Nasalisation of /æ/ and sound change in Australian English

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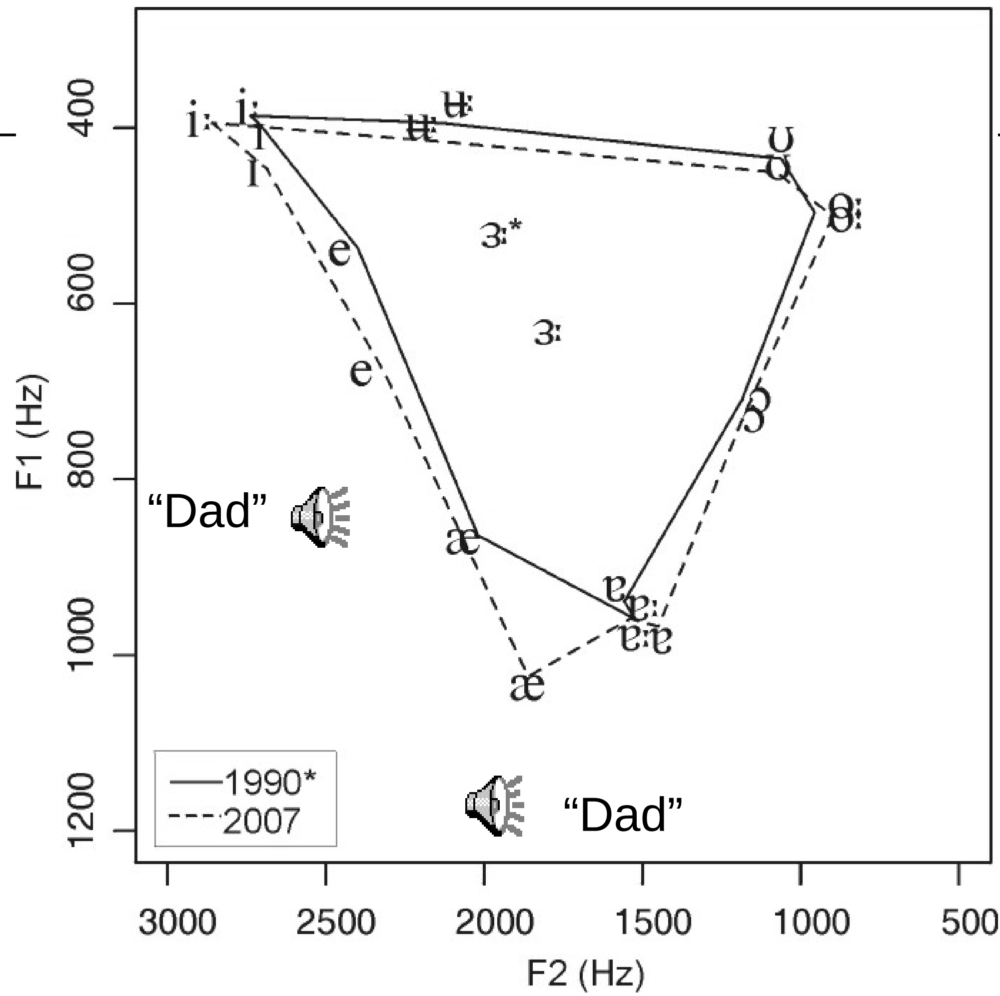
Background

- Recent innovation in Australian English (AusE)
  - lowering of the short front series of vowels /æ, e, ɪ/ (TRAP, DRESS, KIT) (Cox and Palethorpe, forthcoming).
- This change began with /æ/ and can be considered a reversal of short front raising
  - determined through apparent time and real time studies (Cox 1999; Cox and Palethorpe 2001).
- Present day /æ/
  - located at the extreme open position of an inverted triangular vowel space in many speakers - previously near Cardinal 3 (Cox & Palethorpe, 2007)

Australian English Monophthongs



Cox and Palethorpe, forthcoming

Token Frequency

- In exemplar models, words that have a high probability of occurrence (token frequency) are believed to skew the distribution of a phoneme in the direction of change (Bybee, 2004; Pierrehumbert, 2002).

- Therefore, in present day AusE, the lowest /æ/ variants should occur in high frequency words.

Contextual Variability

- Equally, we would expect distribution skewing, to result from phonetic environment.

- The vowel /æ/ is interesting because it is substantially influenced by the nasal context.

- Numerous studies have shown that nasalised /æ/ is phonetically raised relative to its oral counterpart (see e.g. Beddor and Hawkins, 1980; Beddor, 1993 etc).

AusE nasalisation of /æ/

- The raised quality of the nasal allophone of AusE /æ/ has been the subject of comment for over 100 years (e.g. McBurney, 1887; Wells, 1982).

