The /el/-/æl/ Sound Change in Australian English: A Preliminary Perception Experiment

Deborah Loakes, John Hajek and Janet Fletcher
University of Melbourne
{dloakes/johnth/janetf}@unimelb.edu.au

Abstract. The /el/-/æl/ sound change in Australian English involves the loss of contrast between prelateral /e/ and /æ/ for some speakers, so that both vowels are realised as [æ]. In Australia, this sound change is popularly and frequently identified as being typical of only speakers from Melbourne and Victoria. However, aside from a small number of production studies, very little research has been carried out into the phenomenon. In this paper, we report on three preliminary perception experiments to determine how Australian English listeners respond to /el/ and /æl/ tokens. Listeners were 386 high-school students and their teachers, with 89% classified as Victorian listeners (from Melbourne and Victoria) and 11% non-Victorian (from elsewhere in Australia). Across all experiments, Victorian listeners consistently performed worse than non-Victorian listeners when presented with /el/-/æl/ stimuli, and also reported more difficulty with all tasks. As well as discussing patterns in listener responses, we address reasons that the /el/-/æl/ sound change may be regionally defined. We conclude with a discussion of how this preliminary perceptual investigation, along with previous production work, accords with Ohala's (1993) model of why sound changes occur.

Keywords: Phonetics, perception, sound change, Australian English, vowels, lateral

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1. Introduction

This paper presents the results of a preliminary perceptual investigation into a sound change underway in Australian English. We first discuss the relevant background and related work in this area, and then describe three perception experiments carried out in Melbourne. Suggestions for future research are also outlined.

The sound change investigated in this paper involves loss of contrast between prelateral /e/ and /æ/ for some Australian English speakers so that both are realised as [æ], despite the fact that the contrast is preserved in orthography. This means that for these speakers words such as *elf* and *bell* are now realised with an [æ] vowel, and minimal pairs such as *celery-salary*, *melody-malady* and *Ellen-Alan* are no longer contrastive. We refer to this phenomenon as the /el/-/æl/ sound change, and note that in Australian English it is popularly and frequently identified as being typical of only speakers from Melbourne and Victoria.[1] This /el/-/æl/ sound change is similar to the phenomenon that occurs in New Zealand English (e.g. Thomas 2004), and in Norfolk Island-Pitcairn English (Ingram & Mühlhäusler 2004). While connection between the varieties is unlikely, and their vowel systems are different, it is certainly possible that similar physiological or universal processes have induced the change.

It is not surprising that the /el/-/æl/ sound change occurs given that the prelateral position, i.e. /V/ + /l/, is notorious for promoting vowel differences and change (e.g. Labov 1994, Cox & Palethorpe 2004). This is because velarised /l/ (or [ɬ]) has significant coarticulatory effects, causing preceding vowels in different varieties of English to become lower and more retracted. Reasons for the occurrence of the sound change can also be related to listener (mis)perception. Under his model of why sound changes occur, Ohala (1993:246) appeals to the notion of hypercorrection noting that "if the listener fails to correct the perturbations in the speech signal variation, then they will be taken at face value and will form part of [the listener's]

[1] We use the term "Melbourne English" to refer to English spoken in this region (i.e. both urban Melbourne and the state of Victoria more generally) so as to both specify the region to which we are referring and to avoid use of the ambiguous term "Victorian English".

conception of its pronunciation". That is, the listener does not account for coarticulation (a link between the cause and effect), and a sound change ensues.

Many examples of sound change and listener misperception can be provided from the phonetic and phonological literature (esp. Ohala 1981, 1993, and also Hajek 1997). Harrington et al. (2008) cite listener (mis)perception of contextual coarticulation as a specific factor that motivates change in the /u/ vowel in British English, seen clearly in the speech of Queen Elizabeth II and the general public over time. They show that this vowel is the subject of a sound change in progress, whereby both older and younger speakers are producing extremely different variants, and, importantly, are responding differently when perceiving tokens produced by older compared with younger speakers. Like Harrington et al. (2008), we suggest that the /el/-/æl/ sound change in Melbourne English is due to differences in listener (mis)perception leading to hypercorrection for some, in this case /el/ → [æl] → /æl/. It is unsurprising that this is reported to occur in Melbourne/Victoria, as opposed to other regions in Australia, given emerging experimental evidence that short front vowels in Melbourne are phonetically lower than elsewhere in Australia (Loakes 2006, Billington 2008 compared with Cox 1999, Butcher 2006). While there is evidence that vowels in Melbourne may be lower than elsewhere, we note that this lowering of short front vowels appears to be a trend occurring in Australian English, and has also been reported to occur in female speech in Sydney and NSW (Cox & Palethorpe 2008).

In Australian English, very little research has been carried out into the /el/-/æl/ sound change. Some studies have focused on production, but to date no studies have focused on vowel perception. The first mention of the /el/-/æl/ sound change was by Bradley (1989). Amongst other observations on speech produced in Melbourne, he noted a large number of /el/ tokens produced as [æl] by both male and female speakers, at both different levels of formality and at different speaking rates. He observed that the /el/-/æl/ sound change was somewhat more common in spontaneous speech compared with read speech, in male speech compared to female speech, and in lower socio-economic groups compared to higher (although the phenomenon was observed in all groups). Fifteen years later, Cox & Palethorpe (2004) carried out a study comparing vowels produced by three groups of young female

regional NSW speakers and one group of young female regional Victorian speakers (from Wangaratta, close to the NSW border). Cox and Palethorpe measured vowels produced by NSW and Victorian adolescents in /hVd/ and /hVl/ frames, and aside from a number of findings as far as other vowels are concerned, they confirmed, through acoustic analysis of formant frequencies, that the /el/-/æl/ sound change was present in the speech of all of the Victorian girls but not in the three groups from NSW. Acoustically, they found that prelateral /e/ and /æ/ were significantly different for NSW girls, but not for the Victorian girls (Cox & Palethorpe 2004:9). That is, the NSW speakers maintained a distinction between /el/ and /æl/, while the Victorian speakers did not. Another interesting, and potentially related, finding from their study is that for over half of the Victorian girls /el/-/æl/ transposition also occurred. This is where speakers produce closer and more retracted /æ/ variants than /e/, a situation where it can be said that "the vowels have exchanged relative height positions" (Cox & Palethorpe 2004:9). This vowel transposition appears to be a partial hypercorrection by speakers resulting in incorrect phoneme assignment.

Loakes (2008) carried out preliminary acoustic phonetic analysis of the /el/-/æl/ sound change, comparing speech recorded in Melbourne in 2002 (modern day data) with speech recorded in Melbourne in 1959/1960 (1960s data). It was apparent that the lateral consonant (and the way vowels interact with /l/) appeared to be responsible for different vowel groupings. Analysis of the 1960s data indicated that speakers for whom /eC/ and /el/, and /æC/ and /æl/ patterned together (i.e. cases where prelateral vowels were no different to vowels in other contexts) were actually producing a more clear sounding [l], while the speakers who were merging prelateral /e/ and /æ/ were producing a darker sounding [ɬ]. None of the modern-day speakers were producing clear sounding [l] in any environment. This was a surprising finding in that while it is well known that the postvocalic lateral influences vowel quality in Australian English and elsewhere (e.g. see Horvath & Horvath 2001), it is the changing lateral (i.e. increasingly velarised lateral), rather than the vowels as such, which appears to have most directly influenced the sound change. We return to a discussion of increasingly velarised /l/ in Australian English further below. Taking both the modern day and 1960s data into account, results in Loakes (2008) accord

well with the above suggestion that the /el/-/æl/ sound change in Melbourne English is in fact due to listener (mis)perception leading to hypercorrection for some.

