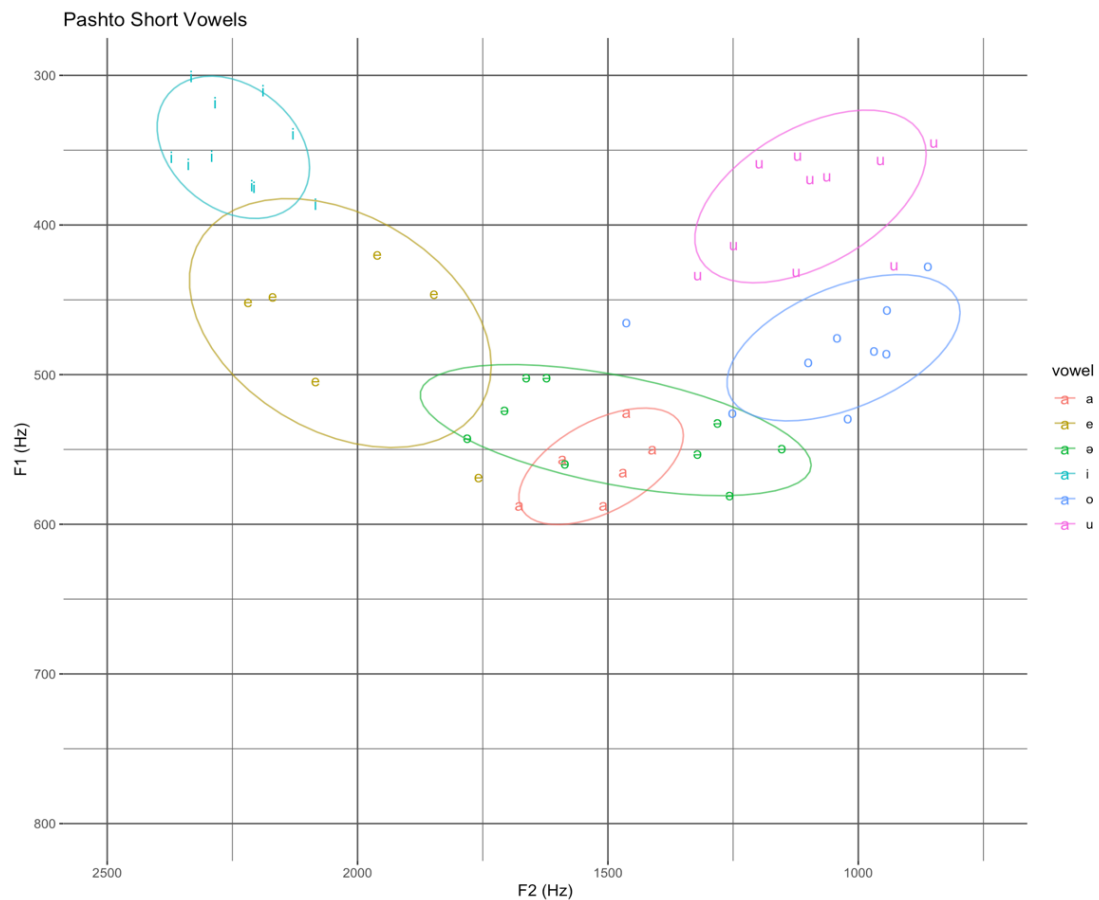


Figure 1: Pashto Short Vowels

3 Long Vowels

Below is the scatter plot of long vowels that have been identified in our data. From all the data available from the Swadesh list and plural noun formation elicitations, only one instance of a long /u:/ was observed (/mu:ŋg/ ‘we’) and similarly, only one long /ə:/ was observed (/kə:/ ‘if’). Furthermore, the position of /u:/ appears to be more central than back, based on its F1 and F2 values, and this example should be looked into further. Ideally, more examples including long /u:/ and long /ə:/ should be elicited for a fairer comparison amongst the long vowels.

Additionally, /a:/ is the only long vowel in Pashto that has been identified as phonemic, and it was relatively easier to obtain data containing the long vowel, as compared to other long vowels. For long vowels, all formant values were obtained as the mean, rather than from the midpoint of the vowels.

