Making sense of consonant palatalization and vowel backness in Irish

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1 Backness in Irish short vowels

1.1 The basic pattern

The Irish language

- Indo-European > Celtic
- Spoken in Ireland
  - Official status ('national and first official language') in the Republic of Ireland
  - Recognized under the ECRML in Northern Ireland but little legal protection
- Traditional speakers mostly limited to pockets of the rural west (*Gaeltacht*): estimates vary but in any case under 100,000 (Nic Pháidín & Ó Cearnaigh 2008)
- Many more speakers claiming L2 competence than 'traditional' L1 speakers
- Significant potential implications for the future of the language (cf. McCloskey 2001)

Sources

- Main source: traditional descriptions
  - Early sources: Finck (1899), Quiggin (1906), Sommerfelt (1922, 1929), Ó Searcaigh (1925), Sjoestedt-Jonval (1931), Holmer (1942, 1962)
  - Descriptive programme at Dublin Institute for Advanced Studies: De Bhaldraithe (1945, 1953), Ó Cuív (1944), Breatnach (1947), De Búrca (1958), Mhac an Fhailigh (1968); also Ó Sé (2000), Ó Curnáin (2007)

  - Descriptive programme at Queen's University Belfast: Wagner (1958, 1959), Stockman & Wagner (1965), Hamilton (1974), Stockman (1974), Lucas (1979), Hughes (1994)
  - Many results summarized in Ó Maolalaigh (1997)
- Little instrumental work, though see Ní Chasaide (1999), Dalton & Ní Chasaide (2005), Ní Chiosáin, Welby & Espesser (2012), Ní Chiosáin & Padgett (2012), Welby, Ní Chiosáin & Ó Raghallaigh (2011), Bennett et al. (2015)

Long vowels

- Unspectacular: between 5 and 8 phonemes ([iː uː eː oː aː] + [ɛː ɔː ɯː])
- In long vowels, backness is independent of the palatalization of flanking consonants (e. g. Ní Chiosáin & Padgett 2012)

(1) a. [kʲuːnʲ] *ciúin* 'quiet'

b. [bʏiːnʏ] *buíon* 'band, company'

- Realization commonly described in terms of 'glides': [bʷiːʏn] for /biːn/

Short vowels

- Much variation in the descriptions: anything between 3 and 6 phonemes (Ó Maolalaigh 1997, Anderson 2016)

3 vowels	4 vowels		5 vowels	6 vowels					
i	i		i	u	i	u	i	u	i	u
e	e		e	o	e	o	e	o	e	o̞
a	a	ɑ	a		a	ɑ	æ		a	ɔ
							a			

- Ní Chasaide (1999) for Gaoth Dobhair Irish: short vowel inventory of [ɪ ʏ ɛ ə ʌ a] — no round vowels!
- Difficulty in phonemicization: the backness of short vowels depends on the palatalization and velarization of surrounding consonants

1.2 Vowel-consonant interaction

Basic generalizations

- Detailed discussion is by Ó Maolalaigh (1997)
- Most important distinctions:
  - Palatalized vs. non-palatalized consonants
  - Velar(ized) consonants (labials, dorsals, velarized coronals [nʏ lʏ]) vs [d t r n l] (weakly velarized; Bennett et al. 2015); also [s]

(2) Cois Fhairrge Irish (De Bhaldraithe 1945)

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

Alternations

- Backness also participates in alternations driven by similar environments

(3) Corca Dhuibhne Irish (Ó Sé 2000)

a.	[gʲlʲʊkəs]	*gliocas*	'cleverness'
b.	[gʲlʲɪkʲ]	*glic*	'clever'
c.	[ʌbɪrʲ]	*obair*	'work'
d.	[ɛbʲɪrʲɪ]	*oibre*	'work-GEN.SG'

Complementary distribution

- Ó Maolalaigh (1997): statements of allophony + 'minor rules' (in reality lexical specificity)
- Ó Siadhail & Wigger (1975), Ó Siadhail (1989): SPE-style account
  - Underlying three-vowel system /ɯ ə a/
  - 'Vowel separation rules': e g. V → [+back] / C_ʃ, xʲ
  - ☞ /gʲlʲɯkʲ/ → [gʲlʲikʲ] but /gʲlʲɯkəs/ → [gʲlʲʊkəs]
- Ní Chiosáin (1991): nonlow vowels are underlyingly underspecified for [±back], receive [±back] specifications by spreading
- Element Theory accounts in a similar spirit: Cyran (1997) for Munster Irish, Anderson (2014) for Old Irish

How many vowels?

