The Border Effect: Vowel Differences across the NSW - Victorian Border*

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1. Introduction

For many years linguists have operated under the assumption that Australian English (AusE) is regionally uniform in its pronunciation with variations occurring mainly in the lexicon (Bryant, 1989). Any accent variability was thought to be along a well-described socio-stylistic continuum from Broad to Cultivated, reflecting affiliation with either a local or a British standard. This variability was not considered regionally significant apart from the suspicion that there were rural/urban correspondences such as those suggested by Mitchell and Delbridge (1965). The "broadness continuum" was primarily associated with an individual's pronunciation of six main vowel types, /eɪ, i, aɪ, oʊ, aʊ, u/, although the architects of this classificatory system acknowledge that other aspects of production such as degree of assimilation, elision and nasality were also important parameters in categorisation.

Recent studies (Cox, 1999; Cox and Palethorpe, 2001) have shown that the AusE vowel system has undergone significant changes since it was first empirically described and there has been some informal debate about the value of continuing to categorise speakers according to the traditional classificatory scheme based on broadness. The reason for this debate is the acknowledged movement away from the extremities of the broadness continuum (Horvath, 1985). This might imply that homogenisation has taken place. However, quite the opposite appears to have occurred. Certainly, in terms of the broadness marker vowels, there may have been a movement towards the centre, that is, reduction in the degree of broadness variation, particularly for /i, u, oʊ, eɪ/. Cox (1996) shows that /aɪ/ and /aʊ/ still exhibit variation in the broadness dimension amongst teenage speakers but suggests that other vowel phonemes (for instance, /æ/) may have assumed at least some of the responsibility for socio-stylistic differentiation. Cox and Palethorpe (1998, 2001) found that one of the fundamental factors influencing vowel variation amongst AusE speakers is regional affiliation and can be largely considered a consequence of peer network or "community of practice" (Eckert, 2000).

A few authors have made suggestions about regional differentiation in AusE pronunciation (Bradley, 1989; Horvath and Horvath, 2001a & b; Oasa, 1989) but, despite this, regional variation remains an underdeveloped area of research endeavour in Australia. It is acknowledged that, by global standards, Australian English displays remarkable uniformity. Blair (1993) suggests that, for Australians, national identity has a stronger influence on pronunciation than provincial affiliation. He believes that Australians have a

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desire to sound Australian first and foremost rather than Victorian or Western Australian for instance. However, a claim of uniformity underplays the very real and socially vital nature of linguistic differentiation that occurs in all speech communities. Eckert (2000) discusses variation with regard to the delicate balance between the influence of local peer related effects and more global societal factors.

At the segmental level, dialectal variations that occur in pronunciation are often the product of vowel realisation, although phonological and phonetic consonantal differences such as rhoticity, vocalisation of /l/, and incidence of flapping, are also prominent in variation studies of English. The present paper focuses on vowel realisation in the two standard consonantal contexts /hVd/ and /hVl/. /hVd/ is the context most often examined in formal vowel production studies as it has predictable coarticulatory effects. The /hVl/ environment has also been selected for the present study as there is a popular perception that speakers from Victoria produce vowel variants preceding /l/ that are differentially distributed relative to speakers from other centres (Bradley, 2001). The effect of /l/ on preceding vowels is typically described as one of retraction and lowering particularly for front vowels with little impact on back vowels (Bernard, 1985). This effect was documented for Australian English as early as 1959 by Cochrane and was also observed in the Mitchell and Delbridge survey (1965). Acoustic studies of pre-lateral vowels for AusE are restricted to Bernard (1985) who showed retraction and lowering of front vowels and Oasa (1989) whose examination of /u/ indicated some regional effects. Their findings are consistent with observations from other dialects of English (Bladon and Al-Bamerni, 1976) although very few researchers have examined the full complement of vowels in this phonetic environment. Aside from Oasa's study of /u/, regional variation in AusE pre-lateral vowels has not previously been acoustically documented.

The /hVl/ environment provides a structure which is fruitful for examination due to the interesting nature of the coda /l/. The lateral alveolar approximant can be described as a bi-gestural articulation involving both tongue tip and tongue body gestures. In English, coda /l/ is usually realised as an allophone having a primarily dorso-palatal lingual configuration (dark /l/). This contrasts with prevocalic /l/ (clear /l/); a primarily apico-alveolar articulation (Gick, 1999; Sproat and Fujimura, 1993). These two realisations, clear /l/ and dark /l/, can be described in terms of gesture theory (Browman and Goldstein, 1990) as having primarily consonantal and vocalic gestures respectively (Gick, 1999; Sproat and Fujimura, 1993). Dark /l/ productions also vary along a continuum from a phonemically consonantal coda to a syllabic vocalised variant (Borowsky, 2001; Hardcastle and Barry, 1989). Labov (1994) views the dark /l/ context as one of the major environments for exits and entrances between different vocalic subsystems during chain shifts and one that causes a large proportion of perceptual confusions across subsystems in natural speech. This is due to the very significant coarticulatory effect that dark /l/ has on preceding vowels (Bladon and Al-Bamerni, 1976). Recasens (2002) describes dark /l/ as embodying a very high degree of articulatory constraint (DAC) such that it exerts significant influence over less constrained preceding vowels and has interesting antagonistic syllabic consequences when the preceding vowel is equally constrained, as in the case of /i/.