- Mitchell and Delbridge (1965) argue that this vowel might be responsible for the charge of excessive nasality in AusE - “nasal twang”.

“It’s mostly done by **hand** and shafts are driven into the **ground** by pick and shovel into **sand**stone”

- The nasal phonetic context has the opposite effect on the vowel than the direction of the change described in the recent literature.

Type Frequency

- Distribution skewness might also be affected by high frequency phonotactic sequences (type frequency) (Hay *et al*., 2003).

- One highly probable phonotactic environment for /æ/ is the pre-nasal context (Vitevitch & Luce, 2004) which is also the context most likely to inhibit lowering of this vowel.

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Paradox

- This leads to an interesting paradox with respect to the vowel change.
- The direction of change reported in the literature is lowering and we therefore expect the token frequency to be reflected in the distribution.
- However, the high frequency nasal context - type frequency - predicts raising.

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Aim

- How is phonetic distribution affected by these two potentially opposing sources and what are the implications for the sound change in progress?

- We will examine some acoustic characteristics of /æ/ in oral and nasal contexts to determine how lexical and phonetic factors interact.

Prediction 1

- Gradient expansion
  - The antagonism between type frequency and the direction of the change may result in an elongated distribution from the phonotactically probable nasal through to the most lexically frequent oral tokens.
  - High frequency oral words should occur at the lower edge of the distribution with vowels in nasal contexts at the high end.

Prediction 2

- /æ/ space
  - We expect the distributions in different phonetic contexts to be contained within the general /æ/ space to maintain the contrast with /e/.
  - High functional load.

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Prediction 3

- Lexical diffusion

  - Word frequency effects rather than regularity would be predicted by Exemplar models (Bybee 2002, Pierrehumbert 2002). Therefore, the distribution of tokens should display frequency effects.

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Method

- 15 lower middle class, general AusE speaking female university students from Sydney's northern districts.
- Recordings were made in a sound treated recording studio in the CLaS at Macquarie University.
- Speakers read isolated words 3 times in random order from a computer screen
  - stressed AusE monophthongs in the standard hVd frame
  - /æ/ and /e/ in the contexts /CVn, CVd/ where C was a range of consonants with differing place, manner and voicing characteristics including /p, b, t, d, k, h, s/

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CVC monosyllables

bad	ban	bed	Ben
pad	pan	ped	pen
Dad	Dan	dead	den
tad	tan	Ted	ten
cad	can	ked	Ken
sad	san*	said	sen*
had	han*	head	hen

Formant and Duration Data

- The frequencies of the first two formants were automatically tracked using the ESPS/Waves (12th order LPC analysis with a 49 ms raised cosine window and a frame shift of 5 ms).
- Labelling of citation form words from wideband spectrograms was carried out using EMU (Cassidy & Harrington 2001).
- Data = F1 and F2 at vowel target and vowel duration for /hVd/ vowels and /æ, e/ in /CVn, CVd/ words
- The values for the three repetitions of each word were averaged for each speaker to overcome the problem of artificially inflating the dataset during statistical analysis.

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Experiment 1: The effect of nasal context

Mixed model with TYPE (oral/nasal) as the fixed factor and SPK (speaker) and C1 (initial consonant) as random factors.

A TYPE effect was found for F1 and F2 and duration.

F1	**TYPE**	**F(1,194)=476.65, p<.000**
	SPK	**WALD Z=2.531 p<.011**
F2	**TYPE**	**F(1,194)=609.32, p<.000**
	SPK	**WALD Z=2.485 p<.013**
Duration	**TYPE**	**F(1,194)=123.55, p<.000**
	SPK	**WALD Z=2.237 p<.025**
	C1	**WALD Z=3.516 p<.000**

Lexical Effects

- There was no C1 (initial consonant) effect for the formants.
- C1 should capture any lexical effects as the initial consonant differentiates the words.
- We conclude from this that there were no spectral lexical effects for this analysis and therefore no frequency effects regarding the distribution.
- The C1 effect for duration relates to the lexical effect where some adjectives in oral context have longer vowels.

