

# Varietal differences in categorisation of /ɪ e æ/ A case study of Irish and Australian English listeners in Melbourne

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## Abstract

This paper presents results of a vowel categorisation task of front lax vowels in /hVt/, /hVl/ and /mVl/ contexts, by 12 native Australian English speakers and 10 Irish migrants residing in Melbourne. Results show significant differences in how listeners categorise these vowels, in five out of six phonetic contexts. Vowels suggested to be undergoing merger in Victoria, specifically /e/-æ/, are not perceived as merged, indicating this phenomenon may be stratified and/or more age-graded than previously reported. Results show clear differences between listeners sharing an L1 but speaking different dialects, even when these dialects are in direct contact due to migration.

**Index Terms:** second dialect acquisition (perception), vowel categorisation, Australian English, Irish English

## 1. Introduction

### 1.1. Background

Australia has long been known as a “classical immigration country”, whereby the inflow of individuals taking up residence in Australia far outweighs the outflow, the numbers of individuals that leave Australia for elsewhere [1]. The larger cities of Australia are viewed as highly multicultural, ‘superdiverse’ [2], and multi-layered, with ongoing immigration resulting in diversification of urban areas, where new migrants settle amongst those who are more established. The number of migrants taking up residence in Australia is currently on the increase, particularly from Ireland, where there has been a long tradition of emigration, particularly to English-speaking countries. Between 2006 and 2014, there was a 39% increase in Irish-born people residing in Australia [3].

Despite increased contact due to migration, there exists a paucity of research into how speakers of the same L1 (English), but a different dialect, produce, process and perceive the sounds within these dialects. This study focuses on how native Irish English (IrE) speakers residing in Australia categorise /ɪ e æ/ in an experimental task. These vowels are of particular interest in the Australian English (AusE) context, as they are reported to have changed substantially over the years, raising “to a peak height” and then lowering again [4], to a point where [æ] is considered at the bottom of the vowel space [5]; see also [6], and can thus be challenging for native AusE listeners [7, 8]. Additionally, in Melbourne where the current study is carried out, a vowel merger is known to be in progress in the community, where /e/ → /æ/. This pre-lateral context is thus also particularly variable in production and perception [7]. While previous research into perception of AusE by native

listeners is limited, Mannell [8] has shown that the perception of these particular AusE vowels has certainly shifted over time, so that the perceptual boundary between /ɪ/-e/ is higher than it once was, while for /e/-æ/ it is lower. Mannell [8] attributes the shifted perceptual boundaries to accompanying diachronic production, reported in particular by Cox (e.g. [5]). The processing of vowel merger has also been shown to be highly variable, as well as being somewhat age-graded [7] and also geographically defined [9, 10].

### 1.2. Variability in second dialect processing

As noted by Sumner and Samuel [11] “listeners are confronted by a remarkably variable signal when they understand spoken language [...] and a central issue in the perception of spoken language [...] is the ways in which this variation is accommodated.” While this is a complex issue for first language processing (see also [12]), even greater complexity is evident when listeners are faced with a second dialect, given the need to deal with multiple linguistic systems (cross-language perception is of course another related matter, but outside the scope of this study).

Second dialect acquisition, and its interaction with sociophonetics, gives us insight into how people cope with speech and communication in their new environment(s). Perception research in this area is relatively limited; but opens up a better understanding of “how sounds and words are learned, represented, processed and linked to social information” ([13]; see also references therein).

Evans & Iverson [14] discuss the issue of second dialect perception as one of potential accent normalisation, where “listeners may be able to fully adjust to vowel differences between accents, provided that they have had previous experience with similarly accented speech”. They assessed how listeners of the same language (English), but of different British dialects, categorise vowels – to determine whether exemplar locations change due to the accent being listened to. Listeners from London heard two different accents and gave goodness ratings for vowel phonemes. Results were complex, but some crucial findings were that listeners were able to adjust their perception depending on the accent, and that in various ways participants’ own backgrounds and production impacted responses. The finding regarding production correlates with a study by Allen & Miller [15], who found that “speech-specific experience” likely weighs heavily in guiding listeners to make choices about phoneme categorisation.

### 1.3. The ‘Superdiversity’ project

The vowel categorisation task in this study was completed by participants as part of a larger study examining second dialect and second language acquisition among two migrant groups (Irish and Chinese) in Melbourne, along with a ‘control’ group of native AusE speakers (see 2.2). The study included the recording of sociolinguistic interviews and wordlists, as well as the recording of ultrasound images of participants reading a wordlist. The vowel categorisation task was generally the last or second-to-last task to be completed by participants, and took approximately fifteen minutes to complete. While reaction times were recorded, they are not reported on here. While the study is in the early stages of analysis, we have previously found that in production (wordlists), the IrE female participants in this study have on average lower and more retracted front lax vowels than the AusE female participants [16], which may well have an impact on the way they in turn categorise vowels. It is important to note that there is to date no comparable research with IrE listeners who have never left Ireland.

