Output optimization in the Irish plural system*

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In this paper I argue that a subpattern of Irish plural allomorphy should be analyzed as output optimizing in character. Specifically, I claim that stress-sensitive alternations between the plural suffixes *-(e)anna* and *-(e)acha* are conditioned by constraints on metrical well-formedness. This analysis connects with independent facts about the the prosodic prominence of [ax] sequences in Irish phonology. I further argue that an explanatory analysis of these patterns must make use of the notion of surface optimization. Alternative frameworks that eschew surface-oriented optimization mechanisms fail to account for synchronic and diachronic properties of the Irish plural system.

1 Irish

Modern Irish (henceforth just 'Irish') is a Celtic language spoken on a daily basis by as many as 70,000 people in the Republic of Ireland (Walsh 2010). In this article I argue that, despite recent criticisms of optimization-based models of morpho-phonology, a subset of Irish plural allomorphy is best understood as an instance of output-optimizing affix selection. Section 2 outlines the Irish plural system and the proposed analysis. In section 3 I argue that non-optimizing models of Irish plural allomorphy miss important synchronic and diachronic generalizations about the Irish plural system, and section 4 concludes.

2 Irish plurals

In Irish, plural nouns are formed with a wide array of suffixal morphology. As a brief illustration, plurality can be expressed by final consonant palatalization (1a), by suffixation of [ə] (1b), and by the simultaneous occurrence of both processes (1c).[1] Pluralization may also be accompanied by changes in stem vowels, such as syncope (1b,c) (see Hickey 1985a,b).

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[1]Descriptive sources on Irish differ somewhat in their transcription practices. I've made little attempt to normalize transcriptions other than converting non-standard phonetic symbols to current IPA norms. [C^j] indicates a palatalized consonant, [C] a velarized consonant. The transcriptions given here largely ignore the tense/lax contrast in sonorant consonants, except when relevant for the issues at hand (tense sonorants are digraphs in Irish orthography, e.g. *nn* [N], though tense *m* [m] is written with a single grapheme as it has no lax counterpart). In Irish orthography acute accents mark underlying (or historical) vowel length rather than stress placement.

(1) a. Final C palatalization
bád [bɑːd] → *báid* [bɑːdʲ] ‘boat(s)’

b. [ə] suffixation, with syncope
focal [fokəl] → *focla* [foklə] ‘word(s)’ (Ó Siadhail 1995)

c. Final C palatalization and [ə] suffixation, with syncope
capall [kɑpəl] → *caiple* [kapʲlʲə] ‘horse(s)’ (Stenson 1978:515)

These examples of plural formation constitute only a small subset of the patterns found in Irish. With respect to plural inflection, Ó Siadhail (1995) divides Irish nouns into six different major classes, with twenty-six smaller subclasses. Unfortunately, as noted in Ó Siadhail (1991:159), it is “very difficult to predict how the plural of any given noun is formed” (see also Stenson 1978:519).[2] In general, nouns that follow a particular pattern of plural formation cannot be grouped together on the basis of semantic, phonological, or other morphological similarity. To illustrate, consider the following nouns:

NOUN	SINGULAR	PLURAL	GENITIVE SG.	GLOSS
cloch	klox	klox-ə	kloxʲ-ə	‘stone’
clog	klog	klog-ənə	kligʲ	‘clock’
deoch	dʲox	dʲox-ənə	dʲiː	‘drink’
troid	tredʲ	tredʲ-ənə	trod-ə	‘fight’
blaosc	bliːsk	bliːsk-ənə	bliːsʲkʲ-ə	‘skull’

Table 1: Some Irish nominal paradigms (Ó Siadhail 1991, 1995, Carnie 2008)

As Table 1 suggests, the choice of plural allomorph cannot be predicted from the segmental content of the noun (see also Lazar-Meyn 1982, Hickey 1985b:155-9). Though both *deoch* and *cloch* end in [ox], the two nouns take different plural suffixes, *deoch* pluralizing with [-ənə] and *cloch* with [-ə]. A similar contrast is provided by *cloch* and *clog*, which pluralize differently despite being almost segmentally identical.

The morphological incoherence of these plural classes is evident when we consider the system of genitive inflection. *Clog*, *deoch*, *troid*, and *blaosc* all take the plural suffix [-ənə], but have distinct patterns of inflection in the genitive singular (most nouns lack a distinct genitive plural form). Nor can the plural be predicted from the genitive: the genitive forms of *blaosc* and *cloch* are derived in the same way (final palatalization with [-ə] suffixation), but the two nouns take different plural suffixes. Since no semantic properties characterize the class of nouns that pluralize with [-ənə] in Table 1, its membership is apparently an arbitrary fact about the lexicon. Exactly analogous arguments can be produced for other plural formatives in the language. (See Wigger 1973, Stenson 1978, Carnie 2008 for more on the arbitrariness of nominal paradigms in Irish.)

[2]The plural forms of derived nouns are somewhat more predictable. See Ó Siadhail (1991:140) for examples.

2.1 A subregularity: *-(e)anna* and *-(e)acha*

At first glance Irish plural morphology appears to be quite erratic. There are nonetheless certain sub-regularities in the system. In particular, two plural markers, *-(e)anna* and *-(e)acha*, have partially predictable distributions. The plural suffix *-(e)anna* typically attaches to monosyllabic nouns (2). Transcriptions and generalizations are representative of Achill Irish, a Western (Connacht) dialect of Mayo.[3] In this dialect the suffix in question is usually realized as *-(e)annaí* [-ənɪ]/[-əni].

(2)	a.	*bior*	[ˈbʲɨr]	→	*biorannaí*	[ˈbʲɨr - ənɪ]	‘rod(s)’	(Stockman 1974:361)
	b.	*ceap*	[ˈkʲap]	→	*ceapannaí*	[ˈkʲap - əni]	‘last(s) (for shoemaking)’	
	c.	*loch*	[ˈlox]	→	*lochannaí*	[ˈlox - əni]	‘lake(s)’	
	d.	*cith*	[ˈkʲixʲ]	→	*ceathannaí*	[ˈkʲah - ənɪ]	‘rain shower(s)’	
	e.	*síog*	[ˈʃɪːg]	→	*síogannaí*	[ˈʃɪːg - ənɪ]	‘haystack(s)’	
								(W III 53:600,1150; W III 54:724,856)

Importantly, the distribution of *-(e)annaí* is not limited to monosyllabic nouns: it also attaches to polysyllabic nouns with final stress (3) (though such forms are not numerous; section 2.3).[4]

(3) Polysyllabic noun with irregular final stress (Hickey 1985b)

a.	*meaisín*	[mʲæː.ˈʃiːnʲ]	→	*meaisíneanna*	[mʲæː.ˈʃiːnʲ - ənə]	‘machine(s)’
b.		[də.ˈgʲrʲiː]	→		[də.ˈgʲrʲiː - ənə]	‘degree(s)’

In contrast, the plural suffix *-(e)acha* [-axə] normally occurs with polysyllabic nouns ending in an unstressed syllable:[5]

(4)	a.	*punnan*	[ˈpɤ.nən]	→	*punnanacha*	[ˈpɤ.nən - ɑxə]	‘sheaf/sheaves’
	b.	*carraig*	[ˈkɑ.rikʲ]	→	*carraigeacha*	[ˈkɑ.rikʲ - axə]	‘rock(s)’
	c.	*sochraid*	[ˈsɔx.riːdʲ]	→	*sochraideacha*	[ˈsox.riːdʲ - axə]	‘funeral(s)’
	d.	*gráinnín*	[ˈgrɑː.nʲiːnʲ]	→	*gráinníneacha*	[ˈgrɑː.nʲiːnʲ - axə]	‘grain(s)’
	e.	*deirfiúr*	[ˈdʲe.rʲə.fʲər]	→	*deirfiúracha*	[ˈdʲe.rʲə.fʲər - axə]	‘sister(s)’
							(W III 53:660; W III 54:346,666,704,1082)

These two suffixes are therefore in complementary distribution: *-(e)annaí* [-ənɪ] attaches to nouns bearing final stress, while *-(e)acha* [-axə] attaches elsewhere.

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[3]For historical reasons Achill Irish has a number of linguistic features which are more typical of Northern dialects. See Wagner (1969:Vol. III, p.272), Stockman (1974), Ó Dochartaigh (1978, 1987), Hickey (2011:123), among others.

References of the form ‘W V P:I’ refer to Wagner (1969) *Linguistic atlas and survey of Irish dialects*. ‘V’ is the volume number, ‘P’ the dialect code (point number), and ‘I’ the number(s) corresponding to the survey item(s).

[4]These forms are from Conamara (Western) dialects, as I have been unable to find attestations of the plural forms of these stems in other dialects. Ó Siadhail (1991:160) characterizes this pattern differently, claiming that *-(e)anna* attaches to “monosyllables and…polysyllables…with a double stress,” i.e. with two equal stress peaks. Authors differ as to whether they transcribe double stress or a single final stress for words like *meaisín*; compare Ó Siadhail (1991:160) with Stockman (1974:350) and Hickey (1985b). In any case, the analysis of plural allomorphy developed in section 2.6 only depends on the presence of final stress in these forms, a fact which seems to be undisputed. The facts here are different in Munster dialects; see sections 2.4.2 and 2.7.

[5]Descriptive sources sometimes transcribe the suffix *-(e)acha* with variation in the backness of the initial low vowel ([a]~[ɑ]) or in the place of articulation of the medial fricative ([x]~[χ]). Rather than normalize this variation, I’ve reproduced transcriptions as given in the original sources.

There are some exceptions to this basic distribution of *-(e)annaí* and *-(e)acha*. Specifically, certain monosyllabic nouns take the suffix [-axə], rather than [-ənɪ] (see Hickey 1985b:158, Ó Siadhail 1991:160 for more discussion):

(5)	a.	*níon*	[ˈnʲiːən]	→	*níonacha*	[ˈnʲiːən - ɑxə]	‘daughter(s)’
	b.	*éan*	[ˈeːən]	→	*éanacha*	[ˈeːn - axə]	‘bird(s)’
	c.	*ubh*	[ɨvʲ]	→	*uibheacha*	[ˈɨvʲ - ɑxə]	‘egg(s)’
	d.	*áit*	[ɑːtʲ]	→	*áiteacha*	[ˈɑːtʲ - ɑxə]	‘place(s)’
						(W III 53:822; W III 54:162,249,349; W III p.272)	

Perhaps unsurprisingly, exceptional forms like (5) are subject to regional variation, and many dialects use regular plural forms like *áiteanna(í)* instead of irregular forms like *áiteacha* (Mac An Bhaird 1974, Stenson 1978, Ó Siadhail 1991:160, Ó Sé 2000:26, etc.).

There is an important asymmetry in these exceptions: examples of irregular suffixation of [-axə] to monosyllables (5) are reasonably common, but forms in which [-ənɪ] exceptionally attaches to polysyllables with non-final stress are essentially nonexistent.[6] So, for both regular and exceptional plural forms, [-ənɪ] has a more narrowly circumscribed distribution than [-axə].

We can thus restate the basic descriptive generalization: barring a set of dialectally unstable lexical exceptions, *-(e)annaí* [-ənɪ] appears adjacent to stressed syllables, and *-(e)acha* [-axə] appears elsewhere.

PLURAL SUFFIX	ATTACHES TO:	LEXICAL EXCEPTIONS?
-(e)annaí [-ənɪ]	Stressed syllables	No
-(e)acha [-axə]	Unstressed syllables (i.e. elsewhere)	Yes: some monosyllabic stems

Table 2: Distributions of *-(e)annaí* [-əni] and *-(e)acha* [-axə]

Lastly, though not all loanwords display this pattern of plural marking, some recent and semi-recent borrowings demonstrate that these suffixes are still quite productive (Ó Siadhail 1991:160):[7]

[6] I know of only a handful of potential counterexamples, none of which hold up to scrutiny. Stenson (1978:502) notes that several /ə/-final polysyllabic noun stems take *-(e)annaí* in Ráth Cairn Irish; however, these forms are pronounced as “the usual trisyllabic plural”, i.e. with a stressed monosyllabic stem (e.g. *comharsa* [ˈkoːrsə] vs. *comharsannaí* [ˈkoːrs-əniː] ‘neighbor(s)’; see also Sommerfelt 1922:180).

A number of polysyllabic noun stems ending in *í* [i(ː)] may also take *-anna(í)*. These include both loanwords (*ailibíonna* ‘alibis’, Carnie 2008:54; *tincéiríannaí* [tʲiŋʲ.kʲɛ.rɪ-əni] ‘tinkers’, *tanúntaíannaí* [ta.nuːn.tɪ-əni] ‘tenants’, W III 54:716,743,746) and native lexical items (*gadaíanní* [gɑ.dɪ-əni] ‘thieves’, *gréasaíanní* [gʲrʲeː.siː-əni] ‘shoemakers’, W III 53,54:723,959,1018,1072; Stockman 1974:158,364). I have little to say about this pattern other than to note that it appears to be systematic, at least in Achill Irish (see Albright & Hayes 2003 for a possible approach to this kind of sub-regularity). Still, it is neither exceptionless (e.g. *giorriacha* [gʲɤ.riː-ɑxə] ‘hares’, *tórraíacha* [toː.riː-axə] ‘wakes’, etc.; W III 53,54:198,424,703,820) nor widely attested outside of the Achill and West Ulster areas. It may be that these forms actually involve a distinct plural suffix *-íanna(í)* [-iːənɪ]/[-iːənə], modeled after the plural marker *-(a)íochaí* [-iːəxiː] (fn. 8; see also Quiggin 1906:152, Wagner 1959:169, Ó Baoill 1996:71-2). Footnote 30 addresses more widespread exceptions in the Irish of Ros Goill.

[7] Examples of *blag*/*blaganna* are widespread on the internet. The forms *acrainm*/*acrainmneacha* were found at “1,000 Téarma Ríomhaireachta” (`http://www.dcu.ie/fiontar/btfbeag/BTFbeag-20.html`; no longer online).

(6)	a.	*bruiseannaí*	[ˈbrɨʃ - əni]	‘brushes’	
	b.	*seideannaí*	[ˈʃed - əni]	‘sheds’	
	c.	*róannaí*	[ˈroː - əni]	‘rows’	(W III 53:18,514,594)
	d.	*blaganna*		‘blog(s)’	
	e.	*jobannaí*	[ˈd͡ʒaːb - əniː]	‘job(s)’	(Hickey 2011:35)
	f.	*stiarpacha*	[ˈʃtʲiə.rəp - axə]	‘stirrups’	(W III 53:p.258)
	g.	*acrainmneacha*		‘acronym(s)’	

The highly productive character of *-(e)anna(í)* and *-(e)acha* is also emphasized by Wigger (1973:66-7), Mac An Bhaird (1974:215), Stenson (1978:479), Lucas (1979:50), Hickey (1985b), Ó Buachalla (1988:44,52), and Ó Curnáin (2007:671,2023).