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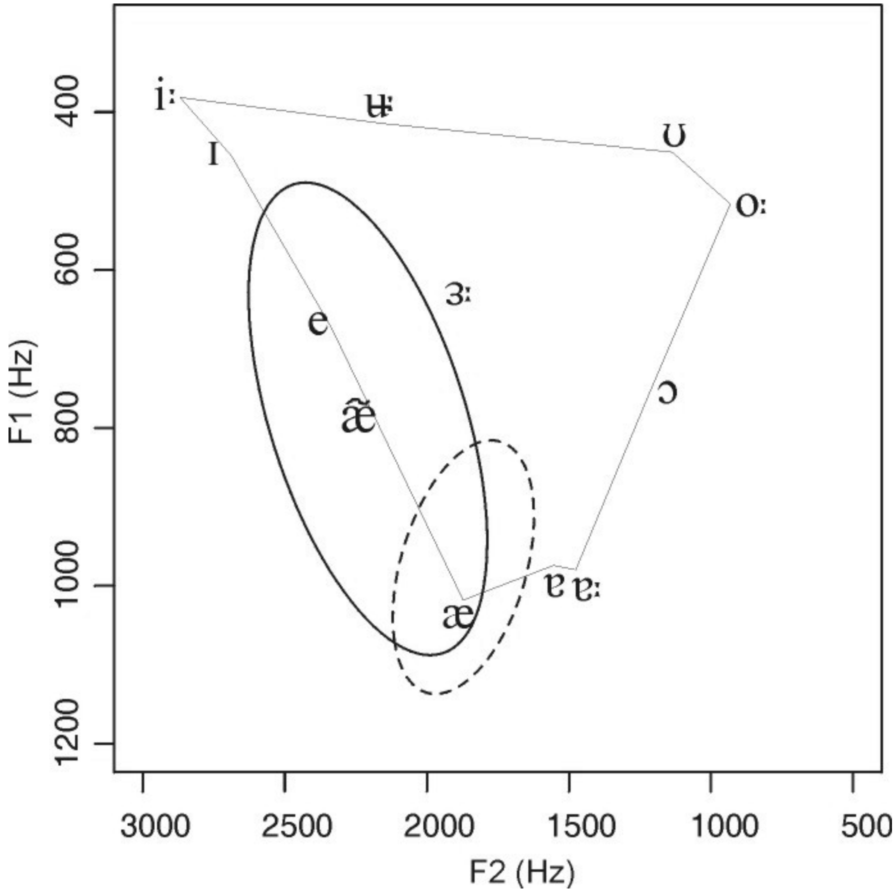
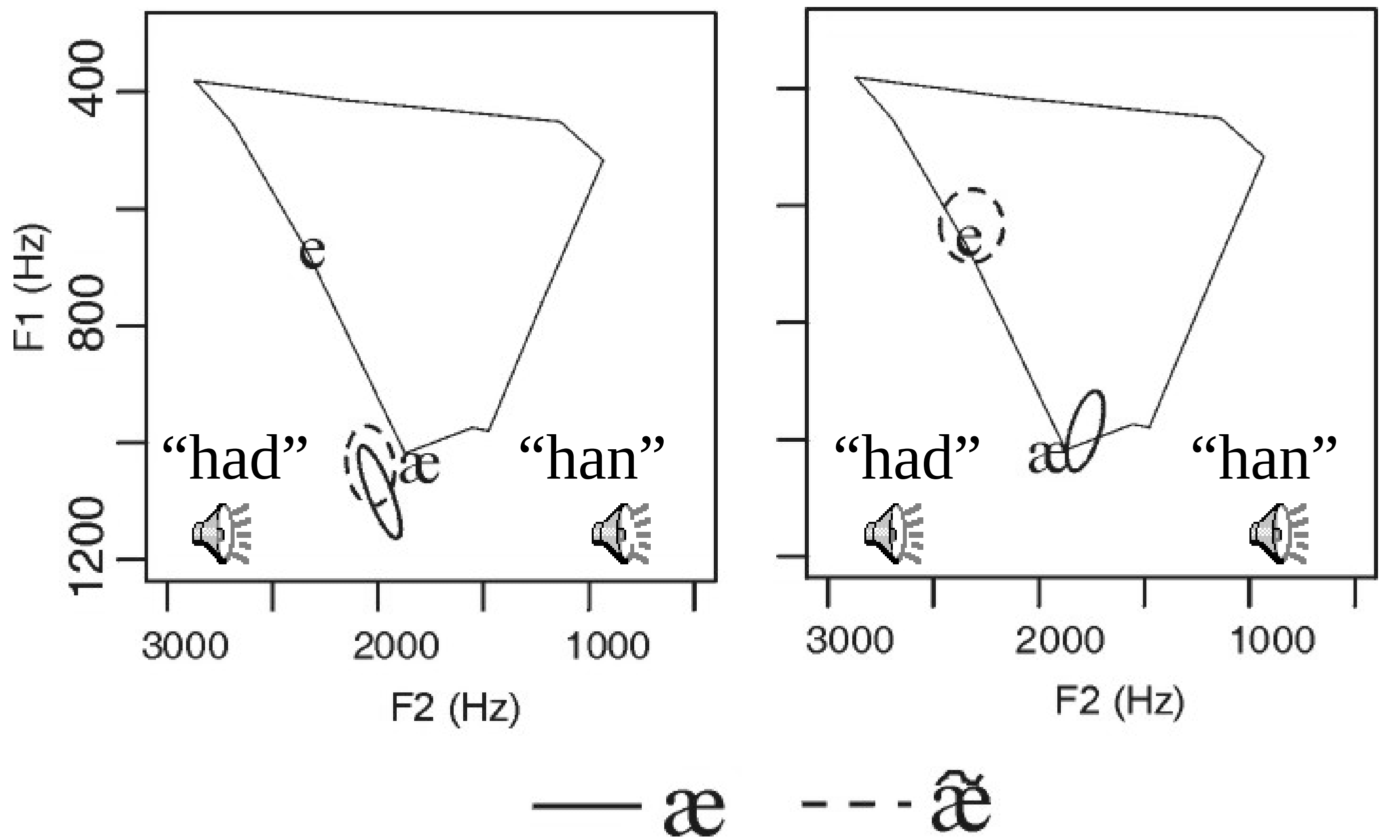
Relationship between æ and æ̃