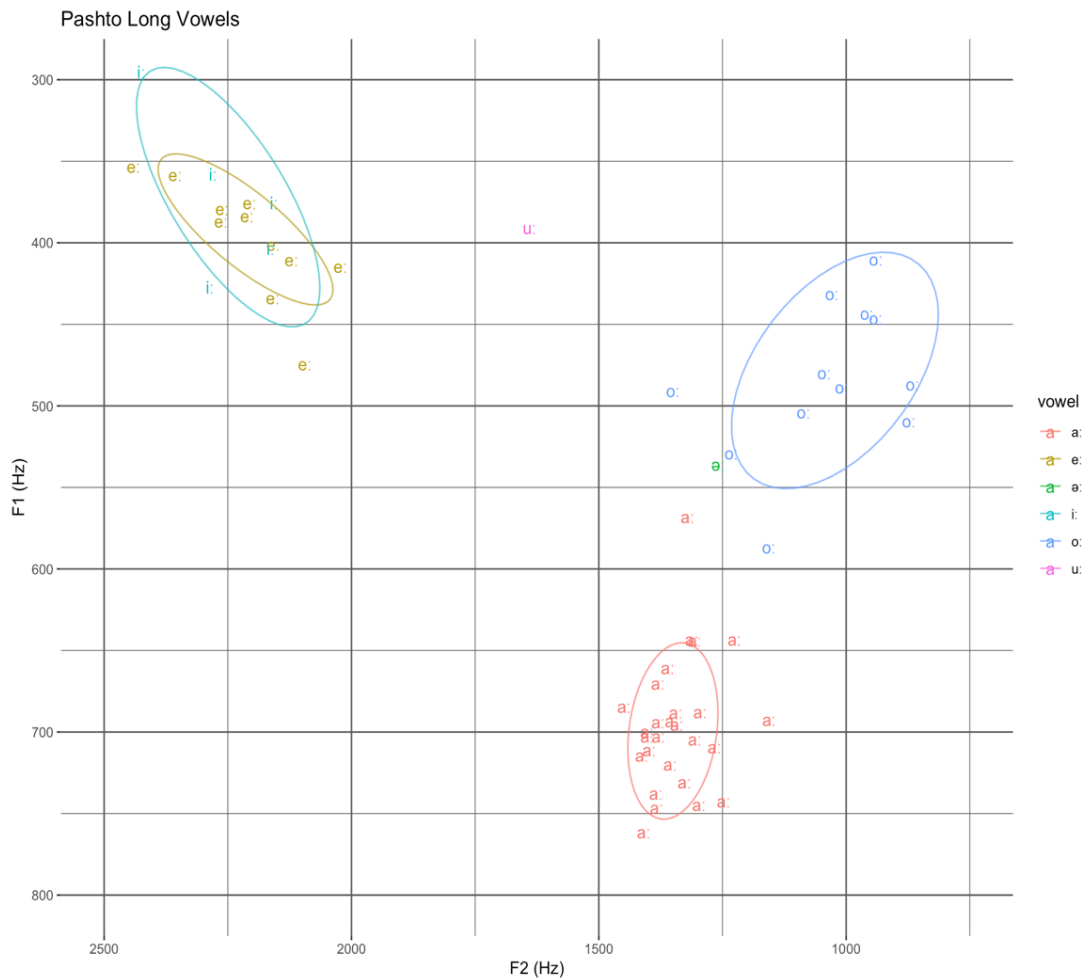


Figure 2: Pashto Long Vowels

3.1 Vowel Quality The following scatter plots will compare the F1 and F2 values of the respective vowels in Pashto. This comparison will begin from the high front vowel, /i:/ and /i/.

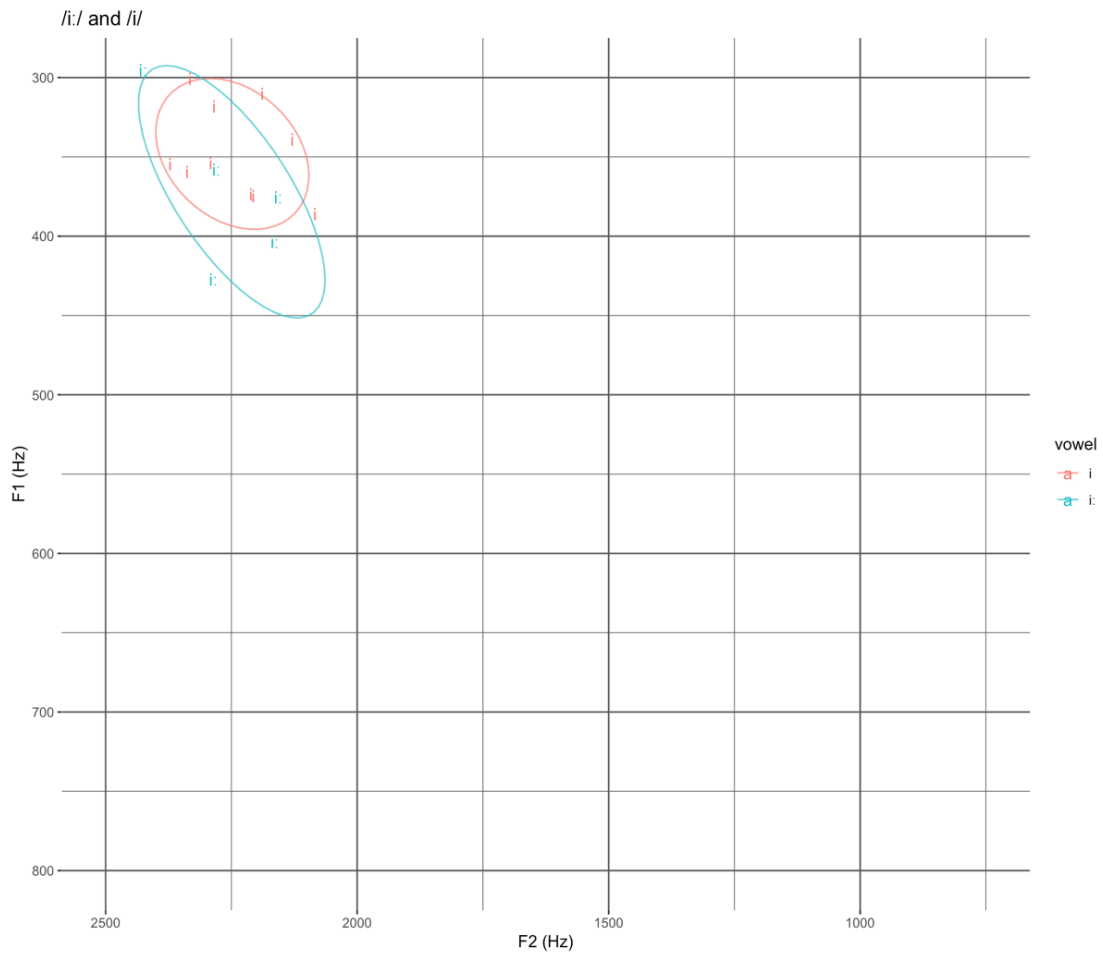


Figure 3: /i:/ and /i/

Based on Figure 3, it appears as if the short /i/ occurs in a more concentrated area, whereas the long /i:/ occurs in a wider range within the mouth. The furthest position reached by the tongue tip is also that of the long /i:/ rather than the short /i/. The range for F1 is wider for /i:/ than /i/, but with regards to F2, both the long and short /i/ appear to have a similar range.

