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Constraining Welsh vowel mutation[1]

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Welsh vowel mutation is a purely positional vowel alternation, the effects of which serve to obscure phonemic contrasts between three vowels in the system, namely barred-i [ɨ], schwa [ə] and [u]. The theoretical interest in this alternation stems from the surface orientation of current phonological theory: is such a non-surface-true state of affairs amenable to plausible modelling in an optimality-theoretic framework, or are the relevant relationships best accounted for through lexical listing? In this paper I argue that a straightforward optimality-theoretic account is available and that this account is simpler than any of its predecessors. The analysis differs from previous derivational analyses (e.g. Thomas 1979, 1984; Williams 1983; Bosch 1996) in various ways, including the underlying values of some of the vowels involved, the avoidance of ad hoc extrinsic rule ordering, and the lack of reliance on intermediate representations. Furthermore, reference to phonological position alone is sufficient, with no need to refer either to stress or to morphological complexity. The correct results emerge primarily through the interaction of a high-ranking structural constraint prohibiting schwa in a final syllable, an input–output faithfulness constraint on vowel features, and a constraint prohibiting a high central rounded vowel, [ʉ].

1. Introduction

Welsh vowel mutation is a purely positional vowel alternation, the effects of which serve to obscure phonemic contrasts between three vowels in the system, namely barred-i [ɨ], schwa [ə] and [u].[2] As Cartmill (1976: 676)

[1] I have benefitted from numerous comments on various incarnations of this work at different times from many colleagues, including Gwen Awbery, David Willis, Bob Morris Jones, Ricardo Bermúdez-Otero, Carol Fehringer, participants at several LAGB meetings and, especially, Maggie Tallerman. I am also indebted to two anonymous referees for *Journal of Linguistics*, whose perceptive and thoughtful comments improved the paper. None of the above-named agrees with everything here. It is with sadness that I acknowledge my debt to the late Dr Lewis Davies for unfailingly kind help with data questions – *heddwch i'w lwch*.

[2] There is a further set of vowel alternations, known as 'vowel affection', which will not be dealt with here. Morris Jones (1913: 120ff., 1921: 33ff.), for instance, distinguishes between 'ultimate a-affection', 'ultimate i-affection', and 'penultimate affection'. These are not positional alternations and derive historically through a process of ablaut, see also Thomas (1966: 102ff.).

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observes, 'it is not possible to construct a rule for vowel mutation … that operates on surface phonology, and has not been since the sixteenth century'. The present theoretical interest in these phenomena stems from the surface orientation of current phonological theory. In view of such a surface orientation, the question arises as to how such a non-surface-true state of affairs could be modelled in an optimality-theoretic framework, or whether indeed the relevant relationships are best accounted for through lexical listing.

In this paper I argue that a straightforward account within Optimality Theory (OT) is available. The analysis differs from previous derivational analyses (e.g. Thomas 1979, 1984; Williams 1983; Bosch 1996) in various ways, including the avoidance of ad hoc extrinsic rule ordering and the lack of reliance on intermediate representations. Moreover, reference to phonological position alone is sufficient, with no need to refer either to stress or to morphological complexity. This account also differs in the assumption of the underlying values of some of the vowels involved. The correct results emerge primarily through the interaction of a high-ranking structural constraint prohibiting schwa in a final syllable, an input–output faithfulness constraint on vowel features, and a constraint prohibiting a high central rounded vowel [ʉ].

After describing the facts of vowel mutation in the following section, section 3 discusses the crux of the analytical problem, namely distinguishing between the two sources of barred-i [ɨ]. The analysis itself constitutes section 4 and the conclusion is presented in section 5.

2. Preliminaries – vowel mutation

Vowel mutation is a positional vowel alternation traditionally said to affect the diphthongs [aɪ], [aɨ], [aʊ] and [ɨʊ] as well as the monophthongs [u] and [ɨ] (see Morris Jones 1913: 116–120, Thorne 1993: 88–91). Note that the vowel barred-i [ɨ] is characteristic of northern varieties of Welsh, which are the focus of this paper. Vowel mutation also occurs in dialects without [ɨ]; the analysis in those varieties will necessarily differ in detail. However, not all dialects exhibit vowel mutation, particularly those generally lacking central vowels (including schwa) such as parts of Pembrokeshire, see Awbery (1984: 79, 1986: 59). The typical characterisation of vowel mutation is that the canonical vowels appear in word-final syllables (including monosyllables), but in non-final position they alternate systematically with another set of vowels, as described below.

The following examples illustrate the full set of forms traditionally grouped together as the vowels undergoing mutation. These forms, thus, reflect both diachronic and synchronic examples of vowel mutation. As will be made clear below, however, the focus of this paper will be on the

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last two alternations, i.e. the alternation between [u] and [ə], and between [ɨ] and [ə].[3]

(1)

ORTHOGRAPHY			PHONETIC VALUE		
final syllable		non-final	final syllable		non-final
ai	∼	ei	[aɪ]	∼	[əɪ]
au	∼	eu	[aɨ]	∼	[əɨ]
aw	∼	o	[aʊ]	∼	[ɔ]
uw	∼	u	[ɨʊ]	∼	[ɨ]
w	∼	y	[u]	∼	[ə]
y	∼	y	[ɨ]	∼	[ə]

In lexical context, these alternations appear as in (2) and (3), where the vowels at issue are underlined in the orthography and given in phonetic transcription on the following line. Note that although other changes are typically encoded in the orthography, the [ɨ] ∼ [ə] alternation is not represented orthographically; *y* in a final syllable standardly represents [ɨ], while *y* in a non-final syllable represents [ə].