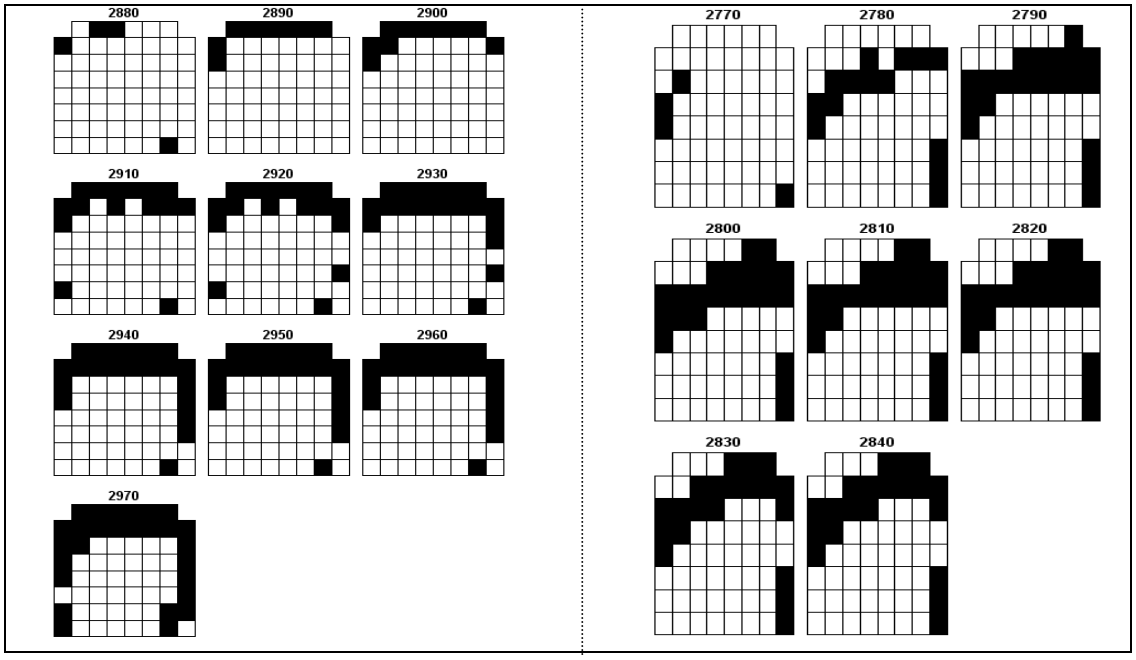
As previously noted, a similar phenomenon has been observed in New Zealand English. Thomas (2004) appeals to exemplar theory to account for the /el/-/æl/ sound change in the New Zealand English vowel system. According to this theory, an exemplar is a remembered token of a speech sound, which is stored in a hearer's mental lexicon and drawn from production (see for example Pierrehumbert 2002). Sound changes are said to occur when speakers draw from overlapping exemplar "clouds". In the case of the /el/-/æl/ sound change, listeners experience both [e] and [æ] tokens for /el/, and thus their remembered exemplars for this phoneme are especially variable (and overlapping) compared to their /e/ exemplars in other contexts for example, which would always be [e]. We return to exemplar theory in the results and discussion section further below to account for some of the patterns observed in our experiments.

Aside from research on vowels it is also important to discuss the lateral, which, as mentioned, is known to be a promoter of sound change in different varieties of English. It is generally accepted that English /l/ varies predictably depending on its position in a syllable (see for example Sproat & Fujimura 1993). It is described as clear [l] (produced with the tongue tip only) when it occurs in syllable onsets, and dark [ɫ] (or velarised, produced with both the tongue tip and raised dorsum) at the end of syllables (the coda). So, in Australian English, words such as *lid* and *filler* should contain a clear [l], while words such as *fill* or *builder* should contain a dark [ɫ]. We note here that some varieties of English, have only a dark lateral in both onset and coda (e.g. Scottish), and some have only a clear lateral in both (e.g. Southern Irish). Additionally, in many varieties of English, including Australian English, syllable-final /l/ can also be vocalised (vowel-like, and produced without tongue-tip contact). In Australia, this occurs mainly in Adelaide, but also for some speakers in other regions (e.g. Horvath & Horvath 2001, Bradley 2004), and is dependent on phonological environment (see e.g. Horvath & Horvath 2001, Borowsky 2001).

Aside from the findings presented in Loakes (2008), we can also offer some new evidence that the lateral in Australian English is actually velarised in contexts other

than coda position, creating more contexts in which listener misperception can occur in this variety. This is shown in the figures below, which show sequences of palatograms for two different /l/ productions. These palatograms have been made using electropalatography (EPG), which records the timing and location of tongue-palate contact during speech production. A speaker wears an artificial palate embedded with electrodes, and the pattern made by the tongue contacting different regions of the palate is recorded and analysed.

Figure 1 shows production of /l/ in the word *welder*, and Figure 2 shows the same sound in the word *weller* produced by a female speaker of English (one of the authors of the paper). The separate images in each figure represents the palate at sequential ten millisecond frames, and the images can be read from top to bottom and left to right. The narrow part at the top of each image is the top of the palate just behind the teeth, while the bottom of the palate represents the velar region. The black squares show where the speaker's tongue contacted the palate, and the white squares show where there is no contact. The number of palates is different due to the different durations of each /l/.



1) [ɬ] **in** ***welder*** **2)** [ɬ] **in** ***weller***

Figures 1-2. EPG palatograms of /l/ in *welder* (Fig. 1) and *weller* (Fig. 2) produced by an Australian English speaker

In Figure 1, /l/ is in coda position in the word *welder* where we would typically expect to find velarisation in Australian English. This figure shows that the Australian English speaker uses both the tip and back of her tongue to produce the sound, with contact patterns evident on both the anterior and dorsal regions of the palate (although the sound starts out as alveolar, it becomes increasingly velarised).

More surprising results are seen in Figure 2, where the speaker produces almost the same velarised pattern in *weller* as seen in Figure 1. The /l/ in Figure 2 is intervocalic, where we expect a non-velarised ("clear") lateral, yet we find a lateral which is actually somewhat more retracted than the coda /l/ in *welder*.[2]

While these results should be interpreted with caution given our limited data, we note that this is evidence nevertheless that Australian English /l/ is velarised in positions other than syllable codas at least for some speakers of Australian English, providing a greater number of opportunities for changed (coarticulated) vowels. Importantly, this suggestion accords with observations by Wells (1982:610), who observed that rather than a predictable clear vs. dark lateral distinction in Australian English, dark [ɬ] appears to occur in all environments.

If we consider these findings together with the research discussed earlier, we see even more evidence that an /el/ sequence may be an ideal site to promote listener misperception, especially in Melbourne/Victoria. That is, /l/ has become increasingly velarised over time and in a greater number of contexts (Loakes 2008, as well as the EPG data reported above), combined with the critical fact that short front vowels in Melbourne/Victoria are lower than vowels elsewhere in Australia (Loakes 2006, Billington 2008 compared with Cox 1999, Butcher 2006), which reinforces the lowering effect on prelateral vowels in this region. Finally, we note that while other Australian English vowels are certainly subject to coarticulatory effects from /l/, it is both front vowels and low vowels which are most affected in this environment (Palethorpe & Cox 2003). Consequently our focus is on the /el/-/æl/ sound change in this investigation.

