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Using dispersion theory to model and explain the short front vowel shift in New Zealand English

Abstract

The short front vowel shift in New Zealand English (NZE) consists of a raising of the TRAP and DRESS vowels (Wells, 1982) and a backing and lowering of the KIT vowel, from front low, mid and high positions, respectively. It is argued here that it is possible to account for these changes using OT constraints based on dispersion theory goals (Flemming, 2004). Dispersion theory uses candidate sets based on sets of phonemes, allowing constraints to be applied to the vowel system as a whole, and avoiding the problem of having to propose constraints that both favour (for example) the TRAP vowel raising towards the 'standard' DRESS vowel, while at the same time disfavouring the 'standard' DRESS vowel in order that it can also raise.

The short front vowel shift in New Zealand English

New Zealand English is generally thought to be one of the best-documented varieties of English in the world. We are fortunate to have recordings of the children of the first settlers, and from all generations of New Zealanders since. Most of the first settlers arrived in New Zealand from the British Isles from the mid to late nineteenth century, and we are fortunate that this period coincides with Ellis's survey of English dialects, therefore providing us with information about the varieties of English that first arrived in New Zealand. Another 'simplifying' factor to consider with respect to New Zealand English is that it is known to be relatively homogenous geographically, with the exception of an area in the far south of the South Island known as Southland.

On the whole, historical reports and studies of the TRAP, DRESS and KIT vowels in New Zealand English have been broadly in agreement, in terms of the development and current realisations of those vowels. What disagreements there have been focused on the extent to which the current realisations are a result of preservation of the speech of the original settlers, and to what extent they are due to innovation. These disagreements have been largely resolved following analysis of the recordings made by the Mobile Unit in the 1940s which recorded the speech of the children of the first settlers, (see in particular Gordon, Campbell, Hay, Maclagan, Sudbury and Trudgill (2004)) and the recordings in the Intermediate Archive which consists of recordings of people with birth dates from the end of the 19th century to the mid 1930s (see in particular Langstrof (2006b)).

The pattern that emerges from the study of historical written records, and recordings from 1946 onwards would seem to be as follows: Early New Zealand speech was characterised by extreme variability, probably between the speakers who first arrived from 1860, and also within the speech of the first and second generations of speakers born in New Zealand to the first settlers. The variation of these early speakers almost certainly included a variety of realisations of the TRAP and DRESS vowel, but the closer realisations went largely unremarked, probably because the 'standard' against which they were being measured (the RP of the time) also had relatively close realisations of those vowels. A centralised KIT vowel was almost certainly not present in the first speakers, even among those settlers with exclusively Scottish backgrounds.

A centralised vowel in unstressed syllables (such as the second syllable in words such as *rabbit* and *cricket* probably emerged in the 1930s or possibly earlier, and was reported by commentators such as Wall from the 1930s and 50s (see Gordon (1998)). A centralised KIT vowel in stressed syllables did not emerge until later. Meanwhile, as Langstrof's (2006a) study of the Intermediate Archive in particular shows, the relatively close TRAP and DRESS vowels became the majority variants, and then began to rise, with the DRESS vowel rising faster than the TRAP vowel.

The raised DRESS vowel overlapped, in terms of the F1 and F2 dimensions, with the space occupied by the KIT vowel, which for a time had a split realisation, especially in male speakers, with some tokens being relatively high and front, and others more centralised. Although the DRESS and KIT vowels overlapped in F1 and F2 space, they were relatively distinct in terms of duration, with the DRESS vowel being longer, and the KIT vowel being relatively short.

This overlap has been resolved with the adoption of a centralised KIT vowel, which in modern NZE is used by all speakers, irrespective of age and sex. There is some evidence (see Bell (1997)) that some fluent Maori speakers use a high front variant some of the time. In terms of the realisation of TRAP and DRESS vowels, some studies (see Maclagan, Gordon and Lewis (1999)) have suggested that closer variants tend to be used by younger female speakers, although other studies (see Watson, Harrington and Evans (1998)) suggest there is very little difference at least in younger speakers between male and female usage.