(2)	ai [aɪ] ∼ ei [əɪ]	taith	'journey'	teithio	'to journey, travel'
		[aɪ]		[əɪ]	
		gair	'word'	geirwir	'truthful'
		[aɪ]		[əɪ]	
	au [aɨ] ∼ eu [əɨ]	haul	'sun'	heulog	'sunny'
		[aɨ]		[əɨ]	
		aur	'gold'	euriad	'golden'
		[aɨ]		[əɨ]	
	aw [aʊ] ∼ o [ɔ]	tlawd	'poor'	tlodion	'the poor'
		[aʊ]		[ɔ]	
		bawd	'thumb'	bodiau	'thumbs'
		[aʊ]		[ɔ]	
	uw [ɨʊ] ∼ u [ɨ]	buwch	'cow'	buchod	'cows'
		[ɨʊ]		[ɨ]	
		uwch	'higher'	uchel	'high'
		[ɨʊ]		[ɨ]	
(3)	(a) y [ɨ] ∼ y [ə]	byr	'short'	byrion	'short PL'
		[ɨ]		[ə]	
		bryn	'hill'	bryniau	'hills'
		[ɨ]		[ə]	

[3] In these examples, orthography is followed by broad transcription in square brackets; northern pronunciation is assumed here. Predictable phonetic variation is not shown. Note, too, that although vowel length may be contrastive in Welsh, length is ignored here as irrelevant to mutation. As Awbery (1986: 56) points out, vowel mutation 'is indifferent to the length specification of the vowel': both long [ɨː] and short [ɨ] alternate with [ə]. On the phonemic values for Welsh orthographic symbols see Ball & Williams (2001).

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(b) w [u] ~ y [ə]	trwm	'heavy'	trymion	'heavy PL'
	[u]		[ə]	
	cwch	'boat'	cychod	'boats'
	[u]		[ə]	
	cwm	'valley'	cymoedd	'valleys'
	[u]		[ə]	

Although this is the typical characterisation in the descriptive literature, the mutations listed in (2), involving diphthongs, are arguably marginal in the synchronic language. For example, although *ai* and *au* do appear as *ei* and *eu* in the penultimate syllable, there are also instances of *ei* and *eu* appearing in final syllables, e.g. *beirdd* 'bards'. The [aʊ] ~ [ɔ] alternation is not generally applicable as there are instances of [aʊ] in the penultimate syllable, e.g. *hawsaf* 'easiest', as well as instances of [ɔ] in the final syllable, e.g. *pechod* 'sin'. Finally, the [ɨʊ] ~ [ɨ] alternation is restricted to occurring only before [χ] (orthographic *ch*), as in the examples given. In light of the exceptional status and essentially diachronic interest of the alternations in (2), the rest of the paper will focus on the monophthongal alternations in (3). Although these are not without exceptions, they are of more general regularity and, at least as regards aspects of the [u] ~ [ə] alternation in (3b), an interesting subset of exceptions behave in a principled fashion.

2.1 *More on the* [ɨ] ~ [ə] *alternation*

As further evidence for the claim that vowel mutation involves a purely phonological positional sensitivity, note that a mutable vowel in a suffix will also mutate if that suffix, in turn, is followed by a suffix, i.e. by another syllable. The suffix in (4b) shows a mutable vowel in a final syllable; this vowel is shown mutated in a non-final syllable in (4c).

(4) (a)	melin	[mɛlɪn]	'mill'
(b)	melin-ydd		'miller'
	[ɨð]		
(c)	melin-ydd-ion		'millers'
	[əð]		

Observe that in examples like (4) the role of morphology is restricted to adding phonological structure through suffixation. Morphological complexity per se is not relevant, nor is morphological content. The important point is that the vowel in question appears in a non-final syllable. The syllable in question has been made non-final in this case through the addition of a suffix.

One other fact involving morphology that is relevant to the domain of vowel mutation should be noted at this point. In certain types of compounds, mutable vowels in apparent non-final position do not mutate provided that

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they are in the final syllable of the first element of the compound. For example, the underlined *y* in *llyndref* 'lake village' is [ɨ], not [ə]: *llyn* + *dref* [ɬɨndrɛv] < *llyn* 'lake' + *tref* 'town', cf. *llyn* [ɬɨn] 'lake' ~ *llynoedd* [ɬənɔɨð] 'lakes'. Vowels in the final syllable of the first element of this type of compound behave as they do in an unambiguously final syllable. This suggests that the domain of vowel mutation is the phonological word and that in such compounds each element is a separate phonological word. See also Allen (1975), who uses vowel mutation as a diagnostic for various types of Welsh compounding.

We saw in (3) that *y* [ɨ] and *w* [u] are alike in mutating to [ə] in non-final position in derived, polymorphemic words. For *y*, however, this mutation also occurs in monomorphemes, as in (5),[4] where /mɨnɨð/ is the postulated underlying form and [mənɨð] is the surface pronunciation.

(5) mynydd /mɨnɨð/ [mənɨð] 'mountain'

With the addition of a suffix to *mynydd*, the second *y*, now in non-final position, also mutates:

(6) mynyddoedd [mənəðɔɨð] 'mountains'

2.2 *The* [*u*] ~ [ə] *alternation*

Turning to the other monophthong affected by vowel mutation, the facts surrounding the [u] ~ [ə] alternation have a further twist compared with those of the [ɨ] ~ [ə] alternation.

As we have seen, the behaviour of *w* parallels that of the other mutating vowels. However, there is a difference. As we see in (7), unlike the case of [ɨ], [u] may appear in non-final position in monomorphemes in a specific context: the /u/ in the penultimate syllable does not lower to [ə] when followed in the final syllable by a further [u].

(7) cwmwl /kumul/ [kumul] 'cloud'
*[kəmul]

On the other hand, when BOTH underlying /u/ vowels are in non-final position then both mutate to schwa, again parallel to the behaviour of [ɨ] seen in (6). (This mutation of *w* [u] is indicated in Welsh orthography by means of a *y* in a non-final syllable.)

(8) cymylau [kəməla] 'clouds'

[4] The assumption here of underlying /ɨ/ in the first syllable, following Thomas (1984: 110f.), is based on the standard value of unmutated orthographic *y*. Thomas' argument extends to other monomorphemic words with *y* representing pre-final schwa in their surface form, e.g. *cybydd* [kəbɨð] 'miser', *cyfarth* [kəvarθ] 'to bark', *sydyn* [sədɨn] 'sudden'. Another possibility is, of course, available: that the underlying phonemic value of orthographic *y* is /ə/.