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[2] /l/ may be less velarised in *welder* (and have greater tongue-tip contact) due to other coarticulatory processes, i.e. anticipatory coarticulation of the following (alveolar) /d/.

2. Aims

Previous research on the /el/-/æl/ sound change in Australian English has examined production of prelateral vowels. In the current investigation, we carry out three preliminary perception experiments to determine how Australian English listeners respond to /el/ and /æl/ tokens. Our research questions are:

1. (Mis)perception plays a role in sound change. Is there evidence of misperception amongst listeners from Melbourne/Victoria regarding vowels in /el/-/æl/ contexts?
2. Do listeners from elsewhere in Australia perform better on the same tasks?
3. How do the two groups of listeners rate the tasks (in terms of difficulty)?

We note that this research is a first approach at perception work into this phenomenon in Australian English. As such, aside from the specific research questions, we also aim to determine the merits and limitations of the particular experiments so that future work may build on the results discovered here.

3. Method

386 listeners participated in three listening tests. These listeners were high-school students and their teachers, attending a VCE English Language workshop held by the School of Languages and Linguistics at The University of Melbourne. Participants listened to linguistics-based lectures, and then participated in questionnaire-based research. Their attention was not drawn to the /el/-/æl/ sound change at any point during the lectures. As well as their opinions on various linguistic matters, sociological information on the participants was also collected, such as their age, sex, and place of education.

For this experiment, the three listening tests were based on studies carried out on the /el/-/æl/ sound change in New Zealand English (e.g. Buchanan 2001, Thomas 2004, Thomas & Hay 2005). The first listening test was an open-choice task, followed by two forced-choice tasks. Participants were also asked to rate the difficulty of the forced-choice tasks.

Place of education (primary and high school) was used to distinguish listeners from Melbourne/Victoria compared to elsewhere in Australia. It was considered that this categorisation would relatively reliably separate listeners who had spent most of their lives in Melbourne/Victoria compared to elsewhere in Australia. The two listener groups are herein referred to as the *Victorian* (n = 345, 89%) and *non-Victorian* (n = 41, 11%) participants.

The majority of respondents in the study were female; 64.6% of the Victorian listeners, and 65.9% of the non-Victorian listeners. Male respondents made up 34.2% of the Victorian and 34.1% of the non-Victorian listeners. 1.2% of the Victorian listeners did not reveal their sex. Responses from English listeners from countries other than Australia, and those from non-native listeners, were excluded from the study.

The majority of listeners in the study were students aged under 20, with those aged 17 years old making up most of the group. This is seen in Table 1 below.

Group	14-16	17	18	19	24+ (teachers)	Unknown
Vic	1.2	71	21.2	2	3.5	0.8
Non-Vic	12.2	53.7	17.1	2.4	14.6	-

Table 1. Participant ages (proportions)

Overall, participants in the Victorian group are younger than those in the non-Victorian group. This can be seen especially in the 17 year old age group, which makes up 71% of the Victorian participants and 53.7% of the non-Victorians. Participants in the 24+ age group are all teachers, with only 3.5% of the Victorians in this age group, and 14.6% of non-Victorians. Victorian listeners in this age group range from 25-58 years of age, while non-Victorians range from 24-61 years of age.

Some methodological limitations should be noted. Firstly, the number of participants in the two groups was unequal, and other sociological information could well have been used to classify listeners. However, given that our first and second research questions aim to investigate whether misperception plays a role in sound change in listeners from Melbourne, and whether responses are different for listeners from elsewhere in Australia, we reasoned that using place of education (as a way of indicating place of residence), was a suitable classifier for most Australians.

Another issue was that listeners heard stimuli through loudspeakers (as opposed to headphones), however the nature of the data collection precluded any other format. Overall, the benefits in carrying out the study in the way we did, allowing responses from a comparatively large number of participants, outweighed the limitations. Previous perception tests on this phenomenon in New Zealand English have been based on far fewer speakers (2 for Buchanan 2001 and 16 for both Thomas 2004 and Thomas & Hay 2005) and have classified speakers according to age group. Given results in Loakes (2008) which showed evidence of the /el/-/æl/ sound change in 1960s data, and the fact that this sound change is regionally defined in Australian English, age group seemed like a less reliable factor for us than the region in Australia in which the listener had spent most of their life. Finally, we acknowledge that it would be useful to know the amount of time that the non-Victorian teachers have resided in Victoria, but this information was not collected.

As mentioned above, the perception experiments were questionnaire-based. Listeners read instructions, heard a male voice producing words with /el/ and /æl/ tokens (and various foils) and were then required to make a judgement about what they had heard.

The speaker who provided data for us to use in the experiments is a 30-year old male speaker of Australian English from Sydney who contrasts /el/ and /æl/ prelaterally.

For the first open-choice task, participants were presented with the following:

This is an experiment about how words sound.

A. Listen to the recordings, and write down which word you hear. Don't worry if you are unsure, we are only interested in your first impression. Also, it is important that you don't change your answer once you have written it down. Each word will be played twice.

1)

2)

3)

The speaker produced *Alan* (1), *fire* (2) and *shell* (3). *Fire* was intended as a foil, and is excluded from further discussion. *Alan* provided an /æl/ token, while *shell* provided /el/. We note that while both of these are nouns, the /æl/ token is from a person's name which may well affect the results given that one of the New Zealand English perception studies found that the names *Ellen* and *Alan* were perceived more accurately by listeners (Buchanan 2001, who suggests this may be a combination of lexical frequency and lexical diffusion effects, as well as the fact that the vowels may be clearer in initial position). Additionally, the syllable structure of the /el/-/æl/ items was different (i.e. /l/ was intervocalic in *Alan* and coda in *shell*), and so results are not directly comparable across the items. For all experimental tasks, the stimuli were played twice.

For the second (forced-choice) task, participants heard a word, and were asked to choose the correct option from a pair. Their instructions for this task are shown below.

B. Listen to the recording, and from the two options given, circle which word you hear. Don't worry if you are unsure, we are only interested in your first impression. It is important that you circle an answer for each question, even if you are unsure. If your answer is based on a complete guess, please circle one of the two words and then put a question mark next to the number. Each word will be played twice.

1)	shoe	show
2)	had	head
3)	had	head
4)	pellet	palate
5)	Allie	Ellie
6)	telly	tally

For this task, correct answers were *show* (1), *had* (2), *head* (3), *pellet* (4), *Ellie* (5), *tally* (6). Item 1 in this section was a foil, while items 2-3 aimed to determine how well listeners could distinguish non-prelateral tokens. Items 3-6 were experimental tokens. Here, another name is included (*Ellie*) but this time an /el/ as opposed to /æl/ contrast.

For the final forced-choice task, listeners heard word pairs and had to choose the correct pair from four possibilities. Their instructions for this are shown below:

C. Listen to the recording, and from the four options given, circle the pair of words you hear, in the order that you hear them. Don't worry if you are unsure, we are only interested in your first impression. It is important that you circle an answer for each question, even if you are unsure. If your answer is based on a complete guess, please circle one of the pairs of words and then put a question mark next to the number. Each pair of words will be played twice, and you will hear tone separating the first and second repetition.