Breatnach (1947: §29)
'In words like *mion*, *crios*, *lios*, where the vowel is preceded by a palatal and followed by a non-palatal it is sometimes difficult to decide whether a speaker is using an advanced variety of [u] or a retracted variety of [i]. In some words there is definite alternation[…] [b]ut very often the vowel does not strike one as being definitely [i]-like nor definitely [u]-like.'

Front-back allophony

De Bhaldraithe (1945: 12–14)

- The **æ**-phoneme has three long members... [æːnʲə] *aithne*, [kʲæːs] *ceas*, [bʲæː] *beatha*, [tæːʃ] *tais*, [tʲæːx] *teach*
- The **a**-phoneme has two long members... [aːnʸəm] *anam*, [baːlʸə] *baladh*, [raː] *rath*, [baːɲə] *bainne*, [ʃaːxt] *seacht*
- The **ɑ**-phoneme has three long members...[ɑːtʲ] *áit*, [ɑːglʸɪʃ] *eaglais* , [fʲɑː] *feadh*

Hickey (2011: 193)
Although all low vowels are long in Cois Fharraige, there is one essential respect in which /a/ and /ɑː/ are phonetically different... the different realisations of /a/ depending on the value of [palatal] of the preceding consonant(s)... [tʲæːŋgə] *teanga*, [baːlə] *baile*...[æː] is a front realisation of /a/ after palatals and [aː] is that after non-palatals... The possible realisations can be given in the following generalised form:
/a/ → [æː] / Cʲ_
/a/ → [aː] / Cʸ_

Ó Sé (2000: 21)
/a/: guta íseal, liopaí neodrach. Nuair is consain chaola amháin a bhíonn in aice leis bíonn sé timpeall ar Ghuta Cairdineálta 4... [gʲarʲɪdʲ] *gairid*, [atʲ] *ait*, [fʲa] *feadh*. Nuair a bhíonn sé idir consan caol agus consan leathan (pé acu ord), bíonn sé beagan siar [a̟] ó GhC 4... [fʲar] *fear*, [katʲɪ] *caite*. Bíonn sé níos faide siar fós [ä] i ndiaidh consan leathan liopach nó [l]... [balʲɪ] *baile*, [latʲ] *loit*... Nuair is consain leathana amháin a bhíonn in aice leis bíonn sé ina ghuta íseal idir GC 4 agus GC 5... [mak] *mac*, [abɪrʲ] *abair*... tá cáilíocht [ä], timpeall an tríú cuid den tslí chun tosaigh ar GhC 5, an-choitianta chomh maith.[1]

Ua Súilleabháin (1994: 483)
I gCorca Dhuibhne agus sna Déise níl acu, den chuid is mó, ach *á* cúil, .i. [ɑː], ag freagairt do *a* gairid tosaigh (.i. [a], m.sh. *fear*) agus cúil (.i. [ɑ], m.sh. *bac*)...[2]

Questions

- At heart the question is about the proper analysis of 'vertical' vowel systems: for recent discussions, see Anderson (2016), Kiparsky (2017)
- Is the front-back distinction in Irish *only* due to coarticulation with surrounding consonants?

[1] /a/: a low vowel, neutral lips. When surrounded by slender consonants, it is roughly Cardinal Vowel 4... [gʲarʲɪdʲ] *gairid* 'short', [atʲ] *ait* 'strange', [fʲa] *feadh* 'throughout'. When it is between a slender and a broad consonant (in whatever order), it is somewhat retracted [a̟] from CV 4... [fʲar] *fear* 'a man', [katʲɪ] *caite* 'worn, past'. It is yet further retracted [ä] following a broad labial consonant or [l]... [balʲɪ] *baile* 'home', [latʲ] *loit* 'damage'. When surrounded only by broad consonants it is a low vowel between CV 4 and CV 5... [mak] *mac* 'son', [abɪrʲ] *abair* 'say'. The [ä] quality, about one third of the way in front of CV5, is also very common.