2.2 *-(e)anna* and *-(e)acha* as contextual allomorphs

There are reasons to believe that [-ənə] and [-axə] are in fact allomorphs of a single underlying plural morpheme. For one, *-(e)anna* and *-(e)acha* are formally similar, being the only productive [-VCV] plural markers in the language.[8] They are also the only plural suffixes with distributions that are clearly conditioned by stress or syllable count. Most importantly, these two suffixes are in (near-)complementary distribution. This distributional pattern makes sense under the assumption that [-ənə] and [-axə] are simply contextually restricted surface forms of a single underlying plural suffix. For convenience, I will refer to this abstract morpheme as $\textsc{m}_x$.[9]

Despite the partial resemblance between [-ənə] and [-axə] the contextual allomorphy described here is clearly a case of suppletion. No phonological process exists in Modern Irish that would convert [x] to [n] or vice-versa, so alternations between [-ənə] and [-axə] must be treated as suppletive (see also section 3.2). Since the distribution of these two suffixes is determined by noun stem stress, this subcase of plural marking instantiates PROSODICALLY CONDITIONED SUPPLETIVE ALLOMORPHY, or PCSA (Carstairs 1988, 1990, Mester 1994, Paster 2006).

I am thus proposing Figure 1 as the basic structure of plural allomorphy in Irish. A given noun may idiosyncratically appear with a particular suffix, as determined by some selectional relation between the two morphemes. When the suffix in question is $\textsc{m}_x$, its actual phonological form is conditioned by phonological properties of the noun it attaches to. While this is a fairly rich morphological structure, the distributional facts support an analysis of plural allomorphy in which *-(e)anna* and *-(e)acha* are recognized as a distinguished pair of affixes, set apart from the other plural morphemes in the system (compare with similar ideas in Bonet et al. 2007, Bonet & Harbour 2012).

[8]Along with *-(e)acha* Irish has a handful of similar plural suffixes with initial long vowels, such as *-(i)óchaí* [-oːxiː] (e.g. *cuislióchaí* ‘veins’) and *-(a)íochaí* [-iːəxiː] (e.g. *coircíochaí* ‘oats’). The quality of the long vowel in these [-Vːxiː] plurals is not generally predictable, and is sometimes variable for a given word.

While these plurals may have been productive at some point, that no longer appears to be the case, and many such nouns also appear in more regular plural forms with *-(e)acha* or *-(a)í* instead (e.g. Mac An Bhaird 1974, Stenson 1978, Hickey 1985b and Ó Curnáin 2007:676-9). As the synchronic relation between these [-Vːxiː] suffixes and plural *-(e)achaí* [-əxiː] is unclear to me, I abstract away from this variation here.

[9]Bennett (2012:205-6) presents an additional argument based on a pattern of double-plural marking that treats *-(e)anna* and *-(e)acha* as a natural class. However, the pattern in question is most robust in Western dialects (Mac An Bhaird 1974, Stenson 1978, Ó Siadhail 1991:140-1, Hickey 2011:277-8), and since the focus of the present paper is on Southern and Northern dialects (section 2.7.1), I will not repeat the argument here.

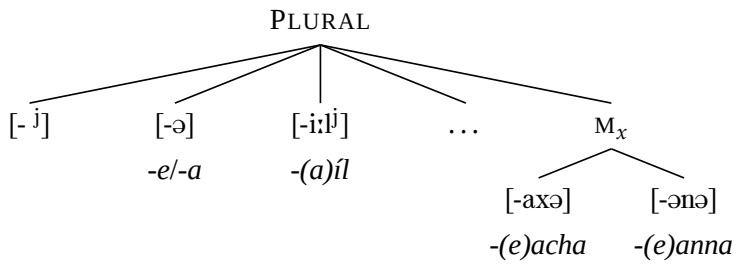

Figure 1: Partial selectional structure of Irish plural morphology

Finally, of the two allomorphs [-axə] can be considered the 'elsewhere' or 'default' variant. As discussed in section 2.1, the distribution of [-ənə] is sharply restricted: it only attaches to stressed syllables; and there are no lexical exceptions in which [-ənə] attaches to an unstressed syllable. In contrast, [-axə] attaches to unstressed syllables, but also exceptionally attaches to a number of stressed monosyllabic nouns. As [-ənə] has more stringent conditions on its distribution than [-axə] does, I assume its appearance is triggered by a specific environment, namely post-tonic position.

In the discussion that follows I argue that this instance of Irish plural allomorphy is best analyzed as a case of output optimization (Mester 1994, Tranel 1996, Kager 1996, Mascaró 1996, 2007, and many others). In particular, I propose that the choice of plural suffix is sensitive to metrical structure: allomorphy avoids marked (σ́H) feet.

2.3 The Irish stress system

Since the distribution of [-ənə] and [-axə] is conditioned by noun stem stress, a brief discussion of the stress system of Irish is in order. An OT formalization is given in section 2.3.2.

2.3.1 Stress placement and non-iterativity

For most dialects of Modern Irish (those in the Northern and Western groups), stress placement is straightforward: excluding a few lexical exceptions, stress falls on the first syllable of the word (Ó Sé 2008 among many others). In these dialects, stress is not conditioned by syllable weight:

(7)	a.	[ˈLH]:	*tromán*	[ˈtrɤ.mɑːn]	'spindle whorl'
	b.	[ˈLHL]:	*cineálta*	[ˈkʲɪ.nɑːl.tə]	'kind (adj.)'
	c.	[ˈLLH]:	*cragarlán*	[ˈkrɑ.gər.lɑːn]	'type of small fish'

(W III 54:231,351; Stockman 1974:367)

Following Doherty (1991) and Green (1997) I take the rigidly initial stress system of Western and Northern dialects to reflect quantity-insensitive trochaic footing at the left edge of the word (e.g. [(ˈkrɑ.gər)lɑːn]).

There is no evidence of secondary stress in most varieties of Irish. One exception is Munster Irish, a full analysis of which lies outside the scope of this paper (but see sections 2.4.2 and 2.7). The lack of secondary stress suggests that footing is non-iterative in most dialects of Irish—content words contain only a single foot. Since I know of no positive evidence for iterative foot structure in the language (apart from secondary stress in Munster Irish), I will assume non-exhaustive footing without further comment (see Ní Chiosáin 1999, Bennett 2012 for evidence supporting this view).

2.3.2 Modeling Irish stress: OT analysis

The initial stress system of Northern and Western Irish can be modeled with four constraints: ALLFEETLEFT (AFL), TROCHEE, WEIGHT-TO-STRESS (WSP), and PARSE(σ) (Green 1996, 1997; see Prince & Smolensky 1993/2004, McCarthy & Prince 1993, McCarthy 2003, 2008a for standard constraint definitions). I assume that HEADEDNESS(ω), the constraint requiring every prosodic word ω to contain at least one foot (its head), is inviolable (i.e. it is part of GEN; Itô & Mester 1992/2003, Selkirk 1995, etc.).

To capture the leftward orientation of stress, I take AFL to be undominated. The ranking {AFL, TROCHEE} ≫ WSP (8b,c) ensures that stress placement will be quantity-insensitive, and AFL ≫ PARSE(σ) (8d) derives non-iterative footing. Though low-ranked, PARSE(σ) still eliminates candidates with monosyllabic feet (8e).

(8) Word-initial primary stress in Irish: TROCHEE ≫ WSP; AFL ≫ {WSP, PARSE(σ)}

/ kɨnʲiːnʲiː /	AFL	TROCHEE	WSP	PARSE(σ)
a. ☞ (ˈkɨ.nʲiː)nʲiː			**	*
b. (kɨ.ˈnʲiː)nʲiː		*! W	* L	*
c. kɨ(ˈnʲiː)nʲiː	*! W		* L	** W
d. (ˈkɨ.nʲiː)(ˌnʲiː)	*! W		* L	L
e. (ˈkɨ)nʲiː.nʲiː			**	**! W

coiníní ‘rabbits’ (Stockman 1974:317)

Note that the winning candidate in (8), [(ˈkɨ.nʲiː)nʲiː], contains an uneven (ˈLH) trochee with a heavy syllable in the weak position of the foot. In many quantity-sensitive languages, feet of this shape are actively avoided (Hammond 1986, Hayes 1995, etc.). In section 2.5 I will argue that (ˈσH) feet are indeed avoided in Irish plural allomorphy, despite the general acceptability of (ˈσH) feet in the language.

While it seems uncontroversial that long vowels and diphthongs should count as heavy (i.e. bimoraic) in Irish, the question of coda weight is more fraught. Word minimality restrictions cannot be used as a diagnostic for coda weight because Irish freely allows monomoraic content words like *rath* [ˈrɑ] ‘luck’ and *te* [ˈtʲe] ‘hot’ (Stockman 1974:38,65; Green 1997:64, Ní Chiosáin 1999:572). In dialects with strict initial stress (8b-d), stress placement simply provides no evidence as to the weight of coda consonants. However, in the quantity-sensitive stress system of Munster Irish (section 2.4.2), codas are inert for stress assignment (“only those syllables containing a long vowel or diphthong count as heavy”, Doherty 1991:19; also Ó Sé 1989, 2008). This suggests that codas are weightless in Munster Irish; I assume that the same is true for all dialects of the language, given the absence of evidence to the contrary. Nevertheless, in sections 2.4 and 2.5 I argue that consonants can be moraic in Irish under very specific circumstances, and that consonant weight influences plural allomorph selection.[10]

[10] There is some limited evidence that the tense sonorants *nn ll rr m* [$N^{(j)}$ $L^{(j)}$ $R^{(j)}$ $m^{(j)}$] are moraic in coda position; see Ní Chiosáin (1991:Ch.4), Hickey (1994), Green (1997:86-90), Carnie (2002) for discussion and references. While the plural suffix *-(e)anna* [-əNə] contains a tense [N], intervocalic sonorants do not behave as moraic with respect to the relevant diagnostics. This bears mentioning because the analysis of plural allomorphy developed here depends on

2.4 The exceptional status of /ax/

The sequence /ax/, as found in the plural suffix *-(e)acha* /-axə/, behaves as prosodically prominent in both quantity-insensitive and quantity-sensitive dialects of Irish. In Ulster and Achill Irish, unstressed [a] resists vowel reduction when preceding [x] (section 2.4.1); in Munster Irish, [ax] sequences attract stress (section 2.4.2). In the following sections, I account for this behavior by arguing that [x] is in fact moraic when occurring in an [ax] string. The prosodic prominence of [ax] sequences becomes important in section 2.5, where it is proposed that the moraic status of [x] in the plural suffix [-axə] partially conditions Irish plural allomorphy.

2.4.1 Vowel reduction in Ulster and Achill Irish

Unstressed short vowels typically reduce to [ə] in Irish (or to [ɨ]/[ɪ] between palatalized consonants). Short vowel reduction is a fairly old feature of the language, and occurs in all dialects (Thurneysen 1946:29, O'Rahilly 1932:110, Ó Sé 1989, and many others). But in many Ulster (Northern) dialects of Irish, unstressed [ax] sequences do not undergo reduction to [əx] (Quiggin 1906:9, O'Rahilly 1932:Ch. XIV, Ó Sé 1989:167, Ó Dochartaigh 1987:Ch. 4, Ó Siadhail 1991:33, etc.). The same pattern of (non-)reduction occurs in Achill Irish (9).

(9) Unstressed [ax] does not reduce in Achill Irish

a.	*cleachtach*	[ˈkʲlʲɑxtɑx]	'accustomed'
b.	*sláthach*	[ˈslɑhɑx]	'mud'
c.	*scalltrachán*	[ˈskɑltrɑxɑːnʲ]	'fledglings'
d.	*leitheadach*	[ˈlʲehədɑx]	'arrogant'
e.	*iascaireacht*	[ˈiəskərʲɑxt]	'fishing'
Cf.			
f.	*tinneas*	[ˈtʲinʲəs]	'sickness'
g.	*luiseag*	[ˈlɤʃək]	'shank'

(Stockman 1974:151,333,365,375,379,381,383)

Strings of the form /ax/ thus pattern with long vowels in resisting vowel centralization in unstressed positions. The implication is that /ax/ sequences are more phonologically prominent than other /aC/ or /Vx/ strings.

This interpretation of (9) is challenged by apparent instances of unstressed [a] in other phonetic contexts. It has been claimed that the long vowels /oː aː/ are realized as short [a] when unstressed in Ulster Irish, e.g *luchóg* [ˈlu.hag] 'mouse' (Ó Siadhail 1991:80) and *amhráin* [ˈo.ɾan] 'song' (Ní Chasaide 1995). Such examples might suggest that unstressed short [a] is actually permitted in these dialects. If so, these derived instances of unstressed [a] would undermine the claim that words like (9a-e) lack reduction because of the inherent prominence of [ax] strings.

While the Ulster /a aː oː/ → [a] merger is often portrayed as a categorical neutralization (e.g. Quiggin 1906:5-17), there is in fact phonetic evidence for a surface distinction between /a aː oː/. Descriptive sources for West Ulster Irish often transcribe unstressed /aː oː/ as long [aː] or half-long [aˑ] (Wagner 1959:88-91, Sommerfelt 1922:122-3, Wagner 1969, Ó Dochartaigh 1987:Chs.

the assumption that *-(e)anna* [-əNə] contains a non-moraic [N] (section 2.5).

2,4).[11] For Achill Irish (9) the shortening of unstressed /aː/ actually depends on phrasal position, giving rise to overt alternations like *coileán* [ˈkɨ.lʲɑːn] ∼ [ˈkɨ.lʲɑn] ‘pup’ (Stockman 1974:310). The sequence [ax], in contrast, is consistently transcribed with a short [a] (Stockman 1974:307-8, Ó Dochartaigh 1987:Ch.4).

The punchline is that the merger of unstressed /aː oː/ and /a/ may be only partial, such that the underlying vowels are still distinguishable on the surface despite some degree of overlap in their phonetic realizations. This is especially true for unstressed /oː/, which encompasses not just [a(ː)] but also mid-back realizations like [o ɔ]. Assuming that these phonetic differences are indicative of a surface phonological distinction between the vowels in question (e.g. Benus & Gafos 2007), these findings are consistent with the view that West Ulster and Achill Irish have a phonological prohibition against unstressed short [a] *except* in the context of a following [x].

