

Capturing The Vowel Change In New Zealand English Over A Thirty Year Period Via A Diachronic Study

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Abstract

In the last 50 years New Zealand English has undergone a vowel shift. In this diachronic study we look at the speech of three male speakers, from recording in the 1950s, 1970s, and 1980s, to investigate this vowel shift. Formant analysis was done on vowels from prosodically accented words extracted from continuous speech. The results show there were significant differences in the vowel spaces over the 3 time periods. In this time a number of vowels have risen, including /e/, /ɜ/ and /ɔ/. This provides further support to theory that the front vowel movement in New Zealand is a push-chain.

1. Introduction

New Zealand English has undergone a large vowel shift in the last 100 years. The ONZE project (Gordon, Campbell, Hay, Maclagan, Sudbury, and Trudgill, 2004), has done an extensive analysis on the speech of NZE speakers born between 1865 and 1880 (hence forth called old NZE). They have showed that the vowel space of old NZE is a quadrilateral with uneven sides, the point vowels being /i/, /a/, /ɔ/, and /u/. In old NZE /i/ is higher and fronter than /e/ which is higher and fronter than /æ/, /a/ is backer and more open than /ʌ/, and /u/ is a similar backness to /a/.

The vowel space of old NZE is quite different to modern NZE. Figure 1 shows the monophthong space of male speakers of modern NZE, from speech recorded in 1995. Modern NZE, as can be seen from Figure 1, has a fronted /a/, /ʌ/ and /u/, a raised /æ/ and /e/, a retracted /ɪ/ and a fronted and raised /ɜ/, /a/ and /ʌ/ form a tense/lax pair. In addition /ɪ/ is lower than both /e/ and /ɜ/. The point vowels are /i/, /a/ and /ɔ/ and the vowel space is essentially a triangle (For more details about this see Watson *et al* 1998).

In Watson *et al* (2000) we analysed the front vowels of NZE speakers born in the 1890s from speech recorded in 1948. There we showed that in the time between then

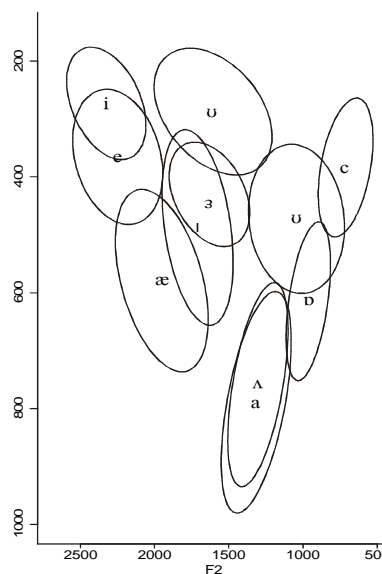


Figure 1: The monophthongs of male speakers of modern NZE, from speech recorded in 1995.

and 1995 /æ/ and /e/ have raised and fronted, and /ɪ/ has retracted.

This lead us to ask three questions: 1. when did /ɪ/ become lower than /e/? 2. Is the NZE vowel movement (involving /ɪ/, /e/, and /æ/) a push train? Or a pull chain lead by the retracting /ɪ/? and 3. Are there other vowels shifting in the NZE vowel space?

The hypothesis for this study is that if we looked at speech recorded at various times between 1948 and 1995 we would be able to capture any vowel shifts in NZE that occurred in the last 50 years. Further by looking at the speech of a single speaker recorded multiple times between 1948 and 1995 we will be able to examine the vowel shift, using the same paradigm as Harrington, Palethorpe and Watson (2000) in their analysis of the Queen's speech.

2. Method

2.1. Database

Table 1: Recording Details

Speaker	Year (19XX)	Speech Act
A	54	Broadcast
	72	Radio Interview
	92	Radio Interview
B	54	Speech in Parliament
	70	Radio Interview
	82	Radio Interview
C	55	Quiz show Host
	69	Quiz Show Host
	85	Radio Interview

We analysed the speech of 3 Pakeha Male speakers of NZE (all native born, and born between 1901 and 1916) recorded over a period of 30 years. The professions for the three speakers were Explorer, Parliamentarian, and Entertainer respectively. For each of the three speakers we had three sets of speech data, speech from the mid 1950s, speech from the late 1960s or early 1970s, and speech from the mid/late 1980s (henceforth the three sets are called the 50s, 70s, and 80s respectively). Table 1 gives the details about the nature of the recording, and when it was recorded. All the data was obtained from the Radio New Zealand Sound Archives.