The next scatter plot is of the /e:/ and /e/ vowels.

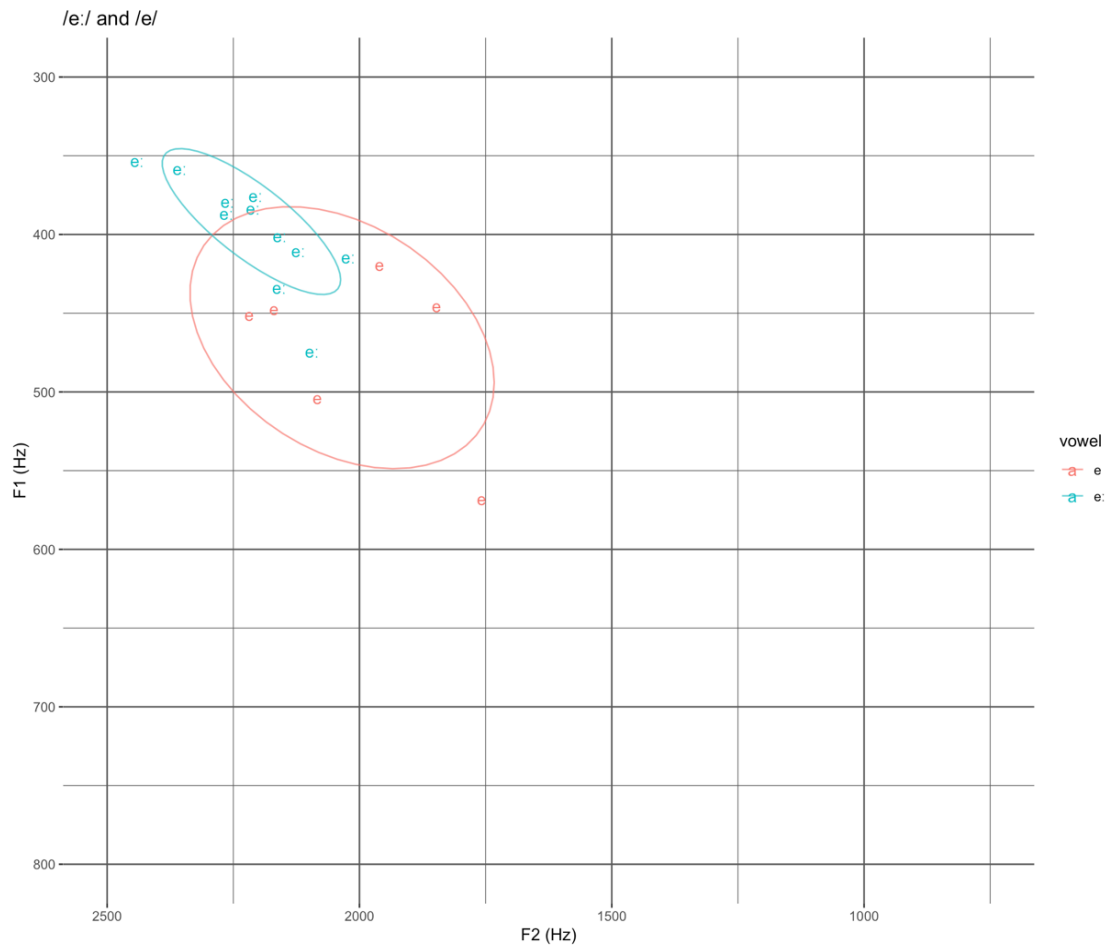


Figure 4: /e:/ and /e/

In Figure 4 above, we see instead a much wider range in terms of the tongue position when it comes to the short /e/, and a more concentrated range in terms of tongue position for the long /e:/. In this plot, it is also much more noticeable that the long /e:/ are further front and higher than the short /e/. As can be seen, the range for F1 for /e:/ is much smaller, and also lower than that of short /e/, and the range for F2 for /e:/ is both smaller and higher than that of /e/. Though there are some areas of intersection between the long and short vowels, there appears to be a relatively clear distinction between the two.

As a long vowel, /e:/ allows for more time for the tongue to get into the position to produce the target sound, and as such, we can see that /e:/ is in a cardinal position rather than /e/. This difference in terms of vowel quality for long and short vowels is suggested in other studies as well (Akaba, 2008).

The next scatter plot is for the long /a:/ and short /a/.

