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Vowel backness and palatalization in Irish and Scottish Gaelic: A study in rule scattering

Although descriptive sources on Irish usually claim there are five contrastive stressed short vowels ([i u e o a]), the status of the backness distinction in the language is disputed, because its distribution is largely predictable from the palatalization of surrounding consonants:

(1) Cois Fhairrge Irish (De Bhaldraithe 1975)

a.	[ˈmʲiʎə]	*milleadh*	'destruction'	(Cʲ_Cʲ)
b.	[ˈkur]	*cur*	'putting'	(C_C)
c.	[ˈdinʲə]	*duine*	'man'	(C_Cʲ where C_1 is not velar(ized))
d.	[ˈkudʲ]/[kidʲ]	*cuid*	'share'	(C_Cʲ where C_1 is velar(ized))
e.	[ˈfʲis]	*fios*	'knowledge'	(Cʲ_C where C_2 is not velar(ized))
f.	[ˈtʲuki]	*tiocfaidh*	'will come'	(Cʲ_C where C_2 is velar(ized))

Scholars working in different frameworks have recognized this predictability (e. g. Ó Siadhail & Wigger 1975, Ó Maolalaigh 1997, Cyran 1997) and offered analyses where Irish possesses an essentially 'vertical' vowel system where only height is distinctive underlyingly and backness is derived by rule.

However, while the influence of consonant palatalization on neighbouring vowels in Irish is uncontroversial (Ní Chiosáin & Padgett 2012), its precise role in the realization of vowels is unclear, as existing descriptions rely mostly on impressionistic reports. This is problematic for two reasons. First, available descriptions tend to underplay variation in vowel backness found both within and across lexical items. Second, they do not allow us to evaluate the possibility that the 'front'/'back' distinction is *entirely* due to coarticulation, though some sources (Breatnach 1947) can be interpreted in this way. Intriguingly, while the historical distribution of vowels in the closely related Scottish Gaelic is not dissimilar to that in Irish, sources generally do not treat that language as showing the same predictability in vowel backness (but see McConville 2013, though he does note 'exceptions').

We report on an acoustic study of Irish and Scottish Gaelic that aims to answer two related sets of questions. First, focusing on Irish, what is the surface inventory of short vowels, and is the distinction between 'front' and 'back' vowels entirely due to coarticulation with adjacent consonants? Second, is the apparent difference between the Scottish Gaelic and Irish systems borne out by the data? Answering these questions allows us to establish the underlying inventory and the existence of phonological rules of vowel fronting and/or backing in both languages.

We conducted an acoustic study covering several varieties of Irish and Scottish Gaelic, controlling for factors known from the literature to influence the backness of short vowels. Average formant measurements over five equal intervals within each vowel were taken to produce formant tracks, and quantitative analysis using generalized additive mixed models was used to ascertain the
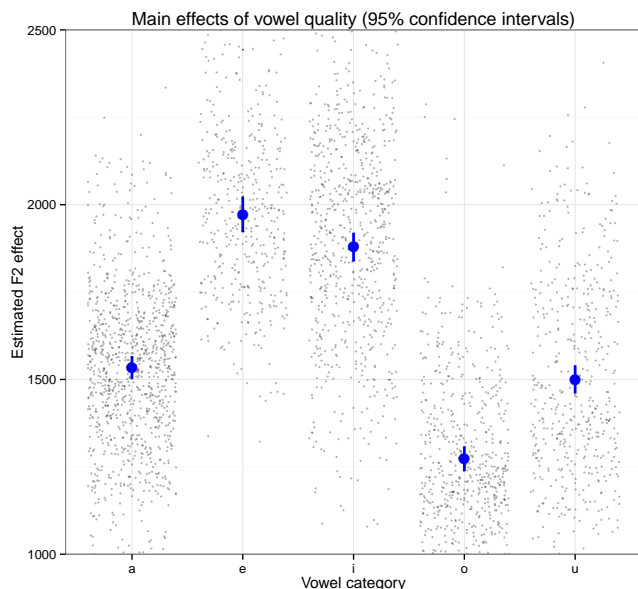

Figure 1: Estimated effects of vowel category adjusted for coarticulation (Irish)

influence of various factors on vowel backness. Our results indicate that coarticulation is *not* sufficient to account for the acoustic distance between front and back vowels: the effects of adjacent segment palatalization are significant, but when they are controlled for the estimated F2 of the back vowels [u] and [o]/[ʌ] (high and mid back vowels are distinct, *contra* Hickey 2011) is significantly different from that of their front congeners. This is true in both Irish and Scottish Gaelic: in fact, the magnitude of the coarticulation effect in the two languages is comparable.

We interpret the Irish situation as a case of *rule scattering* (Bermúdez-Otero 2015): the sound system of the language contains both a gradient coarticulation mechanism and a categorical rule arising from a phonologization of the gradient pattern. The phonological grammar is responsible for the largely complementary distribution of front and back vowels: building on work by Ó Maolalaigh (1997), we argue that the relevant process is best interpreted as a fronting of back vowels in the context of palatalized consonants, as well as (non-velarized) coronals. The phonetic contribution of palatalization is non-negligible but insufficient to account for the effects of the categorical process.

This case of rule scattering is interesting, because the categorical pattern is *not* the direct outcome of the phonologization of coarticulation. Instead, several sound changes in Irish conspired to produce a system with a weaker surface backness contrast in short vowels compared to the more robust distinction in Scottish Gaelic; examples are raising and lowering changes affecting mid vowels (Ó Maolalaigh 1997), e. g. the lowering of [e] in a Cʲ_C context: it is more restricted in Scottish Gaelic compared to Irish, allowing for minimal pairs such as *deach* [dʒɛx] 'went' vs. *deoch* [dʒɔx] 'drink'.

In conclusion, we suggest that there is insufficient evidence for the proposition that the backness contrast in Irish and Scottish Gaelic short vowels can be entirely collapsed either in the output of the phonology (so that it would be entirely due to phonetic coarticulation) or in underlying representations (so that it would be entirely possible to derive it by rule from one vowel per height). Instead, largely predictable backness specifications result from the action of phonological rules on distinct representations for front and back vowels, to a large degree reflecting the outcome of the life cycle of phonological processes (cf. Moulton 2003, Kiparsky 2015).

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