[2] In Corca Dhuibhne [West Kerry] and in the Déise [Waterford/Southeast Munster] for the most part they only have back *á*, i. e. [ɑː], corresponding to short front *a* (i. e. [a], e. g. *fear* 'man') and (short) back *a* (i. e. [ɑ], e. g. *bac* 'hindrance')

  - /ɯ/ → [ɯ] → 'sounds like [i]': three (concrete) phonemes;
- ☞ Irish is like Marshallese (Choi 1992, 1995)
  - /ɯ/ → [i] or [u]: three (abstract) 'phonemes'
- ☞ Irish is like Moloko (Gravina 2014, Kiparsky 2017)
  - /i/ or /u/ → SR [i] or [u]: five (concrete) 'phonemes', low functional load
- ☞ Irish isn't actually very interesting

2 Acoustic study

2.1 Methods

Recordings

- Irish (and Scottish Gaelic, not reported here)
- Wordlist (mostly monomorphemic) controlled for factors known to influence fronting and backing
  - All three heights
  - Palatalization C vs. Cʲ vs. ∅ on both sides
  - Place: labial vs. coronal vs [s] vs. dorsal
- Frame sentence: *Can X go ciúin* 'Sing X quietly'
- ☞ Chosen for comparability across Irish/ScG
- 2 repetitions (3 for one speaker)
- Presented on a screen in random order in Irish spelling, self-paced reading
- So far 2,358 tokens (excluding mistakes, vowels other than short monophthongs)

Analysis

- Manual mark-up and auditory coding
- Automatic formant measurement with Praat using FormantPro (Xu 2007)
- Time normalization: average measurements over five periods of equal duration within each vowel
- Regression modelling in a Bayesian framework, coded in R (R Core Team 2016) and Stan (Carpenter et al. 2016)
- Effects of consonant place and palatalization modelled as autoregressive terms: crucially, they are non-linear

- 6 speakers in all: two each from Munster (Corca Dhuibhne), Connacht (Conamara) and Ulster (Gaoth Dobhair)
- Key questions
  - Is there a distinction between categories, or is it all down to coarticulation?
  - What is the distribution of the phonological categories?
  - How many short vowel 'phonemes' are there in Irish?