To summarize, in West Ulster and Achill Irish [ax] strings are exempt from an otherwise general process of short vowel reduction in unstressed syllables. This resistance to reduction suggests that [ax] sequences are prosodically more prominent than other [aC] or [Vx] sequences in these dialects (e.g. Green 1996, 1997). The facts are different in East Ulster Irish: here long /aː oː/ seem to fully reduce to short [a] when unstressed, and unstressed /ax/ further reduces to [əx] (Ó Dochartaigh 1987).[12] I postpone further discussion of East Ulster varieties until section 2.7.1.

2.4.2 Munster Irish stress

Further evidence for the prosodic prominence of [ax] strings can be gleaned by examining the stress patterns of Munster Irish, a dialect group located in southern Ireland. Like Irish more generally, Munster Irish has default word-initial primary stress. However, Munster Irish differs from most dialects in that the stress system is quantity-sensitive. The basic descriptive generalization is that primary stress falls on the leftmost syllable containing a long vowel or diphthong within an initial three-syllable window, otherwise on the first syllable.[13]

EXAMPLE	WESTERN DIALECTS	MUNSTER IRISH	WEIGHT PROFILE
cailíní ‘girls’	[ˈka.lʲiː.nʲiː]	[ka.ˈlʲiː.nʲiː]	LˈHH
marcaraer ‘mackerel’	[ˈmar.kə.reːr]	[mar.kə.ˈreːr]	LLˈH
anagal ‘corrupt matter’	[ˈa.nə.gəl]	[ˈa.nə.gəl]	ˈLLL

Table 3: Quantity-sensitivity in Munster Irish (Ó Siadhail 1991:129-30, Doherty 1991:20-1)

[11] It’s worth noting that unstressed long vowels are often transcribed as half-long for Western and Southern dialects too, despite the fact that these dialects (unlike Ulster Irish) are normally described as preserving long vowels in unstressed syllables (e.g. Ó Cuív 1944:62, Breatnach 1947:69, Mhac an Fhailigh 1980:56-7, and Ó Curnáin 2007:37).

[12] The complete shortening of unstressed long vowels tends to coincide with the reduction of historical /ax/ in Ulster, but there are nonetheless dialects which fully shorten unstressed /aː oː/ while retaining unstressed [ax] (e.g. Rathlin, an East Ulster dialect; Holmer 1942:22,41,44). The point here is only that there are dialects in which the non-reduction of /ax/ is transparently exceptional; East Ulster dialects like Rathlin may require a different treatment (section 2.7.1).

[13] The empirical facts about stress in Munster Irish are more complicated than this simple description suggests. For example, [HH] words deviate from this pattern and carry stress on the second rather than leftmost heavy syllable, [HˈH] (section 2.7). There are various lexical exceptions to the basic stress pattern, and in some cases stress may be conditioned by morphology. I omit several such nuances here as they do not bear on the present discussion. For more details see Blankenhorn (1981), Ó Sé (1989, 2000, 2008), Doherty (1991), Green (1996, 1997), Iosad (2013).

As mentioned in section 2.3.2, coda consonants do not generally contribute to syllable weight in Munster Irish. There is, however, one exception: in the absence of long vowels, primary stress will fall on a [C_0ax] syllable in second position.

(10) a. /bakax/ → [bə.ˈkax] *bacach* 'lame'
b. /mʲɨʃnʲax/ → [mʲɨʃ.ˈnʲax] *misneach* 'courage'
c. /sasənax/ → [ˈsa.sə.nəx] *Sasanach* 'English person' (Doherty 1991:28)

The stress-attracting character of [ax] is supported by synchronic alternations like *nead* [ˈnʲad] ∼ *neadacha* [nʲɪˈdaxə] 'nest(s)' and *cheannaigh* [ˈxʲanigʲ] '(s)he bought' ∼ *ceannach* [kʲəˈnax] 'buying' (Ó Cuív 1944:77,105, Ó Sé 2000:89,104).[14]

The Munster Irish stress system thus relies on the ternary weight distinction { [V͡V], [Vː] } > [ax] > [V] (Doherty 1991, Green 1996, and references there). Only the combination of [a] and [x] draws stress rightward; other [aC] and [Vx] strings do not attract stress. The special prominence of [ax] sequences must therefore owe to the joint influence of [a] and [x] in contact.[15]

There is thus both quantitative and non-quantitative evidence that [ax] strings are more phonologically prominent than corresponding [aC] or [Vx] strings in Irish. What remains to be explained is *why* [ax] shows this unusual constellation of properties. In the next section, I argue that the sequence [ax] is phonologically prominent in Irish because [x] bears an independent mora when following [a].

2.4.3 Syllabification

Besides the stress-attracting properties of [ax] in Munster Irish, and their resistance to reduction in West Ulster and Achill Irish, Doherty (1991) claims that [ax] also behaves exceptionally with regard to syllabification: in a surface [axV] string, intervocalic [x] is parsed into the same syllable as the preceding [a].[16]

(11) Intervocalic coda syllabification of [x] in Munster Irish (Doherty 1991:28)
a. *slisneacha* [sliʃ.ˈnʲax.ə] 'chips'
b. *spealacha* [spə.ˈlax.ə] 'scythes'

Strong evidence for backwards syllabification of [x] with [a] comes from the observation that [ax] sequences attract stress in Munster Irish even when followed by a vowel, as in *oideachas* [ə.ˈdʲax.əs] 'education' (Hickey 2011:312). Under the generally accepted view that stress is a property of syllables (Liberman & Prince 1977, Hayes 1995, etc.), it would be deeply surprising to find that hypothetical onset [x] in an [a.xV] string was responsible for attracting stress to a preceding heterosyllabic [a]. Given that onset consonants do not usually contribute to syllable

[14] It has been claimed that peninitial [hax] syllables systematically resist stress (e.g. Blankenhorn 1981); see Hickey (2011:312-3) for a phonological analysis of this pattern which is consistent with the claims made here.

[15] Ó Sé (2000:46-7) suggests that certain other [aC] strings may also be stress-attracting in the Irish of Corca Dhuibhne (Dingle), e.g. *iomard* [ə.ˈmard] 'reproach, affliction', *réasac* [rʲeː.ˈsak] 'undertow', etc. It is not clear to me whether these examples constitute real cases of phonological stress attraction or simply exceptional, lexicalized stress. For one, some of the examples Ó Sé (2000) provides are loanwords, and some of the [aC] strings in question differ from [ax] in that they draw stress away from an adjacent long vowel (e.g. *réasac*). See also Iosad (2013).

[16] Ní Chiosáin et al. (2012) provide an overview of the various claims that have been made about the syllabification of intervocalic consonants in Irish. Compare also Green (1996, 1997).

weight—much less to the weight of the *preceding* syllable—such a pattern would be all the more striking. As hypothesized in Doherty (1991:28n), these observations imply that [x], under some narrowly circumscribed conditions, counts as a moraic coda consonant in Irish (see also Noyer 1990). (I will return to the question of why [x] bears a mora specifically when preceded by [a].)

The additional fact that unstressed [ax] resists centralization in Ulster Irish (9) can be captured under the assumption that vowel reduction only targets monomoraic syllables in these dialects. If [ax] strings always form a bimoraic rhyme [ax$_{\mu}$], it then correctly follows that they should be exempt from reduction, just like long vowels. This is so even when the [x] is intervocalic [ax$_{\mu}$.V]:

(12) a. *scealbracha* [ˈskʲaləbrɑxə] 'rock fissures' (Achill, Stockman 1974:379)
b. *buailteachas* [ˈbuilʲtʲaxəs] 'summer grazing' (West Ulster, Quiggin 1906:9,59)

I conclude that there is credible evidence that intervocalic [x] in an [axV] string is moraic and tautosyllabic with the preceding [a]. All subsequent transcriptions will reflect this syllabification.

Doherty's (1991) claim is not as radical as it perhaps seems: there is good empirical evidence for backward syllabification both in Irish and in other languages. Impressionistic and experimental studies of Irish are in rough agreement that intervocalic consonants are parsed as codas when following a stressed short vowel, [ˈCVC.V] (see Green 1997, Dalton & Ní Chasaide 2005, 2007, Ní Chiosáin et al. 2012 on Irish; Clements 1986, Ladefoged et al. 1998 on Scottish Gaelic; and Cohn & McCarthy 1998:§3, Bennett 2012:221-2 for cases outside Celtic). I conclude that backwards syllabification, though typologically rare, is nonetheless attested and therefore plausible in the case of [ax.V] strings (especially when stressed [ˈax.V]). Bennett (2012:216-22) provides some additional arguments that backward syllabification might be favored for intervocalic [x] in Irish; those arguments are omitted here for reasons of space.

Still unexplained is why [a], but no other vowel, behaves as prosodically prominent when preceding [x]. There is good reason to believe that this is a non-accidental fact. In particular, I would suggest that Irish [x] is phonologically a *glide-like counterpart* of [a]. If this is correct, then [ax] sequences are quasi-diphthongal—a structural analysis that explains why [ax] strings pattern with true diphthongs for stress attraction in Munster Irish and vowel reduction in Ulster Irish.

I have in mind here a parallel between the behavior of [ax] rhymes and the distribution of post-vocalic [ɹ] in various varieties of English. In dialects of English with 'intrusive *r*', the approximant [ɹ] is inserted in hiatus environments whenever the first vowel is one of [a ɔ ə] (e.g. McCarthy 1993 and references there).

(13) Intrusive *r* (Gick 1999)
a. *ma is* /maː # ɪz/ → [maːɹɪz]
b. *law is* /lɔː # ɪz/ → [lɔːɹɪz]
c. *coda is* /kodə # ɪz/ → [kodəɹɪz]

Several authors have pointed out that intrusive [ɹ] is the glide counterpart of the non-high back vowels [a ɔ ə]—precisely those vowels that license its appearance (Kahn 1976, Gick 1999, Baković 1999, Itô & Mester 2009). This observation has led many of those same authors to propose that intrusive [ɹ] is not epenthetic in a strict sense, but rather represents the breaking of a vowel in hiatus into a vowel-glide-vowel sequence. The choice of [ɹ] as the intrusive segment then follows from the fact that [ɹ] is roughly homorganic with [a ɔ ə], the vowels that provide its source.

The proposed analogy is this: the glide counterpart of [a] is [ɹ] in English, but [x] in Irish.[17] Evidence for this view comes from the featural composition of [a] and [x]. Under standard feature theories these two segments share at least some place features, most notably [DORSAL] and [+BACK] (e.g. Sagey 1986). Furthermore, some dialects of Irish realize velarized /x/ as the *uvular* fricative [χ] (e.g. Sommerfelt 1922:72, Breatnach 1947:40-1, Ó Curnáin 2007:171,408-14, Bennett et al. 2012, and fn. 5). It is therefore plausible that Irish /x/ shares the feature [-HIGH] with /a/ as well. There is a real sense, then, in which [x] and [a] are phonologically homorganic.

For concreteness, I offer the following proposal. I assume that there is a weak bias against onset [x] in Irish, as suggested by the fact that word-initial [x] is always morphologically derived, never underlying (Ní Chiosáin 1999; see Bennett 2012:216-22 for details). This bias can be encoded as a violable markedness constraint, *ONSET/[x] (Smith 2008, Flack 2009). Second, I assume that *DIPHTHONG penalizes any complex nucleus [V͡β] in which V and β have differing dorsal specifications (Casali 1996, Rosenthall 1997). Importantly, [a͡x] nuclei do not violate this constraint: [a] and [x] are phonologically homorganic, sharing at least the features [DORSAL,+BACK]. (As [HIGH] and [LOW] are not contrastive for dorsal consonants in Irish, I remain agnostic regarding the specification of these features on [x]; see McCarthy 1994, Dresher 2009, Backley 2011:§3.6)

In general, the markedness of onset [x] is not sufficient to trigger backward syllabification of intervocalic [x]: the drive to avoid codas and derived diphthongs outweighs the bias against onset [x] (14a). But following [a], backward syllabification of [x] is permitted because [a] and [x] are homorganic: [x] is parsed as an offglide to [a], [a͡x$_\mu$] (14b). Like all complex nuclei in Irish, [a͡x$_\mu$] then counts as bimoraic. As *ONSET/[x] is inactive for consonants other than [x], the default pattern of intervocalic syllabification will still be [V.CV] (14c).

(14) a. {NOCODA, *DIPHTHONG} ≫ *ONSET/[x]

/ ixV /	FAITH	NOCODA	*DIPH	*ONS/[x]	ONS
a. i͡x$_\mu$.V			*! W	L	* W
b. ix.V		*! W		L	* W
c. ☞ i.xV				*	

b. *ONSET/[x] ≫ ONSET

/ axV /	FAITH	NOCODA	*DIPH	*ONS/[x]	ONS
a. ☞ a͡x$_\mu$.V					*
b. ax.V		*! W			*
c. a.xV				*! W	L

[17] Unlike English approximant [ɹ], the Irish [ɾ] is a trill or tap, and [ɾʲ] something like a weak trill or fricative. Irish [ɾ$^{(j)}$] thus lacks the vocalic character of English [ɹ] (though this may be changing under contact with English, e.g. Hickey 2011:376). While [ɣ] would seem to be a better consonantal counterpart to [a] than [x], [ɣ] is restricted to word-initial position in Irish, and thus cannot follow [a] within the same word.

c. FAITH ≫ {*DIPHTHONG, NOCODA, ONSET}

/ a͡urəs /	FAITH	NOCODA	*DIPH	*ONS/[x]	ONS
a. ☞ a͡u.rəs		*	*		*
b. a͡ur.əs		**! W	*		** W
c. a.rəs	*! W	*	L		*
d. ʔa͡u.rəs	*! W	*	*		L
e. a͡u.rə	*! W	L	*		*

amhras 'doubt' (Hughes 1994:628)

Finally, to prevent other dorsal consonants from syllabifying with [a] (e.g. [a͡k]), I assume first that obstruents are prohibited from syllable nuclei in Irish (*[-SON]/NUC is undominated; Prince & Smolensky 1993/2004, Zec 1994); and second, that [x] is phonologically an approximant and thus exempt from this restriction (see Ó Dochartaigh 1987:Ch.6 and appendices for possible supporting evidence within Irish, and Martínez-Celdrán & Regueira 2008 on Western Romance).