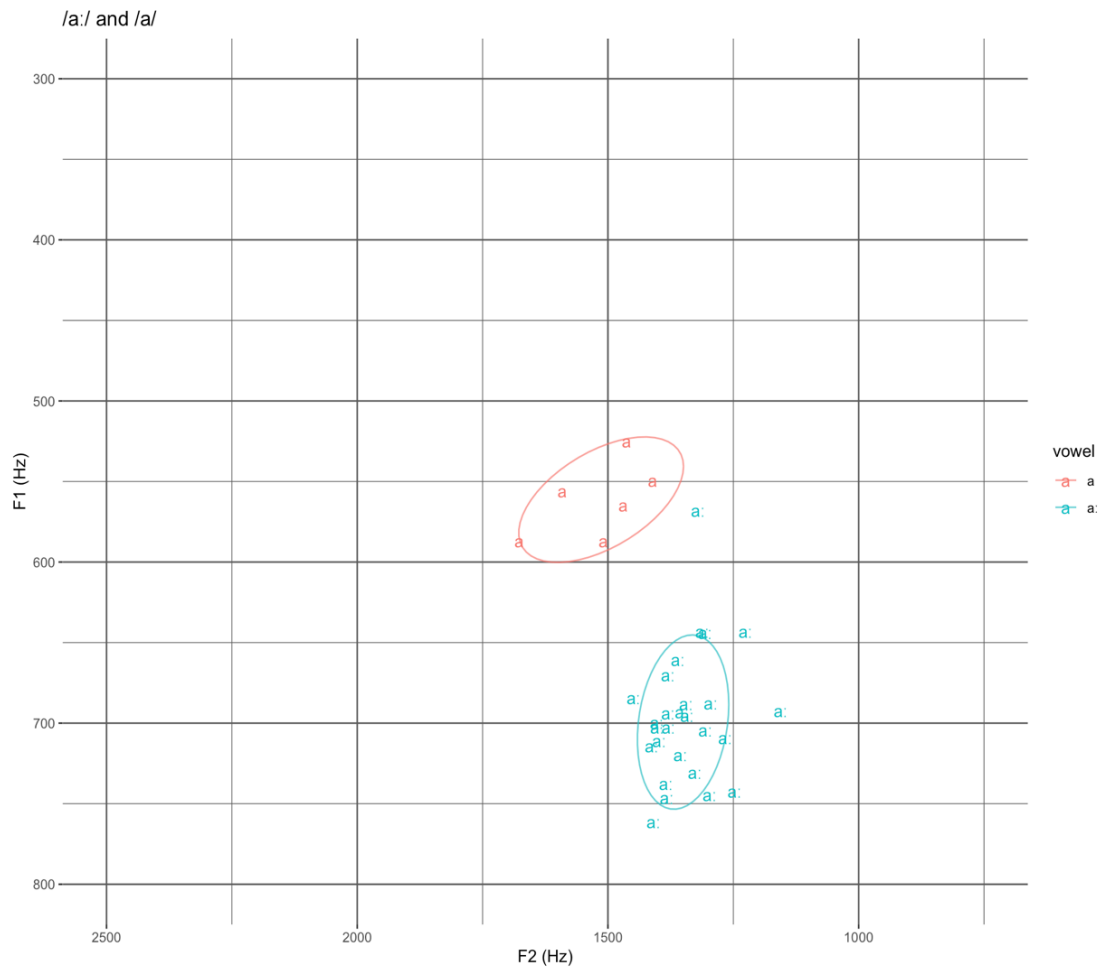


Figure 5: /a:/ and /a/

As mentioned previously, /a:/ is the only long vowel that is considered phonemic in the Pashto vowel system. When looked at in terms of formant values, a clear and separate divide between the tongue position can be seen, with the short /a/ being more central and higher than the long /a:/, which is both lower and further back than the other. Here, there is an outlying example that appears to have been the short /a/ mistakenly perceived as a long /a:/. One possible explanation for this is that stress may have influenced the perception of the length of the vowel, causing the vowel to sound longer than it actually is.

The next scatter plot illustrates the formant values for /o:/ and /o/.

