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SQUIB

Vowel change as systemic optimisation: why the New Zealand English front vowel shift is not a good example

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This article discusses the relation between articulatory features and phonetic properties in the light of a specific type of vowel change, namely a push-chain in the front vowel system of New Zealand English. Specifically, an idea put forward by Hawkins (1976), which claims that the NZE front vowel shift is an example of phonological optimisation in vowel systems, will be discussed in some detail. It will be argued, contra Hawkins, that the NZE front vowel shift is not a good example of phonological optimisation in vowel systems due to the existence of intermediate systems in the speech of individuals showing complex patterns of allophonisation, turning the idea of economy on its head.

1 Introduction

This article discusses the relation between articulatory features and phonetic properties in the light of a specific type of vowel change, namely a push-chain in the front vowel system of New Zealand English (NZE). Specifically, an idea put forward by Hawkins (1976), which claims that the NZE front vowel shift is an example of phonological optimisation in vowel systems, will be discussed in some detail.

The idea of sound change as optimising phonological systems is a recurrent topic in explanatory approaches to language change. It goes back to at least Jespersen (1909), and has been put forward on various occasions by subsequent researchers in the structuralist and generative tradition (Martinet 1955; Jakobson 1961; King 1969). More recent generative approaches to language change have frequently focused on concepts such as 'rule simplification', i.e. a child generalises the most economical grammar on the basis of phonological or grammatical data (see Lightfoot 1979, 1999 for a generative account of syntactic change in Middle English, and much of Kiparsky's work on phonological change, e.g. Kiparsky 1982, 1995). In other words, a child being confronted with a range of data upon which to build a phonology would choose the most economical rule set, i.e. the smallest set of rules that still 'accounts for' the data. In turn, the drive towards economy favours symmetrical systems (more or less by definition, since asymmetries increase the analytical complexity of any system).

Of course, explaining language change has traditionally been a minor concern in generative phonology. Those researchers who have attempted to frame explanatory approaches to language change in generative terms have retained the same theoretical primitives and acid tests in evaluating competing hypotheses as generativists focusing

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on the synchronic domain: a strong focus on rule economy and simplicity, modularity with respect to explanatory primitives (such as articulatory features) and, by implication, a strong commitment to explaining language change as real-world instantiations of these theoretical primes. And even though neo-generativist models of phonological change such as Blevins (2004) have acknowledged the problems associated with analysing and explaining sound change on the basis of overly formalist machinery developed to formalise synchronic data, they also utilise a number of traditional concepts such as articulatory features.

The objective of this article is to present an argument against Hawkins' proposal specific to the short front vowel shift in New Zealand English as well as to discuss general problems in interpreting phonological features as articulatory.

2 Background

2.1 *The NZE front vowel shift*

Contemporary New Zealand English is characterised by a front vowel space that differs substantially from the systems found in its closest relatives (Australian English, South-Eastern British English). Rather than having three short front vowels (/ɪ/, /ɛ/, /æ/), only the latter two are front vowels in NZE, whereas /ɪ/ is a centralised mid-high/mid vowel. For detailed accounts of the vowel system of NZE, see Bauer (1979, 1986, 1992) and Wells (1982). It has been shown that the front vowel change was endemic, and therefore relatively recent (Gordon *et al.* 2004; Langstrof 2006). In addition, the mechanisms of the change in terms of its sequential timing are now relatively well understood: Langstrof (2006) has shown that the change was a push-chain, which implies that /ɛ/ and /æ/ raised before /ɪ/ centralised. Crucially for the argument of this article, there exist speakers who show raised /ɛ/ but uncentralised /ɪ/ but no speakers with centralised /ɪ/ and unraised /ɛ/, which (a) indicates that the shift is a push-chain and (b) that this chain shift operates sequentially, i.e. it is not the case that any given speaker maintains equidistance between vowels in their own vowel space. Figure 1 shows formant frequency data from a speaker (J.M.) with a system showing substantial overlap between /ɛ/ and /ɪ/ in F1/F2 space. It should be pointed out that this speaker is rather typical of a range of speakers of NZE during earlier stages of the chain shift (cf. the group plots in Langstrof 2006).

In what follows it will be argued that systems like these cast doubt on the argument that the NZE front vowel shift serves to optimise the vowel space of NZE.