2.2. Analysis

The radio recordings were digitized to a 16 bit number, at a sampling rate of 20 kHz. The speech was continuous, however only the vowels from prosodically accented words were selected for analysis; in addition if the vowels were preceded by an approximate they were not included. Around 3600 vowels tokens were analysed. The formant tracks were automatically tracked in ESPS/WAVES+ (12th order LPC analysis, cosine window, 49 ms frame size, 5 ms frame shift). All formant data was checked and corrections were made by hand if necessary. The first formant (F1) and second formant (F2) values at the vowel target were obtained. The vowel targets were identified by hand. For the vowels from each speaker one way ANOVAs with year as the main factor were performed, and where there was

significance post hoc comparison on the vowels were done using Bonferroni. All significant levels have $p < 0.01$. The labelling was done using EMU, the formant data analysis was done using EMU/R, and the statistical analysis was done in SSPS.

3. Results

3.1. The 1950s data

Figure 1 shows the vowels in F1/F2 space for the 1950s data for all three speakers, it can be seen they are all alike. There is some similarity to modern NZE in the 1950s vowel spaces: the entire vowel space is more triangular like than quadrilateral, (in particular speakers A and B), in addition on an individual vowel level /u/ is quite fronted, and /ʌ/ and /a/ are both open central vowels forming a tense/lax pair. However unlike modern NZE the /ɪ/ vowel is higher than both than /e/ and /ɜ/, for two speakers /ɪ/ is as front, or fronter than /e/, and finally /ɔ/ is considerably lower than /i/. In addition /e/ and /æ/ are not as raised as in modern NZE.

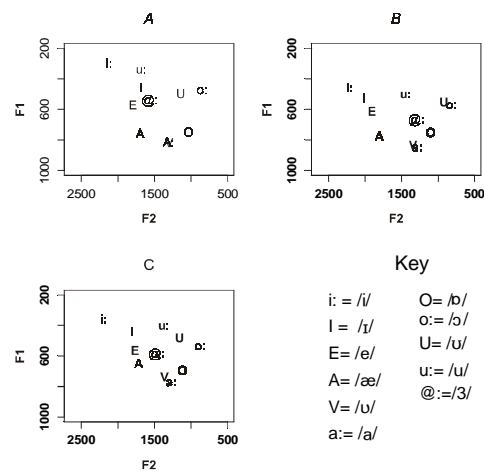


Figure 2. The vowel spaces of the three speakers A, B, and C respectively from recordings made in the 50s. The vowel centroids are indicated with MRPA labels.

3.2. Vowel spaces for the three speakers across a thirty year period.

Figure 3 shows the F1/F2 spaces for the three speakers from their speech from the 50s, 70s, and 80s. Each year set is plotted on a separate graph. The formants have been converted to the erb scale (Moore and Glasberg, 1983), a semi-logarithmic scale used in order to describe the vowel space in terms of perceptual contrasts.