In terms of factors conditioning the variation in realisation of the vowels, there is limited evidence for the influence of sex or social class, and some evidence for the influence of the following segment, in particular /l/ and /r/.

It is possible that the picture of the extreme variety of the early settlers focusing into one standard variety which has since been used (with the one exception of Southland) all over New Zealand since its emergence is in fact an over-simplification (see Carfoot, 2010). For the purposes of this paper, however, it will be assumed that the New Zealand English dialect began with TRAP and DRESS vowels that were front, but variable in height, and a front, high KIT vowel, and that this distribution was resolved into a pattern with a mid-high front TRAP vowel, a mid, front DRESS vowel and a mid, central KIT vowel, and it is the change from one to the other for which we should try to account.

This paper will begin with a brief overview of dispersion theory, before going on to discuss its application to the short front vowel shift of New Zealand English.

Dispersion Theory (Flemming, 2004)

Optimality Theory (Prince and Smolensky, 1993) starts from the assumption that the grammar of a language is determined by the ranking of a universal set of constraints, which are violable rather than absolute. In theory it should be possible to produce the full inventory of constraints available in human language and to manipulate their rankings to model all the variations that occur between languages and dialects, but this feat has not so far been achieved in practice, and

one can question whether it is a practicable goal. Indeed, when attempting OT analysis of particular data sets, one of the challenges is to use constraints that are both adequate from the point of view of explaining the data, but also well-motivated in terms of what is otherwise known about the way that language works, ie, not purely *ad hoc*.

Despite the fact that OT is output-driven, and that the output is the only known part of the system, an OT analysis assumes that for a given input (deduced from facts about morphological rules, for example, or from adult language, or from the source language of a loan word) there is a large, or possibly infinite, number of possible outputs produced by a generator (gen), giving a set of candidates for the output form, which are then evaluated (eval) against a set of (ranked) constraints.

Since the development of classical OT, there have been various attempts to refine and redefine it, in order to account for data sets intractable to classical OT analysis. The main aim of many of these refinements, such as sympathy theory, candidate-chains and stratal OT has been to account for opacity effects.

Dispersion theory, on the other hand, differs from classical OT in that it focuses on sub-systems within a language (such as the consonants or vowels available), rather than on individual segments. One result of this focus, is that the inputs and candidates in dispersion theory consist of sets of phonemes, rather than words.

The basis of the theory is that an optimal phonological system will balance the perceptual need for maximally different phonemes, with the articulatory need for easily articulated phonemes. As such, the constraints that operate in dispersion theory can include constraints on the distance between phonemes, as well as constraints on allowable segments. If perceptual considerations predominate, then the tendency will be for phonemes to be maximally distinct, if production considerations predominate, the tendency will be for the most easily articulated sounds to predominate.

The foregoing summary is an oversimplification, since each sound segment in speech will occur within a context, and it may be that certain contexts only allow a set of allophones. In a language which has only back, rounded vowels and front unrounded vowels, of various heights, a listener only need identify the F1 and F2 of a vowel.

Flemming's (2004) paper is presented in a volume (Hayes, Kirchner and Steridade 2004) whose stated aim is to focus on the question of where markedness laws come from. The title of the volume 'Phonetically Based Phonology' gives a clue to the type of answer that is provided by the contributors. The details of how Flemming's (2004) version of dispersion theory might be applied to the question of the New Zealand English short vowel shift will be discussed in the next section, however, the relevant parts of his paper may be understood as follows:

Flemming's paper is aimed squarely at considering the perceptual aspect of phonetically-driven phonology. Although he mentions phonetic cues as being a part of the process of perception, the majority of his discussion centres around contrasts between segments, focusing mainly, but not exclusively, on vowel systems. He observes (p 233) that 'it does not seem to be possible to

provide a sound basis in perceptual phonetics for constraints on the markedness of sounds independent of the contrasts that they enter into'. It is suggested that standard phonological and perceptual explanations differ in their implications as to why particular vowel distributions are optimal or not.