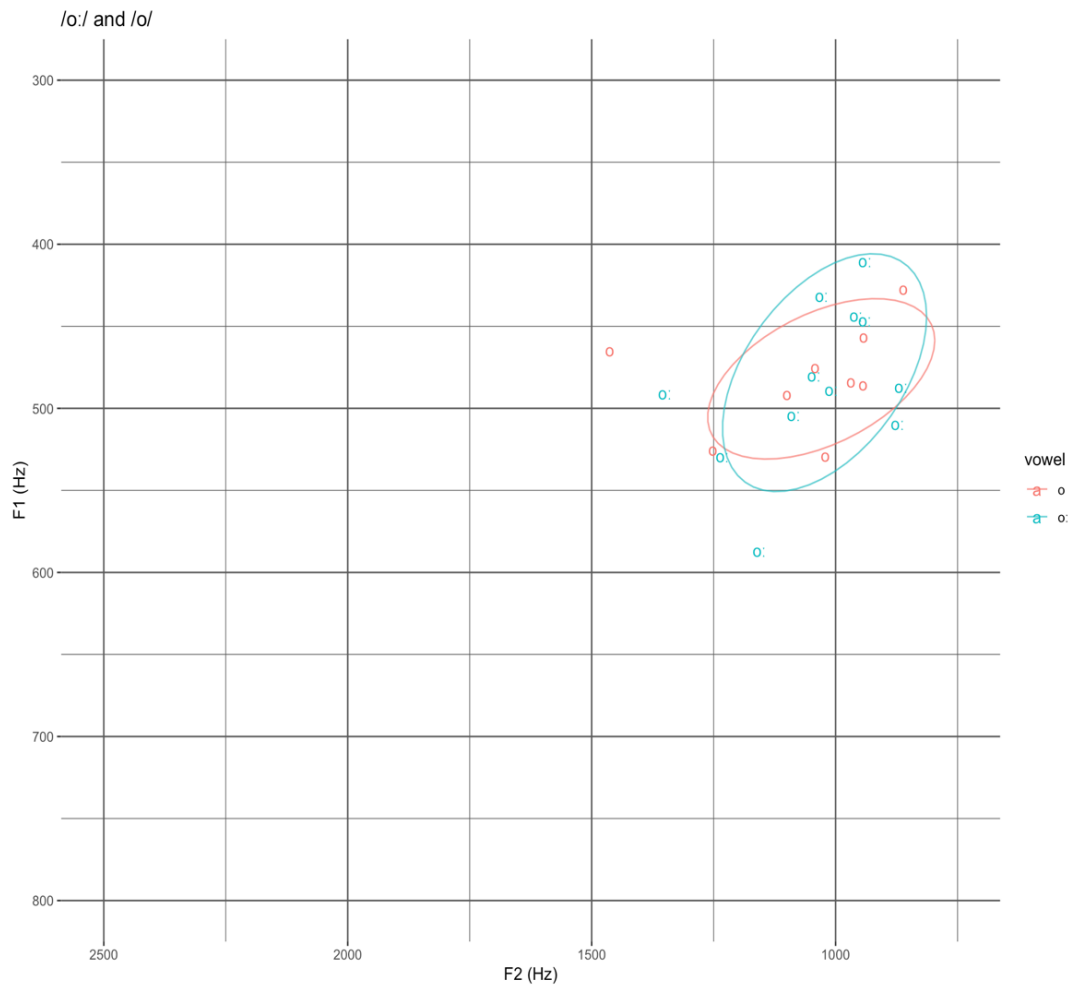


Figure 6: /o:/ and /o/

In this scatter plot, both long and short /o/ appear to have roughly the same formant values, with a general overlap. On a closer look, however, the long /o:/ has a lower F1 and F2 value when compared to the short /o/. This means that the long /o:/ is slightly further back and also higher than the short /o/.

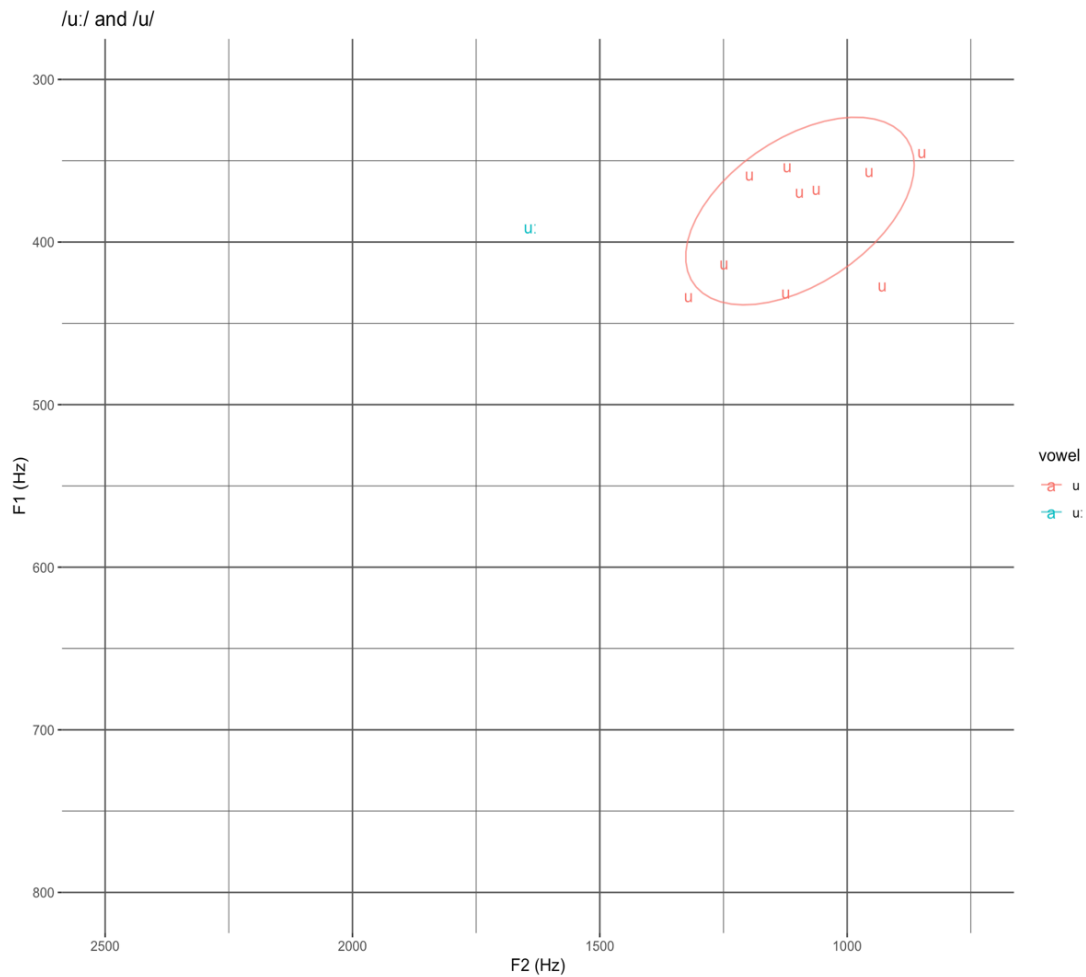


Figure 7: /u:/ and /u/

For Figure 7, only one instance of long /u:/ was identified, and which also appears to be an anomaly. When comparing this scatter plot with previous ones, the position of /u:/ is too far separated from that of short /u/. There has not been any high central vowels identified in Pashto, and this position for long /u:/ may be due to the place assimilation as influenced by the preceding and following nasals /m/ and /ŋ/ which are bilabial and velar respectively. However, it is more likely for there to be regressive assimilation, where the /u:/ is affected by the following velar nasal, and thus is produced further back in preparation for the following speech sound, but that does not appear to be the case here.