1) (a) palate pellet	(b) pellet palate	(c) pellet pellet	(d) palate palate
2) (a) palate pellet	(b) pellet palate	(c) pellet pellet	(d) palate palate
3) (a) tally tally	(b) telly tally	(c) telly telly	(d) tally telly
4) (a) tally tally	(b) telly tally	(c) telly telly	(d) tally telly

Correct answers for this task were *pellet-pellet* (1c), *pellet-palate* (2b), *tally-telly* (3d) and *telly-telly* (4c). In this task, participants were faced with two non-contrastive /el/-/el/ items, and two contrastive /el/-/æl/ and /æl/-/el/ items. We note that in cases where the stimuli were the same (i.e. 1 and 4), listeners were presented with exactly the same audio simply played twice, as opposed to the speaker having said the item twice.

For both forced-choice tasks, participants were also asked to rate the difficulty of the task, as shown below:

Please rate how difficult you found this task (circle an option).

1 (very difficult)

2 (difficult)

3 (moderately difficult)

4 (moderately easy)

5 (easy)

6 (very easy)

4. Results and Discussion

4.1. Experiment 1

For the open-choice task in which listeners had to write down which word they heard, responses to the /æl/ token (*Alan*) are shown in Figure 3 below.

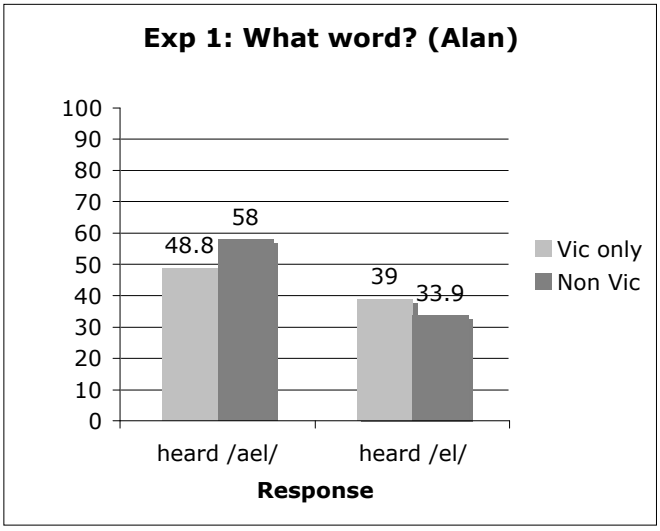

Figure 3. Responses to experiment 1 (correct word *Alan*)

Note that this figure focuses only on cases in which participants wrote *Alan* (the correct answer) or *Ellen*. Values here do not add up to 100% because cases in which participants wrote other words, or wrote nothing, have been excluded. The respondents who wrote nothing (i.e. those who most likely couldn't determine whether the answer was /e/ or /æ/), had a larger effect amongst the Victorian group (8.1% of cases for non-Victorians, 12.2% of cases for Victorians).

Firstly, we see from this figure that non-Victorians wrote the correct word *Alan* in more cases than the Victorians (58% compared to 48.8%). Additionally, while a relatively large proportion of participants in both groups heard /el/ (responding with *Ellen*), errors were more common amongst the Victorian listeners (39% compared to 33.9%).

Results for the /el/ token (in *shell*) are shown below.

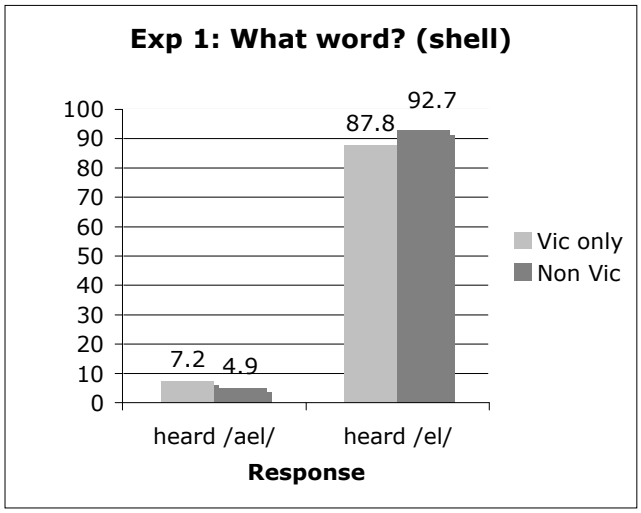

Figure 4. Responses to experiment 1 (correct word *shell*)

Again, this figure focuses only on the relevant contrasts, where participants wrote the correct word (*shell*) or *shall*. As above, cases in which participants wrote other words, or wrote nothing, have been excluded. However for this token, far fewer participants made errors or failed to respond (2.4% of cases for non-Victorians, 5% of cases for Victorians).

The divergence in responses across the two categories (where responses for /æl/ in *Alan* were correct far less often than responses for /el/ in *shell*) may have occurred for a number of reasons. Firstly, it is possible that listeners may simply have become accustomed to contrasts in this particular speaker's phonology, and hence the order of presentation (where *Alan* was presented before *shell*) helped listeners decide more easily that they had heard this speaker producing an /el/ in *shell* as opposed to /æl/ in *shall*. That is, listeners had been exposed to an /æl/ token from this speaker already, and whether or not they correctly perceived this, there was a point of comparison when presented with /el/.

Additionally, the fact that /el/ occurred in a monosyllabic word and /æl/ in a disyllabic word may have influenced listener responses. Similar to the current experiment, Thomas & Hay (2005) found that accuracy was significantly higher for New Zealand English listeners when presented with monosyllabic words compared to disyllabic words, even though acoustic differences in vowel production amongst the two sets of words were not significant. Thomas and Hay suggest that because vow-

els are significantly longer in the monosyllabic words in their data, listeners are afforded more opportunity to categorise the vowel correctly.[3] Related to this, the differing syllable structure of the words, with /l/ in intervocalic position in *Alan* and in word-final coda position for *shell,* may also have affected listener responses.

Finally, the results (where listeners performed relatively poorly when presented with *Alan*, and relatively well when presented with *shell*) may have been an artefact of the lexical categories to which the words belong. That is, the potential confusion for listeners where *Alan* is concerned would be within the same lexical category. Listeners needed to choose whether they had heard the male name *Alan* or the female name *Ellen*. In contrast, for the *shell* token, the issue is more complex than simply choosing a phonological contrast from one lexical category. Here, listeners needed to choose whether they had heard a noun (*shell*), or a modal auxiliary (*shall*). While these reasons are beyond the scope of the current investigation, it is possible that lexical frequency effects, or potentially even a noun bias, may well have influenced our results. We note that lexical frequency effects are probably the most likely influence on these results, as *shall* is a marked form rarely used in Australian English, and often associated with British English.