2.2 *Optimisation in phonological systems*

Although it is not always clear what reflects 'optimality/economy' in phonological systems, the following two (interrelated) points have gained some currency in the literature in both the structuralist and the generativist tradition (I will here restrict myself to vowel systems):

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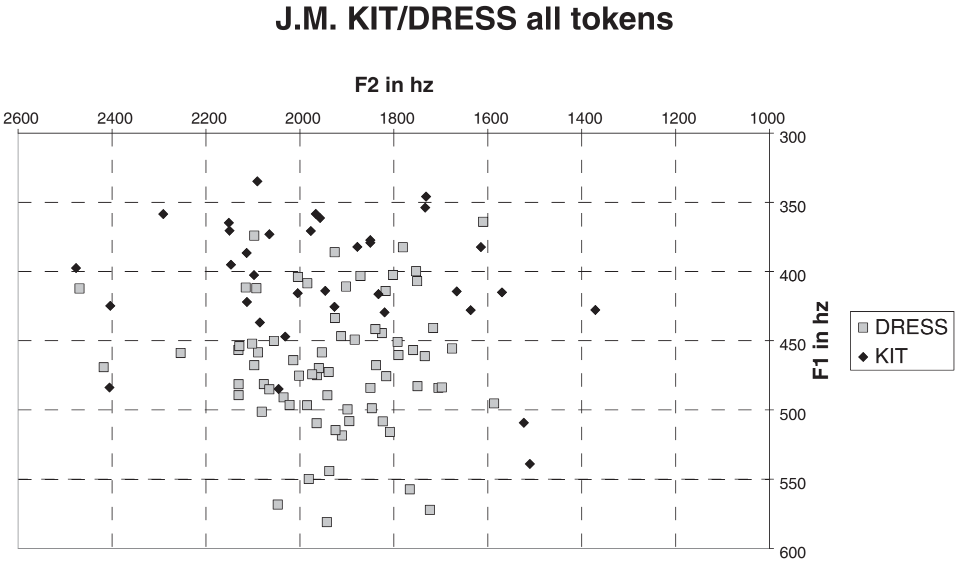

Figure 1 F1/F2 plot of /ɪ/ (= KIT) - /ɛ/ (= DRESS) tokens in the speech of J.M.

(1) Optimal systems are more symmetrical than non-optimal ones.

The notion of *symmetry* in vowel systems relates to either one of two interrelated things, (a) whether the front and back vowel series in a given vowel system have the same number of members in the same position, (b) whether the minimum feature specification is the same for any member of the phoneme inventory (see below). Consider two vowel systems comprising four and five members respectively, as schematised below.

	A		B	
	front	back	front	back
high	i	u	i	u
mid				o
low	a	ɒ	a	ɒ

In this case system A would be more symmetrical than system B, as the back vowel series in the former is a mirror image of the front vowel series. System B on the other hand is asymmetrical in that the back vowel series consists of three elements rather than two.

(2) Optimal systems can be described with fewer features/rules.

In a similar vein, optimality can be argued to reflect a state where all members of a vowel system can be accurately specified using fewer features than is the case in some other, less optimal system. In addition, each member of a vowel system can be described by using the same features in optimal systems (i.e. the necessary number of features is sufficient to accurately specify each vowel), rather than having rogue elements that require features that are unnecessary elsewhere in the system. The two

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exemplary vowel systems sketched above illustrate this point as well: all members of system A can be described by two features, one height feature and one backness feature:

Feature specifications in system A

i	[+high] [−back]
a	[−high] [−back]
u	[+high] [+back]
ɒ	[−high] [−back]

Each member of the system is therefore accurately specified, and each conceivable combination of feature value combinations is utilised by the system. System B on the other hand could be specified as follows:

i	[+high] [−back]
a	[−high] [+low]
u	[+high] [+back]
o	[−high] [−low] [+back]
ɒ	[+low] [+back]

It is clear that in this system, only one member requires three features in order to be accurately specified, and it is only for that one vowel that an additional feature ([+/− low]) is required. Therefore, optimality in vowel systems can be regarded as a function of both spatial symmetry as well as feature matrix economy.