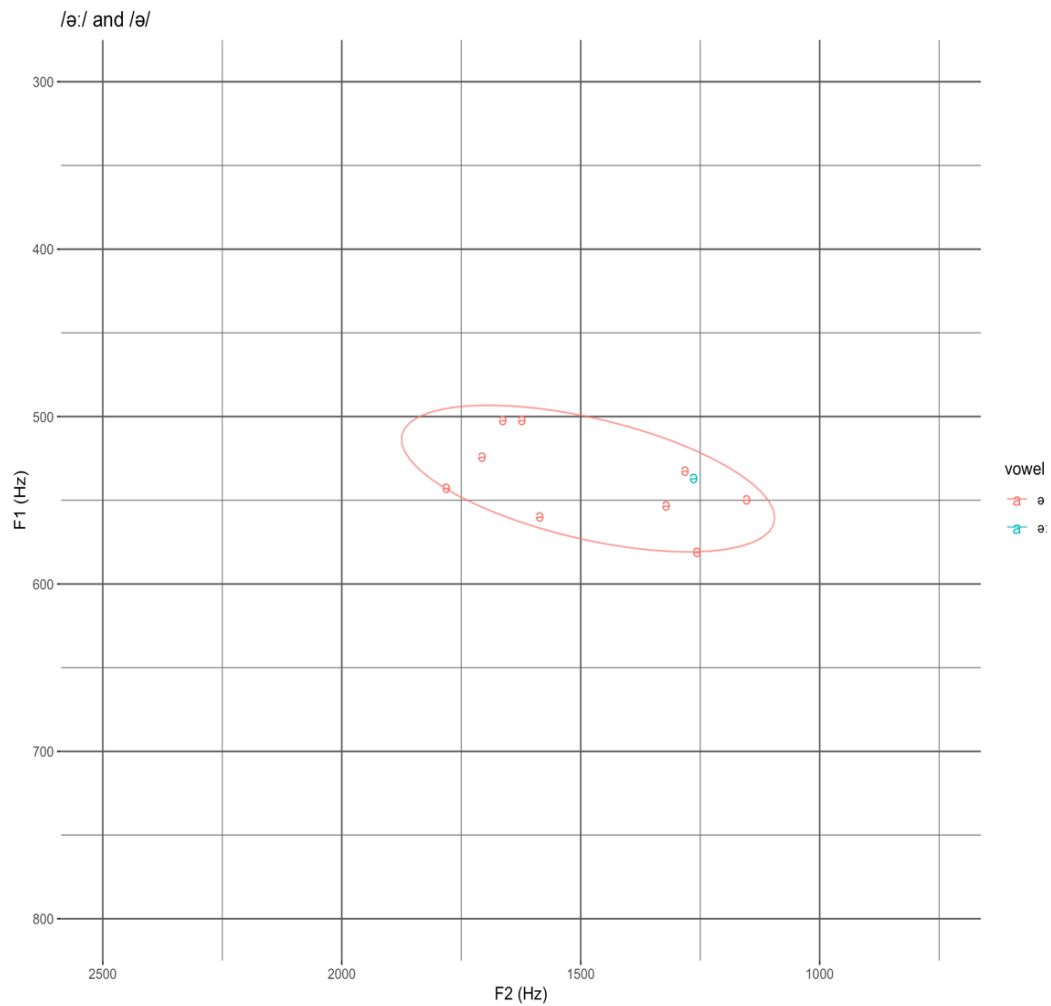


Figure 8: /ə:/ and /ə/

Lastly, only one instance of a long /ə:/ was identified in the data available as well. Unlike the long /u:/, the long /ə:/ appears to be completely overlapping with the short /ə/, though there is too little data available to say for certain that this is so. Moreover, the short /ə/ has a very wide range as a central vowel, and its F2 values range from almost 1150Hz to 1900Hz. The long /ə:/, however, is produced further back than the other /ə/ in general.

3.2 Length In addition to the F1 and F2 values, the duration for each long vowel was also extracted through Praat. The average duration for each long vowel is given in the table below.

Table 1: Average Vowel Length

Vowel	Average Duration (s)	n=?
/a:/	0.2414531	27
/e:/	0.2396207	11
/ə:/	0.27638033	1
/i:/	0.24760899	5
/o:/	0.27870869	12
/u:/	0.30741875	1

As seen in Table 1 above, the average length of long vowels ranges from 0.24 seconds to 0.3 seconds.

3.2.1 Length by Syllable Position /a:/ The average vowel duration for each occurrence was also calculated based on the syllable position, that is, if the vowel is in a monosyllabic word, or in the first or second syllable of a bisyllabic or polysyllabic word.

Table 2: Average Vowel Length by Syllable Position

Vowel	Syllable	Average Duration (s)	n=?
/a:/	Monosyllabic	0.284695425	6
	First syllable	0.244594677	12
	Second syllable	0.208436102	9
/e:/	Monosyllabic	0.373619521	1
	First syllable	0.213279595	4
	Second syllable	0.234848301	6
/i:/	Monosyllabic	0.242647935	2
	First syllable	0.271178274	2
	Second syllable	0.210392544	1
/o:/	Monosyllabic	0.287737326	7
	First syllable	0.252220077	4
	Second syllable	0.321462719	1

The findings based on the syllable position of the respective long vowels did not show any clear pattern or trend, that a certain syllable position would allow for the duration of a long vowel to be shorter or longer when comparing monosyllabic and polysyllabic words.