One last word is in order regarding the exceptional prominence of [ax] rhymes. I have argued that the phonological prominence of /ax/ sequences can be attributed to the fact that such strings are quasi-diphthongal. This might lead us to expect that other homorganic [VC] sequences, such as [uv] and [ij], should behave similarly with respect to stress assignment, vowel reduction, etc. They do not. This contrast in prominence may owe to the relatively high sonority of low /a/. In phonetic terms, the low vowel /a/ has higher intrinsic duration and overall intensity than non-low vowels (e.g. House 1961, Lehiste 1970, Gordon 2006, Parker 2002). In some languages (e.g. Gujarati) the high sonority of /a/ manifests itself phonologically through the preferential stressing of syllables which contain /a/ (Kenstowicz 1997, de Lacy 2002b, etc.). I suspect that something similar is occurring with /ax/ sequences in Irish. The phonetic salience of [a], along with the additional duration contributed by homorganic [x], might encourage speakers to treat [ax] strings as phonologically heavy (though not as heavy as long vowels and diphthongs; see Blankenhorn 1981:236-9, Ó Sé 2008:87-8, and fn. 19).[18] Whether the special contribution of [a] is best captured by reference to moras, sonority, or phonetic duration is a debate which would take the present discussion too far afield; see Blevins (2006), Gordon (2006), de Lacy (2007a), Ryan (2011, 2014), and work cited there for details.

In this section I have argued that there are robust empirical grounds for assuming backwards syllabification of [x] in an [ax] string, such that [ax] is parsed as a bimoraic rhyme [ax$_{\mu}$]. The importance of this conclusion lies in the fact that the plural suffix /-axə/ contains an underlying, potentially bimoraic /ax/ sequence, as shown in the next section. This observation provides the key to understanding the pattern of Irish plural allomorphy described in section 2.1.

2.4.4 *-(e)acha* is underlyingly /-axə/

The two phonological hallmarks of underlying /ax/ are (i) resistance to unstressed vowel reduction in West Ulster and Achill Irish, (ii) stress attraction in Munster Irish. Beginning with West Ulster

[18] Also of interest is the fact that the loss of coda /x/ in some Northern Irish dialects has led to compensatory lengthening of preceding vowels (Ó Dochartaigh 1987, Kavitskaya 2002).

and Achill Irish, we find that the plural suffix *-(e)acha* is indeed realized as unreduced [-axə]:

(15) No reduction of *-(e)acha* in West Ulster and Achill Irish

a.	*láirigeacha*	[ˈlɑːrʲɨkʲ - ɑxə]	‘thighs’	(West Ulster, Quiggin 1906:137)
b.	*aibhneacha*	[ˈivʲnʲ - aχə]	‘rivers’	(West Ulster, W IV 86a:1151)
c.	*iriseacha*	[ˈirʲiʃ - axə]	‘basket strap(s)’	(Achill, Stockman 1974:374)

Similarly, the first vowel of *-(e)acha* attracts stress in Munster Irish (16); when stressed, this vowel retains its underlying /a/ quality.

(16) *-(e)acha* attracts stress in Munster Irish

a.	*leapacha*	[lʲə.ˈpax.ə]	‘beds’	
b.	*spriocacha*	[spʲrʲə.ˈkax.ə]	‘targets’	(Ó Sé 2000:101,124)

I conclude that /-axə/ is the underlying form of the plural marker *-(e)acha*. This suffix therefore has the potential to surface as [ax$_{\mu}$.ə], with a heavy-light weight profile. This distinguishes *-(e)acha* /-axə/ from the allomorphically-related suffix *-(e)anna* /-ənə/, which contains only reduced, monomoraic underlying vowels. In the following section I argue that the stress-sensitive distribution of *-(e)acha* and *-(e)anna* follows from the fact that *-(e)acha* contains a phonologically prominent /ax/ string. In section 2.7.1 I return to some problems posed by the reduction of unstressed /-axə/ to [-əxə] in Munster, Connacht, and East Ulster.

2.5 An OT analysis of Irish plural allomorphy

In this section I analyze the distribution of *-(e)acha* and *-(e)anna* in terms of output optimization: *-(e)anna* appears when the selection of *-(e)acha* would lead to ill-formed metrical structure. I focus first on West Ulster Irish, Achill Irish, and Munster Irish, as these are the three dialect clusters in which the distribution of *-(e)acha* and *-(e)anna* is most transparently output-optimizing. The metrical system of Munster (Southern) Irish is more complex than the initial-stress systems of West Ulster and Achill Irish, and so I tackle Munster Irish in a separate section (2.7). Other dialects of Irish (Conamara Irish and East Ulster Irish) are dealt with in section 2.7.1.

2.6 West Ulster and Achill Irish

The guiding intuition of this analysis is that *-(e)acha*, which contains the prosodically prominent sequence /ax/, cannot attach to a stressed syllable in West Ulster and Achill Irish. The reason is simple: suffixation of /-axə/ to a stressed syllable would create an ill-formed (ˈσH) trochee, [(ˈσ.ax$_{\mu}$)ə].[19] The suffix /-ənə/, found adjacent to stressed syllables, appears only when needed to avoid such ill-formed feet. This instance of Irish plural allomorphy is thus output optimizing: the suffix /-ənə/ is chosen exactly when it helps to maximize the metrical well-formedness of the resulting word.

[19] If foot construction is allowed to refer directly to phonetic properties like duration (section 2.4.3), it may be possible to restate this analysis in non-moraic terms. Assuming that [ax] strings are phonetically longer than other [aC] or [Vx] sequences, feet of the form [(ˈσ.ax)ə] might be avoided because the phonetic length of [ax] exceeds whatever durational threshold is set for the weak branch of the foot. An attraction of this duration-based model of weight is that it may offer insight into why [ax] is heavier than other [VC] rhymes, but lighter than long vowels and diphthongs (section 2.4.2). See also Blankenhorn (1981), Green (1996, 1997), Gordon (2006), Ryan (2011, 2014).

Hence the central premise of the analysis is that this subpattern of Irish plural allomorphy is non-arbitrary. Nevertheless, certain stipulations about the lexicon are still necessary. I follow Mascaró (1996, 2007) in assuming that related allomorphs form a partially-ordered set in the lexicon, with forms at the top of the scale serving as the preferred realizations of the morpheme in question. In OT, these preference relations can be enforced by the constraint PRIORITY, which assigns violations to output forms in which a morpheme is realized as one of its dispreferred allomorphs.

(17) PRIORITY (Mascaró 2007):
Respect lexical priority (ordering) of allomorphs. Given an input containing allomorphs $\{M_1, M_2, \ldots, M_n\}$, and a candidate M_i', where M_i' is in correspondence with M_i, PRIORITY assigns as many violations as the depth of ordering between M_i and the highest dominating morph(s).

For the case at hand we can take /-axə/ to be the preferred allomorph, positing the lexical ordering { -axə > -ənə }. Effectively, this ordering encodes the observation that /-axə/ serves as the default, 'elsewhere' variant in this pattern of contextual allomorphy (section 2.2).[20] Transcriptions in this section are representative of Achill Irish, which does not reduce unstressed [ax] to [əx] and which realizes *-(e)anna* as *-(e)annaí* [-ənɪ]. I return to the question of vowel reduction in section 2.7.1.

(18) *-(e)acha* as the default allomorph

/ rɨlʲikʲ/ + {-axə > -ənɪ}	PRIORITY
a. ☞ (ˈrɨ.lʲi)kʲax$_{\mu}$.ə	
b. (ˈrɨ.lʲi)kʲə.nɪ	*! W

reiligeacha 'graveyards' (Stockman 1974:334-5)

A decisive ranking for this analysis concerns PRIORITY and WSP. Looking at polysyllabic stems, we can demonstrate that PRIORITY must dominate WSP:

(19) PRIORITY ≫ WSP

/ karikʲ/ + {-axə > -ənɪ}	PRIORITY	WSP
a. ☞ (ˈka.ri)kʲax$_{\mu}$.ə		*
b. (ˈka.ri)kʲə.nɪ	*! W	L

carraigeacha 'rocks' (Stockman 1974:334-5)

The plural suffix /-axə/ surfaces with a moraic [x$_{\mu}$], thereby creating a non-initial heavy syllable and giving rise to a WSP violation. This WSP violation could be avoided by selecting the allomorph /-ənə/, [n] being non-moraic. Since the optimal form appears with the allomorph /-axə/, we can conclude that WSP violations are tolerated in order to avoid the dispreferred allomorph /-ənə/. In other words, PRIORITY outranks WSP.

[20] Another possibility is that *-(e)anna* is relatively more marked (and thus dispreferred) because it contains a tense sonorant [N] (i.e. [-əNə]). On this view, the distribution of /-axə/ and /-əNə/ would be determined entirely by the relative ranking of markedness constraints (e.g. *TENSESONORANT), without needing to invoke PRIORITY (e.g. Wolf to appear). The transcriptions given here ignore tenseness for sonorants, which is indicated in Irish orthography using digraphs (e.g. *nn* in *-(e)anna*), except in the case of tense *m*.

2.6.1 Monosyllabic nouns and WSP_{FT}

As long as PRIORITY is undominated, nothing compels the appearance of the dispreferred allomorph /-ənə/ with monosyllabic noun stems: *-(e)acha* will wrongly be preferred across the board.

(20) Monosyllabic noun stems: *-(e)acha* incorrectly selected

/ lox / + {-axə > -ənɪ}	PRIORITY	WSP
a. ☹ (ˈlo.xə)nɪ	*	
b. ☞ (ˈlo.xax$_{\mu}$)ə		*!

lochannaí 'lakes' (W III 53:1150)

This dilemma can be resolved by positing a variant of WSP relativized to foot-internal positions. Any constraint that evaluates foot-internal unstressed heavy syllables as being more ill-formed than unfooted heavy syllables will prefer a candidate like [(ˈklo.gə)nə] (with the non-default allomorph *-(e)anna*) over a default form like [(ˈklo.gax$_{\mu}$)ə]. Call this constraint WSP_{FT}:

(21) WSP_{FT} (Hayes 1981, Kager 1999:184, Norris 2013, McCarthy et al. to appear):
Assign one violation for every heavy syllable in the output that is both unstressed and foot-internal.

The intuition behind WSP_{FT} is that (ˈσH) trochees are more ill-formed than (ˈσL) trochees because (ˈσH) trochees contain a prominent, heavy syllable in the weak branch of a foot—an extremely non-prominent position (e.g. Prince 1991, Hayes 1995, Dresher & van der Hulst 1998, Kager 1999:151, Gouskova 2003, de Lacy 2004, 2007a, McCarthy 2008b, and citations there). Bennett (2012) argues that WSP_{FT} is independently active in the phonology of Conamara Irish, though that dialect group is largely outside the focus of this paper (section 2.7.1).

High-ranked WSP_{FT} correctly favors *-(e)anna* over *-(e)acha* in post-tonic position. We now understand the prosodic motivations for *-(e)anna* ∼ *-(e)acha* allomorphy: allomorph selection avoids ill-formed metrical feet.[21]

(22) $\text{WSP}_{\text{FT}} \gg$ PRIORITY $\gg$ WSP

/ lox / + {-axə > -ənɪ}	WSP_{FT}	PRIORITY	WSP
a. ☞ (ˈlo.xə)nɪ		*	
b. (ˈlo.xax$_{\mu}$)ə	*! W	L	* W

The special prominence of [ax] strings therefore interacts with reasonable constraints on prosodic structure to determine the distribution of plural allomorphs in West Ulster and Achill Irish.

Since WSP_{FT} is freely violated in monomorphemic words of Irish, it must be the case that WSP_{FT} is dominated by the same metrical markedness constraints that dominate WSP:[22]

[21] The intuition that [ax] syllables are prohibited from the weak branch of a foot is shared by Doherty's (1991) analysis of Munster Irish stress. However, in Doherty (1991) the prohibition against (ˈσ.ax) feet is simply stipulated; here it is attributed to independently plausible constraints on the well-formedness of feet.

[22] I assume throughout that high-ranked FtBin rules out candidates containing degenerate feet, e.g. *[(ˈgɤ)bɑːʃ.tʲə].

(23) {ALLFTLEFT, TROCHEE} ≫ {WSP_{FT}, WSP}

/ gɤbɑːʃtʲə /	ALLFTLEFT	TROCHEE	WSP_{FT}	WSP
a. ☞ (ˈgɤ.bɑːʃ)tʲə			*	*
b. gɤ(ˈbɑːʃ)tʲə	*! W		L	L
c. (gɤ.ˈbɑːʃ)tʲə		*! W	L	L

gabáiste ‘cabbage’ (W III 53:250)

Though WSP_{FT} is too low-ranked to condition surface stress placement, the effects of WSP_{FT} are nonetheless manifest in plural allomorph selection. As with other cases of optimizing PCSA, the selection of *-(e)anna* with monosyllabic stems thus amounts to THE EMERGENCE OF THE UNMARKED (McCarthy & Prince 1994, Mascaró 1996, 2007).

2.6.2 PARSE(σ) and syllabic binarity

The ranking WSP_{FT} ≫ PRIORITY ≫ WSP accounts for much of the facts. However, one piece of data remains intransigent under this ranking: noun stems consisting of a heavy monosyllable are incorrectly predicted to surface with /-axə/:

(24) Heavy monosyllabic noun stems: wrong candidate emerges as optimal

/ ʃɪːg / + {-axə > -əmɪ}	WSP_{FT}	PRIORITY	WSP	FTBIN
a. ☹ (ˈʃɪː.gə)nɪ		*!		
b. (ˈʃɪː.gax$_{\mu}$)ə	*!		*	
c. ☞ (ˈʃɪː)gax$_{\mu}$.ə			*	

síogannaí - ‘haystacks’ (W III 53:600)

Candidate (24b) *[(ˈʃɪː.gax$_{\mu}$)ə] is correctly eliminated by WSP_{FT}. But candidate (24c) sidesteps this violation of WSP_{FT} by leaving the offending [x$_{\mu}$] unfooted, *[(ˈʃɪː)gax$_{\mu}$.ə]. This candidate then wrongly emerges as the optimal output form, as PRIORITY favors the /-axə/ allomorph.

The task, then, is to find a constraint that eliminates *[(ˈʃɪː)gax$_{\mu}$.ə] for containing a monosyllabic foot. A clear contender is PARSE(σ), which will favor disyllabic footing under all circumstances (FTBIN is another option, but under most formulations it does not distinguish [(H)H] feet from [(HH)] feet). PARSE(σ) is relatively low-ranked in Northern and Western Irish: words contain just one left-aligned foot, and so many syllables are left unparsed. But low-ranked PARSE(σ) can still exert pressure to make that single foot disyllabic (section 2.3.2). To eliminate candidates which avoid WSP_{FT} by leaving [x$_{\mu}$] unfooted, PARSE(σ) must outrank PRIORITY:

(25) PARSE(σ) ≫ PRIORITY

/ ʃɪːg / + {-axə > -əmɪ}	PARSE(σ)	WSP_{FT}	PRIORITY	WSP
a. ☞ (ˈʃɪː.gə)nɪ	*		*	
b. (ˈʃɪː.gax$_{\mu}$)ə	*	*! W	L	* W
c. (ˈʃɪː)gax$_{\mu}$.ə	**! W		L	* W

The formerly problematic (25c) is eliminated by PARSE(σ), as it fails to foot the post-tonic syllable. The crucial observation is that losing candidates either violate WSP$_{\text{FT}}$, or violate PARSE(σ) to a greater extent than the winner. Effectively, this prevents /-axə/ from attaching to monosyllabic stems: [σ-axə] plurals will always be ill-formed with respect to some aspect of foot parsing.