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Although specific to the vowel [u] amongst the mutating vowels, this behaviour is highly systematic for that vowel, as shown by the further data in (9), where all instances of orthographic *y* in the right-hand column represent [ə].[5]

(9)	cwpwrdd	'cupboard'	cypyrddau	'pl.'
	cwcwll	'cowl'	cycyllau	'pl.'
	mwnwgl	'neck'	mynyglau	'pl.'
	mwrthwl	'hammer'	myrthylau	'pl.'
	bwgwl	'menace'	bygylau	'threats'
	bwrlwm	'gurgling'	byrlymu	'bubble over'
	swmbwl	'goad'	symbylau	'pl.'

More will be said below about the behaviour of *w* [u]. At this point, however, there is one more relevant fact about the phonological system of Welsh vowels that needs to be noted.

In addition to the [ɨ] represented by orthographic *y*, there is another [ɨ] vowel, represented by orthographic *u*. This barred-i, however, does not alternate with schwa, e.g. *budd* [bɨð] 'benefit' vs. pl. *buddion* [bɨðjɔn], *[bəðjɔn]. Thus, the two [ɨ] vowels must be distinguished within the Welsh vowel system, given their differing behaviour with respect to alternation with schwa.

In summary, the main facts to be accounted for are the alternation between barred-i and schwa in one set of cases, the stability of [ɨ] in a different set of cases, and the alternation between [u] and [ə].

3. Distinguishing between alternating *y* [ɨ] and stable *u* [ɨ]

Apart from accounting for the alternations seen so far, those cases in which barred-i does not alternate with schwa must also be accounted for. As we have already seen in (3a), in words written with orthographic *y*, barred-i alternates with schwa, as is shown in (10).

[5] For the sake of completeness, it should be mentioned that there are, in fact, words with *w* [u] in the penultimate syllable and a vowel other than *w* [u] in the final syllable which do not mutate. This typically involves words borrowed from English, e.g. *bwlio* [buljo] 'tease, annoy', *bwlffyn* [bulfɨn] 'bullfinch', *cwsmer* [kusmar] 'customer', *cwmni* [kumni] 'company', *swper* [supar] 'supper' and many more besides. As an anonymous referee points out, the [u] ~ [ə] alternation is becoming lexicalised and has failed to apply to English loans for centuries, and even some later Welsh words lack the alternation. Conversely, there are a few words in which pre-final *w* mutates despite being followed by *w* in the final syllable, e.g. *bygwth* [bəguθ] 'threaten' (a variant of *bwgwth* [buguθ]). See also Fynes-Clinton (1913) and Thomas (2000).

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(10) syn [sɨn] ~ syndod [səndɔd] 'amazed' ~ 'wonder'
llyn [ɬɨn] ~ llynoedd [ɬənɔɨð] 'lake' ~ 'lakes'
bryn [brɨn] ~ bryniau [brənja] 'hill' ~ 'hills'

As just noted, however, Welsh also represents barred-i with orthographic *u*. The barred-i in these words shows no alternation, as in (11).

(11) budd [bɨð] ~ buddion [bɨðjɔn] 'benefit' ~ 'benefits'
llun [ɬɨn] ~ lluniau [ɬɨnja] 'picture' ~ 'pictures'
sudd [sɨð] ~ suddion [sɨðjɔn] 'juice' ~ 'juices'

In pre-OT generative phonology several derivational analyses distinguished between *y* and *u* by means of an underlying featural distinction and rules targeting relevant features. These analyses include Thomas (1979, 1984), Williams (1983) and Bosch (1996),[6] to which we now turn.

Thomas (1979, 1984)[7] deals with vowel mutation by means of a vowel lowering rule applying in a pre-final syllable. In the context of the present discussion, the important question is how he allows the lowering rule to affect *y* [ɨ] without also affecting *u* [ɨ], bearing in mind that the phonological analysis is entirely independent of orthography and that, on the surface, *y* and *u* are phonetically identical in final syllables. Thomas contends that 'the internal structure … can be clarified once we cease to concentrate on the phonetic units which are the surface structure of the phonology and, instead, build an analysis on the structural relationships which underlie them' (1984: 105). Thus, perfectly consistently with the assumptions of generative phonology, Thomas argues that despite the surface identity of *y* and *u* in final syllables, they can still be distinguished within the phonological system by appealing to differing abstract underlying representations. Referring to *y* as /ɨ$_1$/ and to *u* as /ɨ$_2$/, Thomas notes that the distinction between the two 'is purely abstract: it is reflected in the surface phonetics only in the participation or otherwise of the segment [ɨ] in the lowering alternations' (1984: 109). For the sake of clarity and ease of discussion, Thomas symbolizes /ɨ$_1$/ as front rounded /y/ and /ɨ$_2$/ as back unrounded /ɯ/, although neither of these segments occurs in the phonetic inventory of modern Welsh.

Featurally, Thomas assigns /y/ (=/ɨ$_1$/) the features [+high, −back, +round], while assigning the features [+high, +back, −round] to /ɯ/ (=/ɨ$_2$/). The lowering rule is written to affect [+high, +round], thus forcing /y/ to surface as schwa. The /ɯ/ remains unaffected by the lowering rule, ultimately surfacing as [ɨ].

[6] Another often-cited analysis is that of Allen (1975). Given the serious flaws in that paper (cf. Cartmill 1976), I will mention it no further here with regard to vowel mutation.

[7] The 1984 paper appeared previously as Thomas (1979). In the following I refer only to the 1984 version and pagination.

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One further point to note about Thomas' analysis, particularly in the light of current phonological assumptions about the absence of intermediate structures, is the iterative application of the lowering rule. As indicated above in (4), (5) and (6), the lowering of /ɨ$_1$/ to [ə] occurs in any pre-final syllable, regardless of whether that syllable is in a stem or a suffix. Thomas achieves this by assuming the iterative application of the lowering rule, with a disjunction of morpheme boundary (+) and word boundary (##) in the rule, so that the rule applies first in the pre-final syllable before a morpheme boundary, then again in the pre-final syllable before a word boundary.