### 1.4. Aims

The broad aims of this study are to compare how IrE listeners, living and working in Melbourne, categorise AusE vowel stimuli as compared to native listeners. As such, this study tests whether ‘perceptual learning’ or ‘accent normalisation’ has taken place, or whether IrE listeners are driven by exemplars from their own accents when categorising vowels. Using vowel continua, we interrogate the potential nuances within crossovers between vowel categories in perception, and what happens in different consonantal environments (i.e. how the listeners deal with coarticulation).

#### 1.4.1. Research Questions

1. Are there differences in how Irish migrants and native AusE listeners categorise the lax front vowels /i e æ/ (in ‘control’ condition /hVt/) produced by a native AusE speaker?
2. (a) How do Irish migrants and native AusE listeners respond to vowels in coarticulated contexts; prelateral /hVI/ and nasal onset prelateral /mVI/?
- 2 (b) Are there differences between the Irish migrant and AusE listeners in the categorisation of vowels known to be undergoing sound change (merger) in southern Victoria, specifically /eI-æI/?

## 2. Method and analysis

### 2.1. Experimental task

The phonetic categorisation task is a forced-choice identification task, presented on an iPad using a specifically designed custom app. Individual words were played to listeners via headphones (Shure SRH840 Reference Studio Headphones) and items were also presented orthographically on ‘buttons’ on the screen. Of the two options presented, listeners made a choice by pressing which of the two items they had heard before moving on to the next item. To create the stimuli, seven-step continua were created using the Akustyk vowel synthesis module [17] in Praat [18]. The continua we use in this study all involve front lax vowels in various contexts, broadly /hVt/, /hVI/ and /mVI/, and include a mix of low and high frequency words, and include proper names. The experiment includes a

number of back vowel stimuli, but we do not report on these here. The items used in this study are shown in Table 1 below.

Table 1. *The six continua analysed in this study. Predicted merger conditions (see [7, 9]) are bolded.*

Phonetic context	/i-e/	/e-æ/
/hVt/	<i>hit-het</i>	<i>het-hat</i>
/hVI/	<i>hill-hell</i>	<b><i>hell-hal</i></b>
/mVI/	<i>mill-Mel</i>	<b><i>Mel-Mal</i></b>

Listeners were timed for each item, and they could not replay the item, go backwards in the experiment, or change their mind once a decision was made. Each item was presented four times, with the orthographic representation shown twice on the left side of the screen, and twice on the right. Listeners were aware they were listening to AusE – the overall study was described to participants as being about the adoption of AusE.

### 2.2. Participants

In total, 12 Australian (7F, 5M) and 10 Irish (5F, 5M) took part in the study and completed the vowel categorisation task. The AusE speakers were all born and raised in Melbourne and had not spent any significant period of time (more than 1 year) outside Melbourne. The Irish migrants came from different towns and villages across the island of Ireland (North and South) and had migrated to Australia at various stages throughout the 2000s, with lengths of residence in Australia ranging from 1 to 14 years. Seven of the ten Irish migrants had only ever lived in Ireland and Australia; three had also lived elsewhere (UK: 2 years and 11 years; USA: 2 years). Year of birth among all participants ranged from 1976 to 1991, with the average age of the Australian group at 33, and for the Irish group at 35.

## 3. Results

### 3.1. Dialectal differences in /hVt/ perception.

Response curves for the control continua, fit using logistic functions in the *quickpsy* [19] package for *R* [20], are shown in Figure 1, with /i-e/ on the left, and /e-æ/ on the right.

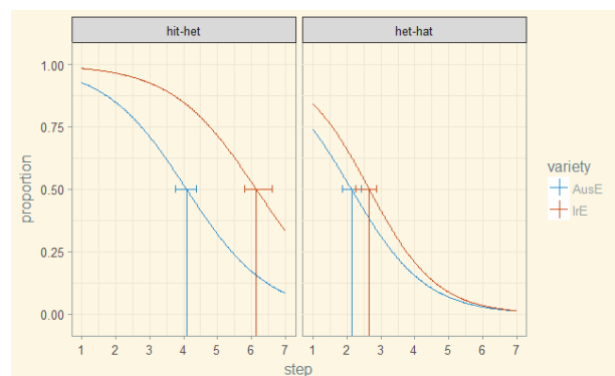


Figure 1. *Response curves for the control conditions /hit-het/ and /het-hat/*

Figure 1 shows that the AusE and IrE listeners have significantly different crossover points for /i-e/, with the AusE listeners switching categories at Step 4 (the mid-point of the 7 stimuli) and IrE listeners crossing over much later at Step 6.