Here we have listed some possible methodological limitations, or motivating reasons other than sound change, which may have affected listener responses. Nevertheless, we found in experiment 1 that non-Victorian listeners more accurately perceived /æl/ tokens in *Alan* and /el/ tokens in *shell* when compared with the Victorian listeners – consistent with our pre-experimental expectations. Before moving on to experiment 2 we note that our results, where /el/ tokens were perceived more accurately than /æl/, accord with findings by Thomas (2004) for 16 New Zealand English listeners. Thomas relates these findings to exemplar theory, a model in which "all perceived tokens are categorised and stored, creating categories that directly represent the variation encountered" (Bybee 2001:51). As previously noted, this means that every time a listener hears a phoneme, it will be stored as an exemplar of how that phoneme may be produced. Under this model, exemplars are also

[3] See also Hajek & Maeda (2000) on similar vowel duration effects on perception in other contexts.

thought to be drawn from in production. So in dialects where the /el/-/æl/ sound change is underway (i.e. New Zealand English, Melbourne English) listeners' lexical categories for /æl/ contain only [æl] exemplars (from words like *Alan*), but their lexical categories for /el/ contain both [el] and [æl] exemplars (because some speakers in these communities produce words like *Ellen* with an initial /e/ vowel, whereas others use /æ/). Because of this, Thomas (2004:128) states that "/el/ tokens are more accurately perceived […] because within the lexical category for the /el/ word there are likely to be some [el] exemplars amongst the many [æl] exemplars, which are activated when the stimulus is perceived."

Relating exemplar theory specifically to our experiment, when listeners are presented with an /el/ stimulus in a word such as *shell*, only the /el/ lexical category is activated so listeners tended to choose the correct word *shell*. The relatively poor responses for /æl/ in *Alan* can also be explained under the exemplar model, because when listeners were presented with an [æl] token, the Victorian listeners (in particular) would have both /el/ and /æl/ lexical categories activated. Choosing the correct token would thus become almost a random exercise, as listeners are likely to have experienced [æl] for both /el/ and /æl/ stimuli.

While non-Victorians performed better than Victorians for this task, the fact that they now live in Victoria means that they are also more likely through direct contact to have [æl] exemplars in their /el/ lexical category, which may explain why the non-Victorians also made errors in this task. Another explanation for non-Victorians making errors in this category is the likelihood that there are incipient signs of this sound change elsewhere in Australia. Such an outcome would not be surprising given the high mobility amongst regions, as well as the fact that Melbourne English is often heard in the media (especially television and radio).

We note that while both groups of listeners tended to choose the correct word for the /el/ task, there were some exceptions in which the word *shall* was chosen (4.9% of non-Victorian listeners and 7.2% of Victorian listeners). This may also be explained under the exemplar model because as mentioned previously, some speakers in Victoria are producing transposed /el/ and /æl/ vowels. In this case, listeners in Melbourne/Victoria may well have (albeit fewer) [el] exemplars in their lexical category for /æl/.

4.2. Experiment 2

We turn now to results for the second, forced-choice, experiment. Figure 5 below shows the proportion of correct answers for all six items – both the three foils, the two /el/ tokens (*pellet* and *Ellie*) and the one /æl/ token (*tally*).

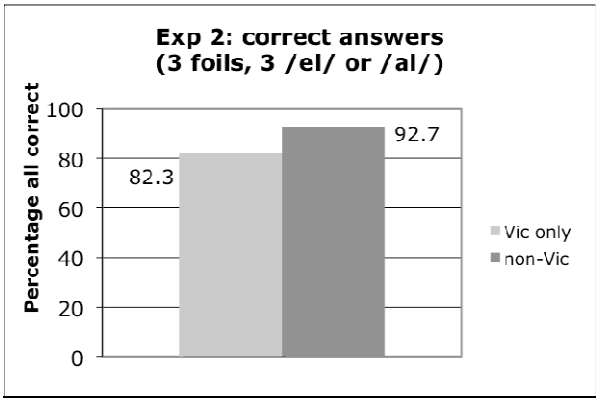

Figure 5. Correct responses, experiment 2 (all results collapsed)

Overall, it can be seen that the non-Victorian listeners made fewer errors than the Victorian listeners. Errors for the non-Victorian listeners occurred at a rate of 7.3%, while errors for the Victorian listeners occurred at 17.7%.

Figure 5 gives a general sense of results for this experiment, but also masks some important information. As far as foils are concerned, non-Victorian listeners made no errors. All 41 participants correctly chose *show, had* and *head* for the first three stimuli. For the Victorian listeners, ten errors were made amongst the 345 participants. Five participants wrongly chose *shoe* instead of *show,* four chose *head* when presented with *had*, and one listener chose *had* when presented with *head.* There are a number of explanations for these results. Firstly, we may expect the Victorian listeners to make more errors than the non-Victorians because of the size of the group. That is, the larger participant numbers in the Victorian group means there is more likelihood of error. Secondly, it may be the case that dialect difference caused confusion for the Victorian listeners where the *head-had* contrast is concerned. That is, because short front vowels produced by speakers from Sydney are somewhat higher than those produced by Victorian speakers, the Victorian listeners who made errors and chose *head* when presented with *had* may simply have been expecting a lower /æ/ vowel in this word.

It is clear that the majority of errors in this experiment occurred where listeners had to distinguish between /el/-/æl/ stimuli. For the non-Victorian listeners, only four errors were observed resulting in the error rate of 7.3% discussed above. Overall, three participants wrongly chose *Allie* when presented with *Ellie*, and one of these participants also wrongly chose *palate* when presented with *pellet*. For the Victorian participants there were 61 errors in total, and these are presented in Table 2. We note that four of the participants who made errors with the foils correctly identified the three /el/-/æl/ stimuli.

Error(s)	Correct response(s)	No. listeners
palate	pellet	17
telly	tally	16
Allie	Ellie	10
palate, telly	pellet, tally	5
palate, Allie	pellet, Ellie	3
Allie, telly	Ellie, tally	2

Table 2. Errors made by Victorian listeners (/el/-/æl/ contrasts only)

The most common error for the Victorian listeners was choosing the word *palate* for the *pellet* stimulus. In all, 25 listeners made this error (for 17 listeners this was the only error, for 8 listeners another error was made as well). The second most common misperception was choosing *telly* for the *tally* stimulus, which occurred for 23 listeners in total. For the *Ellie* stimulus there were somewhat fewer errors, with 15 listeners in total choosing *Allie*.

For experiment 2, participants were instructed to inform us if they had made a guess. Only a small subset of the Victorian listeners (13 subjects) made guesses, while none of the non-Victorian listeners did. For the Victorians, guesses were all made only for the three /el/-/æl/ stimuli. One listener made a guess for each three stimuli, three listeners made a guess for two of the stimuli, and nine listeners made one guess (for various stimuli).

In all, we have seen that again, the Victorian listeners made more errors than the non-Victorians. Assessing patterns in the results for experiment 2, we see that for the non-Victorians this was exclusively for /el/ contrasts (wrongly choosing *Allie*

and *palate* for *Ellie* and *pellet* respectively). Given the previous discussion, using an exemplar model we may expect /el/ tokens to be identified better than /æl/ tokens, because when listeners are presented with an [æl] token, both /el/ and /æl/ lexical categories would be activated. We suggested that non-Victorian listeners may also have both categories activated, given that they now reside in Victoria. However, here the reverse is true. This particular result may be partially explained by the order of presentation, where the two /el/ stimuli were presented before the one /æl/ token. It may be the case that these listeners were all able to correctly identify /æl/ once they had heard the two /el/ tokens produced by this speaker. It is possible also that the non-Victorian listeners were hypersensitive to the /el/-/æl/ sound change, and may have chosen /æl/ because they are aware that this is a possible variant of /el/ in Victoria (and were unaware that the speaker was from Sydney). The idea that listeners can shift their perception based on the dialect of the speaker has been explored by Hay et al. (2009) who showed that New Zealand English participants were less likely to produce merged *near-square* tokens, and to report that that such tokens were the same in perception tests, when they met with a researcher who spoke a variety of American English as opposed to New Zealand English. Hay et al. (2009:283) conclude that participants accommodate to the dialect of the researcher, and that "[e]xposure to another dialect […] shifts participants' production (and perception) of vowels undergoing merger". The researcher who carried out this experiment was from Melbourne and does not distinguish /el/-/æl/ in production, and so, aside from possible shifts in perception based on the participants' expectations about the speaker of the stimuli, we also cannot rule out the effect that the researcher had in our study.