2.6.3 Noun stems with exceptional stress

Recall from section 2.1 that *-(e)anna(í)* also attaches to polysyllabic nouns with exceptional final stress, such as [dəˈgʲrʲiː - ənə] 'degree(s)' (Hickey 1985b; the example is from a Western dialect). I assume that final stress in most varieties of Irish corresponds to a prespecified, but non-initial trochee (but see section 2.7 on Munster Irish).[23]

(26) Exceptional non-initial stress

/ gə.(ˈlɑːn)tə /	TROCHEE	ID(STR)	AFL	WSP$_{\text{FT}}$	PARSE(σ)	WSP
a. ☞ gə(ˈlɑːn)tə			*		**	
b. (gə.ˈlɑːn)tə	*! W		L		* L	
c. (ˈgə.lɑːn)tə		*! W	L	* W	* L	* W
d. (ˈgə)lɑːn.tə		*! W	L		**	* W

galánta 'very nice' (Stockman 1974:350)

The fact that such nouns pluralize with /-ənə/ rather than /-axə/ follows directly: since post-tonic syllables are parsed as the weak member of a trochee whenever possible, /-axə/ will be dispreferred in post-tonic position whether or not the stressed syllable is word-initial.

(27) Polysllabic nouns with irregular final stress pluralize with /-ənə/

/ dəˈgriː / + {-axə > -ənə}	TROCH	AFL	WSP$_{\text{FT}}$	PARSE(σ)	PRIORITY	WSP
a. ☞ də(ˈgʲrʲiː.ə)nə		*		**	*	
b. də(ˈgʲrʲiː.ax$_{\mu}$)ə		*	*! W	**	L	* W
c. (dəˈgʲrʲiː)ax$_{\mu}$.ə	*! W	L		**	L	* W

2.6.4 Accounting for lexical exceptions

Some monosyllabic nouns exceptionally pluralize with /-axə/, despite ending in a stressed syllable.

(28) a. *iallacha* [ˈiəl - ɑxə] 'spurs'
b. *éanacha* [ˈɛːn - ɑxə] 'birds'
c. *áiteacha* [ˈɑːtʲ - ɑxə] 'places' (Stockman 1974:10,29,195)

I assume that different noun stems in Irish may be associated with different cophonologies, expressed as lexically-specific rankings of PRIORITY and WSP$_{\text{FT}}$ (e.g. Anttila 2002, Inkelas & Zoll

[23] Green (1996) accounts for non-initial stress by assuming that words like *galánta* [gəˈlɑːn.tə] have an underlying, unstressable /ə/ in the initial syllable. See also Ó Sé (2000:53), Iosad (2013).

2007; see Bonet et al. 2007, Pater 2010 for alternative approaches). Exceptional monosyllabic nouns belong to a cophonology in which PRIORITY dominates WSP_{FT}.

(29) Lexically exceptional /-axə/ suffixation: cophonology with PRIORITY ≫ WSP_{FT}

/ ɛːn / + {-axə > -ənɪ}	PARSE(σ)	PRIORITY	WSP_{FT}	WSP
a. ☞ (ˈɛː.nax$_{\mu}$)ə	*		*	*
b. (ˈɛː.nə)nɪ	*	*! W	L	L

PRIORITY being undominated, this ranking will always select the default allomorph /-axə/ for these noun stems, even at the cost of violating WSP and WSP_{FT} (29a).[24]

One more lexical generalization needs to be captured. Nouns taking /-ənɪ/ always end in a stressed syllable, without exception (section 2.1). This asymmetry falls out immediately from the ordering of allomorphs enforced by PRIORITY:

(30) No lexical exceptions involving *-(e)anna(í)* (independent of cophonology)

/ CVCV / + {-axə > -ənɪ}	PARSE(σ)	PRIORITY	WSP_{FT}	WSP
a. ☞ (ˈCV.CV)ax$_{\mu}$.ə	**			*
b. (ˈCV.CV)ə.nɪ	**	*! W		L

As long as PRIORITY consistently dominates WSP, no ranking of these constraints will force /-ənɪ/ to attach to an unstressed syllable. The general point is that an account of plural allomorphy in terms of PRIORITY can derive all and only the attested lexical exceptions to the basic distributions of *-(e)anna* and *-(e)acha*.

A reviewer worries that *-(e)acha* occurs with too many monosyllabic stems in Irish for such forms to be considered 'exceptional'. Four points are worth emphasizing here. First, all detailed treatments of the Irish plural system agree that monosyllabic nouns taking *-(e)acha* belong to a minority pattern, and an unstable one at that (section 2). Second, there is good evidence that morpho-phonological regularities (such as the avoidance of *-(e)acha* with monosyllabic stems) may be learned as productive, grammatically-controlled patterns even in the face of numerous exceptions (e.g. Zuraw 2010, Gouskova & Becker 2013). Third, speakers appear to learn restrictions on inflectional allomorphy that are not straightforwardly predictable from lexical frequencies, but which may nonetheless reflect phonological well-formedness conditions (e.g. Becker et al. 2012; see also Marcus et al. 1995, Pinker & Ullman 2002). Finally, all analyses of this data must account for the fact that *-(e)acha* freely occurs with polysyllabic stems, and *-(e)anna* does not. This observation holds regardless of how often *-(e)acha* might also occur with monosyllabic stems. I conclude that even if exceptional monosyllabic forms with *-(e)acha* were especially frequent, that itself would not be a counter-argument against the OT analysis developed here.

[24]It should be mentioned that a number of nouns taking *-(e)acha* show a [V] ∼ [∅] alternation in the plural, e.g. *paidir* [ˈpɑdʲərʲ] ∼ *paidreacha* [ˈpɑdʲrʲ - ɑxə] 'prayer(s)' (Stockman 1974:15.84) (see also Stenson 1978). Hickey (1984, 1985a,b) and Bennett (2012) argue that these [V] ∼ [∅] alternations represent cases of vowel epenthesis in the singular rather than syncope in the plural (see also Carnie 2008:16 and (1c) above). The underlying form of a noun like *paidir* would then be monosyllabic /pɑdʲrʲ/. Nouns showing [V] ∼ [∅] alternations under suffixation thus also belong to the class of monosyllabic noun stems that exceptionally appear with *-(e)acha* rather than *-(e)anna*.

2.7 Munster Irish

The central hypothesis of section 2.5 is that *-(e)anna* /-ənə/ appears after stressed syllables in order to prevent the formation of [ˈσH] sequences. Recall from section 2.4.2 that Munster Irish differs from most other dialects in having a robust system of weight-conditioned non-initial stress. If the analysis of plural allomorphy given above for West Ulster and Achill Irish were extended directly to Munster varieties, we should expect a large number of polysyllabic nouns with final stress, e.g. *bradán* [brə.ˈdɑːn] 'salmon' (Holmer 1962:31), to pluralize with *-(e)anna* rather than *-(e)acha*.

There is widespread regional variation in the formation of plurals—recall, for example, that the noun *áit* 'place' may be realized as either *áiteacha* [ɑːtʲ - axə] or *áiteanna* [ɑːtʲ - ənə] depending on the dialect. It nevertheless appears that the distribution of *-(e)anna* is the same in Munster as it is elsewhere: only monosyllabic nouns may pluralize with this suffix (Mac An Bhaird 1974, Ó Sé 2000:Ch.6, Ó Buachalla 2003:Ch.3, McCarthy no date).[25] As expected, *-(e)acha* typically affixes to polysyllabic nouns in these varieties, though it may attach to monosyllabic nouns as well. With polysyllabic nouns (31c,d,e) or monosyllabic nouns containing a long vowel (31f,g), the underlying /ax/ of *-(e)acha* remains unstressed and undergoes reduction to [əx]. Stress shift occurs when *-(e)acha* attaches to a monosyllabic noun containing a short vowel (31h,i), given that [ax] is in the second syllable of the word (section 2.4.2).

(31) Munster plurals in *-(e)anna* and *-(e)acha*

a.	*gobanna*	[ˈgob - ənə]	'beaks'	
b.	*básanna*	[ˈbɑːs - ənə]	'deaths'	
c.	*mogallacha*	[ˈmogəl - əxə]	'meshes'	
d.	*anamacha*	[ˈanəm - əxə]	'ghosts'	
e.	*cathaoireacha*	[kaˈhiːrʲ - əxə]	'chairs'	
f.	*léimeacha*	[ˈlʲeːmʲ - əxə]	'jumps'	
g.	*cliabhacha*	[ˈkʲlʲiːəv - əxə]	'baskets'	
h.	*ceirteacha*	[kʲerˈtʲ - axə]	'rags'	
i.	*scoilteacha*	[skɪlʲˈtʲ - axə]	'fissures'	(Ó Sé 2000:96,102,110,107,116)

Note that polysyllables bearing final stress (31e) do not pluralize with *-(e)anna*, but with *-(e)acha*.

The distribution of *-(e)anna* and *-(e)acha* in Munster Irish can also be modelled as output-optimizing with respect to metrical structure. For West Ulster and Achill Irish, contextual allomorphy largely emerges from the ranking $\textsc{wsp}_{\textsc{Ft}} \gg$ PRIORITY: better to choose a non-default allomorph than to derive a heavy syllable in the weak branch of a foot, *[(ˈσ.ax$_{\mu}$)ə…]. Given the richer word-level prosody of Munster Irish, plural allomorph selection turns out to be optimizing with respect to a wider array of metrical well-formedness constraints. In this dialect group, *-(e)anna* appears whenever affixation of *-(e)acha* would force the construction of an iambic foot (32b), a non-initial foot (32c), or an ill-formed (ˈσ.H) foot (32d).[26]

[25]Mac An Bhaird (1974) and Ó Sé (2000) give various *-(e)anna* plurals with orthographic forms that suggest a polysyllabic noun stem, e.g. *bioránanna* 'pins', *leigheasanna* 'cures', *seabhacanna* 'hawks', etc. All of these stems are actually monosyllabic in the relevant Munster dialects, e.g. *biorán* [bʲrʲɑːn], *leigheas* [lʲa͡ɪs], *seabhac* [ʃo͡ʊk], and so on (Ó Sé 2000, McCarthy no date).

[26]The analysis in this section was checked with the help of OTSoft, a Windows program which

(32) Plural allomorphy in Munster Irish: {AFL, TROCHEE} ≫ PRIORITY

/ gob / + {-axə > -ənə}	WSP_{FT}	AFL	PARSE(σ)	TROCHEE	PRIORITY	WSP
a. ☞ (ˈgo.bə)nə			*		*	
b. (go.ˈbax$_{\mu}$)ə			*	*! W	L	
c. go(ˈbax$_{\mu}$.ə)		*! W	*		L	
d. (ˈgo.bax$_{\mu}$)ə	*! W		*		L	* W

This result holds for all monosyllabic stems, including those that contain a long vowel (33). High-ranked PARSE(σ) again guarantees that selecting *-(e)anna* will be preferable to leaving *-(e)acha* unfooted in an attempt to dodge violations of WSP_{FT} (33b,c) (section 2.6.2).

(33) Plural allomorphy in Munster Irish: {WSP_{FT}, PARSE(σ)} ≫ PRIORITY

/ bɑːs / + {-axə > -ənə}	WSP_{FT}	AFL	PARSE(σ)	TROCHEE	PRIORITY	WSP
a. ☞ (ˈbɑː.sə)nə			*		*	
b. (ˈbɑː.sax$_{\mu}$)ə	*! W		*		L	* W
c. (ˈbɑː)sax$_{\mu}$.ə			**! W		L	* W

As in section 2.6, monosyllabic noun stems that exceptionally pluralize with *-(e)acha* (31f-i) can be accounted for by assigning them to a cophonology in which PRIORITY is undominated (29).

The remaining task is to show that polysyllabic noun stems will uniformly surface with *-(e)acha* as the plural allomorph. For stems consisting of only light syllables, this is trivial. Nouns that begin with an [LL] string follow the unmarked pattern of initial trochaic footing, [(ˈLL)...]. Since PRIORITY will demand the appearance of *-(e)acha* whenever metrical markedness is not at stake, *-(e)acha* correctly surfaces as the plural allomorph in these forms.

(34) Plural allomorphy in Munster Irish: PRIORITY ≫ WSP

/ mogəl / + {-axə > -ənə}	WSP_{FT}	AFL	PARSE(σ)	TROCHEE	PRIORITY	WSP
a. ☞ (ˈmo.gə)lax$_{\mu}$.ə			**			*
b. (ˈmo.gə)lə.nə			**		*! W	L
c. mo.gə(ˈlax$_{\mu}$.ə)		*! W	**			L

The picture is more complex for noun stems bearing non-initial stress: why do finally-stressed polysyllables like *cathaoireacha* [kaˈhiːrʲ - əxə] 'chairs' take a different plural allomorph than finally-stressed monosyllables like *básanna* [ˈbɑːs - ənə] 'deaths'? The answer is that final stress in these forms actually involves two different metrical parses. If TROCHEE is ranked below ALLFTL non-initial stress will typically involve iambic rather than trochaic footing (35). Under iambic footing post-tonic [ax.ə] will actually be unfooted, and so WSP_{FT} will be fully satisfied (35a). All else being equal, PRIORITY again enforces the selection of *-(e)acha* as the surface plural

partially automates OT analyses (Hayes et al. 2013). The OTSoft input files are available at `http://pantheon.yale.edu/~rtb27/supp/IrishPlurals/`.

allomorph.

(35) Plural allomorphy in Munster Irish: WSP$_{FT}$ ≫ TROCHEE

/ kahiːrʲ / + {-axə > -ənə}	WSP$_{FT}$	AFL	PARSE(σ)	TROCHEE	PRIORITY	WSP
a. ☞ (ka.ˈhiː)rʲax$_{\mu}$.ə			**	*		*
b. (ˈka.hiː)rʲax$_{\mu}$.ə	*! W		**	L		** W
c. (ˈka.hiː)rʲə.nə	*! W		**	L	* W	*
d. (ka.ˈhiː)rʲə.nə			**	*	*! W	L
e. ka(ˈhiː)rʲax$_{\mu}$.ə		*! W	*** W	L		*

There is some corroborating evidence that non-initial stress in Munster Irish involves iambic footing. In [LˈH] words the initial unstressed short vowel retains its underlying quality whenever the stressed second syllable contains a long high vowel [iː uː] (O'Rahilly 1932:86, Ó Cuív 1944:104-5, Breatnach 1947:124, Ó Sé 1989:159, Green 1997:43, Ó Sé 2000:38-9, Iosad 2013, among others).