2. Aim

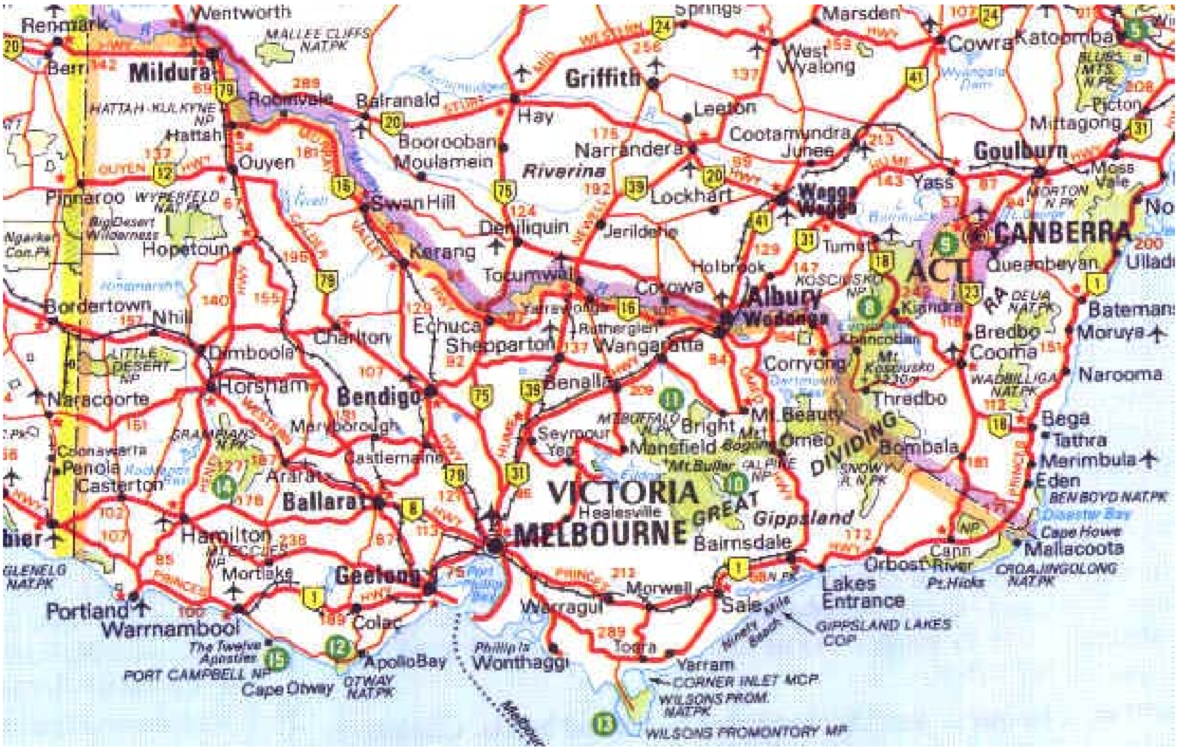
The present paper investigates the acoustic structure of vowels produced by teenage girls from regional NSW and Victoria in two different consonantal contexts; /hVd/ and /hVl/.

There are two broad aims. The first is to examine the effect of dark /l/ on preceding vowels. The second is to determine the extent to which phonetic environment impacts on regional differences with the aim of examining acoustic variability according to area.

3. Method

3.1 Populations

13 fifteen year-old girls from a Catholic girl's school in Wangaratta Victoria and 20 fifteen year-old girls from co-educational state schools in three regional centres in NSW; Temora (n=7), Junee (n=7), Wagga (n=6) served as speakers (see Map 1). Cox (1996) found no differences between Catholic and Government schools for F1 and F2 for vowels in the /hVd/ context spoken by teenagers from Sydney. Subjects selected for the present analysis were born in Australia and had lived in their current local area for over 10 years. They were unaware of the exact nature of the data collection although they knew that the research involved an examination of their voices. All were informally screened for articulation and reported normal hearing. All could be described as having a General AusE accent.



Map 1. Regional centres from which subjects were drawn for this project.

3.2 Data Analysis

3.2.1 Speech Data

Both groups of speakers read the 18 AusE vowels in the fully stressed /hVd/ and /hVl/ contexts in citation form from flash cards. Three lists of words were presented in different randomised order. The authors acknowledge that the controlled phonetic environment used in the test material may not be representative of natural connected speech patterns. However such responses were elicited in order to obtain material that is directly comparable with other such data available to us in our archives. Speakers were recorded in quiet locations within their schools using DAT technology. A female interviewer collected the Victorian data and the NSW data was collected by a male interviewer. Both interviewers could be described as speakers of General Australian English. Willemyns, Gallois, Callan and Pittam (1997) found, in a study of Communication Accommodation Theory (CAT), that "job applicants were rated as broader-accented in response to male interviewers than in response to females". This factor should be taken into account when interpreting the results from this research. Only the data from the eleven monophthongs, /i, ɪ, e, æ, a, ʌ, ɒ, ɔ, ʊ, u, ɜ/, will be presented here.

3.2.2 Acoustic Analysis

Speech data was sampled at 20khz with 16bit resolution and each vowel was annotated using standard procedures well established in the analysis of vowel data (Harrington, Cox and Evans, 1997). Automatic formant tracking was examined and hand modified if necessary. All data was checked by two experienced phoneticians to ensure reliability and consistency of labelling. Data from the first two formants (F1 and F2) was extracted at the vowel target for the 11 monophthongs.

4. Results

All analyses of variance (ANOVA) were carried out in SPSS with a level of significance of $p<.05$ and with *post-hoc* *t*-tests having a *p* value of .005.

4.1 Experiment 1

Twoway ANOVA was used to examine Phonetic Context x Vowel for each town in order to compare /hVd/ and /hVl/ environments ($p<.05$). F1 and F2 data were examined separately. Table 1 shows the significant interactions and *post-hoc* results for Experiment 1. For F1, Junee and Wangaratta displayed highly significant interactions. Temora had a significant main effect for context with a non-significant interaction indicating that F1 values of all vowels were equally affected. Wagga did not display any F1 effects. All centres demonstrated significant F2 effects. Figure 1 shows a retraction and lowering of the short front /ɪ/ and /e/ and a retraction of the central vowels /ɜ/ and /u/ before /l/.

Table 1. Twoway ANOVA comparing Context X Vowel for each town and formant separately. Interactions are reported.