Current phonological theory, however, assuming standard Optimality Theory, does not admit intermediate structures. Thus, intermediate application of phonological rules is no longer available as an explanation. Note, however, that the 'absence of intermediate structures' just referred to assumes a non-stratal approach to OT. Stratal OT would allow certain intermediate levels of representation (see Kiparsky 2000, Bermúdez-Otero forthcoming), though not, strictly speaking, iterative rule application. However, stratal OT crucially relies on morphological criteria, such as specific definable classes of stems or affixes, to motivate the association between specific strata and particular constraint rankings. As regards vowel mutation, however, the kinds of morphological criteria that motivate strata do not appear to be involved.[8] The intermediate structures allowed by stratal OT are thus irrelevant to the problem at hand.

An unnecessary complication in Thomas' account surrounds the differing behaviour of [u] as compared with alternating [ɨ]. In order to capture the difference between the mutation in the first syllable of *mynydd* [mənɨð] 'mountain' and the absence of mutation in the first syllable of *cwmwl* [kumul] 'cloud', together with the mutation associated with the first two syllables of *cymylau* [kəməla] 'clouds', Thomas distinguishes between monomorphemes and morphologically complex forms and posits rules specific to each alternation relative to morphological complexity. As the analysis in section 4 will show, this is unnecessary. It is also misleading, in that morphological complexity per se is not relevant.

Williams (1983) revises Thomas' analysis in several ways. While accepting his basic approach and reasoning, she rejects Thomas' reliance on the feature [round] for distinguishing the vowels in question. Instead, she proposes using

[8] As Bermúdez-Otero has pointed out to me (p.c.), the analysis presented here raises a theory-internal question about Richness of the Base (see Prince & Smolensky 2002: 209), which may be amenable to a stratal-OT approach. In the present paper, however, my aim is to explore a reasonable OT analysis of vowel mutation itself. Hannahs (in progress) considers the theoretical implications of Richness of the Base for a monostratal account of Welsh vowel mutation.

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the feature [length],[9] arguing that 'the feature reflects the fact that [+length] vowels are the only monophthongs descended from originally long vowels, and are long in a wider range of environments in the modern language' (p. 246).

Williams explores the diachronic origins of the two sources of [ɨ] and why there are two sets of monophthongs, '/i/ and /ɯ/ which never reduce to schwa …, and /y/ and /u/, which take part in the reduction and lowering processes' (1983: 241). In an elegant analysis of the facts, Williams proposes an underlying vowel system for Modern Welsh which reflects the surface vowel system in stressed syllables in Primitive Welsh (*c*. 6th century).[10] Thus, Williams' analysis of vowel mutation embodies a synchronic analysis which in certain respects recapitulates the historical development of the Welsh vowel system.

Williams' analysis represents a refinement of Thomas' account, but it raises many of the same issues with regard to current phonological thinking. Despite the interesting parallel she draws between the vowel system of Primitive Welsh and the underlying system she posits for Modern Welsh, her account still relies on ad hoc extrinsically ordered rules and intermediate representations. Similar to Thomas' account, Williams also needs to refer explicitly to morphological structure, encoding a morpheme boundary (+) into her rule deriving schwa from /u/. As will be shown below, morphological structure per se is irrelevant.

The third analysis to be discussed here, Bosch (1996), relies on distinctions between pitch prominence, associated with the final syllable, and stress, associated with the penultimate syllable. The central focus of Bosch (1996) is the question of autosegmental licensing. She approaches the vowel alternation problem from the perspective of prominence, distinguishing between two sorts of prominence associated with specific structural positions (see also Williams 1989, as well as Thomas 1984: 121 and Ball & Williams 2001: 165–185). Bosch observes that pitch prominence falls on the final syllable, while metrical prominence – stress – regularly falls on the penultimate syllable. Crosslinguistically, stressed syllables normally license the greatest number of vowel contrasts. (On such licensing, see Goldsmith 1989, Bosch & Wiltshire 1993.) Thus, in the Welsh case, penultimate stress should lead us to expect the greatest number of vowel contrasts in the penultimate syllable. On the contrary, however, here we appear to find a reduced vowel, schwa, in a

[9] Note that Williams' use of the feature [length] is distinct from the feature [long] used to distinguish between synchronically short and long vowels (see Williams 1983: 244f.). In fact, Williams argues that Welsh vowel length should be lexically unspecified and that surface vowel length can be derived by rule. This analysis does not contradict the vowel length facts mentioned in footnote 3.

[10] Both Williams and Thomas posit underlying vowel phonemes which more closely reflect older varieties of Welsh than they do the modern surface vowel systems, viz. high back unrounded /ɯ/ and high front rounded /y/, which do not surface in Modern Welsh.

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stressed position. Bosch's way of reconciling her characterisation of schwa in Welsh as a 'reduced' vowel with the fact that it nonetheless appears in a stressed syllable is to view the Welsh system as having two separate types of prominence (for which there is also phonetic evidence).

Despite this argument, and the distinctions it makes possible between final and non-final syllables, it is difficult to support the claim that schwa in Modern Welsh really is a reduced vowel in any meaningful sense. Diachronically, Welsh schwa arose through vowel reduction associated with a shift in the stress system (see Jackson 1953: 664–681). However, that does not mean that schwa in the modern language is a 'reduced' vowel: it contrasts phonologically with a number of full vowels in the system, and there is no general tendency for other full vowels to reduce to schwa; it is not a 'default' vowel in Welsh. Indeed, Williams (1989: 181) characterises schwa as a separate phoneme. In terms of syllable structure also, a 'reduced' vowel would be expected to head a 'reduced', i.e. structurally less complex, syllable. However, penultimate syllables in Welsh are no less complex than other types of syllables. Note, too, Williams' (1989: 47) observation that stressed vowels in penultimate syllables are shorter than vowels in other positions. This applies to all vowels, though, not just schwa, which seems to suggest that it is the POSITION that is significant, rather than the contents of that position. Awbery (1984: 77f.) notes only two structural differences between schwa and the other vowels of northern Welsh: schwa is always a short vowel – there is no long version of schwa[11] – and schwa must be followed by a consonant, not by another vowel. Perhaps a more accurate way of characterising Welsh schwa is to liken it to wedge [ʌ] in General American English, where wedge is said to occur in stressed syllables and is not a reduced reflex of full vowels, whereas schwa is a reduced correspondent of full vowels occurring in unstressed syllables.

