Problems of phonemicization

Irish short vowels revisited

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1 Backness in Irish short vowels

1.1 The basic pattern

Long vowels

- Main source: traditional descriptions (Ó Maolalaigh 1997: 88ff.)
- Long vowels: 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. [bʷiːnʷ] *buíon* 'band, company'

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	i u	i u	i u	i u	
e	e	e o	e o	e o	e o	e o̤	
a	a ɑ	a	a	a ɑ	æ	a ɔ	
					a		

- Difficulty in phonemicization: the backness of short vowels depends on the palatalization and velarization of surrounding consonants

1.2 Previous work

Basic generalizations

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

(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, x^j
- 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

Phonological interpretation

- All these accounts assume that at least in the nonlow vowels the surface forms contain distinct categories [i e] vs. [u o]
- Another possibility is that the vowels *are* in fact central, and the front-back distinction is due to coarticulation

  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.'

Questions

- Is the front-back distinction in Irish attributable *solely* to coarticulation with surrounding consonants?

☞ UR /ɯ/ → SR [ɯ] → 'sounds like [i]': three (concrete) phonemes
☞ UR /ɯ/ → SR [i] or [u]: three (abstract) 'phonemes'
☞ UR /i/ or /u/ → SR [i] or [u]: five (concrete) 'phonemes', with complementary (?) distribution

- What do we mean when we count 'phonemes'?

2 Acoustic study

2.1 Methods

Recordings

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

Analysis

- Manual mark-up and auditory coding by both authors
- Automatic formant measurement with Praat using FormantPro (Xu 2007–2015)
- Time normalization: average measurements over five periods of equal duration within each vowel
- Sanity check for this presentation: outlier tokens within each vowel and speaker removed (automatic measurement errors, miscategorization)
- Generalized additive mixed models (Wood 2006) fit in R (R Core Team 2016) using package `mgcv`
- GAM(M)s allow us to easily estimate nonlinear effects: our particular interest is the effect of neighbouring consonant palatalization on F2 over time

Results

- 6 speakers in all: two each from Munster (Corca Dhuibhne), Connacht (Conamara) and Ulster (Gaoth Dobhair)
- Key questions
  - Is there a distinction between phonological 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?

2.2 Results: vowel distribution

The distribution of vowels

- Our results broadly confirm the overall complementary distribution of front and back vowels
- Connacht (and to a smaller degree 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