- [æ̃] -raised and fronted.
- Extreme variation extends into the /e/ range.

Example from 2 speakers showing the degree of individual variation present.



The SPK effect shows individual difference.

Clustering

- kmeans clustering based on the Euclidean distance of F1 and F2 between nasalised /æ/ and oral /e/ identified two groups of speakers.
- Only one third of the speakers have a gradient oral to nasalised /æ/ within the /æ/ category space as predicted.
- The majority instead have a clear (categorical) distinction between the oral and nasalised vowel such that the nasalised /æ/ patterns with /e/.

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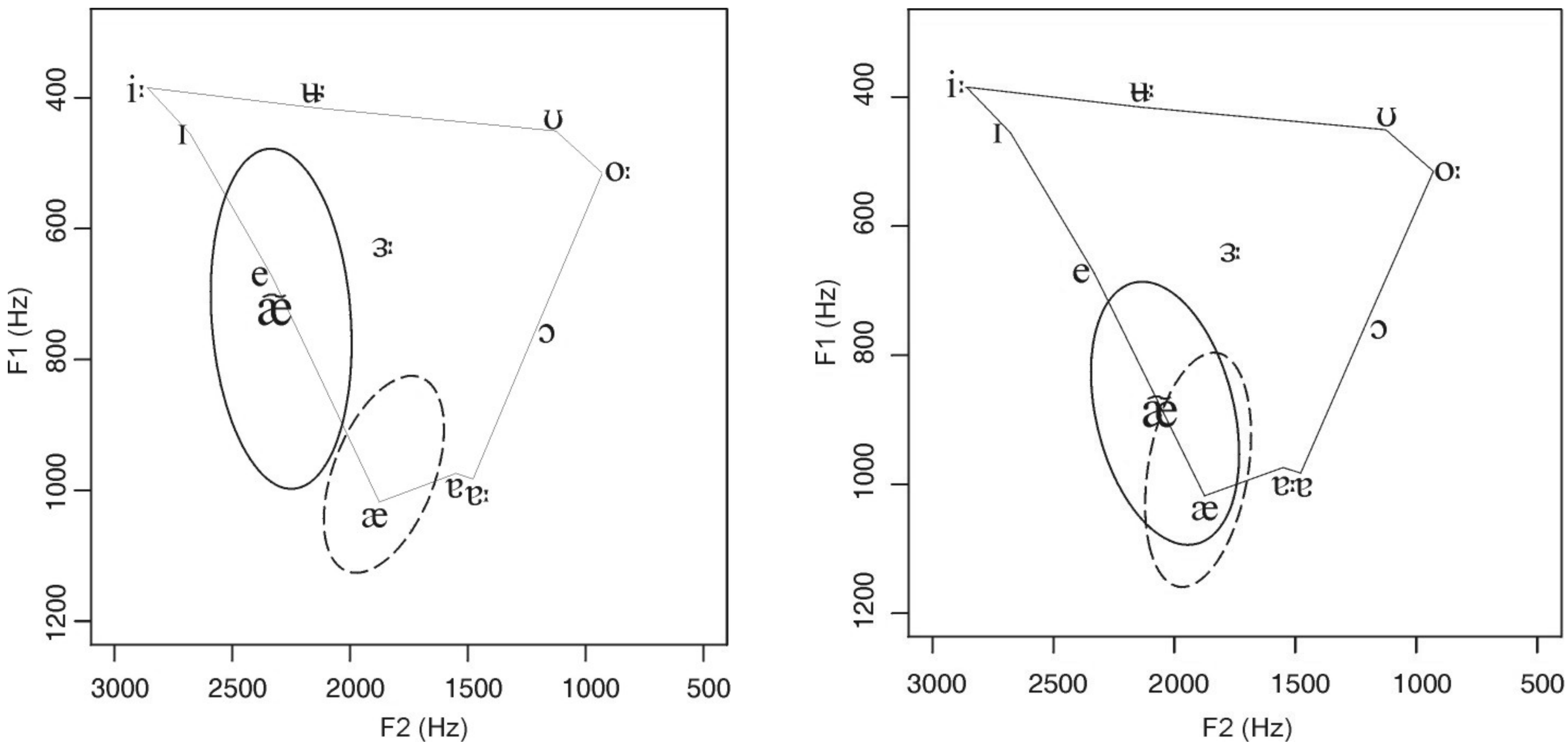
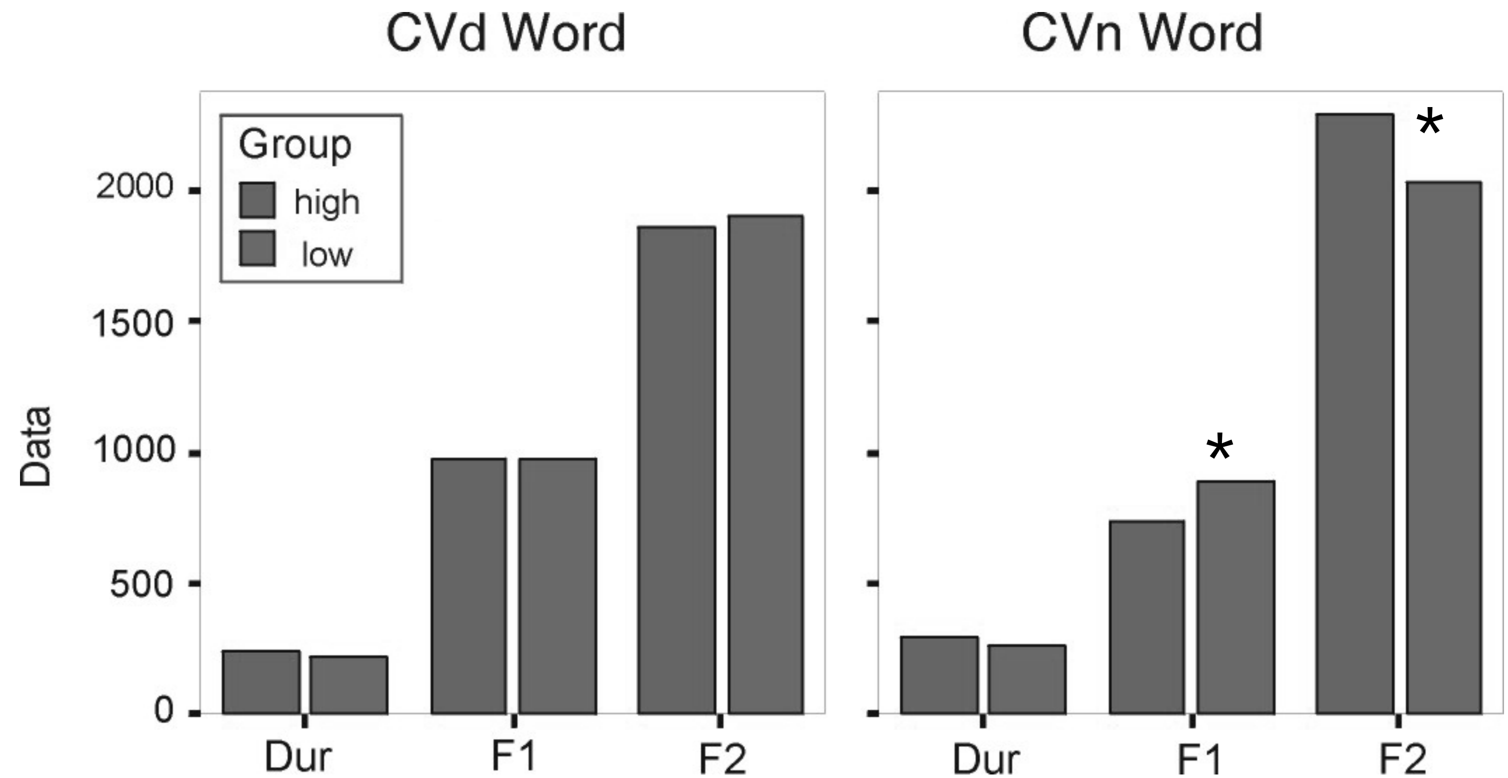
The distribution of /æ/ for the two groups of speakers.