Town	Parameter	*df*	*F*	*p*	*post hoc*
Junee	F1	10, 408	2.890	.002	/ɜ/
Wangaratta	F1	10, 824	28.003	.000	/i,ɪ,e,u,ɜ/
Junee	F2	10, 408	30.874	.000	/ɪ,e,u,ɜ/
Temora	F2	10, 419	17.956	.000	/ɪ,e,u,ɜ/
Wagga	F2	10, 338	28.778	.000	/ɪ,e,u,ʊ/
Wangaratta	F2	10, 824	49.515	.000	/i,ɪ,e,æ,ʌ,ʊ,u,ɜ/

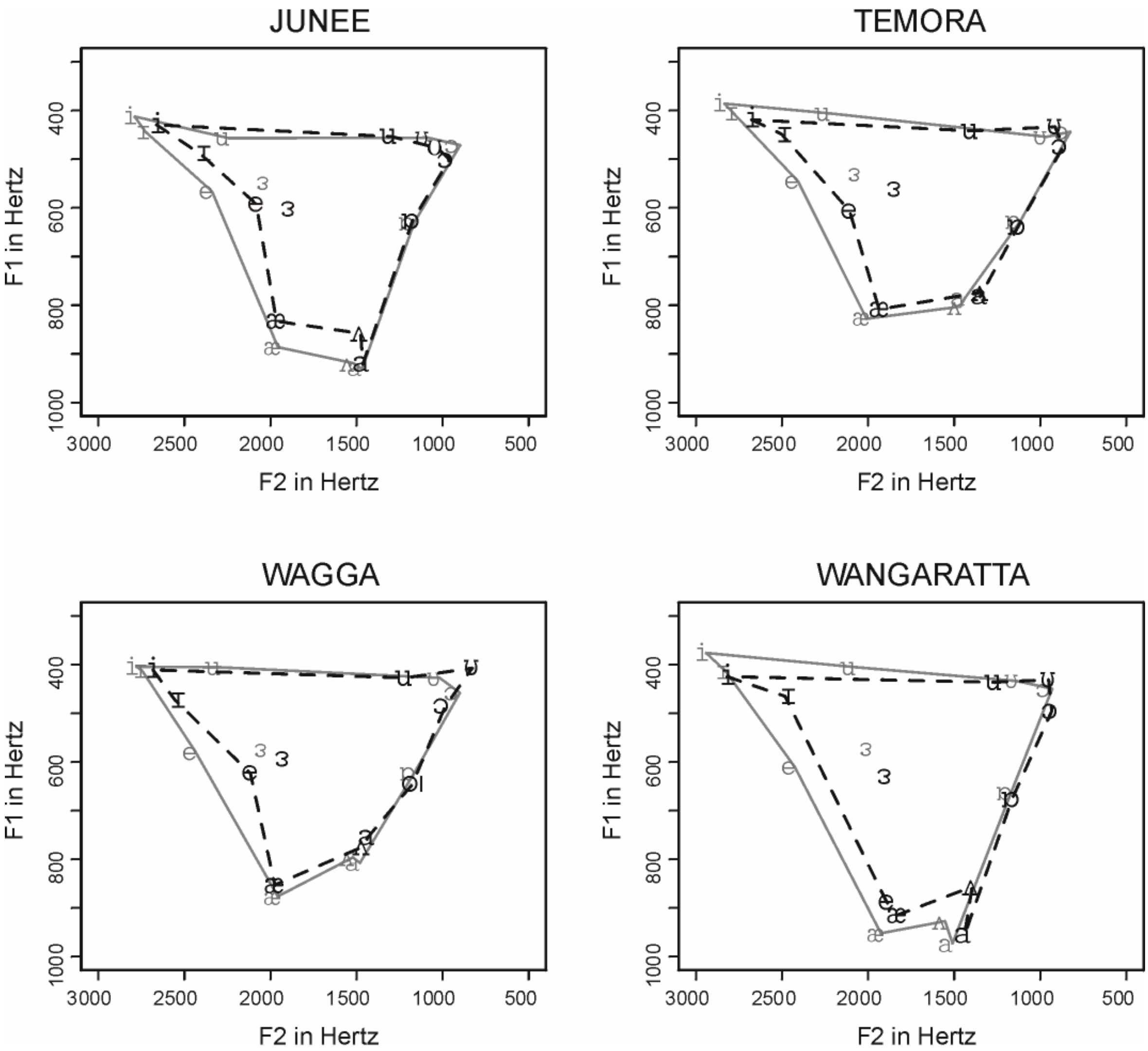


Figure 1. F1/F2 Vowel Space plots for Monophthongs in /hVd/ (solid line) and /hVl/ (dashed line) contexts.

4.1.2 Experiment 1: Overview

The results from experiment 1 are consistent with Bernard (1985). High fronted and central vowels are most affected. However, Bernard also found retraction for /i/ and lowering of /æ/. There is no evidence here of /æ/ lowering, possibly due to the very low nature of the "new" AusE /æ/ (Cox, 1999), and /i/ only retracts significantly for Wangaratta speakers. /ʉ/ shows a dramatic effect in retraction for all groups of speakers. Predictably, the back vowels were not substantially affected.

4.2. Experiment 2

Oneway ANOVA was used to examine each context (/hVd/, /hVl/) and vowel separately to assess homogeneity across the NSW towns. F1 and F2 data were independently analysed.

4.2.1 /hVd/ Context

For the /hVd/ environment there were very few significant differences between the three NSW towns. Only /a/ and /ʌ/ displayed effects and only in F1 [/a/: $F(2,54)=11.28$, $p<.000$; /ʌ/: $F(2,55)=12.19$, $p<.000$]. *Post-hoc* comparisons reveal that Junee is significantly different from Temora and Wagga. Figure 2 shows the superimposed monophthong vowel spaces for the three NSW towns. Junee speakers produced a much more open /a/ and /ʌ/ compared with Temora and Wagga speakers. There were no significant F2 differences.