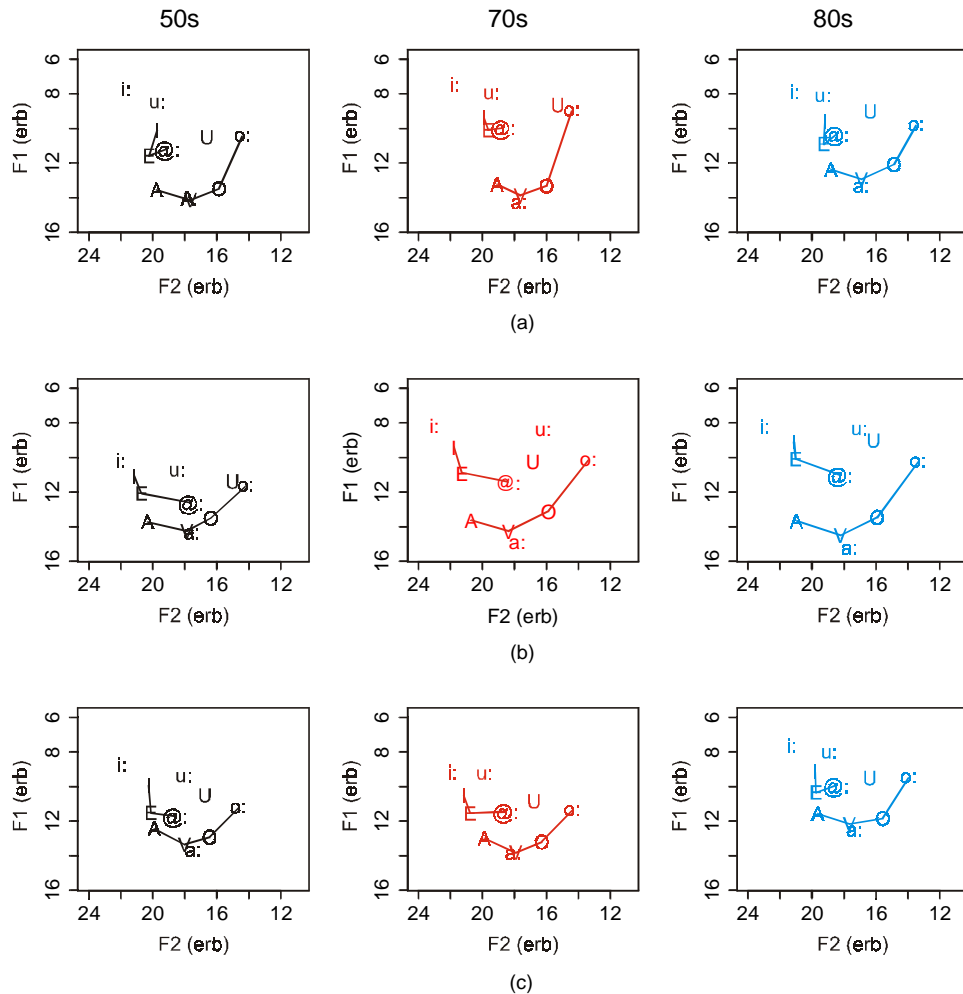


Figure 3: The vowels in F1 and F2 spaces from the 50s (left column), 70s (middle column), and 80s (right column), for (a) Speaker A (top row), (b) Speaker B (middle row), and (c) Speaker C (bottom row). The centroids of the vowels are indicated with MRPA labels, where $i:$ = /i/, $I=$ /ɪ/, $E=$ /e/, $A=$ /æ/, $a:=$ /a/, $V=$ /ʌ/, $O=$ /ɒ/, $o:=$ /ɔ/, $U=$ /u/ and $@:=$ /ɜ/.

Connecting lines have been drawn between the vowels /ɪ/, /e/ and /ɜ/, and between /æ/, /a/, /ʌ/, /ɒ/ and /ɔ/ as a visual aid to enable comparison between the vowel spaces, both across the time periods, and across the speakers.

There are significant differences between the vowel spaces from the 50s, 70s, and 80s for each speaker. Tables 2-4 give the results of ANOVAs, with year as the main factor for each vowel, for speakers A, B, and C respectively. The significance of the post hoc comparisons, are indicated with ***, significant differences between the 50s and 70s are given in column 9, between the 50s and 80s are given in column 10, and between 70s and 80s are given in column 11.

The significant changes found in the vowel spaces of the three speakers are as follows:

For speaker A, for the /i/ vowel F1 was lower in the 70s than the 50s and in the 80s, F2 was higher in the 50s than the 80s. For /ɪ/ F1 was higher in the 50s than the 70s. For /e/ F1 was lower in the 70s than the 50s, but was higher in the 80s than the 70s, F2 was lower for the 70s than the 50s, and in turn the 80s was lower than the 70s. For /æ/ F1 is lower for the 80s than the 50s and 70s and F2 is lower in the 70s and 80s than the 50s. For /ʌ/, /a/ and /ɒ/ F1 and F2 were lower in the 80s than in the 50s and 70s. For /ɔ/ F1 is lower in the 70s than the 50s, but the 80s was higher than the 70s, F2 was lower in the 80s than the 50s and 70s. The mean formant values for /u/ are listed in tables 2-4,