He proposes (2004: 236) there are three functional goals which interact to determine the selection of phonological contrasts:

i Maximise the distinctiveness of contrasts
ii Minimise the articulatory effort
iii Maximise the number of contrasts

These goals, and their interactions, will be more fully discussed in the following section, when their application to the data will also be explored. At this point it should be noted that the constraints interact, and in some cases conflict.

Applying Dispersion Theory to the TRAP, DRESS and KIT vowels in New Zealand English

This section will deal first with the TRAP vowel, then the contrast between the TRAP and DRESS vowels, and finally with the KIT vowel and its interaction with the TRAP and DRESS vowels. The dispersion based constraints used in this analysis are:

1) *[LOW SHORT VOWEL], based on the dispersion goal of minimizing effort,
2) [MAX CONT], an instantiation of the dispersion goal that the number of contrasts should be maximized, or that mergers are dispreferred
3) [MIN EFFORT], an instantiation of the dispersion goal of minimizing effort.

The case against a low TRAP vowel

Flemming (2004: 245 ff) argues that short low vowels are generally disfavoured. He proposes that "...producing low vowels is increasingly difficult as vowel duration is reduced, and this motivates raising for short low vowels, leaving a smaller range of the F1 dimension for distinguishing F1 contrasts." He cites Lindblom (1963) who found that "the F1 of Swedish nonhigh vowels decreases exponentially as vowel duration decreases." Flemming goes on to explain (2004: 245):

"These effects are commonly attributed to the greater articulator movement involved in producing a low vowel between consonants: low vowels require an open upper vocal tract to produce a high F1, whereas all consonants (other than pharyngeals and laryngeals) require upper-vocal tract constrictions, so producing a low vowel between consonants requires substantial opening and closing movements. Westbury and Keating (1980, cited in Keating 1985) provide evidence than vowel duration differences are indeed related to distance moved: they found that vowels with lower jaw positions had longer durations in a study of English. This, producing a low vowel with the same duration as a higher vowel will typically require faster, and consequently more effortful, movements. Reduction of low /a/ to [ɐ] or [ə] in unstressed

syllables is accordingly commonly reported both impressionistically and in experimental studies such as Lindblom 1963."

Flemming (2004: 275) also notes that Crosswhite (2004) 'proposes that vowel raising is desirable in unstressed syllables'. She in fact produces a complex picture in terms of unstressed syllables, but in doing so also refers to the relationship between vowel height and duration in general, mentioning 'it has been found for a number of languages that low vowels tend to be longer in duration than mid vowels, which in turn tend to be longer than high vowels' (2004: 208); this correlation is attributed to lower vowels being typically associated with more jaw depression.

These phonetic facts would provide an explanation for the rise of any given low vowel within a system, especially a system with a variety of inputs, as may be found when a number of different dialects of a language come into contact with each other, as was the case in early New Zealand English.

A variety of inputs means that a number of different outputs may be considered as faithful to the input. The reason that varieties remain relatively stable from generation to generation is that FAITH constraints operate to ensure that children acquiring a language reproduce, to a large extent, the dialect that already exists.

It should be noted that although it can be argued that short low vowels are dispreferred on phonetic grounds, it is not true to say that the lower a short vowel is, the less it is preferred. Indeed, the least dispreferred short vowel, in terms of articulatory effort is schwa, which is frequently realised with a mid-open quality. The dispreference for low short vowels is translated into the constraint *[LOW SHORT VOWEL].

The constraint *[LOW SHORT VOWEL] is relevant to the short front vowels in NZE since it provides a motivation for a closer TRAP vowel to be preferred over more open variants in a situation where variants of differing degrees of openess are in the input.