As regards Bosch's analysis, she follows Thomas' underlying representations, with alternating [ɨ] represented as underlying /y/ and non-alternating [ɨ] represented as /ɯ/. Her account is that 'the high labial vowels /u/ and /y/ reduce to schwa in all but the final syllable' (1996: 135). This reduction is dependent on distinguishing between stress assignment at the W(ord)-level and at the P(hrase)-level. Relying on this distinction, stress assignment at the W-level (for final stress) and stress assignment at the P-level (for penultimate stress) achieve the desired results: when /y/ appears in a final syllable, and therefore is subject to W-level stress, it fails to 'reduce' to schwa.

While all these analyses work within the context of derivational phonology, they rely on essentially ad hoc, extrinsically ordered phonological rules and iterative rule application. Moreover, the analyses make

[11] Note, however, that vowel length is contrastive only in stressed monosyllables (see Thomas 1992: 327). Since schwa never occurs in a native stressed monosyllable, the lack of long schwa can be attributed to the absence of any kind of schwa in that particular position.

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unnecessary distinctions concerning morphological complexity. Bosch's account has the advantage of integrating some of the unusual aspects of the Welsh stress system; however, it rests on an assumption that schwa necessarily represents a reduced vowel, which does not accurately reflect the status of schwa in the vowel system of Modern Welsh.

In contrast, a much simpler account is available. The analysis proposed below has the advantage of obviating certain ad hoc aspects of previous analyses, including iterative, extrinsically ordered rules. Moreover, it underscores the role of schwa in the system and allows a simpler analysis of vowel mutation within the phonological word, relying exclusively on position, rather than on stress facts. Thus, morphological distinctions which are irrelevant to vowel mutation are avoided.

4. Analysis

4.1 *The basics*

Within the framework of Optimality Theory, the following analysis models the relevant distinctions by means of interacting structural constraints together with constraints on input–output faithfulness. As will become clear, part of the solution lies in identifying appropriate input segments in order to draw the correct distinctions, particularly between the alternating and non-alternating segments.

Let us initially assume that the surface values for *y* and *u* in final syllable position reflect their input values (cf. Lexicon Optimization, Prince & Smolensky 2002: 191ff.): in other words assume the input {ɨ}. Starting with the *br*[ɨ]*n* ~ *br*[ə]*niau* type of alternation, we clearly need a constraint banning the occurrence of schwa in a final syllable.

(12) *ə-Finalσ: Schwa does not occur in a final syllable

Assuming the input {brɨn} and comparing the output candidates [brɨn] and [brən], the *ə-Finalσ constraint distinguishes correctly between them.

(13) *bryn* [brɨn] 'hill'

Input {brɨn}	*ə-Finalσ
(a) ☞ brɨn	
(b) brən	*!

Note that this raises a question about the unit of evaluation of the constraint. As observed in section 2 with respect to compounding, the phonological

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word is relevant here as well. There are a number of proclitics in Welsh that (being monosyllabic) would appear to have schwa in the final syllable. These include, among others, the definite article *y* [ə], *yr* [ər]; the preposition *yn* [ən] 'in' and the first person singular possessive *fy* [və] (see also Hannahs & Tallerman 2006). Given the status of these items as proclitics and the fact that they therefore cannot occur in final syllables (since they do not occur in isolation without hosts), they do not present any counterevidence to the constraint, provided that the unit of evaluation is the phonological word (understood here to include a clitic and its host).[12] Given the complete absence of truly word-final schwa in the native lexical vocabulary,[13] the constraint against final schwa must be highly-ranked within the constraint hierarchy.

Turning to *bryniau* [brənja] 'hills', we presumably need a constraint prohibiting the occurrence of [ɨ] in non-final position. Compelling barred-i in the input to surface as schwa will also entail the violation of a faithfulness constraint on input–output identity (IDENT-IO) in vowels, although this constraint will be ranked lower than the constraint prohibiting non-final barred-i.

(14) *ɨ-NONFINALσ: Barred-i occurs only in final syllables
(15) IDENT-IO (vowel): Input vowels match output vowels
(16) *bryn-iau* [brənja] 'hills'

Input {brɨn-ja}	*ə-FINALσ	*ɨ-NONFINALσ	IDENT-IO (vowel)
(a) ☞ brənja			*
(b) brɨnja		*!	

If we then consider the monosyllabic *pur* [pɨr] 'pure', it would appear to be accounted for in the same way as *bryn*, assuming underlying /pɨr/. In the following tableau the candidate [pɨr] is correctly selected as more harmonic than the non-occurring competitor candidate *[pər].

[12] More accurately, of course, it is likely that the unit of evaluation is the Clitic Group, in the sense of Nespor & Vogel (1986). Given the existence of a number of other considerations involving clitics and hosts, such as consonant mutation (see Pyatt 2003) and stress placement (see Williams 1989), I leave the question of clitic group vs. phonological word for future research.

[13] There are, nonetheless, some borrowed forms with schwa in a final syllable, e.g. *syr* [sər] 'sir'.