(36) Exceptional non-reduction in Munster Irish

a.	*bailighim*	[bɑ̲.ˈlʲiːmʲ]	'I gather'
b.	*cocaí*	[ko̲.ˈkiː]	'small piles of hay'
c.	*poitín*	[po̲.ˈtʲiːnʲ]	'moonshine'
d.	*oileamhaint*	[e̲.ˈlʲuːnʲtʲ]	'act of rearing'
e.	*urrús*	[u̲.ˈruːs]	'security'
Cf.			
f.	*coiscéim*	[kʲə̲ʃ.ˈkʲeːmʲ]	'footstep'
g.	*casóg*	[kə̲.ˈsoːg]	'coat'
h.	*scioból*	[skʲə.ˈboːl]	'barn'
i.	*cromán*	[krə̲.ˈmɑːn]	'hip bone'

(Ó Cuív 1944:19-23,65-7,105; Breatnach 1947:8)

I take this co-variation to be an indication that Munster Irish places conditions on the relative sonority of vowels within the same foot, e.g. *cocaí* [(ko.ˈkiː)], *beagán* [(bʲə.ˈgɑːn)], etc. (see Bennett 2012, 2013, Bennett & Henderson 2013 for more discussion and for similar patterns in other languages). Pretonic vowel reduction thus supplies some further evidence for an iambic parse in Munster Irish words bearing second-syllable stress.[27]

The preceding analysis is incomplete in several respects. First, the proposed constraint ranking fails to generate third-syllable stress on long vowels, as in *pusachán* [pu.sə.ˈxɑːn] 'pouter' (Ó Sé 2000:46-7). This failure owes to the dominance of ALLFEETLEFT, in particular over WSP. Under this ranking, it's better to leave a heavy syllable unstressed than to construct a non-initial foot, e.g. [pu(sə.ˈxɑːn)]. This ranking arises because WSP must be low-ranked to permit the selection of

[27]The quality of initial short vowels is also retained in Munster Irish when the third syllable bears primary stress, e.g. *spealadóir* [spʲa̲.lə.ˈdoːrʲ] 'reaper', *feirmeóir* [fʲe̲.rʲə.ˈmuːrʲ] 'farmer' (Breatnach 1947:83,125). This is arguably a different phenomenon from the retention of initial vowel quality under second-syllable stress: reduction does not interact with the quality of the stressed vowel; and as discussed later in this section, some authors have suggested that these unreduced initial syllables actually bear secondary stress (see Ó Cuív 1944:67, Doherty 1991, Ó Sé 2000, Iosad 2013, and references therein).

[-axə] with polysyllabic nouns, and to correctly prevent third-syllable stress on [ax] (34).

One way to rectify this issue would be to redefine WSP such that it does not apply to [ax] sequences (something like this is needed in any case, given that third-syllable long vowels attract stress while third-syllable [ax] does not, (34); see also fn. 19). This redefinition of WSP would allow for the promotion of WSP above AFL, providing a resolution to the apparent ranking paradox. (This can be confirmed by inspecting the supplementary OTSoft files associated with this article.)

Secondly, this analysis fails to generate second-syllable stress in forms that begin with an [HH] sequence, e.g. *díomhaoin* [dʲiː.ˈviːnʲ] 'idle' (Ó Sé 2000:16). If left-aligned trochaic footing is preferred by default, then initial stress [(ˈH)H]/[(ˈHH)] should always trump non-initial [H(ˈH)]/[(HˈH)] stress in these forms. This is a notorious problem in the literature on Munster Irish stress. Various solutions have been proposed, typically involving richer representational assumptions (Green 1996, 1997, Iosad 2013, and references there) or appeal to the fact that Munster Irish words regularly begin with an LH pitch melody, which might favor second-syllable stress (Blankenhorn 1981; see also Ó Sé 1989, de Lacy 2002a, Bennett & Henderson 2013). I have little to add to this debate, but the issue is largely orthogonal to the present discussion.

Third, this analysis fails to produce the secondary stresses that have been reported for Munster Irish. For example, Ó Sé (2000:49) claims that [ˈHLH] words sometimes have a final secondary stress, e.g. *údarás* [ˈuː.də.ˌrɑːs] ∼ [ˈuː.də.rɑːs] 'authority'. But as noted above, the ranking AFL ≫ WSP prevents weight-driven stress from falling outside of an initial two syllable window (34).[28]

The failure to generate such stresses may in fact be a virtue of the present analysis, as the evidence for secondary stress in Munster Irish is not strong. Many putative secondary stresses are described as variable or optional (Holmer 1962, Ó Sé 2000, 2008, Iosad 2013). As far as I am aware there are no acoustic studies of stress in Irish, and thus no instrumental phonetic data confirming the existence of non-primary stresses. Secondary stress never conditions phonotactics or allophonics, so the only empirical evidence for such stresses comes from impressionistic fieldworker descriptions (with the exception of [LLH] forms, discussed below). Note further that non-initial secondary stress is limited to heavy syllables. Taken together these observations suggest that the secondary stresses reported for Munster Irish may be auditorily real but grammatically inert, corresponding to the inherent perceptual prominence of heavy syllables rather than a true phonological stress peak (Gordon 2006; for closely related discussion see de Lacy 2007b, 2014, Blaho & Szeredi 2011, Newlin-Łukowicz 2012, Bennett 2013, Gordon 2014, Tabain et al. 2014).

The clearest cases of secondary stress involve [ˌLLˈH] forms like *achainí* [ˌaxɪˈnʲiː] 'request' (Ó Sé 2000:49). These are the only forms in which secondary stress precedes the main stress, and the only forms in which secondary stress falls on a light syllable. The secondary stress in [ˌLLˈH] forms is further manifested by a resistance to vowel centralization in the initial syllable. But as Iosad (2013) notes, these facts are also compatible with the view that initial secondary stresses correspond not to metrical accent, but to post-lexical initial prominence effects involving word-initial lengthening and/or a word-initial boundary tone (e.g. Klatt 1976, Gordon 2014; see section 2.7.1 for arguments that vowel reduction is post-lexical in Munster Irish). I conclude that the evidence for phonological secondary stress in Munster Irish is at best mixed, and given our current state of understanding should probably not be used as a basis for theory comparison.

Finally, the proposed analysis of plural allomorphy in Munster Irish is committed to the view

[28] If WSP is redefined so as to apply only to long vowels, the ranking WSP ≫ AFL will suffice to derive the secondary stresses reported for heavy third syllables. See the supplementary OTSoft files.

that stem-final stress on polysyllables always involves iambic footing. Monosyllabic nouns uniformly take *-(e)anna* (32)/(33), but polysyllabic nouns bearing final stress take *-(e)acha* (35). This difference was analyzed above as a difference in footing: monosyllabic noun stems show trochaic footing [(ˈσ-ə)nə] ∼ *[(ˈσ-ax$_\mu$)ə], while polysyllabic nouns with final stress show iambic footing [...(σˈσ)-ax$_\mu$ə]. Were footing to be trochaic in these forms, we would wrongly predict the selection of *-(e)anna* as a response to violations of WSP$_{\text{FT}}$, *[...σ(ˈσ-ax$_\mu$)ə].

In general the ranking AFL ≫ TROCHEE will favor iambic footing [σ(σˈH)σ] over a more poorly-aligned trochee [$\sigma\sigma$(ˈH)σ] (35e) The question is whether this generalization about foot parsing holds for all forms bearing final stress. Ó Sé (1989, 2000, 2008) notes that regular final stress occurs in the following cases (examples from Ó Sé 2000:10,49,112):

[LˈH]: [kaːˈlʲiːnʲ]	[HˈH]: [lɑːˈnuːnʲ]	
cailín ‘girl’	*lánúin* ‘married or engaged couple’	
[ˌLLˈH]: [ˌkʲaːnəˈhoːrʲ]	[ˈHLˌH]: [ˈuːdəˌrɑːs]	[ˈLLLˌH]: [ˈloːxəˌrəˌɡɑːn]
ceannaitheoir ‘buyer’	*údarás* ‘authority’	*luchargán* ‘leprechaun’

For reasons enumerated above we should be skeptical about the final secondary stresses reported for [ˈHLˌH] and [ˈLLLˌH] forms; in any case these examples are easily accommodated with iambic footing, [(ˈH)(LˌH)] and [(ˈLL)(LˌH)]. In (35) it was shown that [LH] forms are straightforwardly compatible with iambic [(LˈH)] footing as well. More problematic are [LLH] and [HH] forms. Iambic footing for [LLˈH] predicts an [L(LˈH)] parse, while the secondary stress reported for the initial syllable would seem to be more compatible with a purely trochaic parse [(ˌLL)(ˈH)]. Recall, however, that these initial secondary stresses are not obviously metrical in nature, and may be closer to the post-lexical edge accents reported for languages like Korean and French (see Jun 2005 for an overview). While footing for [HˈH] forms is something of an enigma, the available evidence is at least compatible with iambic footing [(HˈH)], though the system developed here will not produce second-syllable stress in these forms without further amendment (see above).

Much more needs to be said about the role of prosodic structure in the determination of stress in Munster Irish. My only intent in this section is to sketch some plausible ways of thinking about the interaction of stress shift, footing, and plural allomorph selection in those dialects.

2.7.1 Opacity and dialect variation

In section 2.4 I argued that post-vocalic [x] counts as moraic just in case the preceding vowel is [a]. This claim was leveraged to account for stress-sensitive allomorphic variation between the plural suffixes /-ənə/ and /-axə/. In West Ulster and Achill Irish, where unstressed /ax/ is realized as surface [ax], the prosodic motivations driving allomorph selection are perfectly transparent. However, other varieties of Irish introduce a complicating factor. In most dialects spoken in Connacht (the West) and Munster (the South), underlying /ax/ surfaces as reduced [əx] rather than [ax] when unstressed (O’Rahilly 1932:109-10 among many others). This reflects a more general process, found in all dialects, which reduces unstressed short vowels to [ə] (or to [ɪ]/[ɨ], depending on consonantal context). In some surface forms containing *-(e)acha*, then, there is no [ax] sequence, and thus no motivation for assigning a mora to the intervocalic [x] in [-əxə].

This pattern of vowel reduction is problematic for the analysis of plural allomorphy proposed here. If reduced [-ə.xə] is preferable to its unreduced counterpart [-ax$_{\mu}$.ə] on general phonological grounds, nothing prevents [-ə.xə]—with a *non*-moraic [x]—from occuring with monosyllabic nouns (37). (For convenience I assume that the constraint driving the reduction of unstressed short vowels is McCarthy's 2008b *V-PLACE$_{weak}$, though nothing depends on this.)

(37) Vowel reduction wrongly preempts allomorph selection

/ alʲpʲ/ + {-axə > -ənə}	*V-PLACE$_{weak}$	WSP$_{FT}$	PARSE(σ)	PRIORITY	WSP
a. ☞ (ˈalʲ.pʲə)xə			*		
b. (ˈalʲ.pʲax$_{\mu}$)ə	* W	* W	*		* W
c. ☹ (ˈalʲ.pʲə)nə			*	* W	

ailpeanna 'chunks' (Ó Sé 2000:107)

In this way, the simultaneity of vowel reduction and affix selection incorrectly circumvents the use of the non-default allomorph /-ənə/. This is a clear case of morpho-phonological opacity: vowel reduction conceals the underlying quality distinctions that condition plural allomorphy. It follows that plural allomorphy in Munster Irish cannot be 'output optimizing' in the strictest sense, since the prosodic motivations behind allomorph selection are masked by the application of an independent process of reduction. This observation is consistent with the finding of Paster (2006:143) that, cross-linguistically, prosodically conditioned suppletive allomorphy is "sensitive to input elements, not surface elements" (see also Wolf 2008, Anderson 2011, Bonet & Harbour 2012).

There are a number of ways to address this opacity problem. One solution is to locate vowel reduction in the post-lexical component of Irish phonology. On this view vowel reduction is *intrinsically ordered* after allomorph selection, given that word formation necessarily occurs in the earlier lexical component of the grammar. These assumptions lead to serial derivations like (38), in which post-lexical vowel reduction obscures the conditions governing plural allomorph selection in the lexical stratum.

(38)

/UR/	LEXICAL (ALLOMORPHY)		POST-LEXICAL (REDUCTION)	[SR]
/$\sigma\sigma$ + PL/	⟶	| ˈ$\sigma\sigma$-$\underline{\text{ax}_{\mu}}$.ə |	⟶	[ˈ$\sigma\sigma$-$\underline{\text{əx}_{\mu}}$.ə]

There is some supporting evidence for a post-lexical treatment of vowel reduction in Irish. In Munster Irish, nouns like *cipín* [kʲɨ.ˈpʲiːnʲ] 'stick', which have an [LH] weight profile, normally bear stress on the second syllable. In sentential contexts, however, stress may retract to the initial syllable of the word. The conditions governing phrasal stress retraction are complex and not fully understood; what matters here is that when words with an [LˈH] profile are followed by a word bearing initial stress, stress typically retracts on the first word, e.g. *cipín dearg* [ˈkʲi.pʲiːnʲ # ˈdʲa.rəg] 'small red stick' (Ó Siadhail 1991:31-2; see also Ó Cuív 1944:67; Ó Sé 1989, 2000:52-4; Ó Buachalla 2003:2).

(39) a. *putóig* [pə.ˈtoːgʲ] 'pudding, sausage'
b. *muice* [ˈmi.kʲə] 'pig (genitive singular)'

c. *an putóig muice* [ə # ˈfu.toːgʲ # ˈvi.kʲə] 'the pork sausage' (Breatnach 1947:112)

(40) a. *corcán* [kər.ˈkɑːn] ‘pot’
b. *mór* [muːər] ‘big’

c. *an corcán mór* [əŋ # ˈkor.kɑːn # ˈmuːər] ‘the big pot’ (Ó Sé 2000:53,92)

(41) a. *scaitseáil* [skətʲ.ˈʃɑːlʲ] ‘lying’[29]
b. *éithigh* [ˈeː.hɪgʲ] ‘falsehood’

c. *ag scaitseáil éithigh* [ə # ˈskatʲ.ʃɑːlʲ # ˈeː.hɪgʲ] ‘telling huge lies’ (Ó Sé 2000:54)

The crucial observation about this pattern of stress shift concerns the quality of the newly stressed vowel. Vowel reduction eliminates all underlying place features from unstressed short vowels; as such, it destroys the otherwise unpredictable information about contrastive vowel quality that is stored in underlying representations like *corcán* /kor̲kɑːn/. (While the backness of short vowels is predictable from the following consonant, height is not; Ó Siadhail 1991:36-7, Ní Chiosáin 1991:140, etc.) Post-lexical stress shift, on the other hand, allows the underlying quality of such short vowels to surface unchanged, e.g. *corcán mór* /kor̲kɑːn # muːər/ → [ˈkor̲.kɑːn # ˈmuːər].