Finally, it is possible that the non-Victorian listeners who made errors for these stimuli were affected by the same misperception that we attest occurs for Victorian listeners. That is, our Sydney speaker was likely producing lower /e/ variants in the prelateral condition (compared to the stimulus presented in *head*), and the non-Victorian listeners who made errors may well have perceived these lower variants as [æ].

For the Victorian listeners, the fact that fewer errors were made with the name *Ellie* (compared to *pellet* and *tally*) is unsurprising. This accords with results seen in

New Zealand English (e.g. Buchanan 2001) where names were identified at higher levels than words in other categories. For the *pellet* and *tally* stimuli, results were almost equal, but slightly more listeners (two) made mistakes with *pellet* compared to *tally.* As for the non-Victorians listeners, listeners made more errors with /æl/ stimuli (although for this group, there were also a relatively large number of errors for this token). Again, this may well have been related to order of presentation, with *pellet* being the first /el/ token listeners were presented with, and the /æl/ stimulus presented last, giving an opportunity for listeners to become accustomed to the contrast.

The limitation discussed for experiment 1, where vowels in monosyllabic words have been found to be recognised more readily than those in disyllabic words, does not apply here as all three /el/-/æl/ tokens occur in disyllabic words.

As mentioned above, listeners were asked to rate how difficult they found experiment 2 along a scale from 1-6 (very difficult to very easy). Results are presented below.

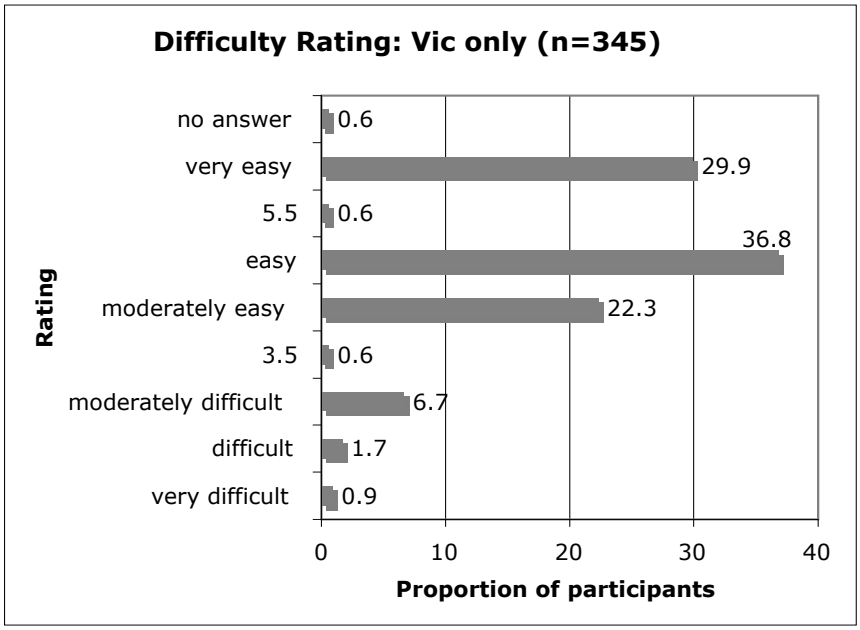

Figure 6. Difficulty ratings for experiment 2, Victorians
(The categories 5.5 and 3.5 are explained in the text below)

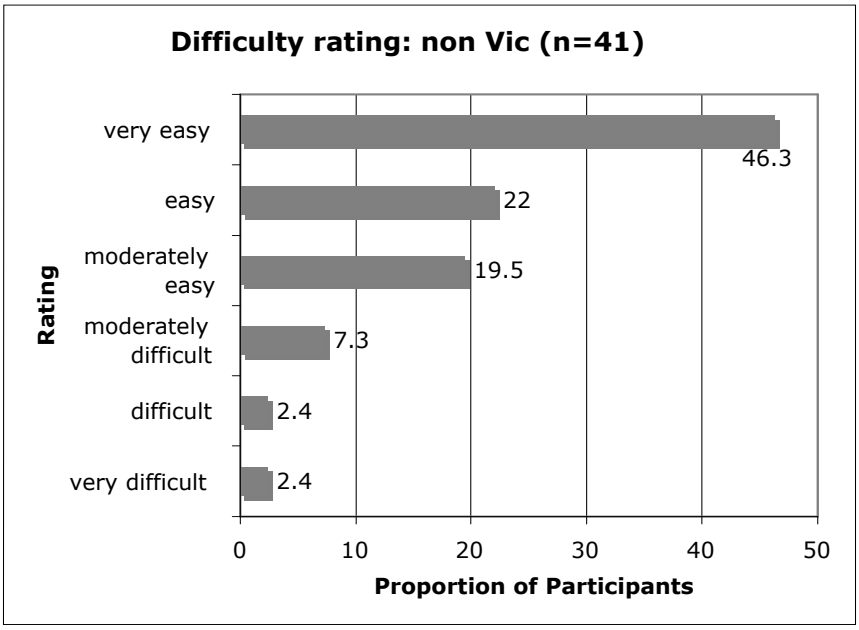

Figure 7. Difficulty ratings for experiment 2, non-Victorians

The first point to note from these figures is that the Victorian listeners have a greater number of points on the scale of difficulty, which was introduced by a small number of participants who placed a mark between the given categories.

Focusing firstly on the non-Victorian listeners, 46.3% chose the "easiest" point on the scale, *very easy*. 22% chose *easy*, and 19% chose *moderately easy.* 12.1% of the non-Victorians chose a point on the scale indicating some degree of difficulty. By way of contrast, for the Victorian listeners the primary response was *easy*, with 36.8% of participants choosing this point on the scale while only 29.9% said the task was *very easy*. Slightly fewer Victorians than non-Victorians indicated actual difficulty with the task, with 9.9% of this group choosing some degree of difficulty compared to 12.1%. However, we note that the actual numbers of participants in these groups are of course vastly different, with the 12.1% of non-Victorians equating to 5 listeners in total, and the 9.9% of Victorian listeners equating to 34 listeners.

Both groups of listeners overwhelmingly reported that they found the task easy. It is clear, nevertheless, that the non-Victorian listeners found it easier overall than the Victorian listeners. This is in line with our expectations that misperception would

occur more readily amongst Victorian listeners where /el/-/æl/ distinctions are concerned.

4.3. Experiment 3

The final experiment was a forced-choice task in which listeners heard word pairs and had to choose which pair they had been presented with from four possibilities. Overall results are shown in Figure 8 below, which shows the number of listeners who made correct responses for all four stimuli.