Experiment 2

- Mixed Model with fixed effect GROUP and SPK and C1 as random factors.
- We might expect that if a speaker has a raised [æ̃], they might also have a raised [æ].

Between Group Results



- F1 GROUP: F(1,12.99)=7.442 p<.017
- F2 GROUP: F(1,13)=14.681 p<.002

Within group statistics

- Mixed model analysis with fixed factor TYPE (oral/nasal) and random factor SPK and C1 for the two groups of speakers separately show:

  - TYPE main effect for F1, F2 and Duration within each group.

  - Nasalised vowels - longer, higher and more fronted

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- Low [æ̃] group

F1 [$F(4,64)=91.8$, $p<.000$]

F2 [$F(4,64)=124.3$, $p<.000$]

Duration [$F(4,64)=13.3$, $p<.001$]

- spk*C1 interaction. Wald $Z=2.29$, $p<.022$.

- Raised [æ̃] group

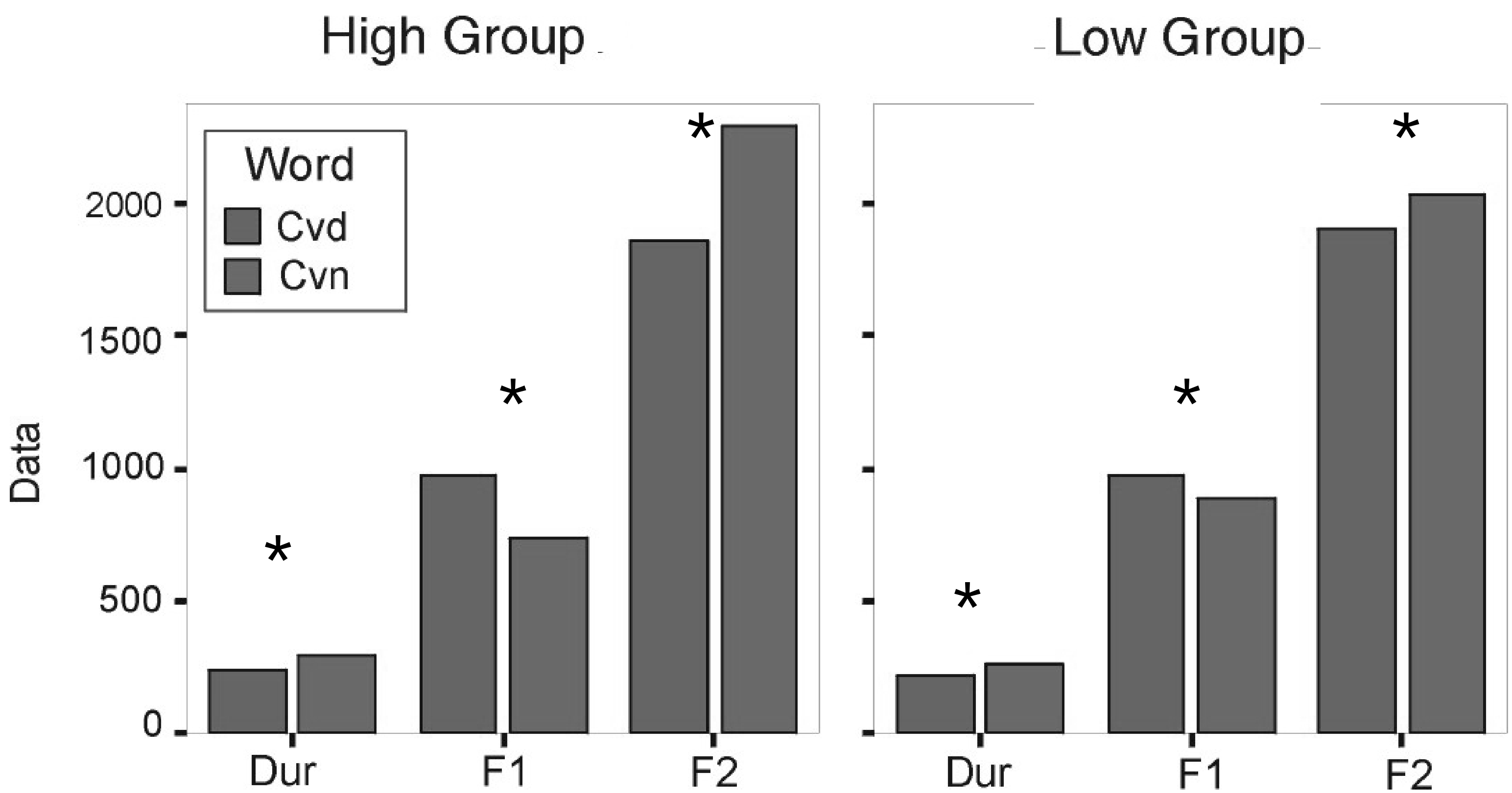
F1 [$F(9,129)=643.8$, $p<.000$]

F2 [$F(9,129)=1272.6$, $p<.000$]

Duration [$F(9,129)=67.6$, $p<.000$]

- spk*C1 interaction. Wald $Z=2.83$, $p<.005$.