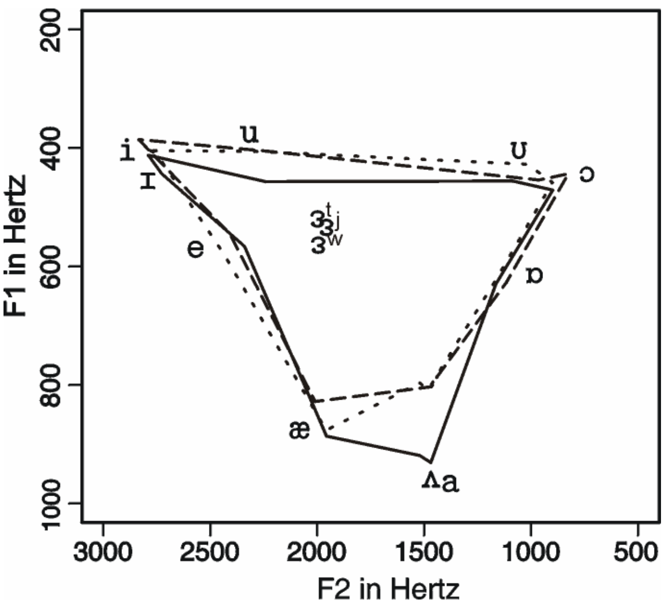


Figure 2. F1/F2 /hVd/ monophthong vowel space for the three NSW towns. Junee ______;Temora -------; Wagga…….

4.2.2 /hVl/ Context

Table 2 displays the significant differences between the three NSW towns for the /hVl/ environment. Figure 3 illustrates the differences through monophthong vowel space plots.

Significant effects were present for F1 of /a/ and /ʊ/ with *post-hoc* comparisons revealing that Wagga and Junee are significantly different for /a/ and Wagga and Temora are significantly different for /ʊ/. For F2, significant effects were present for /ʌ/ and /ʊ/. *Post-hoc* comparisons show differences between Junee and Temora for /ʌ/, and Junee and Wagga for /ʊ/.

4.2.3 Experiment 2: Overview

Experiment 2 shows that speakers from the three NSW towns cannot be considered homogeneous with respect to their vowel productions and therefore cannot be combined as a NSW group to be compared directly with the Victorian speakers. Instead, it is necessary to include all four towns individually in the comparisons.

Table 2. Oneway ANOVA comparing NSW centres: /hVl/ environment.[1]

Vowel	Parameter	*df*	*F*	*p*	*post hoc*
/a/	F1	2,55	11.050	.000	J vs. W
/ʊ/	F1	2,48	9.010	.000	J vs. W
/ʌ/	F2	2,54	6.777	.002	J vs. T
/ʊ/	F2	2.48	11.544	.000	J vs. W

[1]For the *post-hoc* result: J=Junee, W =Wagga, T=Temora, Wn=Wangaratta

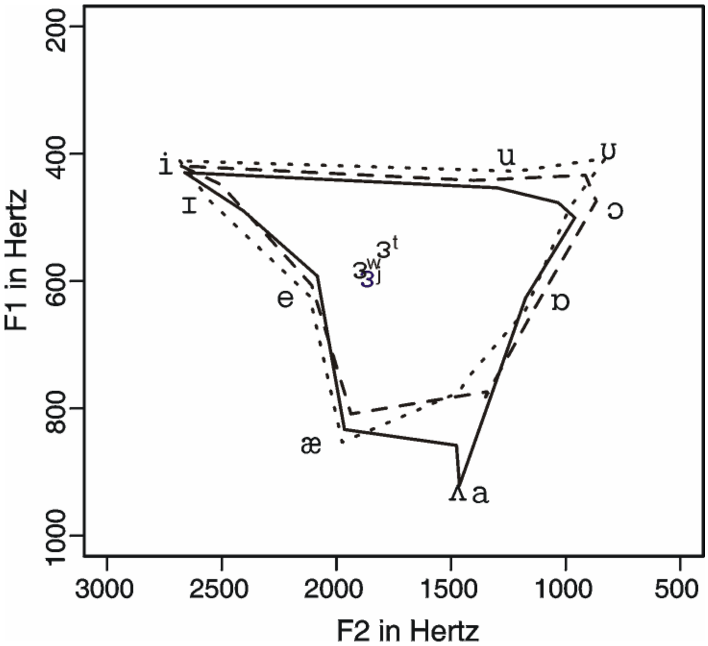


Figure 3. F1/F2 /hVl/ monophthong vowel space for the three NSW towns. Junee ______;Temora -------; Wagga…….

4.3 Experiment 3

Oneway ANOVA was used for each context (/hVd/, /hVl/) and vowel separately to determine differences across all four towns. F1 and F2 data were analysed independently.

4.3.1 /hVd/ Context

Table 3 displays the results from Experiment 3 showing that there are numerous significant location effects. Figure 4 shows that Wangaratta speakers have very open /æ, a, ʌ/. Junee speakers also have a very open /a/ and /ʌ/. For F2, /i, ʊ, u/ have significant effects for location. *Post-hoc* comparisons reveal that Wangaratta differs from Wagga for /i/, Temora for /ʊ/ and all NSW towns for /u/. Figure 4 shows that Wangaratta speakers have a more retracted /u/ and a more fronted /i/ and /ʊ/.

Table 3. Oneway ANOVA comparing all four centres: /hVd/ environment.

Vowel	Parameter	*df*	*F*	*p*	*post hoc*
/æ/	F1	3,93	7.399	.000	Wn vs. T
/a/	F1	3,92	20.143	.000	Wn, J vs. T,W
/ʌ/	F1	3,93	12.274	.000	Wn, J vs. T,W
/u/	F1	3,79	6.786	.000	Wn vs. J
/i/	F2	3,93	4.804	.004	Wn vs. W
/ʊ/	F2	3,94	7.452	.000	Wn vs. T
/u/	F2	3,79	12.889	.000	Wn vs. J,T,W