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

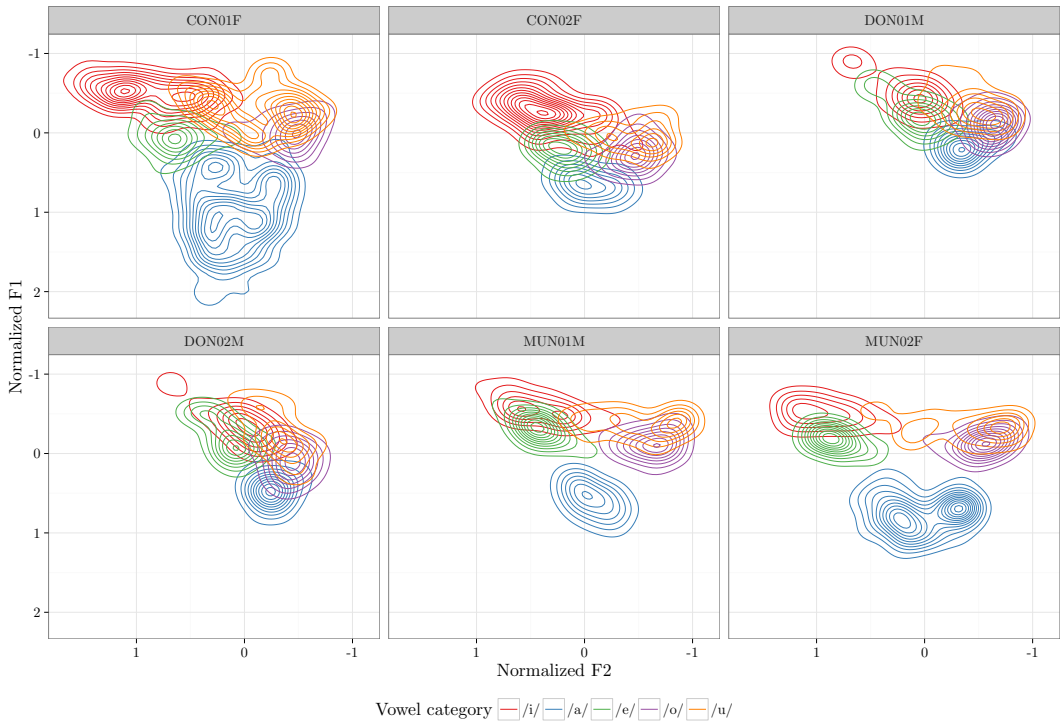

Figure 1: Density of distribution, midpoints, 5-category model

The model

- Dependent variable: F2 normalized by speaker
- Main effects:
  - Vowel
  - Place of preceding and following consonants
  - Palatalization of preceding and following consonants
  - Place × palatalization interaction for preceding and following consonants
  - ☞ Smooth of time by place × palatalization of preceding and following consonants
- Random effects

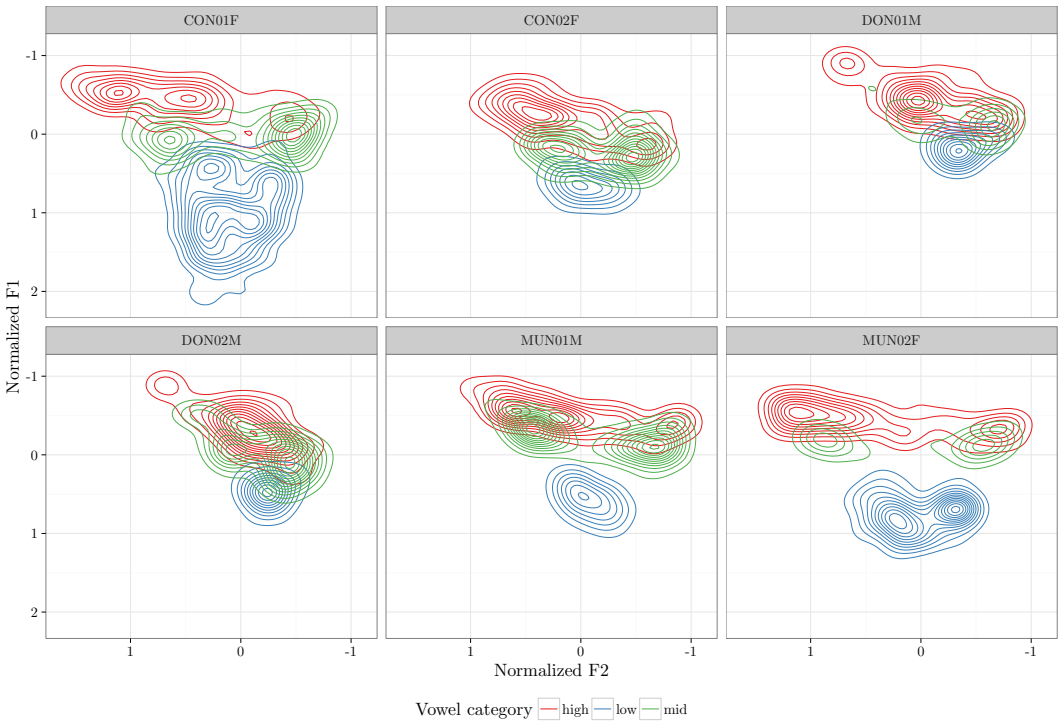

Figure 2: Density of distribution, midpoints, 3-category model

Model	AIC_c	BIC
Five categories	−12164.48	−6459.65
Three categories	−9491.32	−4723.98

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

- Random slope by vowel with random intercept by speaker
- Random slope by variety within each word (to account for Munster *idir* = Connacht *eidir* = Ulster *eadar* 'between')
- Random smooths by preceding and following consonants