Tableau 1 shows the situation where the inputs for the TRAP vowel vary between /æ/ at the lowest and /ɛ/ at the highest.

	æ, ɛ	FAITH	*[LOW SHORT VOWEL]
a.	æ		*!
b. ☞	ɛ		
c.	ɪ	*!	

Tableau 1 Tableau showing the effect of the constraint *[LOW SHORT VOWEL] on a variable input for the TRAP vowel

Candidates a. and b. are both examples of variants that are present in the input. Candidate c. is not derived from the input, lying outside the range of possible inputs. Candidate a. fails since it violates the constraint *[LOW SHORT VOWEL], and candidate c. fails since it violates [FAITH], candidate b. wins since does not violate either constraint. At this point there is no

evidence for the ranking of the two constraints, since a violation of either constraints means a candidate fails.

The key to the operation of this change is a variable input. In the case where the input is invariably /ae/ the output will also invariably be /ae/, due to the existence of a highly-ranked FAITH constraint. It is therefore necessary to provide a mechanism for moving from one stable front short vowel system (as exists in standard Southern British English for example) to another, in this case New Zealand English, which at some point means that an input of /I/ resulting in an output of /ə/.

It should be noted that tableau 1 is simplified since it assumes that there are a total of three possibilities for the realisation of the TRAP vowel, whereas, of course, vowel space is continuous and there are an infinite number of possible realisations. Flemming's (2004) constraint MinDist in fact provides a way to limit the possibilities, since it specifies that each distinct vowel should be a minimum distance away from each of its closest neighbours.

In terms of non-violation of the constraint *[LOW SHORT VOWEL] there are two obvious repair strategies, (assuming no deletion) where the input includes a low short vowel: that is to raise the vowel or to lengthen it. As far as I am aware, there is no evidence of a low but lengthened TRAP vowel occurring to any noticable extent in NZE at any time, but it should be noted as a possible alternative that would have been explicable in phonetic terms.

The interaction of the TRAP and DRESS vowels

The preceding section explains how Flemming's (2004) model would explain the emergence of a non-low TRAP vowel given a variety of realisations of TRAP vowel in a speech community. This section will show how the use of the constraint MaximiseContrasts can be applied in conjunction with the FAITH to model the changes in the TRAP and DRESS vowels. In the following section, the constraint MinEffort will be added to the tableaux to show how its inclusion can explain the changes in the TRAP, DRESS and KIT vowels.

MaximiseContrasts is a direct instantiation of Flemming's third goal 'Maximise the number of contrasts'. It would also be possible to express this constraint as [*Merge]. [MinEffort] expresses the goal 'Minimise the articulatory effort'.

Tableau 2 below, gives three possible outputs given inputs of variable height for both TRAP and DRESS.

	æ-ɛ, ɛ-ɪ	FAITH	MaximiseContrasts	*[LowShortVowel]
a.	æ, ɛ			*!
b.	☞ ɛ, ɪ			
c.	ɛ, ɛ		*	

Tableau 2 How the constraint MaximiseContrasts, in conjunction with FAITH and *[LowShortVowel] gives the correct output for a mixed input for TRAP and DRESS vowels in NZE

In this tableau, Candidate a. fails since it violates *[LowShortVowel], and candidate c. fails because it violates MaximiseContrasts. None of the three candidates violates FAITH, and it is also not possible to rank the constraints relative to each other, since the optimal candidate does not violate any of the constraints.

Considering the KIT vowel together with the TRAP and DRESS vowels

Tableau 3 has an input which probably existed in the English of the first settlers in New Zealand, that is variable TRAP and DRESS vowels and a non-variable high front KIT vowel. Using the constraints used in Tableau 2, there are four possible, equally optimal outputs when the constraints are not ranked relative to one another.