(a) **(b)**

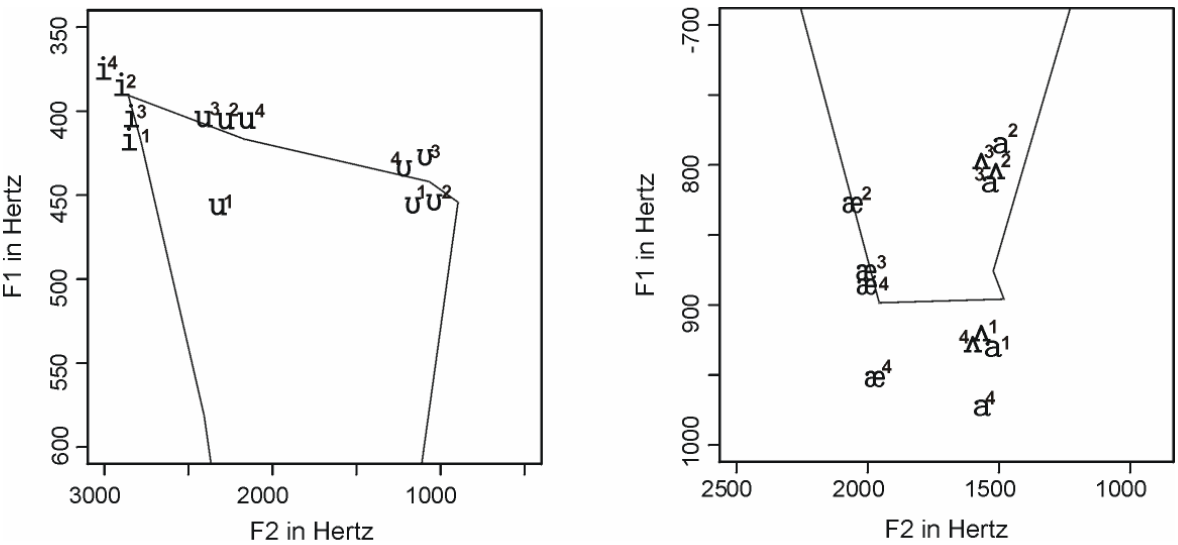


Figure 4. F1/F2 vowel space plots showing a) the top of the space, b) the bottom of the space. Mean values of vowels that display significant effects in /hVd/ are indicated for the four towns. [1= Junee, 2= Temora, 3= Wagga, 4=Wangaratta]

4.3.2 /hVl/ Context

Table 4 shows the significant effects for location for vowels in the /hVl/ environment. The major effect is between Wangaratta and the NSW towns for /e/. It can be seen in Figure 5 that Wangaratta speakers produce a significantly lower and more retracted /e/. Wangaratta and Junee speakers have a more open /a/ than Temora and Wagga speakers, and Junee speakers produce a much lower and more fronted /ʊ/ than Wagga speakers. For /æ/, Wangaratta speakers have a significantly more retracted production than Junee and Wagga speakers.

Table 4. Oneway ANOVA comparing all four centres: /hVl/ environment.

Vowel	Parameter	*df*	*F*	*p*	*post hoc*
/e/	F1	3,93	58.181	.000	Wn vs. J, T, W
/a/	F1	3,90	16.647	.000	Wn, J vs. T, W
/ʊ/	F1	3,84	6.828	.000	W vs. J
/i/	F2	3,93	6.312	.001	Wn vs. J
/e/	F2	3,93	15.747	.000	Wn vs. T, J, W
/æ/	F2	3,93	8.278	.000	Wn vs. J, W
/ʊ/	F2	3,84	7.041	.000	W vs. J

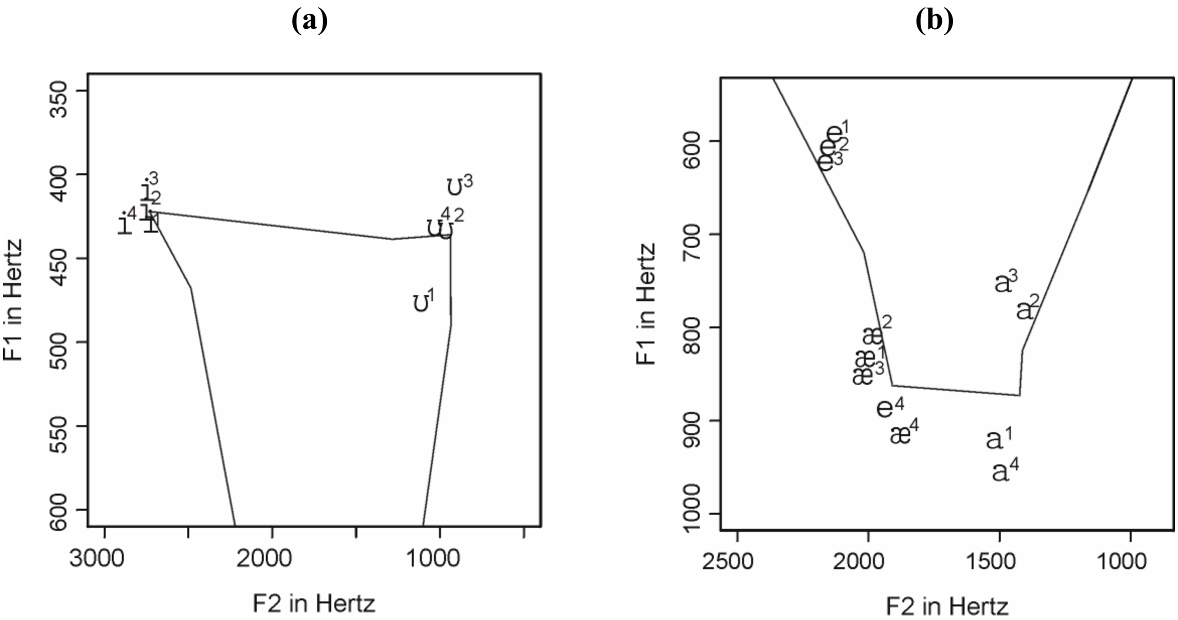


Figure 5. F1/F2 vowel space plots showing a) the top of the space, b) the bottom of the space. Mean values of vowels that display significant effects in /hVl/ are indicated for the four towns. [1= Junee, 2= Temora, 3= Wagga, 4=Wangaratta]