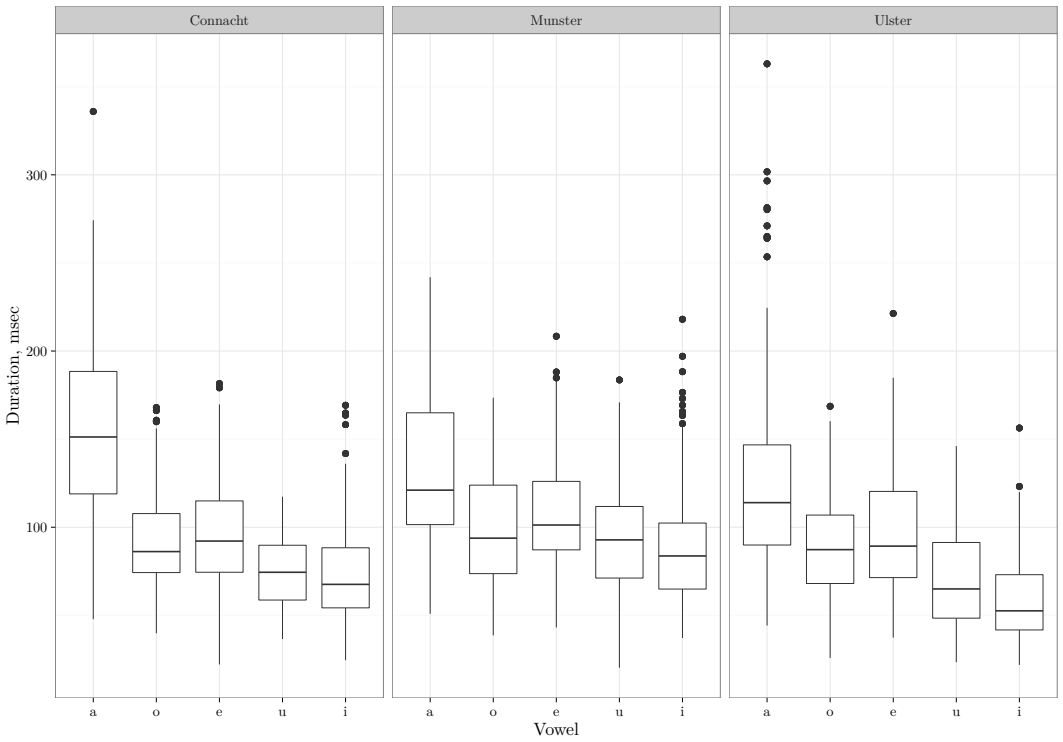


Figure 1: Vowel duration by vowel and variety

Sanity check: durations

- Connacht speakers show a greater magnitude of lengthening for [a]
- Consistent with traditional descriptions treating the low vowel as phonetically long

2.2 Results: vowel distribution

The distribution of vowels

- Our results broadly confirm the overall complementary distribution of front and back vowels
- Connacht (and probably Munster) speakers follow the traditional generalizations
- Ulster speakers seem to have a freer distribution

(4)

a.	[ɤgʲɪ]	*uige*	'web'
b.	[kʲɤn]	*cion*	'affection'
c.	[ʌlʲ]	*oil*	'raise, educate'
d.	[ʃɪk]	*sioc*	'frost'

- We do not focus on Ulster speakers too much here: better understanding of the whole system is needed (cf. Ó Maolalaigh 1997, Ó Baoill 1999)

2.3 Results: contrast or coarticulation

Contrast or coarticulation?

- Non-negligible overlap in the clouds for front and back vowels
- The effects of surrounding consonant place and coarticulation are (unsurprisingly) significant
- However, they are insufficient to account for the front/back distinction