3.3 Stress The following table describes the data for /a:/ in terms of whether it carries lexical stress or not.

Table 3: Stress Placement for /a:/

ID	Pashto	English Gloss	Stress on /a:/?
NPL002	majá:n	fish (pl)	Yes
NPL003	k ^h abá:n	fish (pl)	Yes
NPL005	marbá:n	birds (male)	Yes
NPL008	má:ra:n	snakes	Yes (1st syllable)
NPL014	wá:zge	fats (n)	Yes
NPL021	sará:n	heads (person)	Yes
SWD025	tá:za	new/fresh	Yes
SWD042	hawá:ɤ	smooth	Yes
SWD070	wá:zga	fat (n)	Yes
SWD140	pá:ɭa	leaf	Yes

SWD151	bá:ra:n	rain	Yes (1st syllable)
SWD152	darjá:b	river	Yes
SWD155	má:lga	salt	Yes
SWD156	ká:le	stone	Yes
SWD171	lá:ra	road	Yes
SWD183	ná:ma	name	Yes
SWD211	tá:wedəl	turn	Yes
SWD232	tá:so	you (formal)	Yes
SWD262	sa:təl	hold	No (Infinitive suffix)
SWD272	guzá:rawəl	throw	Yes

As seen above, the long /a:/ is generally stressed when it occurs in the word, with the exception of SWD262 /sa:təl/ ‘hold’. This has been attributed to the fact that /sa:təl/ ends with an infinitive suffix /-əl/ which is expected to carry stress (David & Brugman, 2014). However, this is not the case for SWD211 /tá:wedəl/ ‘turn’ and SWD272 /guzá:rawəl/ ‘throw’, where the infinitive suffix appears to take on secondary stress instead, and allowing the long /a:/ to carry primary stress. Additionally, where the long /a:/ appears more than once in a single word, stress appears to be attracted to the first syllable rather than to the second syllable. This is seen in NPL008 /má:ra:n/ ‘snakes’, and SWD151 /bá:ra:n/ ‘rain’.

4 Summary

In the short comparison that was conducted on the vowel quality of the short and long vowels, findings revealed that the cardinal properties of long vowels was only significant for /e:/ and /a:/, and it was less apparent for the remaining long vowels /i:/, /ə:/, /o:/, and /u:/. The length of the long vowels did not seem to vary significantly across different vowels, and an assessment based on the syllable in which the vowel is found in also did not turn out to be significant, with the longest and shortest vowel durations varying by position for each vowel. Lastly, stress placement was noted as being attracted to long vowels, as shown in Table 3, with some exceptions, such as when a suffix or another morpheme that inherently carries stress is attached to the root, though this does not appear to be consistent throughout our data.

5 Appendix

1. Formant Data for Figure 1

Vowel	F1 (Hz)	F2 (Hz)	Vowel	F1 (Hz)	F2 (Hz)
a	586.72	1509.48	u	358.1	1197.47
a	586.83	1676.93	u	426.23	928.68
a	555.8	1590.95	u	353.09	1120.89
a	564.64	1469.79	u	344.22	848.73
a	549.26	1411.06	u	355.95	955.53
a	524.7	1462.91	u	368.75	1096.38
ə	541.69	1780.89	o	483.22	968.36
ə	548.49	1152.76	o	474.58	1042.1
ə	501.06	1662.83	o	528.32	1020.9
ə	558.74	1585.78	o	484.98	943.81
ə	579.87	1256.96	o	455.84	942.61
ə	501.18	1622.68	o	524.77	1251.31

ə	531.3	1281.26	o	426.73	861.08
ə	552.3	1321.07	o	490.99	1099.58
ə	523.13	1706.51	e	568.04	1758.18
i	359.35	2337.64	e	503.6	2083.57
i	338.91	2129.04	e	447.01	2169.19
i	373.58	2210.94	e	445.31	1847.00
i	374.53	2206.78	e	450.75	2218.52
i	385.73	2083.76	e	418.93	1960.26
i	310.11	2188.52			
i	318.04	2284.06			
i	300.44	2331.96			
i	353.7	2290.98			
i	354.37	2371.82			
u	366.81	1062.38			
u	432.9	1320.68			
u	413.06	1249.01			
u	430.94	1123.92			

2. Formant Data for Figure 2

Vowel	F1 (Hz)	F2 (Hz)	Vowel	F1 (Hz)	F2 (Hz)
a:	692.3634148	1155.654802	e:	375.3366042	2205.68544
a:	742.0548289	1247.440928	e:	414.5346415	2022.337353
a:	702.4162755	1379.40273	e:	410.366478	2120.898143
a:	704.3112148	1305.631122	e:	353.0918239	2440.584049
a:	746.1792885	1382.31872	e:	379.0427261	2261.539899
a:	714.1834661	1412.715842	e:	358.2252171	2356.058114
a:	643.0363475	1225.746059	e:	433.6844431	2159.057019
a:	567.7218057	1320.520521	e:	383.2212733	2210.936543
a:	693.0010926	1352.656756	e:	474.223388	2094.064828
a:	643.6108743	1306.123014	ə:	535.9174404	1258.941899
a:	744.3103945	1297.228223	i:	295.0655764	2425.333452
a:	695.0317595	1342.13216	i:	403.241537	2163.654337
a:	730.6173159	1326.769779	i:	375.1783096	2156.756382
a:	761.0549356	1408.992879	i:	357.7531476	2279.635167
a:	737.4969466	1384.311631	i:	427.1472343	2285.950585
a:	699.5408355	1402.647361	o:	431.040196	1028.49018
a:	710.8643235	1397.924929	o:	486.432515	865.388748
a:	660.6480049	1360.536055	o:	479.76815	1044.23043

a:	684.0497523	1448.885226	o:	528.692132	1231.99017
a:	687.3726986	1294.909806	o:	490.691418	1349.66921
a:	643.0267319	1311.783129	o:	586.41869	1156.26134
a:	693.6809382	1379.963074	o:	443.325905	957.870139
a:	702.2712535	1401.895876	o:	410.126416	939.564432
a:	719.5112403	1355.307914	o:	509.115819	872.990697
a:	709.1056869	1266.143069	o:	446.020037	939.728384
a:	687.811964	1344.18077	o:	503.68174	1085.97283
a:	670.0470689	1380.076314	o:	488.325244	1008.25987
e:	386.7161919	2263.498172	u:	390.664263	1639.92797
e:	400.8578624	2157.94702			