Further support for this analysis of the vowel alternations in (41) comes from the observation that certain words resist post-lexical stress shift, e.g. *bothán tuí* [bə.ˈhɑːn # ˈtiː] ‘hay shed’. Ó Sé (2000:53) accounts for this contrast by assuming an underlying /ə/ in the initial syllable of words resisting stress shift; since schwa is not generally stressable in Munster Irish, the underlying /ə/ blocks phrasal stress retraction (see also Green 1996). The distinction between words like *bothán* (which block stress shift) and words like *corcán* (which do not) provides strong evidence that phrasal stress retraction recovers the underlying quality of the initial vowel, rather than simply raising or fronting/backing [ə] under phrasal stress.

Now if vowel reduction were a lexical process, it would have to precede phrase-level stress shift, which is clearly post-lexical. But this cannot be correct: lexical vowel reduction would neutralize underlying short vowels to [ə]/[ɪ], making it impossible to recover the different vowel qualities seen under post-lexical stress shift (42). Vowel reduction must therefore follow phrase-level stress assignment.

(42) /kor̲kɑːn # muːər/ $\xrightarrow[\text{V REDUCTION}]{}$ kər̲.ˈkɑːn … $\xrightarrow[\text{STRESS SHIFT}]{}$ $\left\{\begin{array}{c} *[\text{ kər̲.ˈkɑːn …]} \\ *[\text{ ˈkər̲.kɑːn …]} \\ *[\text{ ˈkur̲.kɑːn …]} \\ \text{etc.} \end{array}\right\}$

If vowel reduction follows post-lexical stress shift, then reduction must be post-lexical too. On this view of things, plural allomorph selection is both phonologically transparent and output optimizing at the lexical level, even if post-lexical vowel reduction leads to surface opacity down the road. See Kim (2010), Anderson (2011) for similar issues in Huave and Surmiran, and Paster (2006), Wolf (2008) for general discussion. (See Wolf 2008, to appear for a non-stratal model of opaquely-conditioned allomorph selection couched in a different variant of derivational OT.)

We can now return to some issues raised above regarding dialect variation in the surface form

[29] Ó Sé (2000:12) gives unreduced [skatʲ.ˈʃɑːlʲ] as the isolation form of *scaitseáil*; this is at odds with the generalization that unstressed pretonic short vowels reduce when followed by stressed [ɑː] (36), e.g. *bradán* [brə.ˈdɑːn] ‘salmon’ (Ó Sé 2000:92). Unfortunately *ag scaitseáil éithigh* is the only phonetically-transcribed example I’ve been able to find showing a potential [a] ∼ [ə] alternation under phrasal stress retraction in Munster Irish.

of the plural suffix *-(e)acha*. This suffix is regularly realized as unreduced [-axə] in West Ulster and Achill Irish (section 2.4.1). For these dialects, there is no opacity problem: the selection of *-(e)anna* with monosyllabic noun stems is always transparently output-optimizing (section 2.6). In Munster Irish, the interaction between plural allomorphy and vowel reduction is indeed opaque, but arguably transparent and output-optimizing at the lexical level.

Things are not so clear-cut for Connacht Irish, the third of the major dialect groups. To the best of my knowledge, the plural suffix *-(e)acha* always surfaces as reduced [-əxə] in these varieties (or as *-(e)achaí* [-əxiː]; see fn. 9 for references). Consequently, in Connacht Irish there is little empirical evidence that the plural suffix *-(e)acha* is underlyingly /-axə/ rather than /-əxə/. Similar issues arise for East Ulster Irish: here *-(e)acha* is typically realized as [-əxə] or [-əhə] (section 2.4.1 and fn. 30). For these dialects too the underlying form of *-(e)acha* must begin with /ə/, not /a/.

It should be clear that the preceding facts rule out the possibility that allomorphic alternations between *-(e)acha* and *-(e)anna* are also optimizing in Connacht and East Ulster Irish. If *-(e)acha* is underlyingly /-əxə/ (with a non-moraic [x]), then the stress-conditioned distribution of *-(e)acha* and *-(e)anna* must be phonologically arbitrary. I am perfectly willing to accept this conclusion (see also section 3 below). Many regularities in Irish plural affixation are phonologically and morphologically arbitrary (section 2). Furthermore, it does not follow that alternations between /-axə/ and /-ənə/ are phonologically arbitrary in *all* dialects. Indeed, all of the complicating factors at play here—the reduction of unstressed /ax/ to [əx] in Connacht and East Ulster; unstressed vowel shortening in Ulster; non-initial stress in Munster; and the [x] > [h] change in East Ulster—are innovative features of the dialects in question (O'Rahilly 1932, Ó Dochartaigh 1987, Ó Sé 1989, 2008, and many others). On the other hand, the distribution of *-(e)anna* and *-(e)acha* must be a relatively old feature of the language, as it cuts cleanly across all major dialect groups. In the Western and East Ulster dialect groups, where all trace of underlying /ax/ has disappeared from the plural suffix *-(e)acha*, the non-optimizing character of this case of plural allomorphy is simply an innovative change.[30]

To summarize:

(43) Dialect variation in the transparency of /-axə/ ∼ /-ənə/ allomorphy

a. West Ulster (Northern) and Achill Irish:
   (i) No reduction of unstressed /ax/
   (ii) Plural allomorphy is always transparently motivated

b. Munster Irish (Southern):
   (i) Post-lexical reduction of unstressed /ax/ to [əx]
   (ii) Motivations for plural allomorphy are rendered opaque by vowel reduction

[30] Ros Goill (a Northern dialect) apparently diverges from other dialects in allowing *-(e)annaí* with a wide range of polysyllabic noun stems (e.g. *bolgamannaí* [bɔləgəm - əni] 'mouthful(s)'; Lucas 1979:50-61). As far as I know this is an idiosyncratic feature of Ros Goill Irish, not reported for any other variety of the language. A reviewer makes the interesting suggestion that the freer distribution of *-(e)anna* in Ros Goill might be connected to the fact the *-(e)acha* is realized with an [h] rather than an [x] in this dialect, i.e. as [-ahə]. The loss of [x] may have obscured the phonological motivations for *-(e)acha* ∼ *-(e)acha* allomorphy, leading to a breakdown in the overall distributional system. The puzzle is why unstressed [-ahə] does not undergo reduction to [-əhə] in Ros Goill, if [-ahə] differs from [-axə] in terms of the phonological prominence of its initial /aC/ sequence. Perhaps this dialect has simply lost the ban on unstressed [a] altogether (section 2.4.1).

c. Connacht (Western) and East Ulster Irish (Northern):
   (i) No evidence that the plural suffix *-(e)acha* contains /ax/
   (ii) Plural allomorphy is probably not synchronically optimizing in character

2.7.2 Consequences

In the preceding sections, I have argued that a subpattern of Irish plural allomorphy involving the suffixes *-(e)anna* and *-(e)acha* can be analyzed as emerging from the interaction of fairly uncontroversial constraints on metrical structure. Taken together, the constraints WSP_{FT} and $\text{PARSE}(\sigma)$ heavily penalize [ˈσH] sequences. Irish plural allomorphy avoids such ill-formed structures by creating [ˈσL] sequences whenever possible. However, Irish does generally tolerate [ˈLH] and [ˈHH] sequences, as in (44).

(44)	a.	*piordóg*	[ˈpʲɤɾ.doːɡ]	'haybale'	[(ˈL H)]
	b.	*cailíní*	[ˈka.lʲiː.nʲiː]	'girls'	[(ˈL H)H]
	c.	*círín*	[ˈkʲiː.rʲiːnʲ]	'bird's comb'	[(ˈH)H]

(Achill Irish, Stockman 1974:163,365,378)

$\text{PARSE}(\sigma)$ and WSP_{FT} are thus mostly dormant in the language at large: the pressures that they exert are generally too weak to materially affect prosodic structure. Irish plural allomorphy thus constitutes an interesting case of the emergence of the unmarked in the metrical domain (Kager 1992, 1993, Mascaró 1996, 2007).

A crucial piece of this analysis is the assumption that *-(e)anna* and *-(e)acha* are allomorphs of a single underlying morpheme: when the phonology of Irish has a choice between two allomorphs, it selects the allomorph that leads to an optimal prosodic structure (at the lexical level). In contrast, other plural suffixes, which have only a single surface form, often give rise to ill-formed [ˈσH] sequences, e.g. the [ˈHH] profile of *brógaí* [ˈbroːɡ - iː] 'shoes' (Stockman 1974:317).

The analysis developed here thus successfully integrates a corner of Irish plural morphology into the broader morpho-phonology of the language. In the following sections I argue that an explicit connection between plural allomorphy and metrical well-formedness must be part of any explanatory account of the prosodically-conditioned distribution of *-(e)anna* and *-(e)acha*.

3 Affix selection as output optimization

Recent years have seen a profusion of research on prosodically conditioned suppletive allomorphy, or PCSA. Two typological generalizations have been cemented in this period. First, some patterns of suppletive allomorphy do seem to be output optimizing, in that the surface distribution of allomorphs is plausibly determined by general conditions on phonological well-formedness. Clitic allomorphy in Moroccan Arabic (45) provides a classic example of this type: variation in the form of the third-person singular masculine clitic [=h] ∼ [=u] is apparently determined by considerations of syllable markedness.

(45) Moroccan Arabic 3p.sg.MASC clitic (Mascaró 1996, 2007)

a. [=h] after vowel-final hosts
   (i) [mʕa=h] ‘with him’
   (ii) *[mʕa=u] (onsetless syllable avoided)

b. [=u] after consonant-final hosts
   (i) [menn=u] ‘from him’
   (ii) *[menn=h] (complex codas avoided)

However, not all patterns of PCSA yield to an analysis in terms of surface optimization. Some irremediably non-optimizing cases of PCSA are also firmly attested. Perfective allomorphy in Tzeltal (46) belongs to this class: no credible markedness constraint explains why the perfect is marked with [-oh] after monosyllabic stems, and with [-ɛh] elsewhere (though cf. Bennett to appear:§5.2 for some complications).

(46) Perfective allomorphy in Tzeltal (Paster 2005)

a. [-oh] after monosyllabic stems
   (i) [j-iˈl-oh] ‘he has seen something’
   (ii) *[j-iˈl-ɛh]

b. [-ɛh] elsewhere
   (i) [s-makliˈj-ɛh] ‘he has listened to something’
   (ii) *[s-makliˈj-oh]

See Paster (2005, 2006, 2009) for more discussion of non-optimizing PCSA.

Given the existence of both optimizing and non-optimizing allomorphy, contemporary work on PCSA falls into two camps (see also Bonet & Harbour 2012). Many authors maintain that some patterns of allomorphy are formally optimizing in character: the distribution of allomorphs emerges from grammatical mechanisms that actively aim to reduce the markedness of output forms. The present article clearly takes this stance, given the contention that plural suffix allomorphy in Irish is conditioned by constraints on surface prosodic structure. A partial list of recent work adopting this view includes González (2005), Elías-Ulloa (2006), Mascaró (2007), Bonet et al. (2007), Wolf (2008, to appear), Kim (2010), Anderson (2011), and Bermúdez-Otero (2012); other relevant references are cited in those works and in section 2.2. Since non-optimizing PCSA is indisputably attested, work in this vein often adopts a hybrid model of allomorph selection making use of both optimization pressures (i.e. surface well-formedness constraints) and some mechanism(s) for encoding phonologically arbitrary distributional requirements (e.g. Bonet et al. 2007, Wolf 2008, Aronoff & Xu 2010, Wolf to appear, Nevins 2011, Bermúdez-Otero 2012, Bonet & Harbour 2012, Kurisu 2012).

On the other hand, it has been argued that the very existence of non-optimizing PCSA constitutes an argument against treating *any* patterns of allomorphy as optimizing in character. Prominent advocates of this view include Paster (2005, 2006, 2009), Bye (2007), and Embick (2010). These researchers offer accounts of allomorphy that rely on a single mechanism, such as lexical subcategorization, for the analysis of PCSA. Support for this view comes from theoretical parsimony: better to model all instances of PCSA using a single tool (or set of tools, as in Embick 2010)

than to segregate optimizing and non-optimizing PCSA into distinct empirical domains, each being analyzed with different grammatical devices.

It has proven difficult to find empirical evidence that would conclusively settle this debate (though Paster 2005, 2006, 2009, Kim 2010 and Deal & Wolf to appear make important strides in this direction). One response to this dilemma has been to put more emphasis on conceptual elegance as the basis for theory comparison. As just noted, considerations of theoretical simplicity seem to favor frameworks that unify all patterns of PCSA under a single mechanism (such as lexical subcategorization) over hybrid models that exploit both arbitrary preference and some optimization procedure to model the same patterns of PCSA.

Parsimony arguments derive their force from Ockham's razor: all else being equal, we should favor simpler scientific models of any given body of data. Such arguments presuppose that the theories under comparison are equivalent in their descriptive and explanatory coverage. But this is very rarely the case in practice: more typically, we evaluate theories that account for overlapping but non-identical subsets of the observed data. In such cases the criteria of formal simplicity, empirical coverage, and explanatory force need to be carefully weighed against each other (see Gauch 2003:Ch.8, as well as Anderson 1974:293, Halle 1979:331, McCarthy 2002:239-40, Bonet et al. 2007, Bye 2007, Wilson 2006, Moreton 2008, Anderson 2011, Bermúdez-Otero to appear).

In this spirit, I will argue that non-optimizing analyses of allomorphy fail to provide an explanatory account of the synchronic distribution of the *-(e)anna* and *-(e)acha* suffixes in Irish. In section 3.2 I show that the diachronic development of the Irish plural system also implicates the workings of a synchronic optimization mechanism. The upshot is that optimization-based models can account for a diachronic pattern that remains unexplained (and unpredicted) by subcategorization-based models of PCSA. This finding undermines any simple parsimony argument for subcategorization over output-optimization, since the two theories do not account for the same linguistic facts. I focus on subcategorization-based approaches in the spirit of Paster (2005, 2006, 2009) and Bye (2007), but the same objections apply to any theory that denies a role for output-optimization mechanisms in PCSA (e.g. Embick 2010).