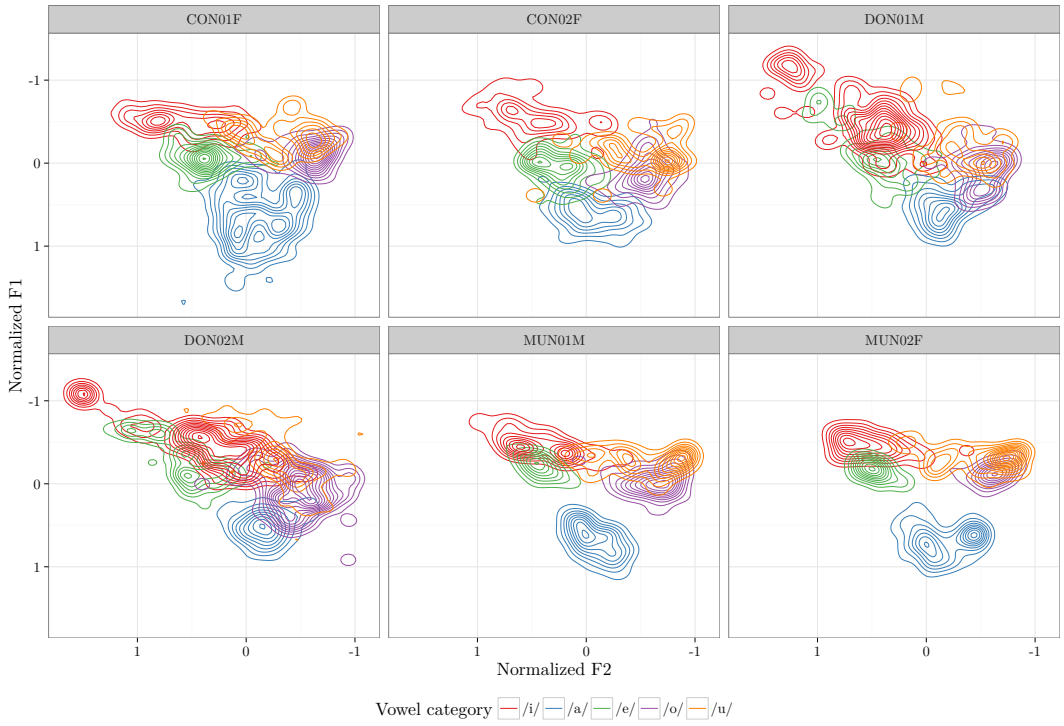


Figure 2: Density of distribution, midpoints, 5-category model

The effect of vowel categories

- This model assumes five vowel categories: [i u e o a]
- An analogous model with only three categories [high], [mid] and [low] is worse at accounting for the variation
- Comparison using leave-one-out cross-validation (Vehtari, Gelman & Gabry 2016)
- Positive difference in ELPD (expected log pointwise predictive density) means the second model explains the data better

- Backness distinction is *not* just due to coarticulation
- Confirmed observations about the perceptual closeness of some categories (Quiggin 1906, Breatnach 1947, Mhac an Fhailigh 1968, Ó Sé 2000)

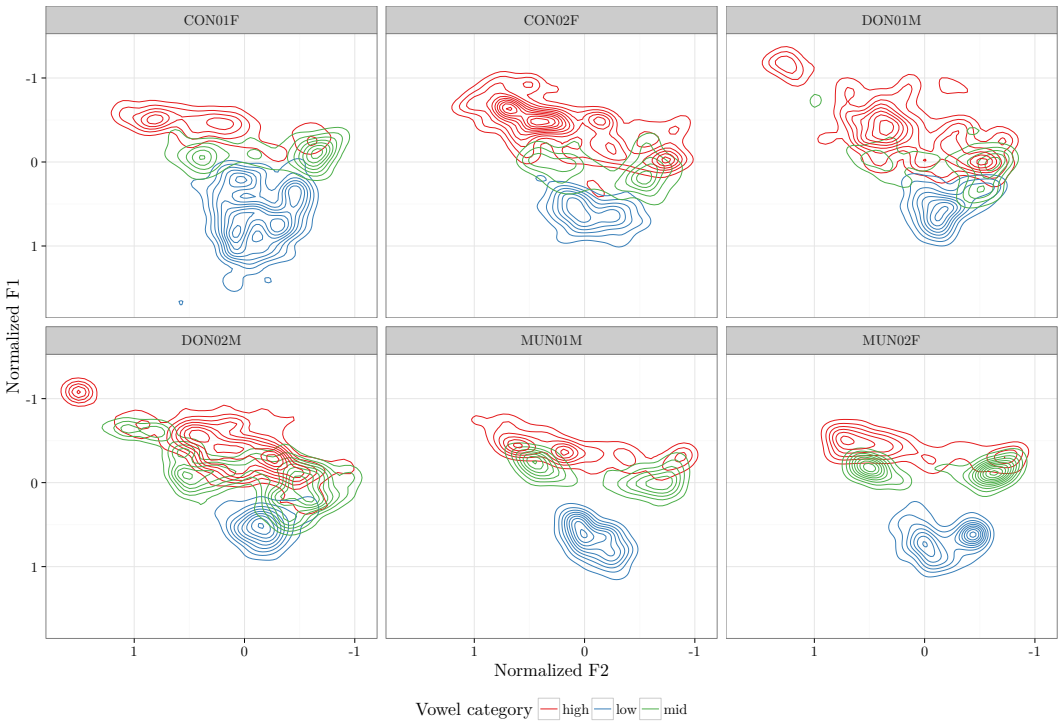


Figure 3: Density of distribution, midpoints, 3-category model

Model	ELPD	ELPD standard error
Three categories	−12840.03	207.34
Five categories	−7476.46	188.92
Comparison	5363.57	111.48

Table 1: Comparison of five- and three-category models

3 Analysis

3.1 Traditional descriptions vs. the acoustic study

Exceptionality: unsystematic variation

- Sources describe a degree of 'variation' between front and back vowels in some contexts/words
- Within-item variation creating 'disharmonic' examples

(5) a. [ɲɪ]/[ɲʊ] *inniu* 'today'
b. [rɪ]/[rʊ] *rith* 'run'

- Not always clear whether this variation is intra- or inter-speaker
- Not always clear whether this is an artefact of the phonetic fronting and backing