Table 2: The Mean F1 and F2 erb values for the 50s, 60s, and 70s for Speaker A (columns 3-5), the results of ANOVAs with year as the main factor (columns 6-8), and where there was significance the results of post hoc comparisons on the vowels using Bonferroni (columns 9-11). For the post-hoc tests significance is indicated with ***. All significant levels have $p < 0.01$

Formant	Vowels	50s	70s	80s	df	F	P	50s/70s	50s/80s	70s/80s
F1	i	7.73	7.45	7.88	2,214	9.351	0.00	***	NS	***
	ɪ	10.13	9.38	9.58	2,100	7.24	0.00	***	NS	NS
	e	11.58	10.10	10.91	2,184	39.47	0.00	***	***	***
	æ	13.55	13.23	12.36	2,182	28.41	0.00	NS	***	***
	ʌ	14.14	13.89	12.94	2,146	44.70	0.00	NS	***	***
	a	14.15	14.33	13.38	2,111	47.78	0.00	NS	***	***
	ɒ	13.44	13.32	12.08	2,163	26.15	0.00	NS	***	***
	ɔ	10.45	8.98	9.82	2,111	93	0.00	***	***	***
	ʊ	10.52	8.66	9.03	2,14	3.53	0.06	-	-	-
	u	8.55	8.02	8.18	2,66	18.67	0.00	***	NS	NS
ɜ	11.19	9.97	10.34	2,52	6.82	0.00	***	NS	NS	
F2	i	21.67	21.74	21.10	2,214	25.58	0.00	NS	***	***
	ɪ	19.73	19.91	19.19	2,100	4.70	0.011	NS	NS	NS
	e	20.25	19.64	19.26	2,184	33.20	0.00	***	***	***
	æ	19.78	19.09	18.82	2,182	68.00	0.00	***	***	NS
	ʌ	17.66	17.63	16.91	2,146	38.75	0.00	NS	***	***
	a	17.73	17.71	16.92	2,111	85.46	0.00	NS	***	***
	ɒ	15.87	16.00	14.87	2,163	18.55	0.00	NS	***	***
	ɔ	14.40	14.40	13.47	2,111	29.11	0.00	NS	***	***
	ʊ	16.61	15.29	16.36	2,14	1.83	0.20	-	-	-
	u	19.72	19.43	19.33	2,66	4.04	0.02	-	-	-
ɜ	19.13	18.72	18.75	2,52	9.79	0.00	NS	***	NS	

but for all speakers there were too few tokens in the database to do any sensible analysis on, so no further comment will be made about this vowel. For /u/ F1 is lower in the 70s than the 50s, for /ɜ/ F1 is lower in the 70s than the 50s, and F2 is lower in the 80s than the 50s.

For speaker B /i/ F1 is higher in the 50s than the 70s and 80s, F2 is lower in the 50s than the 70s. For /ɪ/ F1 is higher in the 50s than the 70s and 80s, F2 is higher in the 70s than the 80s. For /e/ F1 is lower in the 70s than the 50s, and lower in the 80s than the 70s, F2 is higher in the 70s than the 50s. For /æ/ and /ʌ/ there are no differences in F1. For /æ/ F2 is lower in the 50s than the 70s and 80s, and for /ʌ/ F2 is lower in the 50s than the 70s. For /a/ and /ɒ/ there no differences for either F1 or F2. For /ɔ/ F1 and F2 are higher in the 50s than the 70s and 80s. For /u/ F1 is higher in the 50s than the

70s or 80s. For /ɜ/ F1 is higher, and F2 is lower in the 50s than the 70s and 80s.