3. Formant Data for Figure 3

Vowel	F1 (Hz)	F2 (Hz)	Vowel	F1 (Hz)	F2 (Hz)
a:	692.3634148	1155.654802	a:	660.6480049	1360.536055
a:	742.0548289	1247.440928	a:	684.0497523	1448.885226
a:	702.4162755	1379.40273	a:	687.3726986	1294.909806
a:	704.3112148	1305.631122	a:	643.0267319	1311.783129
a:	746.1792885	1382.31872	a:	693.6809382	1379.963074
a:	714.1834661	1412.715842	a:	702.2712535	1401.895876
a:	643.0363475	1225.746059	a:	719.5112403	1355.307914
a:	567.7218057	1320.520521	a:	709.1056869	1266.143069
a:	693.0010926	1352.656756	a:	687.811964	1344.18077
a:	643.6108743	1306.123014	a:	670.0470689	1380.076314
a:	744.3103945	1297.228223	a	586.72	1509.48
a:	695.0317595	1342.13216	a	586.83	1676.93
a:	730.6173159	1326.769779	a	555.8	1590.95
a:	761.0549356	1408.992879	a	564.64	1469.79
a:	737.4969466	1384.311631	a	549.26	1411.06
a:	699.5408355	1402.647361	a	524.7	1462.91
a:	710.8643235	1397.924929			

4. Formant Data for Figure 4

Vowel	F1 (Hz)	F2 (Hz)	Vowel	F1 (Hz)	F2 (Hz)
e:	386.7161919	2263.498172	e:	383.2212733	2210.936543
e:	400.8578624	2157.94702	e:	474.223388	2094.064828
e:	375.3366042	2205.68544	e	568.04	1758.18
e:	414.5346415	2022.337353	e	503.6	2083.57

e:	410.366478	2120.898143	e	447.01	2169.19
e:	353.0918239	2440.584049	e	445.31	1847
e:	379.0427261	2261.539899	e	450.75	2218.52
e:	358.2252171	2356.058114	e	418.93	1960.26
e:	433.6844431	2159.057019			

5. Formant Data for Figure 5

Vowel	F1 (Hz)	F2 (Hz)	Vowel	F1 (Hz)	F2 (Hz)
ə:	535.9174404	1258.941899	ə	579.87	1256.96
ə	541.69	1780.89	ə	501.18	1622.68
ə	548.49	1152.76	ə	531.3	1281.26
ə	501.06	1662.83	ə	552.3	1321.07
ə	558.74	1585.78	ə	523.13	1706.51

6. Formant Data for Figure 6

Vowel	F1 (Hz)	F2 (Hz)	Vowel	F1 (Hz)	F2 (Hz)
i:	295.0655764	2425.333452	i	374.53	2206.78
i:	403.241537	2163.654337	i	385.73	2083.76
i:	375.1783096	2156.756382	i	310.11	2188.52
i:	357.7531476	2279.635167	i	318.04	2284.06
i:	427.1472343	2285.950585	i	300.44	2331.96
i	359.35	2337.64	i	353.7	2290.98
i	338.91	2129.04	i	354.37	2371.82
i	373.58	2210.94			

7. Formant Data for Figure 7

Vowel	F1 (Hz)	F2 (Hz)	Vowel	F1 (Hz)	F2 (Hz)
o:	431.0401962	1028.490175	o:	488.3252441	1008.259874
o:	486.4325151	865.388748	o	483.22	968.36
o:	479.7681501	1044.230429	o	474.58	1042.1
o:	528.6921319	1231.990169	o	528.32	1020.9
o:	490.6914182	1349.66921	o	484.98	943.81
o:	586.4186897	1156.261342	o	464.41	1463.12
o:	443.3259051	957.8701394	o	455.84	942.61
o:	410.1264163	939.5644316	o	524.77	1251.31
o:	509.1158192	872.9906966	o	426.73	861.08
o:	446.0200367	939.7283839	o	490.99	1099.58
o:	503.68174	1085.97283			

8. Formant Data for Figure 8

Vowel	F1 (Hz)	F2 (Hz)	Vowel	F1 (Hz)	F2 (Hz)
u:	390.6642627	1639.927975	u	426.23	928.68
u	366.81	1062.38	u	353.09	1120.89
u	432.9	1320.68	u	344.22	848.73
u	413.06	1249.01	u	355.95	955.53
u	430.94	1123.92	u	368.75	1096.38
u	358.1	1197.47			

6 References

- David, A. B., & Brugman, C. M. (2014). *Descriptive grammar of Pashto and its dialects*. Berlin: De Gruyter Mouton.
- Akaba, S. (2008). *An Acoustic Study of the Japanese Short and Long Vowel Distinction*. University of Kansas. <http://hdl.handle.net/1808/4170>.