☞ Need more lexical coverage in the study

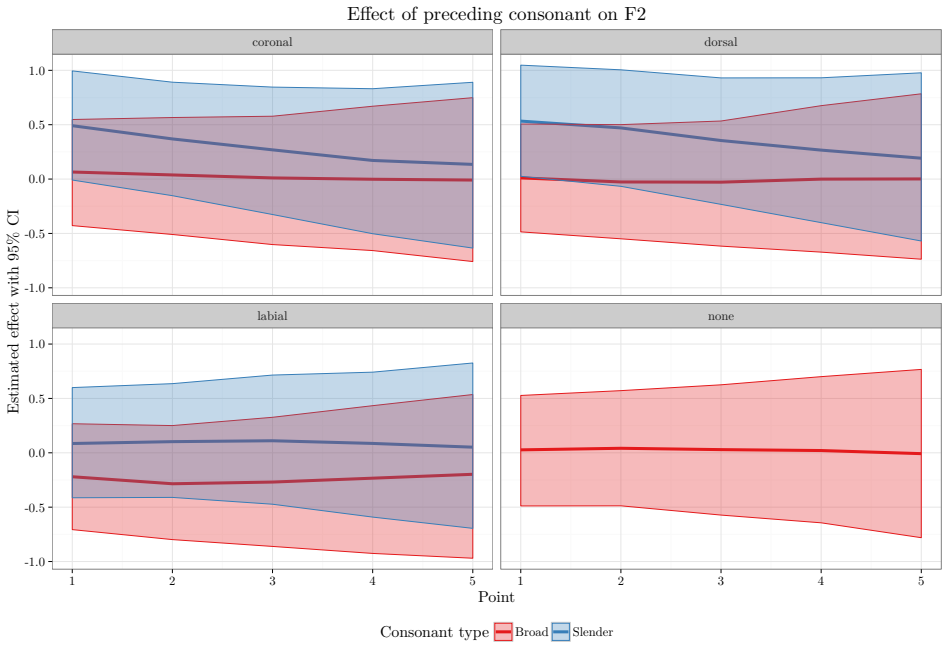


Figure 4: Effects of preceding consonant by place and palatalization

Exceptionality: systematic variation

- 'Free variation' in well-defined contexts (in most/all lexical items affected)
- Notably $C_{[velar(ized)]}\_C^{j}$

(6) a. [kʊdʲ] ∼ [kɪdʲ] *cuid* 'share'

b. [gʌdʲ] ∼ [gɛdʲ] *goid* 'steal'

- Our data: strong effects of coarticulation on both sides produce phonetically centralized vowels, hence perceptual difficulty
- No evidence of categorical [front] ∼ [back] variation
- Probably [ɪ ɛ]

3.2 How many allophones?

Case study: Munster [a] vs. [ɑ]