For speaker C /i/ F1 and F2 are lower in the 80s than then 50s or 70s. For /ɪ/ F1 is lower in the 80s than the 50s and 70s, and F2 is lower in the 80s to the 70s. For /e/ F1 is in the 80s than the 50s and 70s, F2 is higher in the 70s than the 50s, but the 80s is lower than both the 50s and the 70s. For /æ/ F1 is higher in the 70s than the 50s and 80s, and the 80s is lower than the 50s and 70s. For /ʌ/ and /a/ F1 is lower in the 80s than the 50s and 70s, and for /ʌ/ there are no differences for F2, but for /a/ F2 is lower in the 80s than the 70s. For /ɒ/ F1 and F2 are lower in the 80s than the 50s and 70s. For /ɔ/, /u/, and /ɜ/ F1 is lower in the 80s than the 50s and 70s, for /u/ F2 is lower in the 50s than the 70s and 80s. There are no significant F2 changes over the years for /ɔ/ and /ɜ/.

Table 3: The Mean F1 and F2 erb values for the 50s, 60s, and 70s for Speaker B (columns 3-5), the results of ANOVAs with year as the main factor (columns 6-8), and where there was significance the results of post hoc comparisons on the vowels using Bonferroni (columns 9-11). For the post-hoc tests significance is indicated with ***. All significant levels have $p < 0.01$.

Formant	Vowels	50s	70s	80s	df	F	P	50s/70s	50s/80s	70s/80s
F1	i	10.15	8.13	8.20	2,123	69.53	0.00	***	***	NS
	ɪ	11.06	9.39	9.11	2,179	44.31	0.00	***	***	NS
	e	12.08	10.89	10.10	2,187	36.42	0.00	***	***	***
	æ	13.72	13.65	13.66	2,176	.12	.89	-	-	-
	ʌ	14.26	14.26	14.51	2,185	2.60	0.08	-	-	-
	a	14.40	14.93	15.3	2,71	4.25	0.02	-	-	-
	ɒ	13.51	13.11	13.45	2,116	3.307	0.04	-	-	-
	ɔ	11.65	10.17	10.24	2,100	36.46	0.00	***	***	NS
	ʊ	11.41	10.21	9.03	2,14	14.25	0.00	-	-	-
	u	10.80	8.46	8.42	2,67	34.29	0.00	***	***	NS
ɜ	12.62	11.42	11.03	2,50	20.46	0.00	***	***	NS	
F2	i	21.99	23.00	22.95	2,123	27.21	0.00	***	NS	NS
	ɪ	21.17	21.78	21.13	2,179	8.00	0.00	NS	NS	***
	e	20.71	21.28	21.02	2,187	6.00	0.00	***	NS	NS
	æ	20.33	20.71	20.98	2,176	10.69	0.00	***	***	NS
	ʌ	17.88	18.38	18.23	2,185	5.70	0.00	***	NS	NS
	a	17.56	17.82	17.66	2,71	1.56	0.22	-	-	-
	ɒ	16.38	15.87	15.93	2,116	4.41	0.014	-	-	-
	ɔ	14.18	13.37	13.36	2,100	6.85	0.00	***	***	NS
	ʊ	15.01	16.83	16.15	2,14	2.53	0.12	-	-	-
	u	18.48	16.19	17.05	2,67	4.95	0.01	NS	NS	NS
ɜ	17.63	18.40	18.26	2,50	6.61	0.00	***	***	NS	

4. Discussion

There is evidence from this study that the vowel spaces of three speakers have moved towards modern NZE in the later recordings, although the results are not as dramatic as that found for the Queen's speech over a similar time period (cf Harrington, *et al* (2000)). For all speakers in this /i/, /ɪ/, /e/, /æ/, and /ɜ/ have risen and/or fronted, /ɔ/ has risen and backed, and /u/ has risen. The extent of movement towards modern NZE differs between speakers to, with Speaker B making the most movement, and C possibly making the least.

It is possible, however that some of the effects noted above may be due to aging. For the 80s recording set the speakers were aged between 69-81 at the time of recording. There is evidence that from the age of at least 70 years onwards there is some anatomical changes in the vowel tract due to ageing (for instance see Linville and Rens, 2001), these anatomical changes will effect the resonant characteristics of the vocal tract. Several studies (eg. Rastasser, McGuire, Kalinowski, and Stuart, 1997) have suggested some vowel centralization for male speakers. Linville and

Rens (2001) found in a study of long-term average spectrum of the entire rainbow passage that the F1 peak for elderly male speakers is significantly lower than for the younger male speakers, though they found no significant difference for the F2 and third formant peak. For speaker C in particular there is a noticeable degree of F1 raising for the vowels in the 80s cf. the 70s and 50s, this is also evident in Speaker A to a lesser degree.