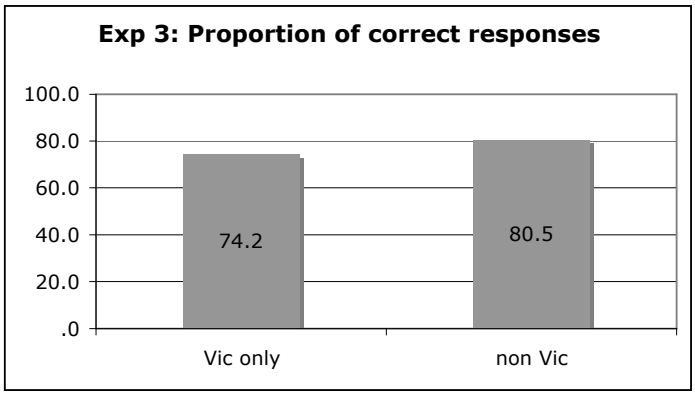

Figure 8. Proportion of correct responses to experiment 3

Here we see that both groups of listeners made a number of errors, with the Victorian listeners making somewhat more errors than the non-Victorians. For the Victorians, the 74.2% correct responses are from 256 of the 345 listeners, while for the non-Victorians, the 80.5% of correct responses are from 32 of 41 listeners.

For the non-Victorians, the types of errors made were minimal and only in the first stimulus presented, which was *pellet-pellet*. Here, eight listeners chose *palate-pellet*, while one listener chose *palate-pellet*. These were the only errors in this task for the non-Victorian listeners, all other responses were correct.

For the Victorian listeners, errors were more varied and made by far more participants amongst this group. As for the non-Victorians, the most common error was also made for the first stimulus presented – 31 listeners chose *palate-pellet* for the *pellet-pellet* stimulus. Another 13 Victorian listeners also chose *pellet-palate*, while another five chose *palate-palate*. The next most common error was for the fourth stimulus *telly-telly*, with seven Victorian listeners choosing *tally-tally*. The remaining errors made by Victorian listeners were varied and lacked clear patterns unlike

those already described, with errors made across all stimuli. Additionally, aside from errors, five Victorian listeners made no response to various stimuli, with between one and three missing answers for each of these listeners. Two of the Victorian listeners also made guesses, with one listener making one guess and the other making two guesses.

Results for experiment 3 show that errors were made by both groups of listeners. As in experiment 2, the non-Victorian listeners made errors only in the first task they were presented with, and this was also the most common source of error for the Victorian listeners. The stimulus presented to listeners here was two /el/ tokens in exactly the same word. Amongst the errors made for this stimulus the most common response chosen were listeners reporting a difference between the two words, as either /æl/-/el/ (the majority of listeners) or /el/-/æl/, and some Victorian listeners also chose /æl/-/æl/. We note that the most common incorrect response for this stimulus was also the first possibility of four that listeners were presented with (i.e. *palate-pellet*). The fact that non-Victorians made no errors for the remaining three stimuli, and Victorian listeners made fewer errors, suggests that listeners may well "learn" how a particular speaker makes the contrasts in question, consequently making fewer errors as the task progresses. Interestingly however, the responses made by Victorian listeners cannot be fully explained by order of presentation, and indicate a level of confusion about the stimuli. The second most common error for Victorian listeners was in the other /el/-/el/ stimulus (*telly-telly*) which was presented to listeners last. So while Victorians also made more errors in the first task in experiment 3, it appears that the /el/-/el/ stimulus was especially problematic perceptually. As well as this, confusion amongst the Victorian listeners is also suggested by the fact that some participants neglected to make a response for some stimuli, and two listeners reported that they had made a guess.

Turning now to listeners self-report on how difficult they found the task, responses for experiment 3 are listed in the figures below.

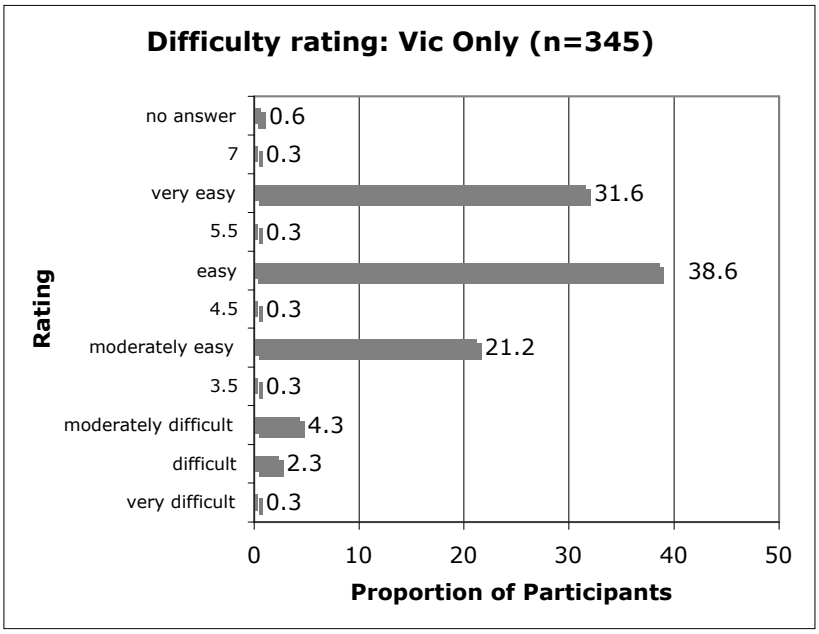

Figure 9. Difficulty ratings for experiment 3, Victorians

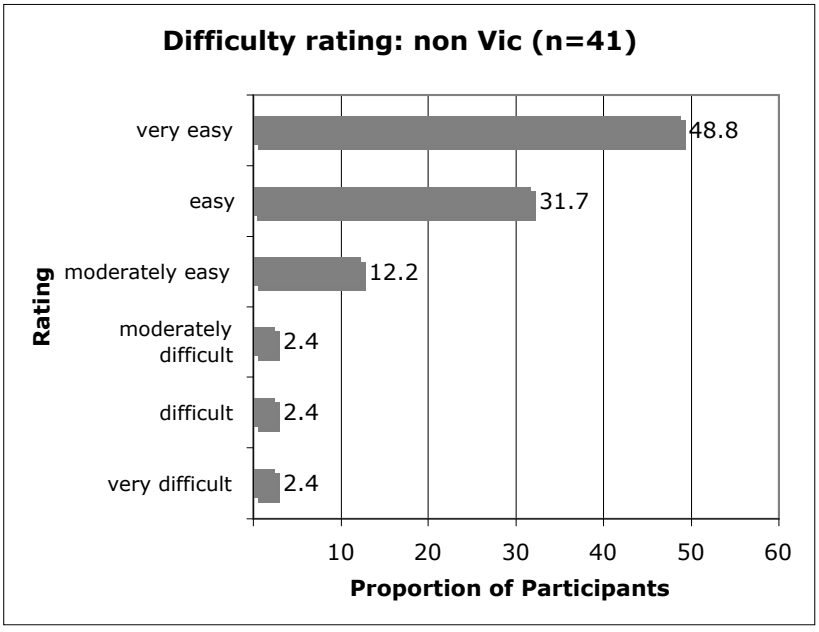

Figure 10. Difficulty ratings for experiment 3, non-Victorians

Again, it can be seen from this figure that Victorian listeners made more varied responses than the non-Victorians, with a number of listeners placing a mark between the given categories. As can be seen by comparison of the above figures, the Victo-

rian listeners found the task more difficult than the non-Victorians overall, as in experiment 2. Almost half of the non-Victorians (48.8%) chose the easiest point on the scale *very easy*, while less than a third of the Victorian listeners chose this option (31.7%). For the Victorian listeners, the most common response was *easy*, with 38.6% of listeners choosing this option compared to 31.7% of non-Victorians. Additionally, a greater number of Victorian listeners (21.2%) reported finding the task *moderately easy* compared to non-Victorians (12.2%). Finally, slightly more non-Victorians reported a degree of difficulty with the task compared to the Victorian listeners (7.2% compared with 6.9%). This pattern of results was also seen in experiment 2, although in the earlier task reports of difficulty were more frequent.