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(17) *pur* [pɨr] 'pure'

Input {pɨr}	*ə-FINALσ	*ɨ-NONFINALσ	IDENT-IO (vowel)
(a) ☞ pɨr			
(b) pər	*!		*

However, the parallel does not extend to multisyllabic *puro* [pɨro] 'purify': since *u* does not undergo mutation it must surface as [ɨ], even in non-final syllables. The constraint hierarchy established, however, does not allow the selection of *puro* [pɨro] as optimal:

(18) *pur-o* [pɨro] 'purify'

Input {pɨr-o}	*ə-FINALσ	*ɨ-NONFINALσ	IDENT-IO (vowel)
(a) pɨro		*!	
(b) ☹ pəro			*

As the tableau in (18) shows, with this input form, this ranking of constraints and these output candidates, *[pəro] is incorrectly selected as the optimal form (hence the 'sad face' ☹). Simply reranking the constraints here would yield the wrong results for the candidates in tableaux (16) and (17). Thus, the problem must lie with the assumptions concerning the input forms. There must therefore be an underlying distinction between the [ɨ] that alternates with [ə] and the [ɨ] that is stable in all positions. Following Thomas or Williams, then, *y* and *u* must be given separate phonemic identities. In Williams' (1983) analysis *u* = /ʉ/ and *y* = /ɨ/; these choices reflect the diachronic development of the Welsh vowel system. By adopting these underlying representations, /ɨ/ will surface as [ɨ] in final position and as [ə] elsewhere, as we have just seen in the tableaux in (13) and (16). The input /ʉ/ must now be made to surface consistently as [ɨ].[14]

[14] As noted by an anonymous referee, positing an abstract non-surfacing phoneme may be seen as undesirable. I would suggest, however, as does Williams, that in this case it allows us to understand the non-alternation of this [ɨ] vowel in terms of its diachronic origin. Moreover, the surface effects of a non-surfacing structure are often observed, as for example with the tonological effects of 'floating' tones as in Hyman (1985) (see also Leben 2006), or the ATR effects in Okpe vowel harmony, in which the underlying [+high, −ATR] vowels /ɪ, ʊ/ surface as [+ATR] [e, o], yet trigger [−ATR] vowel harmony, see Hoffman (1973) (see also Calabrese 2005: 279–300).

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In order to achieve the desired result, we need to consider the surface vowel system of Welsh. The central vowels of Modern Welsh are high central [ɨ] and mid central [ə]. Neither of these vowels is rounded. Thus, a constraint prohibiting central rounded vowels will prevent the surface occurrence of barred-u. Moreover, given that /ʉ/ is high, central and rounded, a candidate containing the mid vowel schwa as an output for /ʉ/ would violate TWO IO faithfulness features, [height] and [round], whereas barred-i as the surface reflex of /ʉ/, being high and central, would violate only one input feature, [round]. Thus, in addition to positing a distinct input segment for stable [ɨ], the IO faithfulness constraint needs to be revised as in (20) to refer to vowel features, rather than to vowel segments. Each featural difference between input and output form will incur a separate violation.

(19) *CENTRAL-ROUND: Central vowels are unrounded

(20) IDENT-IO (vowel feature): Input vowel features match output vowel features

(21) *pur* [pɨr] 'pure'

Input {pʉr}	*ə-FINALσ	*CENTRAL-ROUND	*ɨ-NONFINALσ	IDENT-IO (vowel feature)
(a) pʉr		*!		
(b) ☞ pɨr				*
(c) pər	*!			**

Although the constraints and the hierarchy established now allow us to correctly select among the competing candidates for *bryn*, *bryniau* and *pur*, note that the wrong output candidate for *puro*, *[pəro], is again selected as most harmonic, despite the differing input segment. In the following tableau, candidate (c) is incorrectly selected over candidate (b).

(22) *puro* [pɨro] 'purify'

Input {pʉr-o}	*ə-FINALσ	*CENTRAL-ROUND	*ɨ-NONFINALσ	IDENT-IO (vowel feature)
(a) pʉro		*!		
(b) pɨro			*!	*
(c) ☹ pəro				**

While *CENTRAL-ROUND correctly prevents barred-u from surfacing, it does not by itself allow the necessary distinction to be drawn between

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alternating *y* and non-alternating *u*. A way is needed to prevent schwa from surfacing when it is associated with underlying /ʉ/, while at the same time allowing/forcing it to surface when it is associated with underlying /ɨ/.

4.2 *Revised account*

Let us re-examine two of the assumptions made above. In the first place, although there is ample evidence for the general validity of a constraint against word-final schwa, there is no general evidence for a prohibition against [ɨ] in a non-final syllable, on which the *ɨ-NonFinalσ constraint is predicated. It is true that the [ɨ] associated with orthographic *y* does not occur in non-final syllables, but that is not the only source of [ɨ]. The occurrence of stable [ɨ] precisely in that position suggests that the *ɨ-NonFinalσ constraint is not appropriate. Secondly, apart from diachronic considerations, it is not clear that the underlying representation of orthographic *y* should be /ɨ/ rather than schwa. In fact, the assumption of underlying /ə/ is justified on several grounds. Empirically, it is the case that *y* represents [ə] throughout the language far more frequently than it represents [ɨ]. Frequency therefore supports underlying /ə/. Theoretically, this choice is supported by Lexicon Optimization (see Kager 1999: 32ff., Prince & Smolensky 2002: 191ff.), which proposes that underlying forms should, as far as possible, match surface forms. There are two surface forms here, [ə] and [ɨ], associated with a single input form; the surface form with the greatest frequency of occurrence is [ə], making it a reasonable choice for representing the input segment, as the output form most often matches input /ə/.

A further advantage to the assumption of underlying /ə/ for the present analysis is that it allows us to abandon one of the constraints proposed above, *ɨ-NonFinalσ. The effects of that constraint can now emerge simply through the ranking of *ə-Finalσ ≫ Ident-IO (vowel feature), provided that the appropriate underlying vowels are posited. Moreover, the absence of the *ɨ-NonFinalσ constraint means that barred-i in words like *puro* will no longer be incorrectly ruled out, which would otherwise require a more highly-ranked constraint in order to rule it in.[15]

[15] An anonymous referee asks why the surface reflex of underlying /ə/ should be [ɨ] in final position, rather than [a] (which would violate as few input features as does [ɨ]). For whatever reason, the low vowel does not occur as one of the results of vowel mutation. Consider the following three points: (i) diachronically, the alternation was a lowering of high /ɨ/ to mid [ə], not to low [a]; (ii) none of the traditional vowel mutations involves a lowering to [a], as shown by the examples in (2) and (3); and (iii) the alternation between schwa and a high vowel in those dialects which lack [ɨ] involves an alternation between a mid vowel and a high vowel: [ə] ~ [i].