	æ-ɛ, ɛ-ɪ, ɪ	FAITH	MaximiseContrasts	*[LowShortVowel]
a.	æ, ɛ, ɪ			*
b.	ɛ, ɪ, i	*		
c.	ɛ, ɪ, ə	*		
d.	ɛ, ɪ, ɪ		*	

Tableau 3 Tableau showing four possible outputs when all three vowels are evaluated by the constraint set from tableau 2.

In tableau 3, each candidate violates one constraint. Candidate a. violates *[LowShortVowel], candidates b. and c. both violate Faith and candidate d. violates MaximiseContrasts. Candidates b. and c. represent the current situations in Australian and New Zealand English respectively, so it would seem that we can determine the actual ranking of the above constraints by designating these as the optimal candidates and re-ranking the constraints accordingly.

Tableau 4 shows the constraint ranking that identifies candidates b. and c. as optimal candidates. Controversially, this tableau shows Faith as being ranked below the other two constraints, although it should be noted that the two non-optimal candidates each incur only one violation (out of a possible three) of the Faith constraint. The remainder of this section will discuss the interaction of Faith with Flemming's constraints.

		æ-ɛ, ɛ-ɪ, ɪ	*[LowShortVowel]	MaximiseContrasts	FAITH
a.		æ, ɛ, ɪ	*		
b.	☞	ɛ, ɪ, i			*
c.	☞	ɛ, ɪ, ə			*
d.		ɛ, ɪ, ɪ		*	

Tableau 4 Ranking resulting from taking into account modern NZE and Australian English outputs

In fact, Flemming's (2004) constraint MaximiseContrasts might be re-framed as *Preserve*Contrasts in the case of New Zealand English, since its effect to preserve the number of

contrasts between input and output. Looked at this way, the constraint MaximiseContrasts may be seen as a species of Faith constraint.

The final constraint to be used in this analysis is one that stipulates minimising of articulatory effort, MinEffort. The relevance of this goal to the development of modern NZE is in the emergence of a mid central KIT vowel, rather than the front high vowel that exists in Australian English. The mid central KIT vowel is not unique to NZE, existing allophonically in South African English[1] and also in some varieties of Scottish English. The mid central KIT vowel is often described as 'schwa-like', and the New Zealand accent is also sometimes described by non-linguists as 'lacking' vowels, both of which descriptions suggest that the KIT vowel resembles, in perception at least, schwa, despite being a stress-bearing vowel.

Furthermore, in many varieties of English non-stress-bearing vowels have two distinct qualities, and this was recognised by Wells (1982) who identified the vowel that occurs in the second syllable of the word *rabbit* in addition to schwa, as appearing in unstressed syllables in many varieties of English. The lack of a *rabbit* vowel as distinct from schwa, was noted in NZE before the tendency to centralise the KIT vowel.

The detailed study of unstressed vowels in NZE and other varieties of English is beyond the scope of this study, (which focuses solely on stressed vowels) however, it is tempting to speculate that the replacement of a mid-central vowel in place of a short front high vowel may have started with the *rabbit* type vowels and then subsequently progressed to KIT vowels, with the latter stage beginning with words where there is both a KIT vowel and an unstressed vowel in the *rabbit* class, such as *cricket* and *women*. In words such as *cricket* and *women*, the process may have been a result of vowel harmony - the latter example, results in the singular and plural forms of the noun *woman* being identical and has been discussed by Deverson (1990).

Langstrof's (2006b) result, where some of the speakers he analysed had a vowel system including a 'split' KIT, with some tokens realised as high front vowels and others as mid and central, may reflect the stage where KIT vowels that harmonised with a local unstressed schwa were mid and central, whereas other KIT vowels were high and front.

Where a speaker's input consists of a KIT vowel that alternates between a short, high, front vowel and a short mid-central vowel, the most obvious motivation for the emergence of an invariable mid-central vowel is that of minimising articulatory effort - the second goal identified by Flemming (2004). Tableau 5 shows how the combination of a KIT vowel input that varies between [ɪ] and [ə] will result in the modern NZE short front vowel system when a MinEffort constraint is in operation.