4.3.3 Experiment 3: Overview

The most striking result from Experiment 3 is that Wangaratta appears to differ from the NSW speakers for certain vowels. Wangaratta has a more retracted /u/ in /hVd/ and a considerably lower and more retracted /e/ before /l/ than NSW. Wangaratta speakers also display a significantly more retracted /æ/ than Wagga and Junee speakers and this difference almost reaches significance for Temora. Figure 6 illustrates the more extensive change in /e/ that occurs in Wangaratta compared with NSW for /e/ before /l/. The figure also shows the finding from experiment 1 that /æ/ also significantly retracts before /l/ for Wangaratta speakers but not for NSW speakers. *t*-tests reveal a significant difference between /e/ and /æ/ before /l/ for speakers from NSW towns but no difference between these two vowels for Wangaratta speakers (at ($p<.005$); for F1 [$t(60.43)=-1.078$, $p<.285$] and F2 [$t(74)=2.07$, $p<0.046$]. Therefore, Wangaratta /æ/ and /e/ can be considered homogeneous in distribution before dark /l/. Figure 7 details the relationship between these two vowels before /l/ for the Wangaratta speakers. It is interesting that for over 50% of the Wangaratta speakers in this study, /æ/ has a realisation that is phonetically closer than /e/. These vowels have exchanged relative height positions.

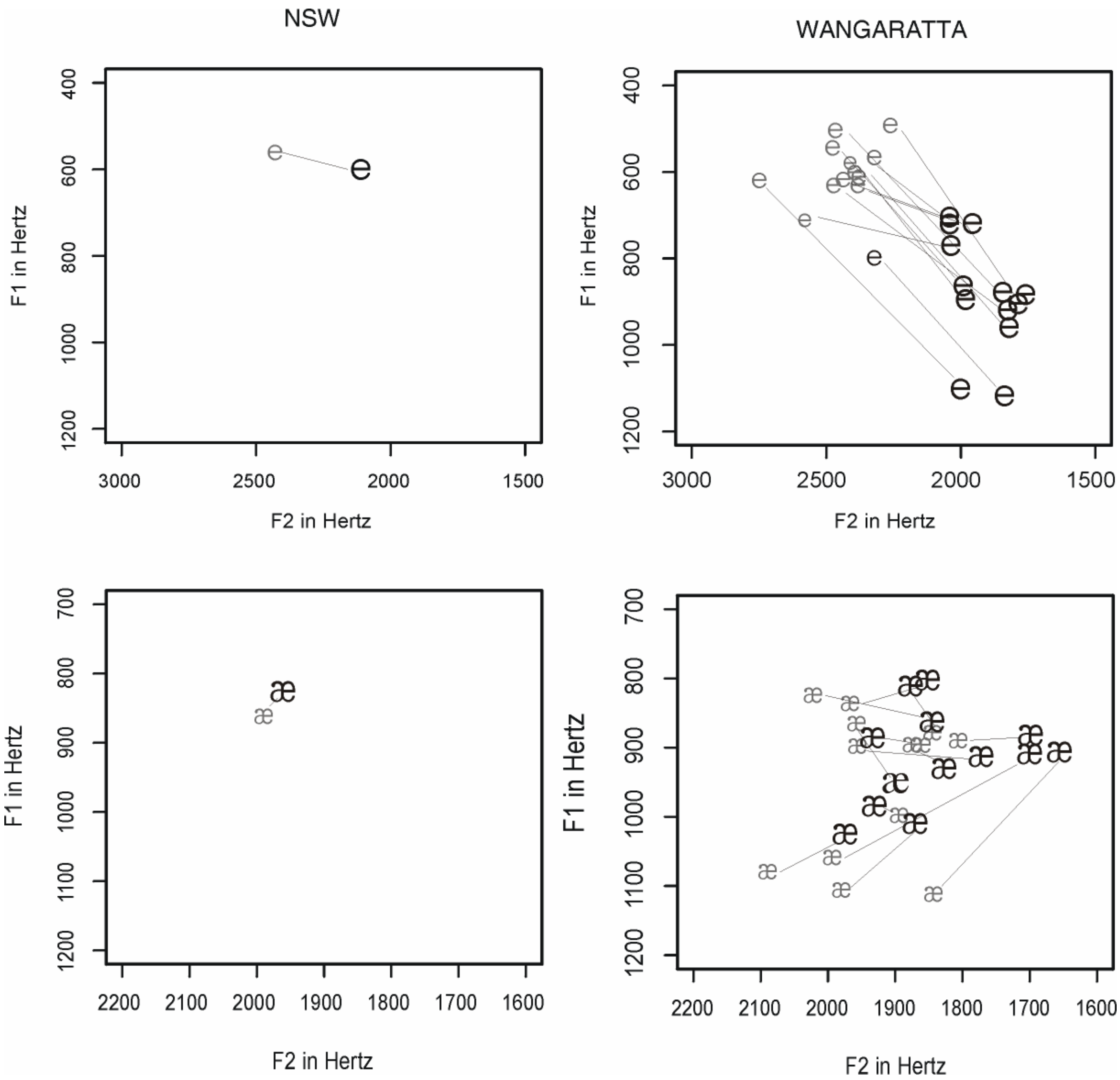


Figure 6. F1/F2 plots showing the mean position of /e/ and /æ/ for /hVd/ (light) and /hVl/ (dark) for NSW (left) and the individual means for /e/ and /æ/ for /hVd/ (light) and /hVl/ (dark) for Wangaratta (right).