Exact crossovers are also shown in Table 2 further below. This suggests IrE listeners need an acoustically lower and more retracted vowel to classify a token as /ɪ/ compared to AusE listeners. Considering the endpoints of the /ɪ-e/ continua, 100% agreement was reached only for Step 1 of *hit* and only for the IrE listeners. 100% agreement was not reached for the AusE listeners for either end of the continua for this contrast. Furthermore, at Step 7 the majority of AusE listeners switch categories to /e/, but this is not true for the IrE listeners, who in many cases categorise Step 7 as /ɪ/.

For the /e-æ/ contrast, there is more agreement amongst the listener groups, in the sense that there is no significant difference in the crossover from /e/ to /æ/ (see also Table 2). Additionally, both listener groups have switched to hearing *hat* at Step 7. At Step 1, there is a lack of certainty for some listeners, so 100% agreement is never reached for *het*, and there is also an overall bias towards *hat*.

Table 2. *Modeled crossover points for /hVɪ/ control condition showing 95% upper and lower CI*  
\*indicates significant differences

Contrast pair	Variety	50% cross-over	95% CI lower	95% CI upper
<i>hit-het</i> *	AusE	4.09	3.73	4.37
	IrE	6.14	5.79	6.51
<i>het-hat</i>	AusE	2.13	1.68	2.46
	IrE	2.65	2.30	2.95

### 3.2. Coarticulatory effects on categorisation

Figure 2 shows that both IrE and AusE listeners have 100% agreement for *hill*. For the IrE group however, a *hill* response is sustained until around Step 5, while the AusE listeners have a gradual decline in *hill* responses until the category crossover at almost exactly Step 5. While the majority of AusE listeners hear *hell* at Step 7, there is still a large number of Irish listeners preferring *hill*.

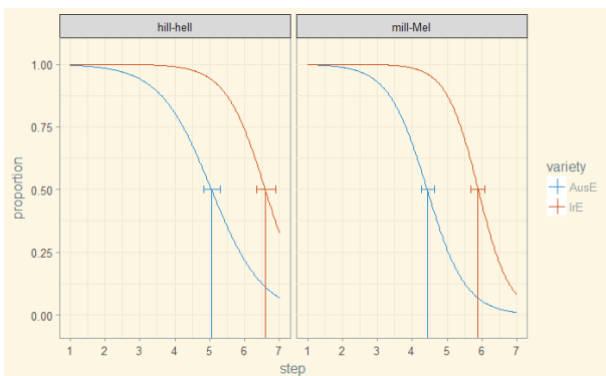


Figure 2. *Response curves for /hill-hell/ and /mill-Mel/*

For /mill-Mel/, responses are very similar to /hill-hell/, in that the IrE group sustain *mill* responses for longer than the AusE group, and again there are significant differences in the crossovers. As seen in both Figure 2 and Table 3, however, the crossovers are slightly earlier in this nasal onset condition.

Table 3. *Modeled crossover points for /ɪ-e/ continua in /hVɪ/ and /mVɪ/ showing 95% upper and lower CI*  
\*indicates significant differences

Contrast pair	Variety	50% cross-over	95% CI lower	95% CI upper
<i>hill-hell</i> *	AusE	5.05	4.85	5.29
	IrE	6.59	6.36	6.87
<i>mill-Mel</i> *	AusE	4.43	4.24	4.60
	IrE	5.89	5.74	6.09

Continuing with the issue of coarticulation, and now including the ‘merger’ context, response curves for the /el-æ/ condition are shown in Figure 3. This shows significant differences between how the IrE and AusE listeners respond. For the /hell-Hal/ context the AusE listeners have a crossover at Step 4 (essentially the exact acoustic midpoint); whereas the IrE listeners have a very late crossover: close to Step 6 (see also Table 4). When a nasal is present, the crossovers are somewhat earlier; as seen in Table 4, it is half a step earlier for the AusE listeners and a full step earlier for the IrE listeners.