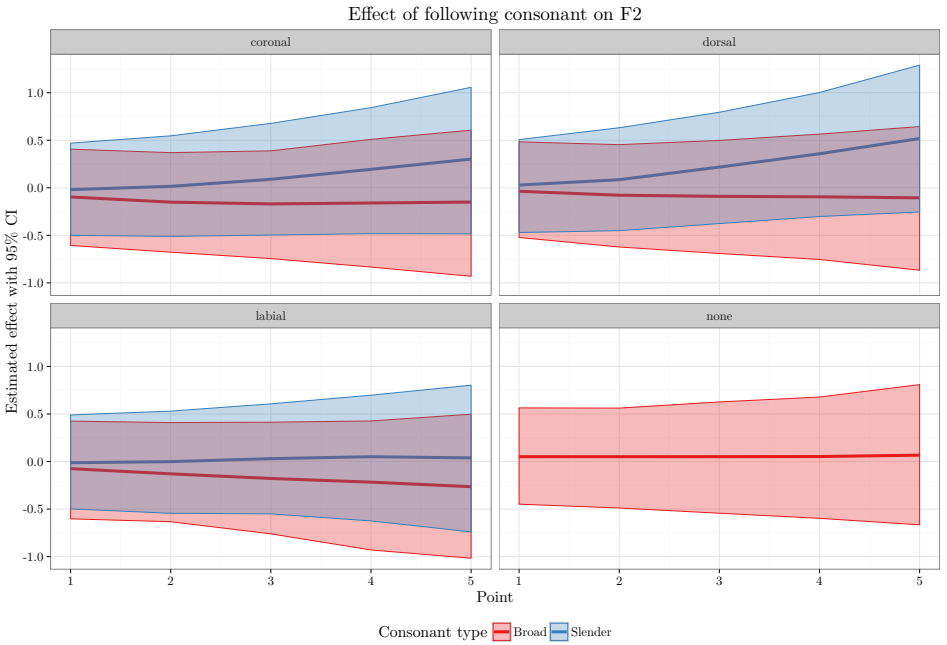
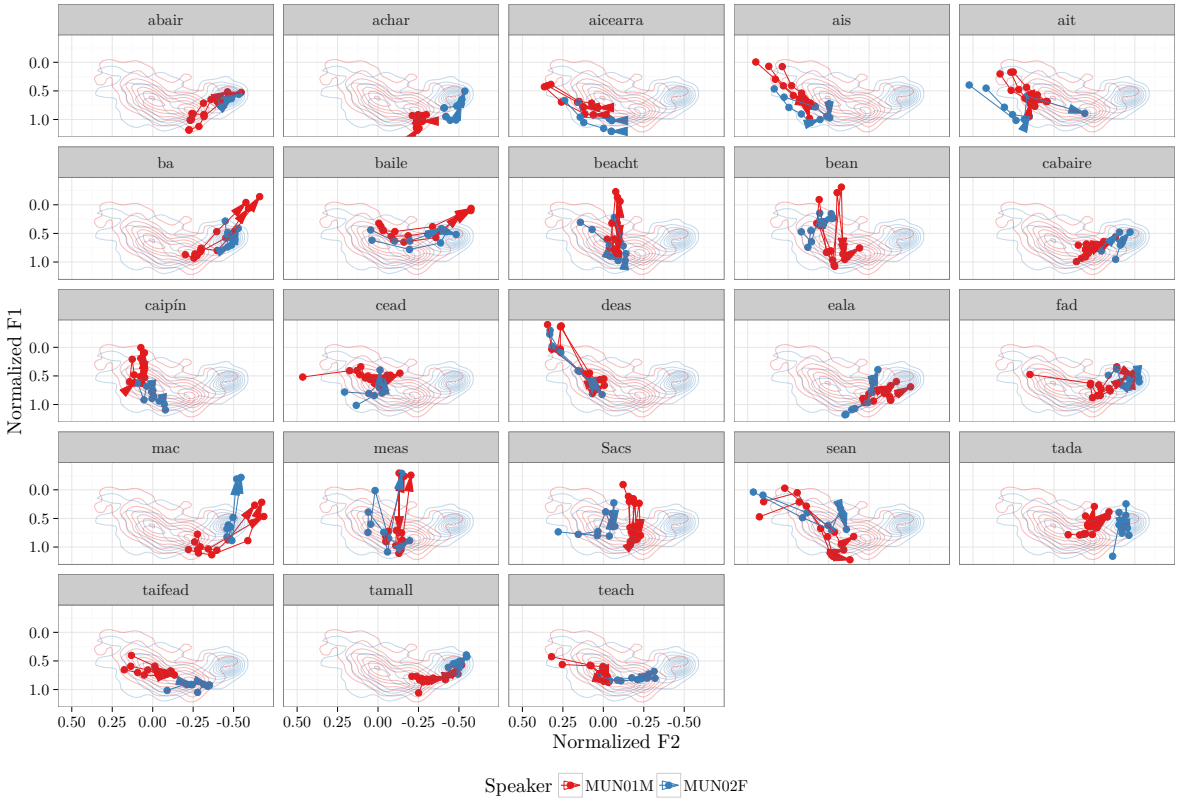


Figure 5: Effects of following consonant by place and palatalization



- The speakers have a consistent *distribution* of [a] vs. [ɑ]