In this tableau, candidate a. violates the constraint *[LowShortVowel] (and MinEffort, given that the constraint of *[LowShortVowel] is an instantiation of the dispersion goal to minimize articulatory effort), candidate b. violates MinEffort and Faith, candidate d. violates MaxCont and

[1] Bowerman (2004: 936) explains that 'The split is an allophonic variation, with the fronter realisation occurring in velar and palatal environments, and the more central one occurring elsewhere... Before [ɬ] the vowel may be as far back as [ɯ]'.

MinEffort, and candidate e. violates MaxCont. Candidate b. represents the situation in modern Australian English. A further consequence of the emergence of a variable input for the KIT vowel is that the Faith constraint becomes redundant in terms of identifying the optimal candidate in tableau 5. The implication of this result is that as soon as the [ə] variant emerges as a possible realisation of the KIT vowel, the constraint MinEffort may operate to result in that variant dominating.

	æ-ɛ, ɛ-ɪ, ɪ-ə	*[LOW SHORT VOWEL]	[MAX CONT]	[MIN EFFORT]	FAITH
a.	æ, ɛ, ɪ	*		*	
b.	ɛ, ɪ, i			*	*
c.	☞ ɛ, ɪ, ə				
d.	ɛ, ɛ,ɪ,		*	*	
e.	ɛ, ɪ, ɪ		*		

Tableau 5 How the inclusion of a MinEffort constraint in conjunction with a variable KIT vowel input results in the modern NZE SFV system as optimal.

At this point, it is useful to consider which or whose grammar is represented in the foregoing tableaux. In standard OT tableaux that deal with the grammar of a stable dialect or variety, the input and output may be taken to represent the synchronic grammar of the speech community as a whole or of any individual within it. In the case of the vowel shift under consideration here, the question is whether the tableaux in this subsection represent the synchronic grammar of individuals who have undergone the shift, (in which case what is the grammar of the individuals who have not), or whether they should be taken to be a more abstract representation of the mechanism by which the shift took place - where the input is the pre-shift grammar, and the optimal output is the emerging post-shift grammar.

Although either of these scenarios would be defensible, the best interpretation is probably that the tableaux here in fact represent the grammar of the individuals who encountered a variety of pre-shift grammars; where the pre-shift grammars provide the input, and the output represents the emerging post-shift grammar. In this interpretation, the pre-shift grammars would be many and various, whereas the post-shift grammars would have a very largely faithful mapping from input to output.

The inherent problem of suggesting a single tableau to represent a key stage in a diachronic shift involving three vowels is that the stage in question in fact involved many individuals, and that those individuals varied in terms of their output grammar, as illustrated in chapters four and six. The purest way to account for all the variety present would be to propose a unique tableau for each individual, perhaps with the ranking of the various constraints subtly weighted according to a stochastic algorithm, however such an approach is not practicable, and to arrive at a justifiable tableau for an individual would surely involve listening to more than ten minutes of conversational data.

Conclusion

The current arrangement of the TRAP, DRESS and KIT vowels in New Zealand English, then is due to a combination of the phonetic pressure to avoid low, short vowels and to minimise articulatory effort, while maintaining both existing phonemic contrasts and phonetic distance between contrasting vowels. This analysis represents a novel use of dispersion theory to model a diachronic chain shift, and well as providing an explanation for the short front vowel shift in NZE.

Avenues for future research

There are two clear avenues for further research following from the findings above. The first would be to investigate the development and effect of the other (short) vowels in New Zealand English on the distribution of the TRAP, DRESS and KIT vowels. In particular, it is possible that the STRUT vowel may have moved towards the space occupied by the TRAP vowel in other varieties of English.

The other avenue would be investigating whether this approach is useful for modeling other chain shifts that are in progress or complete in other dialects of English, or other languages.

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