3.1 Subcategorization misses synchronic phonological generalizations

As the first step in a subcategorization-based analysis of Irish plural allomorphy, we can offer the following subcategorization frames for *-(e)anna* and *-(e)acha*:

(47) Subcategorization frames for /-ənə/ and /-axə/ (after Paster 2006)

Plural allomorph A	Plural allomorph B
$[\,[\ldots{}'\sigma]_{\text{N.STEM.SG}}\ \text{-ənə}_{\text{PL}}\,]_{\text{N.PL}}$	$[\,[\ \ ]_{\text{N.STEM.SG}}\ \text{-axə}_{\text{PL}}\,]_{\text{N.PL}}$

The subcategorization frame for /-ənə/ specifies an inviolable prosodic condition on its host stem (final stress), while the empty subcategorization frame for /-axə/ designates it as the less-restricted, default (or 'elsewhere') allomorph.

Subcategorization frames (hence SUBCAT frames) are inherently non-explanatory. As bare statements of the combinatoric restrictions on individual allomorphs, they offer no insight into why a given case of PCSA might show a particular pattern of contextual variation rather than one of the logically possible alternatives. For proponents of SUBCAT-based approaches, this is a strength of the theory: the expressive power of SUBCAT frames allows them to model even the most arbitrary instances of phonologically-conditioned suppletion.

For critics of the SUBCAT approach to PCSA, this expressive power is instead a theoretical weakness. At least some patterns of PCSA are conditioned by phonotactic principles that are observably active in the synchronic phonology of the language in question, such as the avoidance of complex syllable margins (45) (González 2005, Wolf 2008). Theories that depend on SUBCAT frames are thus forced to re-state quite general phonotactic principles in the lexicon, as allomorph-specific combinatoric restrictions. In doing so, they introduce a duplication problem: the theory must recapitulate the same phonological generalization(s) in distinct components of the grammar, thereby muddying the argument from theoretical economy in favor of the SUBCAT approach to PCSA (Kisseberth 1970, Prince & Smolensky 1993/2004; though see Anderson 1974:293, Hale & Reiss 2008:14, Paster 2013, Bermúdez-Otero to appear for counter-arguments to this objection).

Returning to the Irish case at hand, SUBCAT frames fail to explain (i) why the suffix alternation /-axə/ ~ /-ənə/ is conditioned by stress, rather than some other factor; and (ii) why this contextual variation involves exceptionally prominent [-ax$_{\mu}$ə] rather than some other arbitrary allomorph, e.g. hypothetical [-ofə]. These are empirical issues, not merely questions of theoretical elegance. In the optimization-based theory defended here, both of these observations can be reduced to general properties of the phonology of Irish, thereby giving the analysis some explanatory bite. The challenge for SUBCAT-based theories of PCSA, then, is to provide an equally suitable account of these facts in non-optimizing terms.

3.2 Diachronic explanation: the loss of generalization is more than putative

As just emphasized, it is incumbent on SUBCAT-based theories to account for the fact that some patterns of allomorphy do appear to be optimizing in nature. This task has often been approached by attributing the appearance of synchronic optimization to properties of historical change. Paster (2006:175) stakes out a strong version of this view, claiming that:

> "the lack of explanatory power is not problematic for subcategorization if there is an external explanation for the apparent optimization. . . if we can explain a case of apparent optimizing PCSA diachronically, then there is no need to incorporate this into the synchronic model of PCSA at the expense of a unitary account of the phenomenon."

A similar position is taken by Embick (2010:§§1.5, 4.3, 7.2).

Paster goes on to suggest that apparently optimizing patterns of PCSA may arise from the morphologization of one or more phonological processes that were active in earlier forms of the language (on which, see Anderson 1988 and others). Her reasoning is as follows: synchronic phonological processes are often output optimizing, in the descriptive sense that phonotactic restrictions tend to ban functionally difficult and/or typologically rare structures (Hayes 1999, Steriade 2001). Over time, speakers may reanalyze such optimizing phonological alternations as being morphological in character. In this way, an optimizing phonological process can become fossilized in the morphology, giving rise to spuriously optimizing patterns of allomorphy.

Whatever its general merits may be, this kind of diachronic explanation is not available for the pattern of plural allomorphy discussed here. The suffixes /-axə/ and /-ənə/ were never related by phonological rule. Indeed, Modern Irish /-axə/ and /-ənə/ have a clear morphological source in the nominal system of Old Irish (here I follow Ó Buachalla 1988; see also Lazar-Meyn 1982, Hickey 1985b, Stüber 1997 and work cited there). Plural /-ənə/ derives from a more marginal

plural marker *-(e)ann*, which occurred in some of the '*n*-stem' paradigms of Old Irish (e.g. *anm-ann* 'name (nom.pl./acc.pl.)'). The ending *-a* was originally a distinct accusative plural suffix (e.g. *con-a* 'hound (acc.pl)'), but later fused with *-(e)ann* to give the plural marker *-(e)anna*. This new suffix was extremely productive, and by Middle Irish had spread well beyond the original *n*-stem nouns.

The historical development of /-axə/ followed a similar path (Strachan 1905a,b, Hickey 1985b). A subset of the Old Irish '*r*-stem' and 'guttural' nouns appeared with an *-ach* extension in some inflected forms. Accusative plurals in this class also took the suffix *-a*, mentioned above.

(48) Old Irish *nathir* 'snake' (Strachan 1905b:9)

a. *nathir* (nom.sg.)
b. *nathr-ach* (gen.sg./gen.pl.)
c. *nathr-ach-a* (acc.pl.)

As with the emergence of *-(e)anna*, fusion of the accusative plural suffix *-a* with the guttural extension *-(e)ach* gave rise to a new plural marker *-(e)acha*, which was then generalized to nominative plurals and to other noun stems.

The most pressing question here is how Modern Irish *-(e)anna* came to have a restricted distribution (I will return to *-(e)acha* shortly). What diachronic mechanisms might be responsible for the fact that modern *-(e)anna* only co-occurs with monosyllabic stems?[31] One could imagine an explanation based on analogy: if the *n*-stem nouns that originally took an *-(e)ann* extension were predominantly monosyllabic, we might expect the use of *-(e)ann* (later *-(e)anna*) to spread first and most robustly to novel stems that were monosyllabic as well. Contingencies of linguistic history would then account for the distribution of Modern Irish *-(e)anna* without invoking any synchronic optimization mechanism.

It's difficult to know what the exact statistical distribution of stem shapes was in Old Irish. However, to my knowledge there is no reason to believe that monosyllables were especially common in the *n*-stem noun class, or among the nouns that *-(e)ann* first spread to. Examples (49) and (50) show that both *-(e)ann(a)* and *-(e)ach(a)* were attested in Old Irish with monosyllabic bases.[32]

(49) Old Irish *-(e)ann* and *-(e)ach* with monosyllabic stems

a. *ceast-ann-a* (< *ceist* 'question')
b. *lom-ann* (< *loimm* 'sip')
c. *mír-enn-a* (< *mír* 'piece')

d. *fal-ach* (< *fail* 'ring')
e. *sal-ach* (< *sail* 'willow')
f. *lar-ach* (< *láir* 'mare')

[31] I am speaking loosely here: stress, rather than syllable count, is responsible for conditioning the distribution of *-(e)anna* and *-(e)acha* (section 2.1). Since Old Irish was like Modern Irish in having almost uniform initial stress (Thurneysen 1946:27), syllable count is a useful proxy for prosodic context.

[32] Data taken from Windisch (1882), Strachan (1905b), Thurneysen (1946), Ó Buachalla (1988), and the online version of the Dictionary of the Irish Language (`http://www.dil.ie/index.asp`). Note that some vowel graphemes indicate secondary palatalization/velarization rather than true syllabic vowels (Thurneysen 1946:§§84-105,156).

(50) Old Irish *-(e)ann* and *-(e)ach* with monosyllabic stems derived by syncope

a. *dírm-ann* (< *dírim* ‘band, troop’)
b. *talm-ann* (< *talam* ‘earth’)
c. *anm-ann-a* (< *anam* ‘soul’)

d. *cathr-ach-a* (< *cathir* ‘city’)
e. *nathr-ach-a* (< *nathir* ‘snake’)
f. *lasr-ach* (< *lasar* ‘flame’)

The crucial forms, of course, are those in which *-(e)ann* attached to a polysyllabic stem. Such examples are not particularly difficult to find, as (51) attests.[33]

(51) Old Irish *-(e)ann* with polysyllabic stems

a. *escong-an* (< *escung* ‘eel’)
b. *aisndís-en* (< *aisndis* ‘exposition’)
c. *genit-en* (< *genitiu* ‘genitive’)
d. *sailecht-an-a* (< *sailechtain* ‘hope’)
e. *murdúch-ann* (< *murdúchu* ‘mermaid’)
f. *englem-en* (< *englaimm* ‘thread’)
g. *fechem-an* (< *fechem* ‘plaintiff’)
h. *brithem-an* (< *brithem* ‘judge’)
i. *léom-an* (< *léo* ‘lion’)
j. *tepairs-en* (< *teipersiu* ‘spring’)
k. *cethramth-an-a* (< *cethramthu* ‘quarter’; Middle Irish example from Stüber 1997)

There appears to be no correlation between stem size and the distribution of *-(e)ann* in Old and Middle Irish (nor has anyone suggested one, as far as I am aware). This is to be contrasted with the modern language, in which *-(e)anna* is categorically unattested with polysyllabic stems. The same point can be made for *-(e)acha*: the distribution of historical *-(e)ach* may have been conditioned by the segmental content of stems, but not by their size (see Lazar-Meyn 1982, Hickey 1985b). The prosodically-determined, complementary patterning of *-(e)acha* and *-(e)anna* is thus an innovation.

But where did this innovation come from? As just argued, no prosodic criterion allows us to distinguish noun stems that took *-(e)ann* in Old or Middle Irish from those that took *-(e)ach* instead. Outside the nominal domain the closest analogical model for *-(e)anna* is the verbal agreement suffix *-(e)ann* (Ó Buachalla 1988), but this suffix showed no prosodic conditioning at all. These facts cast doubt on the notion that the modern distributions of *-(e)anna* and *-(e)acha* arose through a process of analogy.

A misperception-based account, of the sort championed by John Ohala and Juliette Blevins in their accounts of Neogrammarian sound change, also seems implausible here (e.g. Ohala 1993, Ohala & Busà 1995, Blevins 2006). To explain the restricted distribution of *-(e)anna*, it would have to be true that *-(e)anna* is (or was) accurately perceived with monosyllabic stems, but not polysyllabic ones. Such suggestions strain credulity.

[33] I include nouns with orthographic *-(e)an* plurals in this list because plural *-(e)ann*, which was originally very marginal, spread to nouns in this class quite early in the development of *-(e)anna* (Ó Buachalla 1988).

We're then left with the possibility that these two suffixes drifted toward a surface-optimizing distribution without any external conditioning by phonetics or proportional analogy. That is, learners of Irish were apparently biased toward positing *-(e)anna* plurals for monosyllabic stems, and *-(e)acha* plurals for polysyllabic ones. If this view is correct, then the historical development of *-(e)anna* and *-(e)acha* **is itself an instance of output optimization** (see also Paster 2006:175,204). In the course of acquisition, learners favored phonologically well-formed [*ó-eanna*] plurals over less optimal [*ó-eacha*] plurals. This bias, when iterated over centuries of acquisition and morphological change, then led toward the sharp distributional skew found for these two suffixes in the modern language (see Martin 2007 for similar ideas). But this is tantamount to admitting that output optimization plays a role in morphological systems: where would such a learning bias come from, if not from the grammar itself?[34]

The historical trajectory of the Irish plural system thus supports a role for optimization mechanisms in allomorph selection. Subcategorization-based frameworks fail to account for either the synchrony or the diachrony of *-(e)anna* ∼ *-(e)acha* allomorphy, precisely because prosodic well-formedness conditions have no place in such theories. This shortcoming is shared by all theories of PCSA which implement a strict separation between allomorph selection and the phonology proper. Alternative grammar-external explanations for the development of *-(e)anna* ∼ *-(e)acha* allomorphy may of course be forthcoming. But in the absence of a concrete proposal along those lines—one which meets the challenges sketched above—we must conclude that the diachrony of Irish plural allomorphy implicates synchronic optimization pressures in allomorph selection.

To be clear, I'm not suggesting that all cases of PCSA should be modeled as synchronically optimizing. Nor am I claiming that the existence of synchronically optimizing PCSA falsifies subcategorization-based approaches to suppletive allomorphy (it does not). Rather, I'm claiming that grammatical theories of PCSA must incorporate the notion of synchronic optimization to account for the pathway of morphological change observed in the diachrony of the Irish plural system. Taken together, the typological and diachronic evidence would seem to support a hybrid model of PCSA in which allomorph selection is conditioned both by phonological markedness and by arbitrary preference (section 3).

It should also be emphasized that hybrid models make no predictions about the relative frequency of optimizing vs. non-optimizing allomorphy (the same is true of subcategorization-based models). Paster's (2006) survey finds that both optimizing PCSA and non-optimizing PCSA are typologically well-attested. If it were to turn out that non-optimizing PCSA is substantially more common than the optimizing sort, that would certainly be a fact in need of explanation. But it's far from clear that the explanation should be sought in formal properties of the grammar: as with many statistical tendencies in phonological typology, the existence of such a skew would almost certainly owe to grammar-external factors (e.g. de Lacy & Kingston 2013).

4 Conclusion

In this paper I argued that a subset of Irish plural formation, involving alternations between the suffixes *-(e)anna* and *-(e)acha*, should be analyzed as output optimizing allomorph selection. Crucial

[34]Something must of course be said about how *-(e)anna* and *-(e)acha* came to be structured as contextual allomorphs of a single underlying morpheme (section 2.2). I assume that this diachronic reanalysis was facilitated by the formal similarity between the two plural markers, given that both suffixes fit a [-VCə] template.

to this analysis was the assumption that surface [ax] strings contain a moraic [x_μ]. The exceptionally moraic status of [x_μ] allows the suffix *-(e)acha* to be targeted by metrical markedness constraints like WSP_{FT}, which then drive the stress-sensitive distribution of plural allomorphs.

This pattern of plural allomorphy also presents a challenge for non-optimizing models of allomorph selection. The diachronic development of *-(e)acha* and *-(e)anna* implicates output optimization mechanisms, as does the current synchronic state of the plural system. Theories that refuse to countenance a role for surface optimization in allomorph selection therefore fall short on explanatory grounds.

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