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

- 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)

Results of the model

- The model was further improved by the addition of an autoregressive term to account for the fact that the formant measurements form a time series
- The significant parametric terms were:
  - Vowel category (unsurprising)
  - Palatalization of preceding consonant (on average, vowels are fronted throughout after slender consonants; Ní Chiosáin & Padgett 2012)
  - Palatalization of following dorsals (on average, vowels are fronted throughout before slender dorsals)
- Some (not all) time smooths were significant
  - Preceding broad labials
  - Preceding slender dorsals
  - Following broad labials
  - Following slender coronals
  - Following slender dorsals

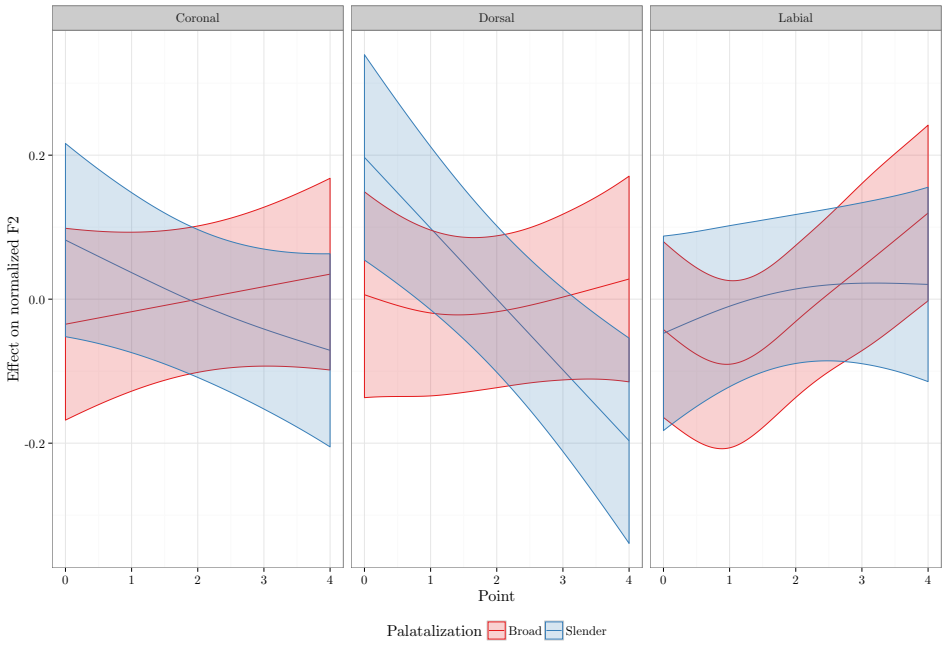

Figure 3: Effects of preceding consonant by place and palatalization

3 Phonological analysis

3.1 How complementary is the distribution?

Exceptionality: unsystematic variation

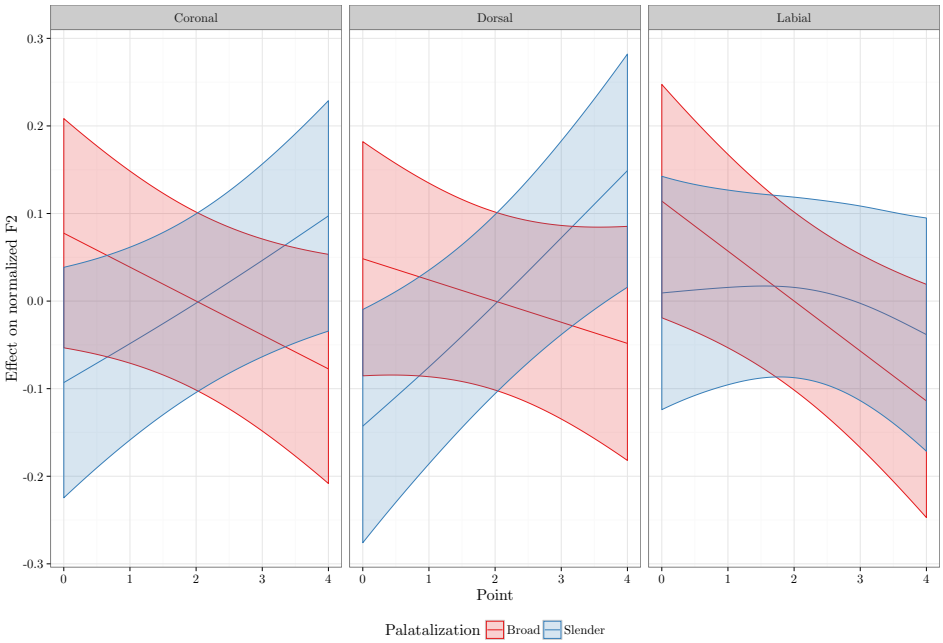

Figure 4: Effects of following consonant by place and palatalization