(a) **(b)** **(c)**

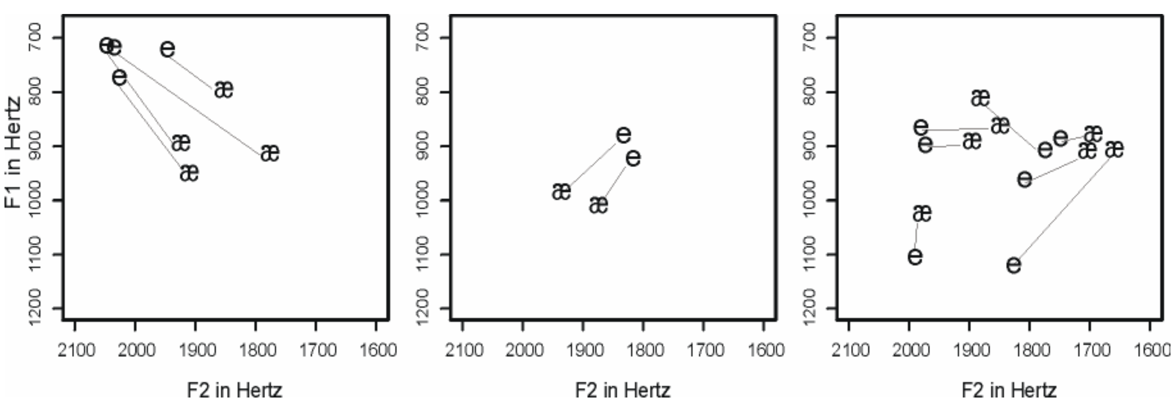


Figure 7. F1/F2 plots for Wangaratta speakers' individual mean values for /e/ and /æ/ in /hVl/. a) speakers who display phonetically lower and retracted /æ/ than /e/, b) speakers who display phonetically lower and more fronted /æ/ than /e/, c) speakers who display phonetically higher and more retracted /æ/ than /e/.

5. Conclusion

The coda /l/ has a significant impact on the target of monophthongs for all speakers. This is most significant for F2 indicating retraction, with the vowels /ɪ, e, u, ɜ/ most strongly affected. This is due largely to the biomechanical properties of the dorsal gesture required for dark /l/ (Recasens, 1999, 2002; Recasens, Fontdevila, Pallarès, 1996). The results of these experiments confirm the observation that in AusE, dark /l/ has substantial impact on preceding short front vowels (Bernard, 1985, Cochrane, 1959, Mitchell and Delbridge, 1965). The effect of /l/ on preceding /u/ has also been discussed by Mitchell and Delbridge (1965) who describe one variant of /u/ before /l/ as being pronounced with a tense vowel very near to the rounded cardinal [u]. In their analysis this modification of /u/ was most often found in the speech of girls from South Australian Independent schools. Oasa's findings (1989) also suggest regional effects for this variant. He reports that Melbourne and Adelaide speakers produce more retracted realisations of /u/ before /l/ than Sydney and Brisbane; however, this differential effect on /u/ was not found in the present analysis. Our NSW speakers produced /u/ before /l/ that was just as retracted as the Victorian speakers. Such a result provides convincing evidence that a vowel shift has occurred.

The present data reveals that /l/ has a particularly strong effect on vowels produced by Wangaratta speakers where /e/ is significantly lowered and retracted compared to NSW speakers to the extent that a conditioned merger between /e/ and /æ/ occurs. This change appears to impact on /æ/ in what might be described as the precursor of a chain shift as indicated by the retraction of /æ/ before /l/ that only occurs in Wangaratta and not in any of the NSW towns. The lowering of /e/ before /l/ in Victoria was first described by Bradley (1989); however, he does not imply a merger. His work prior to this time (e.g. Bradley, 1980) does not mention /e/ lowering, suggesting that the shift is rather a new phenomenon. The NSW towns show /e/ retraction and a small degree of lowering in line with Bernard (1985) but little or no /æ/ movement. This result for /æ/ is contrary to Bernard (1985) who found lowering and retraction of /æ/ before /l/. Previous research (Cox, 1999; Cox and Palethorpe, 2001) has shown that AusE /æ/ has progressively lowered over the past 40 years and may now be at the floor of the space with therefore no possibility of further lowering. There is no evidence in this data of raised /æ/ before /l/ as in "Elbert" for "Albert", a phenomenon that has been popularly suggested for Victorians. Instead our results suggest that Victorian girls are more likely to produce "shall" for both "shell" and "shall".

The results from the /hVd/ analysis reveal that the three NSW centres generally exhibit the same variations. One exception is Junee which is more similar to Wangaratta for the vowels /a/ and /ʌ/. The difference for the low vowels for speakers from Junee and Wangaratta is interesting and there are a number of possible explanations. These girls may be producing more open articulations, that is, lower jaw and lower tongue. This type of articulation would be suggestive of clearer speech or more emphasised vowels (Erickson, 2002) which could best be seen in the low vowels because the tongue dorsum movement and the jaw position are not antagonistic as they are for emphasised high vowels. For the high vowels, there may be emphasised tongue position but the lower jaw acts as an antagonist and so greater peripherality is not in evidence. Another possible explanation is that these girls had shorter vocal tracts possibly resulting from small stature compared with other girls of the same age. They would therefore have higher formant frequencies. If this explanation were correct, we would expect the girls' vowel spaces to shifted diagonally towards the lower left (i.e. higher F1 and F2). This does not occur. Numerous studies of the non-linear nature of male/female differences in formant frequencies (Fant, 1966, 1975; Nordstrom, 1977) point to anatomical differences other than size to account for the more noticeable differences in the low vowels between males and females. Specifically, the ratio of the pharyngeal to oral cavity length leads to a greater discrepancy between the low vowels than the high vowels. The result is similar to that found here and could suggest a maturational effect. However, Mackenzie Beck (1997) states that the growth of the vocal apparatus in girls is mainly due to linear scaling up of the pre-pubertal vocal structures rather than a significant change in the relative proportions as is found in men. We therefore conclude that the differences in the low vowels for Junee and Wangaratta may be due to these girls producing more emphasised vowels (Erickson, 2002).

The most interesting difference between Wangaratta speakers and NSW speakers in the /hVd/ context is the more conservative retraction of /u/ for Wangaratta speakers. This result is in agreement with Oasa (1989) that NSW speakers use more fronted variants than Victorians. The formant values in the present analysis are even higher than Oasa's for both Victorian and NSW speakers indicating that the process of /u/ fronting is continuing.

One limitation of the present study is that it relies on target data alone and there is no examination of dynamic information. The target is representative of the vowel at its best approximation in the context. However, in /hVl/ environments this target may be a very transient event in the vowel excursion and may not be the best way of representing the effect of the consonant. Further examination of vowel dynamics is in progress to establish the extent to which the /l/ influences different vowel types and whether there are variations within the dynamic structure that differentiate populations. A useful addition to this analysis for completeness would be the inclusion of diphthongs (see Palethorpe and Cox, to appear).