Within Group Results



All comparisons within the groups were significant

Experiment 1 and 2 - Findings

- [æ] and [æ̃] differ in duration, F1 and F2 for all speakers.
- Two groups differ on the F1 and F2 characteristics of [æ̃] .
- They do not differ on
  - oral [æ]
  - duration within vowel type.
- Lexical identity does not affect formants within vowel type for the words examined in this analysis.

Experiment 3: Contrast Maintenance

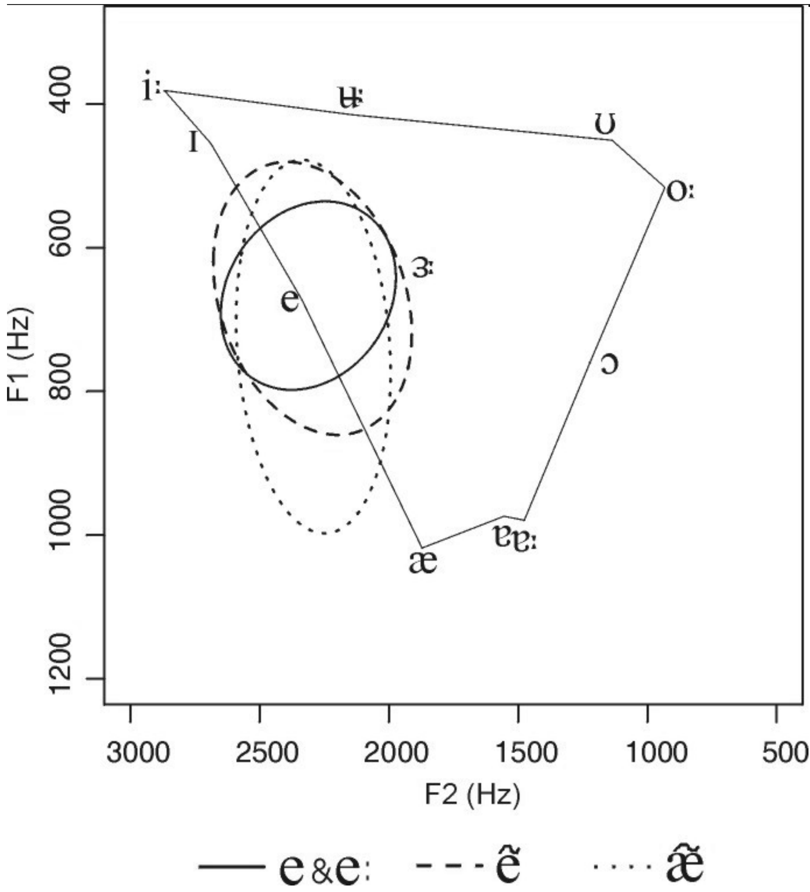
- How does the raised group maintain the contrast with /e/ (DRESS)?

- Mixed model with fixed factor TYPE ([æ̃], [ẽ], and oral [e]) and C1 and SPK as random factors.

Experiment 3: Results

- TYPE main effect for F1, F2 and duration.
  - F1 [F(9,198)=44.26, p<.000]
  - F2 [F(9,198)=5.52, p<.005]
  - Duration [F(9,198)=566.29, p<.000].
- no C1 effect - reinforces the finding above that there are no lexical effects present in this analysis.

Distribution around /e/



Pairwise comparisons:

F1 – [e] and [ẽ] are significantly phonetically raised from [æ̃] (p<.000).

F2 – [æ̃] and [ẽ] are significantly more fronted than [e] (p<.005).