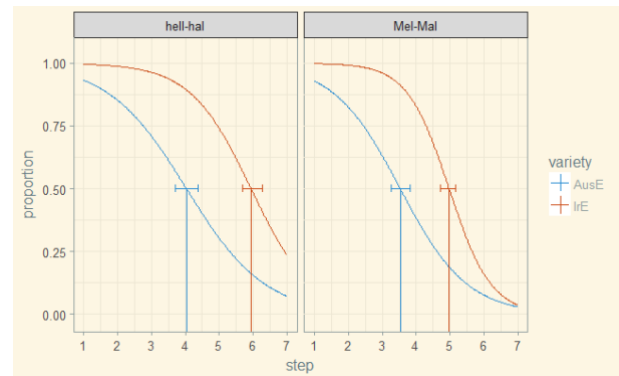


Figure 3. *Response curves for /hell-Hal/ and /Mel-Mal/*

The /hell-Hal/ context is dubbed the ‘merger condition’, but there is little evidence for a merger in perception among the AusE listeners, as well as (less surprisingly) for the IrE listeners. The endpoints of the continua show that the majority of AusE listeners hear *hell* at Step 1 and *Hal* at Step 7 – indicating very little ambiguity. Previous research showing a merger in perception shows listeners: (a) have a preference for *hell*; and (b) have a tendency for answering at random by point 7 (if [eɪ] can be the same as [æɪ]), then it follows that people cannot accurately categorise Step 7), [e.g. 7, 10]. While many of the IrE listeners are still answering *hell* by Step 7, these results tend to mirror the other continua analysed so far, with IrE listeners having a late crossover and lack of agreement at this stage, rather than a merger in perception.

Table 4. *Modeled crossover points for merger condition /el-æ/ showing 95% upper and lower CI*  
\*indicates significant differences

Contrast pair	Variety	50% cross-over	95% CI lower	95% CI upper
<i>hell-Hal</i> *	AusE	4.03	3.76	4.34
	IrE	5.94	5.70	6.26
<i>Mel-Mal</i> *	AusE	3.53	3.21	3.78
	IrE	4.97	4.75	5.19

## 4. Discussion and conclusion

The results presented in this paper show differences in categorisation behaviour by IrE and AusE listeners when responding to AusE stimuli. The findings show that Irish participants tolerate a higher F1 and lower F2 (a more open and retracted vowel) before switching to the next category in each of the following pairs: *hill-hell*, *hell-Hal*, *mill-Mel*, *Mel-Mal* and *hit-het* – IrE listeners had significantly different crossovers from the AusE listeners in these cases. The *het-hat* contrast was an exception. Lack of certainty amongst the IrE and AusE listeners for /e/ in Step 1, and the early crossover for both listener groups, could be a word frequency effect (*het* is infrequent) or could be related to the fact that both listener groups simply require a phonetically higher vowel in this context. On the issue of the vowel crossovers for IrE and AusE listeners, we can say that while AusE vowels have lowered and retracted over time (e.g. [4]); in perception, the IrE cohort has even lower and more retracted vowels. For the female speakers at least, this corroborates with their production of close front vowels (i.e. [16]).

Addressing the effect of coarticulation on perception, the results of this study mirror expectations. For the AusE listeners, crossovers are always latest for /hV/ contexts, and earliest for the control condition. The context with a nasal falls in between, indicating a “push and pull” between anticipatory and carryover coarticulation. For the IrE listeners this pattern is also observable, but only in the /e-æ/ condition. For /ɪ-e/, the nasal onset has the earliest crossover followed by the control condition, and finally the prelateral (crossovers are all quite close for the IrE listeners, however, all falling between 5.89 and 6.59). Despite varietal differences, for the cohort as a whole, the lateral lowers the vowel in perception (‘downshifting’ – category crossover is later) and the nasal onset raises the vowel in perception (‘upshifting’ – category crossover is earlier). Previous research on vowel merger in perception, using precisely the same research tool as this study, has shown varying degrees of ambiguity in categorisation of /eɪ-æɪ/ in southern Victoria (see 1.1). However, in this study we have little evidence of merger by the native Melbourne listeners. While still to be independently verified, this may be highlighting an age-graded phenomenon, whereby younger listeners are now *not* merging in perception. This may have gone unreported previously as listener groups in earlier studies have been older than the participants here.

Finally, results show that the response curves work well for native AusE listeners, with the crossover points largely in the centre of Step 1 and Step 7. This is unsurprising as Step 4 is an acoustic midpoint synthesised from real speech stimuli by an AusE speaker. The *het-hat* context is an exception, with many of the listeners biased toward *hat*, as discussed. The vowel continua do not ‘match’ in the same way for IrE listeners (less agreement; very late crossovers). This finding gives support for the idea that listeners are very much guided by their own dialects in making vowel phoneme judgements [following 14,15]). The IrE listeners, despite listening experience (to varying degrees through living, studying and working with Australians), still ‘hear’ through their first dialect. Future research with these participants will test the effect of length of residence to see whether prolonged exposure to AusE results in changes in categorisation behaviour.

This study provides solid support for the idea that people’s dominant dialect (in which they have received the most exposure, and which they evidently speak) influences their categorisation of vowels in a second dialect. The study also opens up the question of the amount of processing difficulty (and even possible misunderstandings) caused in a new dialect environment, despite the shared language. We will address this in future research, comparing processing times across the IrE and AusE cohorts, and with more fine-grained analyses relating to individual participants’ own productions.

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