3 Feature economy and the NZE front vowel shift

Hawkins' (1976) analysis of the short front vowel chain shift in New Zealand English argues for optimisation as the driving force behind the restructuring of the NZE short vowel space. The argument is based on a comparison of the initial and the final stage of the shift, which can be sketched as follows:

initial				*final*		
front	central	back		front	central	back
ɪ		ʊ		ɛ	ɪ	ʊ
ɛ		ɒ		æ	ʌ	ɒ
æ	ʌ					

The centralisation of /ɪ/, /ɛ/, /æ/ as well as the raising of /ɛ/ and /æ/ in NZE have brought about a system which is more symmetrical than the initial system as well as being more feature-economical in that (a) only two degrees of height are relevant in the shifted system (whereas three levels were required in the initial one) and (b) all possible binary feature specifications are being utilised in the final system (whereas in the initial system, the feature [+/− low] was redundant in the back series, and both height features were redundant in the central series).

General problems with the idea of optimality in sound change abound, and have been discussed *in extenso* by e.g. Lass (1980, 1997) and McMahon (1994). I will give only a brief summary of these general problems, and will subsequently focus on the problems imposed upon this approach by the specifics of the NZE front vowel chain shift.

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Whose symmetry?

This relates to the fact that symmetry is essentially an aesthetic notion and rests heavily on the method of plotting. Diagrams of vowel systems that are construed on the basis of impressionistic articulatory phonetics look rather different from those based on acoustic data, which in turn look different from plots based on acoustic data, but converted onto perceptual scales (see Labov 1994). From Maclagan's (1982) acoustic plots it is by no means self-evident that /ɪ/ is a central vowel for these speakers (it is clearly still closer to /ɛ/ and /æ/ than it is to /ʌ/ in the front-back dimension), although the speakers plotted there represent fairly advanced New Zealand English. On a weighted F2 scale, /ɪ/ would be even more removed from /ʌ/ for the same speakers.

What about varieties that do not show the optimised set-up?

The most vexing problem for optimality/economy accounts of vowel change is of course the fact that so many changes that might bring about optimality do not occur in the first place, and that some changes even counteract this alleged tendency (see Lass' (1997) discussion on changes in the history of English verb paradigms that counteract optimisation and levelling processes). In the case of short front vowels in contemporary English, the optimal system (i.e. B above) is found only in NZE as well as in South African English, and there only under a rather favourable interpretation of the phonetic facts (see Wells 1982 and Lass 1987 for a description of vowel quality in SAE). For a large majority of speakers in the UK and Northern America, however, the three-way short front vowel set-up does not seem to be much of a problem. More dramatically, the nearest relative to NZE has taken the exact opposite path: /ɪ/ has undergone fronting and raising in Australian English, while the processes affecting /ɛ/ and /æ/ are rather similar. In the face of these facts, optimality can hardly be taken as a strong motivation to change vowel systems (in fact, if we accept Hawkins' diagrams and look at the speaker numbers, we might well conclude that there is a strong tendency in English to maintain non-optimal short front vowel set-ups).

However, these general points are discussed elsewhere at length. I would now like to turn to the challenge posed to optimality accounts arising from the data on the intermediate stages of New Zealand English.

4 Problems with the notion of 'optimality' specific to NZE short front vowels

The major problem with accounts such as the one by Hawkins arises from a number of assumptions that are false on both theoretical and empirical grounds. These can be subsumed under the following themes:

4.1 Ignoring intermediates

The first problem with Hawkins' account is the exclusive focus on the assumed initial and final stages of the short front vowel shift. However, it was shown in Langstrof (2006) that this vowel shift does not come about abruptly. Rather, there are intermediate

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stages[1] which are properties of individuals, i.e. linguistically ‘real’ rather than merely the artefacts of plotting groups. Speaker J.M. (see figure 1 above) shows such an intermediate stage, and his short front vowel system shows the following characteristics (for in-depth statistical analysis of conditioning factors, see Langstrof 2006):

– /ɛ/ and /ɪ/ show some overlap in F1/F2 space.
– This overlap is not complete.
– /ɪ/ tokens in velar stop environments are outside the overlapping space by being closer and/or fronter.
– /ɪ/ tokens in fricative environments are outside the overlapping space by being more central.
– Most /ɪ/ tokens within the overlapping space are in bilabial stop and/or nasal environments.
– /ɛ/ tokens in nasal environments remain outside the overlapping space (by being lower).
– Most /ɛ/ tokens in the overlapping space occur in front of voiced nasals.
– /ɛ/ and /ɪ/ show almost no overlap if duration is factored in. (Langstrof 2009)