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Thus the revised analysis proposed here assumes distinct inputs for alternating [ɨ] and stable [ɨ], namely /ə/ and /ʉ/, respectively, along with the constraint ranking *ə-FINALσ ≫ *CENTRAL-ROUND ≫ IDENT-IO (vowel feature).

To test these assumptions and the posited constraint ranking, consider the following tableaux (23)–(26), showing the evaluation of potential candidates for *bryn*, *bryniau*, *pur* and *puro*. In the tableau in (23), the schwa in candidate (a) is properly marked as violating the highest constraint in the hierarchy. The (b) candidate [brɨn], despite incurring an IO faithfulness violation, surfaces correctly.

(23) *bryn* [brɨn] 'hill'

Input {brən}	*ə-FINALσ	*CENTRAL-ROUND	IDENT-IO (vowel feature)
(a) brən	*!		
(b) ☞ brɨn			*

In tableau (24) below, the underlying schwa is correctly allowed to surface; the faithfulness violation of IDENT-IO (vowel feature) by candidate (b), *[brɨnja], prevents that candidate from surfacing. Note that any other vowel in the first syllable would have fared even worse: schwa and barred-i differ featurally only with respect to height; they share centrality and (lack of) rounding. Assuming one violation for each differing feature, any other vowel in the system would have incurred at least two violations of IDENT-IO (vowel feature), compared with the single violation incurred here by [ɨ].

(24) *bryn-iau* [brənja] 'hills'

Input {brən-ja}	*ə-FINALσ	*CENTRAL-ROUND	IDENT-IO (vowel feature)
(a) ☞ brənja			
(b) brɨnja			*!

In tableau (25), candidate (c) is correctly ruled out by the constraint against the occurrence of schwa in a final syllable. The underlying central rounded vowel of candidate (a) falls foul of the *CENTRAL-ROUND constraint, correctly allowing candidate (b) [pɨr] to surface, in spite of the violation of the IDENT-IO faithfulness constraint.

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(25) *pur* [pɨr] 'pure'

Input {pʉr}	*ə-FINALσ	*CENTRAL-ROUND	IDENT-IO (vowel feature)
(a) pʉr		*!	
(b) ☞ pɨr			*
(c) pər	*!		**

Finally, the tableau in (26) shows the surfacing of barred-i in a non-final syllable, provided that this vowel is associated with non-alternating [ɨ] (underlying /ʉ/) rather than with alternating [ɨ] (underlying /ə/).

(26) *pur-o* [pɨro] 'purify'

Input {pʉr-o}	*ə-FINALσ	*CENTRAL-ROUND	IDENT-IO (vowel feature)
(a) pʉro		*!	
(b) ☞ pɨro			*
(c) pəro			**!

Thus, assuming distinct underlying vowels for alternating [ɨ] and stable [ɨ], together with the constraint hierarchy shown, we can correctly distinguish between alternating [ɨ] ~ [ə] and stable [ɨ].

It was pointed out earlier, with regard to examples (5) *mynydd* [mənɨð] 'mountain' and (6) *mynyddoedd* [mənəðɔɨð], along with numerous monomorphemic examples such as *cybydd* [kəbɨð] 'miser', *cyfarth* [kəvarθ] 'to bark', *sydyn* [sədɨn] 'sudden' (see footnote 4), that the traditional assumption was that the non-final vowels in these words are derived from /ɨ/. Under the present analysis this is an unnecessary assumption. Rather, this account brings with it the further simplification to the grammatical system that schwa in monomorphemes is simply a direct reflection of the underlying value of the vowel in question.

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(27) *mynydd* [mənɨð] 'mountain'

Input {mənəð}	*ə-FINALσ	*CENTRAL-ROUND	IDENT-IO (vowel feature)
(a) ☞ mənɨð			*
(b) mənəð	*!		
(c) mɨnɨð			**!

(28) *mynydd-oedd* [mənəðɔɨð] 'mountains'

Input {mənəð-ɔɨð}	*ə-FINALσ	*CENTRAL-ROUND	IDENT-IO (vowel feature)
(a) mənɨðɔɨð			*
(b) ☞ mənəðɔɨð			

(29) *cybydd* [kəbɨð] 'miser'

Input {kəbəð}	*ə-FINALσ	*CENTRAL-ROUND	IDENT-IO (vowel feature)
(a) ☞ kəbɨð			*
(b) kəbəð	*!		

Under this analysis, the non-final vowels in these words surface as schwa simply because they are schwa underlyingly and no constraints prohibit the occurrence of schwa here at the surface. Nothing further needs to be said about them.

4.3 *Accounting for* [u] ~ [ə]

Consider now one more piece of the puzzle, namely the behaviour of orthographic *w* [u], which alternates with [ə] in a non-final syllable – except when followed by another [u] in the final syllable. First consider the related pair *cwm* [kum] 'valley' ~ *cymoedd* [kəmɔɨð] 'valleys'. *Cwm* [kum] correctly surfaces under the assumptions made to this point, and assuming that the surface [u] reflects the input vowel /u/.