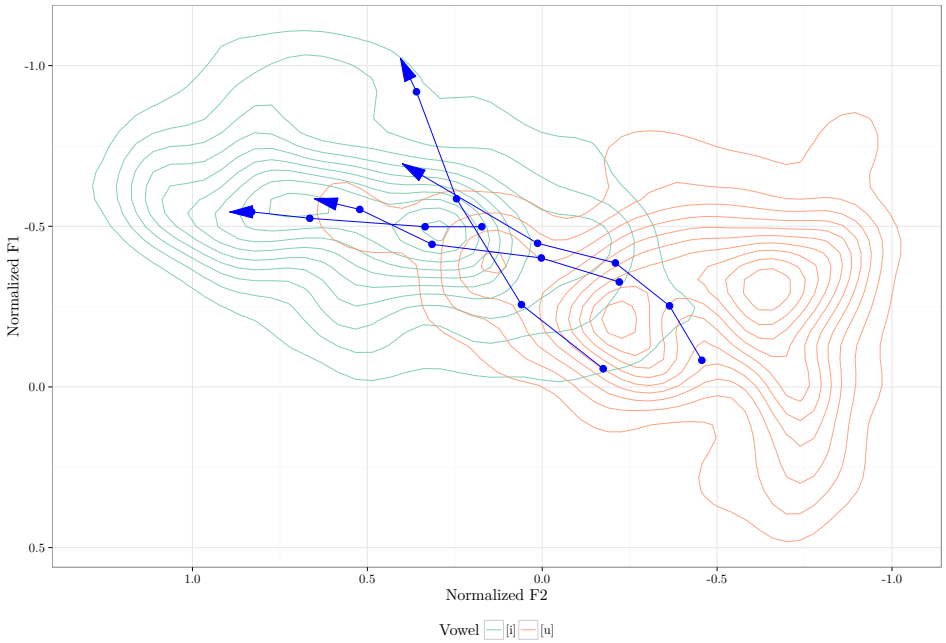


Figure 6: Connacht speakers, *cuid* in the vowel space

- NB *Sacs* [a] not [ɑ] for one speaker though
- Speaker MUN02F has a much greater *distance* between the two 'allophones'
- ☞ Her [ɑ] seems significantly further back than the other speaker's
- Need more speakers, more lexical items: too many potential sources of variability

3.3 Documenting Irish vowels

Doing fieldwork for phonology

- In this kind of study, for statistical results to be valid, we need (at least rough) balance in conditions
- We do implement mixed effects (Gelman & Hill 2007, Baayen 2011, Bates et al. 2015), but still ideally need balance if we want to say something about every condition
- Quick study: one word per condition, only two repetitions → still a *lot* of data to mark up
- Reading task, fairly unnatural setting

Our speakers

- Recorded in Dublin but all middle-aged, grew up in the *Gaeltacht*; all would be regarded as 'good' traditional speakers
- All literate in Irish, at least primary and secondary (for some also tertiary) Irish-medium educated
- Some familiar with task (e. g. broadcasting experience)
- Speak the language every day, many have day jobs related to the language

- Well-embedded in Irish-language networks
- Even so…
  - Spelling pronunciations: *soir* 'eastwards' elicited as [sɛrʲ] even when it is [ʃɛrʲ]/[ʃɛj] in Donegal
  - Attempts to pronounce words not in normal use in dialect
- All familiar issues in documenting minority languages, in evidence despite long tradition of linguistic description and language planning

3.4 Conclusion

How many vowels?

- We can reject the otherwise not implausible suggestion that backness distinctions are due *only* to coarticulation with consonants
- We can accept that coarticulation creates significant variability *within* each vowel category
- Not least, there is significant overlap between different categories
- We can model the variability without recourse to finely grained 'allophones' or 'glides' (cf. Ní Chiosáin & Padgett 2012): it emerges from continuous effects

Results and prospects

- The descriptions of vowel patterning in Irish are broadly confirmed
  - There are five (or more) surface categories of short vowel
  - There is *also* coarticulation between consonants and short vowels
  - Cf. 'rule scattering' (Bermúdez-Otero 2010, 2015)
- Required work
  - More than 2 repetitions per condition
  - More than 1 word per condition
  - Variety-specific word lists
  - Comparison with long vowels
  - More speakers

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