The fact of overlap is somewhat problematic if it is to be accounted for in terms of the traditional feature framework[2] since things like height features specify different heights for different vowels, i.e. vowels that are different with respect to this feature should not be of the same height, which is exactly what we find for a substantial number of /ɪ/ and /ɛ/ tokens. This might be remedied in two ways: one might either devise complex allophonic rules in order to capture the phonetic facts, or one might introduce another feature that is related to the solid duration distinction between the two. The first route would entail at least the following mappings (somewhat simplifying the phonetic facts):

/ɪ/ → [i], i.e.:	[+high] [−low] [+front] [+raised (?)]	/__	{k/g/ŋ}
→ [ɨ]	[+high] [−low] [−front] [−raised]	/__	[+cont] [+str]
→ [ɪ]	[+high] [−low] [+front] [−raised]	/__	elsewhere

1 The term ‘intermediate’ in this context refers to the overall lifetime of the chain shift. Speakers showing this type of set-up tend to be third- and fourth-generation New Zealanders born between the 1890s and the 1930s.
2 Always assuming that features are indeed ‘articulatory’, or map onto articulations in a rather straightforward way rather than being merely ‘mental entities’.

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Although this might work in formal terms in that one would be able to eliminate the problems of phonemically different vowels receiving identical feature specifications, the main problem with this is that it turns the notion of 'optimality' on its head. That is, whereas the initial stage required one additional feature to separate the front vowels, at least no further allophonic specifications are required. From the point of view of feature economy, the NZE front vowel shift moves through a stage of lesser optimality in order to eventually arrive at the optimal stage. Again, this would not be a problem if an argument could be made that such intermediate systems arise as artefacts of plotting data from different speakers, and that single speakers have either the non-optimal initial stage or the optimal final one. This, however, is not the case, which brings up the problem of teleology in sound change: is it plausible that a generation of speakers acquire an elaborate and somewhat awkward front vowel feature specification in order to allow for their successors to have an optimal system? In addition, it seems clear that if we do want to separate those allophones of /ɪ/ that occur inside the overlapping space from those that do not, we would need a further distinctive feature. In the above feature specification I have tentatively introduced an ad hoc feature [+/− raised], which essentially fulfils that role. Again, although this might be just about permissible in technical terms, this further clutters up the phonology in that it is only necessary in order to specify a small number of allophones of one vowel only, and therefore runs counter to the alleged trend towards optimality in the system (neither the preceding nor the following stage require such a feature; no other vowel in the intermediate stage requires such a feature).

An alternative solution might be to simply introduce another feature in order to disentangle overlapping distributions. It was previously shown (Langstrof 2009) that there exist solid durational differences between /ɪ/ and /ɛ/ NZE. One might therefore be tempted to simply introduce a further feature (let's say [+/− long]) in order to uniquely specify each segment. Again there are both technical and theoretical problems with this approach. First of all, it is unclear what the actual feature would be. If we take the phonetic facts at face value, [+/−long] would probably be a plausible choice. However, we are here concerned with vowels that are in the vicinity of other vowels such as /iː/ and /ɪə/, which are longer than both /ɪ/ and /ɛ/. Distinguishing /ɪ/ and /ɛ/ on the basis of a length feature while distinguishing /iː/ from /ɪ/ and /ɛ/ by some other feature (such as [+/− tense]) is surely ad hoc, since it disregards the continuum along the length dimension between the three vowels. A solution would be to recognise three degrees of length by introducing a further feature such as [+/− short]. This is questionable on theoretical grounds. First of all it seems clear that the length distinctions are solid even in the speech of speakers with little overlap between the two vowels (cf. Maclagan & Hay 2007). If features are indeed articulatory, one would have a situation in which some phonetic dimension becomes phonologically relevant only in one generation of speakers, although the nature of that dimension does remain after the problematic stage. This brings us back to teleology: why would a specific generation of speakers acquire a more complex feature specification than

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their predecessors, if the ultimate goal (as well as driving force) of this process is optimality?