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(30) *cwm* [kum] 'valley'

Input {kum}	*ə-FINALσ	*CENTRAL-ROUND	IDENT-IO (vowel feature)
(a) ☞ kum			
(b) kəm	*!		*

As for *cymoedd* [kəmɔið] 'valleys', we need a way of preventing the underlying /u/ in /kumɔið/ from appearing in non-final position. It was argued above with respect to alternating [ɨ] that its behaviour was unlikely to be the result of a constraint prohibiting barred-i in a non-final syllable, since this would produce the wrong result for stable [ɨ]. One might therefore question the likelihood of a constraint against non-final [u], i.e. *u-NONFINALσ. Note, however, that there is a fundamental difference between the behaviour of [ɨ] and that of [u]: because of the association of [ɨ] with two different phonemes, a constraint prohibiting [ɨ] incorrectly affects the output of both the alternating and the non-alternating phoneme. As regards /u/, though, it is not the case that there is another source for [u]. Rather, the exceptional behaviour involves the occurrence of non-final [u] when [u] also appears in a final syllable. Thus, we can posit a constraint against the occurrence of [u] in non-final position to account for words like *cymoedd* [kəmɔið]:

(31) *u-NONFINALσ: [u] appears only in final syllables
(32) *cym-oedd* [kəmɔið] 'valleys'

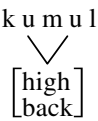
Input {kum-ɔið}	*ə-FINALσ	*CENTRAL-ROUND	*u-NONFINALσ	IDENT-IO (vowel feature)
(a) ☞ kəmɔið				*
(b) kumɔið			*!	

There is one further adjustment to be made, however, in order to account for the non-mutating behaviour of [u] when the [u] in question is followed by another [u] in the final syllable, as in *cwmwl* [kumul] 'cloud'. In this case, the constraint needs to scan not only the position of the [u], but also to determine whether an [u] in non-final position is followed by an [u] in final position. That is, non-final [u] is prohibited UNLESS it is followed by [u] in final position. It appears that the [u] vowels are linked, presumably to a single set of features. In some sense, the 'non-final' [u] in such a form is not completely non-final, given its association with the following, final [u]. It is only when BOTH [u] vowels are non-final, as in *cymylau* [kəməla]<⁄kumul-a⁄ 'clouds', that the mutation occurs.

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This is reminiscent of Itô's coda condition (1986: 50ff.): in her analysis a doubly linked coda, i.e. a coda associated with two skeletal positions, escapes a filter designed to prohibit a coda consonant that is linked to a single skeletal position. In the *cwmwl*-type case, I argue that both instances of [u] are linked to a single set of features (thus avoiding an Obligatory Contour Principle (OCP) violation; see Odden 1986). In order for the mutation to occur, the [u] in question must be in non-final position. But in this case, because of the linking, this non-final [u] is still associated with the final syllable and so the mutation does not occur.[16]

(33)



In (33), we see that the two instances of the vowel [u] are jointly linked to a single set of features, shown here as [high] and [back]; thus, *cwmwl* [kumul] surfaces with both [u] vowels intact, i.e. unmutated.

(34) *cwmwl* [kumul] 'cloud'

Input {kumul}	*ə-FINALσ	*CENTRAL-ROUND	*u-NONFINALσ	IDENT-IO (vowel feature)
(a) kəmul				*
(b) ☞ kumul				

Only when both /u/ vowels are non-final do they mutate to schwa. And in this case both vowels undergo mutation.

(35) *cymyl-au* [kəməla] 'clouds'

Input {kumul-a}	*ə-FINALσ	*CENTRAL-ROUND	*u-NONFINALσ	IDENT-IO (vowel feature)
(a) ☞ kəməla				**
(b) kumula			*!*	

[16] Bosch (1996: 146f.) makes a similar point, but views it in terms of licensing: [u] in a final syllable licenses [u] in a pre-final position. When the rightmost [u] is no longer in final position, neither [u] is licensed, so schwa results.

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In this way, the mutating behaviour of [u], together with its peculiarity of not mutating when followed by [u] in a final syllable, is brought into the analysis.[17]

5. Conclusion

The present paper has revisited the problem of accounting for the vowel mutation alternations [ɨ] ~ [ə] and [u] ~ [ə], at the same time addressing the alternation of [ɨ] with [ə] in one set of cases and the absence of alternation in a different set of cases. As has been shown, a straightforward optimality-theoretic account is available. In fact, the account is simpler than any of its predecessors. In this account, I have assumed different underlying vowels from those posited by Thomas and Williams, i.e. /ə/ for alternating barred-i, and /ʉ/ for the stable segment. The analysis rests on the interactions of a high-ranking structural constraint prohibiting schwa in final syllable (*ə-Finalσ), a constraint prohibiting high central [ʉ] (*Central-round), an input–output faithfulness constraint on vowel features (Ident-IO (vowel feature)), and a constraint prohibiting the occurrence of (singly linked) [u] in a final syllable (*u-NonFinalσ). The assumption of underlying /ə/ for the alternating vowel is supported empirically by frequency of occurrence: Welsh orthographic *y* most often represents [ə]. Theoretically, this accords with Lexicon Optimization (Prince & Smolensky 2002: 191ff.), whereby an output segment should ideally mirror its input correspondent. Under these assumptions, alternating orthographic *y* and non-alternating orthographic *u* (phonetically [ɨ]) can be correctly distinguished in both final and non-final syllables. The [u] ~ [ə] alternation, while requiring a further constraint, is also consistent with this analysis.

The strength of this account lies in its simplicity. Unlike previous accounts, there is no need for ad hoc extrinsically-ordered rules or iterative rule application, nor is there any need to refer to intermediate levels of representation. Moreover, it becomes unnecessary to distinguish between morphologically complex and simple forms – the analysis relies exclusively on phonological position. Finally, the proposed analysis operates independently of any stress facts. Once the appropriate underlying forms are identified, and the constraints and their ranking are established, it becomes simply

[17] An interesting question raised by an anonymous referee is how monostratal OT can model the differing phonological behaviours of words of different origins. As seen in footnote 5, a number of loans, particularly from English, fail to undergo the [u] ~ [ə] alternation. In view of the fact that this paper explicitly rejects the need for stratal OT to account for vowel mutation, the question remains of how specific lexical classes can be tied to (or exempt from) the effects of specific constraints. I leave a fuller answer for further research, but would suggest that it is plausible that specific classes of lexical items (e.g. words of a particular linguistic origin) could be marked in the lexicon as subject to, or exempt from, specific constraints without necessarily requiring a stratal architecture.

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a question of distinguishing between final and non-final syllables within the phonological word.

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