Any significant movement between the vowels in the 50s and 70s can reasonably not be attributed to aging. Within this restricted set /i/, /ɪ/, /e/, /ɜ/, /ɔ/ and /u/, have risen for A and B, in addition for B /i/, /e/, /ɜ/, and /æ/ have also fronted. For speaker C /e/ and /u/ have fronted. These are all movements in the direction of modern NZE. There is no indication for any speaker in this study that /ɪ/ has retracted or fallen between the 50s and 80s. For all speakers, regardless of year, /ɪ/ remains more raised than both /e/ and /ɜ/: this is unlike modern NZE. Thus the results from this study support the theory that the front vowel movement is part of a push chain, as the /e/ is raised without noticeable

Table 4: The Mean F1 and F2 erb values for the 50s, 60s, and 70s for Speaker C (columns 3-5), the results of ANOVAs with year as the main factor (columns 6-8), and where there was significance the results of post hoc comparisons on the vowels using Bonferroni (columns 9-11). For the post-hoc tests significance is indicated with ***. All significant levels have $p < 0.01$.

Formant	Vowels	50s	70s	80s	df	F	P	50s/70s	50s/80s	70s/80s
F1	i	8.71	9.16	7.60	2,107	68.00	0.00	NS	***	***
	ɪ	9.93	10.51	9.17	2,52	14.36	0.00	NS	***	***
	e	11.53	11.55	10.35	2,115	52.78	0.00	NS	***	***
	æ	12.44	12.99	11.55	2,133	77.57	0.00	***	***	***
	ʌ	13.36	13.82	12.16	2,87	56.20	0.00	NS	***	***
	a	13.74	13.91	12.57	2,53	24.18	0.00	NS	***	***
	ɒ	12.92	13.19	11.84	2,109	37.45	0.00	NS	***	***
	ɔ	11.23	11.39	9.50	2,86	98.34	0.00	NS	-	-
	ʊ	10.51	10.87	9.53	2,6	3.59	0.09	-	***	***
	u	9.46	9.32	8.09	2,32	20.85	0.00	NS	***	***
ɜ	11.71	11.46	9.96	2,41	55.80	0.00	NS	***	***	
F2	i	21.94	21.86	21.29	2,107	17.11	0.00	NS	***	***
	ɪ	20.27	21.16	19.81	2,52	6.58	0.00	NS	NS	***
	e	20.12	20.77	19.74	2,115	48.98	0.00	***	***	***
	æ	19.91	19.88	19.64	2,133	5.58	0.00	NS	NS	NS
	ʌ	18.02	17.92	17.67	2,87	1.79	0.17	-	-	-
	a	17.48	18.08	17.36	2,53	13.64	0.00	NS	NS	***
	ɒ	16.46	16.29	15.58	2,109	10.88	0.00	NS	***	***
	ɔ	14.66	14.39	13.96	2,86	3.94	0.02	-	-	-
	ʊ	16.74	16.77	16.39	2,6	0.81	0.92	-	-	-
	u	18.08	19.88	18.93	2,32	17.31	0.00	***	***	NS
ɜ	18.62	18.55	18.51	2,41	0.46	0.63	-	-	-	

retraction of /ɪ/. The results also suggest that /ɜ/ has risen (and fronted). In modern NZE both /e/ and /ɜ/ are more raised than /ɪ/ which has been attributed to its retracting and falling. However the rising of /e/ and /ɜ/ may have given an impression that the movement of /ɪ/ is greater than it actually has been. Further work is required to look at this.

5. Conclusions

The study is further confirmation that the speech of an individual can change over time in accordance with the general population. It also shows that degree of the changes vary between individuals. However it is likely the changes in the vowels observed in a diachronic study are much more conservative than those found in a synchronic study. Further, there are issues about the aging of the speakers that needs to be considered for a diachronic study. Nonetheless the results of this diachronic study suggest that between the 50s and 80s the vowels /i/, /ɪ/, /e/, /ɜ/, /ɔ/ and /u/, have risen and/or fronted in the direction of modern NZE.

6. References

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