4.2 Problems with cause–effect relationships (the push-chain mechanism)

The fact of push-chain relationships between vowels that differ in some (and only that) 'spatial' feature (such as height or backness) is problematic for feature-based accounts of phonology once we recognise the steps that comprise the overall process as *successive* events. Again, it is not the case that a speaker has either the initial or the final stage. Rather, /ɛ/ raising and /ɪ/ centralisation occur at different points in time (as well as in space) and it is perfectly possible for one individual to show the former step, but not the latter. If we want to live without the complex machinery of allophonic sub-specification outlined above and also do not want to introduce features that are ad hoc as well as ephemeral, we would have to either abandon a 'realist' view of feature-to-articulation mappings, or choose to ignore the data (see section 5 below).

4.3 The impossibility of encoding gradualness into discrete systems

Elaborating on section 4.2 above, it should be clear that the major problem for accounts such as Hawkins' is the gradual nature of this particular process (and many related processes found in other varieties of English, as well as other languages) vis-à-vis the abrupt nature of changeover in vowel typologies implicit in such feature-based accounts. Any decision as to when this abrupt changeover 'occurred' seems to be entirely arbitrary.

4.4 Assigning endpoints randomly

A further problem is the assignment of endpoints of such a process. More specifically, it can be asked why one would compare the vowel systems of stages A and B above and disregard not only the intermediate stages, but also the preceding as well as the following ones. For example, it seems clear that /ɛ/ continues to rise even after /ɪ/ has moved out of the way (Maclagan & Hay 2007). Why would a process continue if the driving force behind it has vanished (i.e. the vowel system is already 'optimal')?

In addition, the initial stage (i.e. stage A) is a comparatively recent development in the history of English, and one may well make the argument that the preceding stages were rather more optimal than that particular typology (i.e. the short vowel system of Early Modern (Southern) English after the split of ME /u/, but before the fronting of ME /a/, can be regarded as symmetrical with two vowels each in the front, central and back column). On the whole it seems that the argument for optimality in NZE short vowels rests mainly on random choices of stages as endpoints.

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5 Discussion/Conclusion

It often seems that the choice as to whether something is 'front', 'back', 'low', etc. is an aesthetic choice on the part of the phonologist rather than backed by any real-world manifestations of these dimensions. In fact some phonologists (e.g. Coleman 1998) clearly commit themselves to such an abstract and purely systemic view. However, this does not seem to be the intention behind the original formulation of these features, which are explicitly termed 'articulatory' in Chomsky & Halle (1968). The problem then is how we arrive at appropriate feature designations in the first place. As I pointed out before, the data presented in Maclagan (1982) show an /ɪ/ vowel that is quite clearly closer to the other two front vowels than to /ʌ/. How do we know that /ɪ/ is a central vowel if there is little evidence from actual data in the case of the speakers plotted by Maclagan? Only if we accept the argument a priori can we state that /ɪ/ is a central vowel because if it weren't, it would receive feature specifications that are identical to /ɛ/.

The major conundrum seems to be that if we regard feature specifications as 'real', i.e. as mental representations that map onto articulation in a straightforward and physically specifiable sense, we cannot regard the NZE front vowel shift as an example of vowel typologies striving towards optimisation. This is due to the fact that intermediate stages with complex patterns of allophonisation are properties of individuals, and must therefore be phonologically specified. Once we do that, we lose the general tendency towards optimisation, since these intermediate stages are in many ways less optimal than both their preceding and their following ones.

In order to salvage the feature-based account of the chain shift one would have to abandon the realist view and resort to a purely abstract approach to phonological features, in which features, or at least some of them, are merely 'contentless dichotomisers' (see Lass 1976: chapter 2, appendix) and are not related to articulatory reality at all. This, however, seems to make matters worse in that it renders real-world observations of vowel articulations entirely meaningless. Therefore, decisions as to which feature specification should be assigned to any given vowel would be entirely arbitrary. This prevents us from making any statements about what is 'optimal' and what isn't, since we cannot in principle know what 'is'.

If one does accept phonetic data as phonologically relevant, one should accept all of it. In the specific case of the short front vowel shift in New Zealand English one would be obliged to take into account not only the randomly assigned endpoints, but also the typologies that are in some meaningful sense related to these stages (i.e. preceding, intermediate and following trajectories of development as well as alternative ones such as AusE, SAE, North American English and British English). Once we do this, however, the argument of phonological optimisation as a driving force behind sound change becomes implausible.

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