The acoustic results confirm impressionistic suggestions of regional differences between female NSW and Victorian speakers; in particular, differences for /u/ and /æ/ but primarily the merger of /e̞/and /æ/ before /l/. This difference is interesting due to the rapidity of the change and extent of the shift. We believe that the results of this project provide evidence for regional variation in AusE that can be attributed to state affiliation.

References

Bernard, J 1985 'Some local effects of post-vocalic [l]' *Festschrift in Honour of Arthur Delbridge*, Beitrage Zur Phonetik und Linguistik 48: 319-332

Bladon, R & Al-Bamerni, A 1976 'Coarticulation resistance in English /l/' *Journal of Phonetics* 4:137-150

Blair, D 1993 'Australian English and Australian National Identity' in Schultz, G (ed) *The Languages of Australia* Occasional Paper, Australian Academy of the Humanities Symposium 14: 62-70 Highland Press, Canberra.

Borowsky, T 2001 'The vocalisation of dark l in Australian English' in Collins, P & Blair, D (eds) *English in Australia* Benjamins, Amsterdam.

Bradley, D 1980 'Regional differences in Australian English phonology' *Working Papers in Linguistics* University of Melbourne.

Bradley, D 1989 'Regional dialects in Australian English phonology' in Collins, P & Blair, D (eds) *Australian English: The Language of a New Society* University of Queensland Press, St Lucia.

Bradley, D 2001 'Mixed Sources of Australian English' paper presented at *The Mitchell Symposium*, Macquarie University, Sydney.

Browman C & Goldstein, L 1990 'Gestural specification using dynamically-defined articulatory structures *Journal of Phonetics* 18:299-320

Bryant, P 1989 'The South-East lexical usage region of Australian English' in Bradley, D., Sussex, R & Scott, G (eds) *Studies in Australian English* Department of Linguistics, La Trobe University, Bundoora.

Cochrane, G 1959 Australian Vowels as a diasystem *Word* 15: 69-88

Cox, F 1996 *An Acoustic Study of Vowel Variation in Australian English* Unpublished PhD Dissertation Macquarie University, Sydney.

Cox, F 1999 Vowel Change in Australian English *Phonetica* 56: 1-27

Cox, F & Palethorpe S 1998 Regional variation in the vowels of female adolescents from Sydney. *Proceedings of the 5th International Conference on Spoken Language Processing*.

Cox, F & Palethorpe, S 2001 'The changing face of Australian English vowels', in Collins, P and Blair, D (eds) *English in Australia* Benjamins, Amsterdam.

Eckert, P 2000 *Linguistic Variation as Social Practice* Blackwell, Massachusetts.

Erickson D 2002 'Articulation of Extreme Formant Patterns for Emphasised Vowels' *Phonetica* 59:134-149

Fant, G 1966 'A note on vocal tract size factors and non-uniform F-pattern scalings' *Speech Transmission Laboratory, Quarterly Progress Status Report* 4: 22-30

Fant, G 1975 'Non-uniform vowel normalisation' *Speech Transmission Laboratory, Quarterly Progress Status Report* 2-3: 1-19

Gick, B 1999 *The Articulatory Basis of Syllable Structure: A Study of English Glides and Liquids*, Unpublished PhD Dissertation, Yale University

Hardcastle, W and Barry, W 1989 'Articulatory and perceptual factors in /l/ vocalisations in English' *Journal of the International Phonetic Association* 15: 3-17

Harrington, J, Cox, F, & Evans, Z 1997 An acoustic phonetic study of broad, general, and cultivated Australian English vowels. *Australian Journal of Linguistics* 17: 155-184

Horvath, B 1985 *Variation in Australian English: The Sociolects of Sydney* Cambridge University Press, Cambridge.

Horvath, B & Horvath, R 2001a 'A geolinguistics of short ɑ in Australian English' in Collins, P and Blair, D (eds) *English in Australia* Benjamins, Amsterdam.

Horvath, B & Horvath, R 2001b 'A multilocality study of a sound change in progress: The case of /l/ vocalisation in New Zealand and Australian English' *Language Variation and Change* 13:37-57

Labov, W. 1994 *Principles of Linguistic Change. Volume 1. Internal Factors*. Basil Blackwell, Oxford.

Mackenzie Beck, J 1997 'Organic variation of the vocal apparatus' in Hardcastle, W & Laver, J (eds) *The Handbook of Phonetic Sciences* Blackwell, Oxford.

Mitchell A & Delbridge, A 1965 *The Speech of Australian Adolescents* Angus and Robertson, Sydney.

Nordstrom, P-E 1977 'Female and infant vocal tracts simulated from male area functions' *Journal of Phonetics* 5:81-92

Oasa, H 1989 'Phonology of current Adelaide English' in Collins, P & Blair, D (eds) *Australian English: The Language of a New Society* University of Queensland Press, St Lucia.

Palethorpe, S & Cox, F (2003) 'Vowel modification in pre-lateral environments' *International Seminar on Speech Production*, Sydney.

Recasens, D 1999 'Lingual Coarticulation' in Hardcastle, W J & Hewlett, N (eds.) *Coarticulation: Theory, Data and Techniques* Cambridge: Cambridge University Press. *pp.* 80 -104.

Recasens, D 2002 'An EMA study of VCV coarticulatory direction' *Journal of the Acoustical Society of America* 111:2828-2841

Recasens, D, Fontdevila, J. & Pallarès, M D 1996 'Linguopalatal coarticulation and alveolar-palatal correlations for velarized and non-velarized /l/' *Journal of Phonetics* 24: 165-185.

Sproat, R & Fujimura, O 1993 'Allophonic variation in English /l/ and its implications for phonetic implementation' *Journal of Phonetics* 21:291-311

Willemyns, M; Gallois, C; Callan, V & Pittam, J 1997 'Accent accommodation in the job interview: Impact of interviewer, accent and gender' *Journal of Language and Social Psychology* 16:3-22