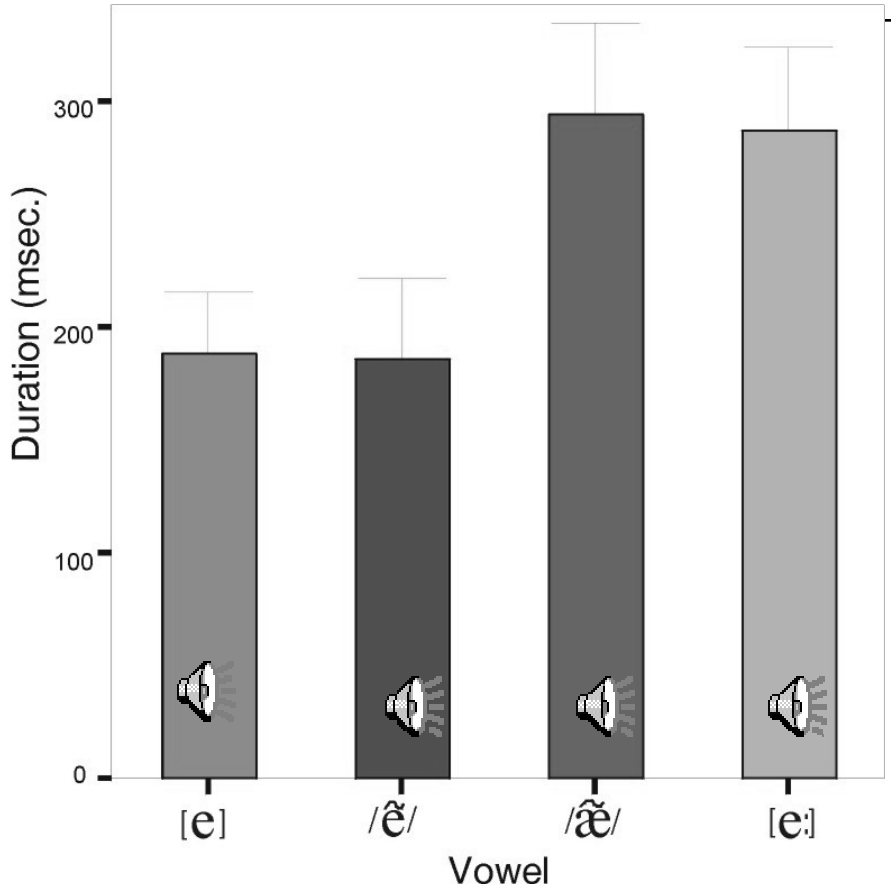
Duration

- [e] and [ẽ] are short vowels contrasting with the longer [æ̃] (p<.000).

- An interesting set of contrasts occurs at the mid front location

	oral	nasal
short	e	ẽ
long	eː	æ̃

Durations of [e], [ẽ], [æ̃], [e:]



head hen han haired

Summary

1. The results show no word specific effects in F1 or F2.
   - lexical frequency did not play a part in the skewness of the distribution.
   - the only lexical effect relates to duration.

2. Nasalisation was found to be the most powerful factor in determining spectral variability.
   - Nasalised /æ/ was raised and more fronted than oral /æ/.
   - The strength of this effect was dependent on the individual.

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3. We identified two groups of speakers on the basis of their [æ̃] production and whether it patterned more with [e] or [æ].

- 66% of our speakers display a categorical split between the oral and nasalised allophones of /æ/.
- One way that speakers maintain the contrast between [æ̃] and [e] is by retaining the length cue.

(Possible enhancement)

Examination of Predictions

- Gradient expansion?
  - This prediction was generally supported when we look at the entire data set.
- /æ/ space?
  - Only 33% of speakers maintain the variation within the /æ/ space
- Lexical diffusion?
  - No evidence found

Allophonic split

- The results for the raised group suggest
  - a phonetic effect has been harnessed phonologically by some speakers - allophonic split – partial phonologisation
  - this phonological effect is licensed as there is minimal impact on contrastiveness due to the length difference.
- However: -

“then” vs “than”

- Anecdotally, some younger AusE speakers have difficulty differentiating between “then” and “than” and use the two interchangeably in written language.

  e.g *“He is smaller then me”.

- The vowel /æ/ before /n/ is typically a long vowel e.g. “man”, “pan”, “ban” but there are a few words that use a short vowel e.g. “can”, “ran”, “than”.

- Here the length distinction that is necessary for /æ/ vs /e/ is removed resulting in a potential loss of contrast.

- “than” becomes a homophone of “then” - reinforced by the typically unstressed nature of function words.

Conclusion

- Strong effects relating to phonetic context (oral/nasal)
- No evidence of word frequency effects or diffusion in support of Labov (2006 etc) for vowel shifts
- These results might suggest a level of phonological representation separate from the word (perhaps supporting a hybrid model of speech processing (McQueen et al, 2006; Pierrehumbert, 2006)).
- However, we acknowledge that there are several limitations to this analysis which reduce the strength of the conclusions.
  - small sample size, citation form laboratory conditions, small number of words and phonetic contexts

"Indeed, it might be that for vowel shifts the phonetic environment is generally more powerful than any other effect because there are fewer words in each phonetic category."

Bybee (2002:267)

Thank you