For all experiments, chi-square tests ($p = 0.05$) were carried out to determine whether differences across the Victorian and non-Victorian groups were significant. No statistically significant differences were observed across the groups. However, as seen throughout this section, we observed a greater trend for misperception of /el/-/æl/, and a greater trend for finding the tasks more difficult, amongst the Victorian listeners.

The fact that no significant differences were observed across the groups may be indicative of the imbalance of sample sizes as well as a number of issues relating to the /el/-/æl/ sound change which have not been addressed here, but which we discuss in detail in Loakes, Hajek and Fletcher (in preparation). That is, precise regional boundaries still need to be determined for this phenomenon – it may well be the case that the /el/-/æl/ sound change is not confined to Melbourne and Victoria. Our listeners who were classed as "non-Victorian" were all collapsed into one group, which, aside from the fact that the listeners are Australian, completely masks regionality – at both state and more local levels. Additionally, we have not addressed sociophonetic effects, in particular the age and sex of the listeners. Analysis of age is particularly important for future work, especially because the non-Victorian listeners in our study tended to be teachers, and therefore older, than the Victorian listeners. As such, it is possible that this introduced age effects which we have not been able to separate out from the overall results.

5. Conclusion

With respect to our research questions, we observed evidence of misperception amongst listeners from Melbourne/Victoria regarding vowels in /el/-/æl/ contexts, and related to this, that listeners from other regions in Australia performed better on the same tasks. This was seen across all three experiments, in which listeners from Melbourne/Victoria consistently performed worse than listeners from elsewhere in Australia when presented with /el/-/æl/ stimuli. Additionally, in some cases listeners from Melbourne/Victoria reported guessing their responses, and they also failed to respond to certain stimuli. In contrast, non-Victorians never reported guessing, and responded to all stimuli in the forced-choice tasks. Finally, with respect to how difficult listeners found the forced-choice tasks, both groups tended to report that they had found the tasks relatively easy, but Victorians reported more difficulty overall.

The three experiments reported here provide the first results into how two groups of Australian English listeners respond to /el/-/æl/ stimuli, and we have seen evidence that the /el/-/æl/ sound change exists in perception for Melbourne/Victorian listeners. While Victorian listeners had, and reported, greater difficulty distinguishing /el/-/æl/ contrasts, a large number of Victorian listeners were also able to distinguish the vowel categories. As such, while we call this phenomenon a sound change, it appears that the sound change is certainly one that is in progress, as opposed to being complete. This is also supported by production results, especially where different speakers are found to produce different categories of vowels (i.e. Loakes 2008).

Methodological limitations with the study were discussed above, and some further limitations which arose throughout the course of the research should also be noted. Firstly, the unbalanced nature of our respondent samples is limiting. Future testing in this area requires a much larger sample of non-Victorian participants, and preferably those resident outside Victoria to more fully control for regional variation, and the potential effect of residing in Victoria.

Secondly, the open-choice task, while providing some interesting results, was too difficult for many listeners when played over loudspeakers. As mentioned, a relatively large number of listeners from both groups either misheard the stimuli completely in experiment 1, or failed to respond at all. Because these kinds of errors

were rare in experiments 2 and 3 (and were made solely by Victorian listeners) this may be an artefact of the way the experiment was conducted. Additionally, we were unable to determine the effect that syllable structure had on listener responses. Future work needs to control for both mono- and multisyllabic words, as well as for the syllabic position in which /l/ occurs.

Thirdly, while our study made reference to lexical frequency effects as a possible reason for participant preferences, focusing on this was outside the scope of the current investigation. Future work should account for lexical frequency effects in both designing perception tests and interpreting responses, so as to more fully appreciate their effect.

Another limitation of the study was the lack of stimuli containing other prelateral vowels. While we included some vowel contrasts in non-prelateral contexts (i.e. *head, had*), interpretation of the results would have been greatly enhanced had we included word pairs with other prelateral vowels, given that perceptual confusions are known to be common in this environment. That is, while we have seen that many Melbourne/Victorian listeners in particular had difficulty distinguishing /el/-/æl/ contrasts, we do not know how well they can distinguish other /Vl/ contrasts. Adding this element to future work, along with a greater number of foils, would also assist with the potential problems caused by order of presentation of the stimuli. This is because speakers would be presented with varying vowels, not simply /el/ and /æl/ vowels played in succession.

Additionally, while we know from previous studies that Melbourne/Victorian listeners often merge /el/ and /æl/ (or produce /el/ very differently from /eC/), we have no information on how the listeners in this experiment produce /el/-/æl/ contrasts. While this was unavoidable given the nature of the data collection, future research should investigate how the same participants both produce and perceive /el/-/æl/ contrasts in Australian English, as was the case in research carried out by Thomas (2004) for New Zealand English. Thomas (2004) found great variability in how well participants could perceive /el/-/æl/ contrasts in their own speech and the speech of others, with accuracy ranging from accurate (sometimes) to only slightly above chance (much more commonly). However, he found no significant correla-

tion between the ways in which participants produced /el/-/æl/ contrasts and the way they perceived them, in either real or nonsense words.

Finally, while listeners were asked to report how difficult they found the forced-choice tasks, no analysis was made to determine whether listeners who reported difficulty with the task actually made more errors than listeners who reported finding the task easy. Future research in this area should determine whether responses are correlated, and hence whether this is an effective question to include in such an experiment.

Despite these limitations, this study has provided perceptual data for a large number of Australian English listeners, where previously only production results have been reported. This study has shown that the /el/-/æl/ sound change also occurs in perception for some listeners, and that it occurs primarily for listeners from a well-defined region in Australia (Melbourne/Victoria). While no significant differences were observed across groups, consistent trends were seen – in line with our expectations before undertaking the experimental work. As well as this, patterns in results from the current investigation have indicated that another (potentially related) sound change, /el/-/æl/ transposition, may have affected the way in which listeners respond to /el/-/æl/ stimuli.

Overall, our preliminary perception study, along with previous production work, accords with Ohala's (1993) model of why sound changes occur – with (some) listeners not accounting for coarticulation, and hypercorrection ensuing. This suggests that, as observed for many sound changes, the /el/-/æl/ sound change also has both articulatory and perceptual bases. Where this phenomenon is concerned, articulatory bases are lowered /e/ vowels and retracted /l/ variants in both syllable onsets and codas, while the perceptual basis (hypercorrection from listeners) means that lowered prelateral /e/ vowels are interpreted as /æ/. However, further work is needed to understand the complex relationship between production and perception where both the /el/-/æl/ sound change and /el/-/æl/ transposition are concerned, especially given that our results show varied responses from listeners from the same region.

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