- The 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

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 either side produce phonetically centralized vowels, hence perceptual difficulty
- No evidence of categorical [front] ∼ [back] variation
- Probably [ɪ ɛ]

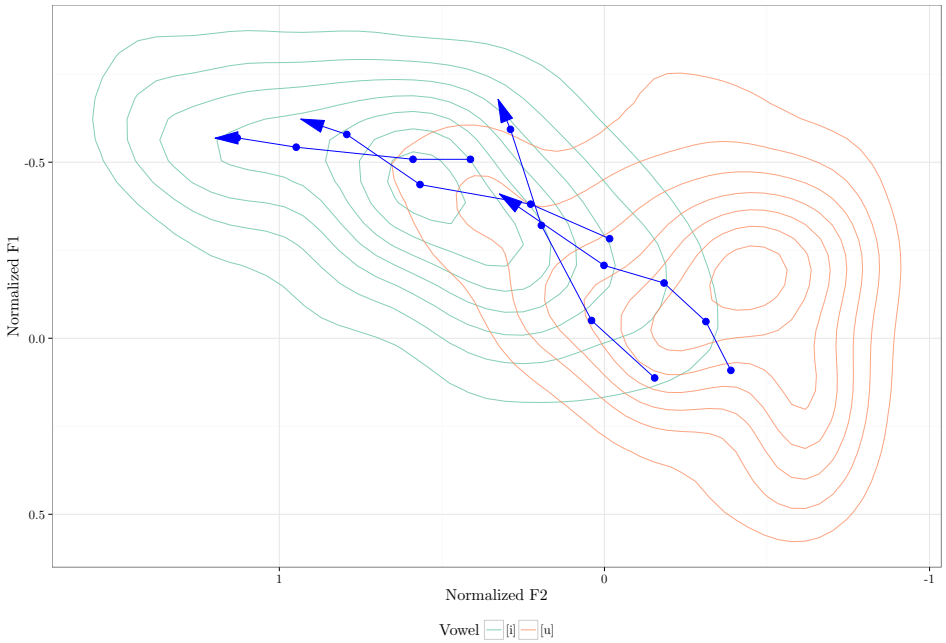

Figure 5: Connacht speakers, *cuid* in the vowel space

Exceptionality: cyclicity

- The allophonic patterns can be disrupted by cyclicity/morphological relatedness
- Morphological cyclicity: Corca Dhuibhne (Ó Sé 2000)

(7) [gɪtər] *goidtear* 'steal-PRES.IMPERS' ([gɪdʲ] *goid*)

- Opacity: presence of a different segment underlyingly (?)

(8) a. [li] *luich* 'mouse-DAT.SG' ([lʊx] *luch*)
b. [kle] *cloich* 'stone-DAT.SG' ([klʌx] *cloch*)
c. [girtʲ] *goirt* 'field-PL' ([rtʲ] ← /rʲtʲ/?)

Genuine exceptions?

- In our data set we do have cases that simply seem to go outright against the established generalizations
- (As noted above, Ulster speakers seem to do this a lot anyway)
- Munster:
  - *giobal* 'rag' is [gʲɪbəl] (also noted by Ó Sé 2000: §29)
  - *ionad* 'place' is [ɪnəd] (completely unexpected)

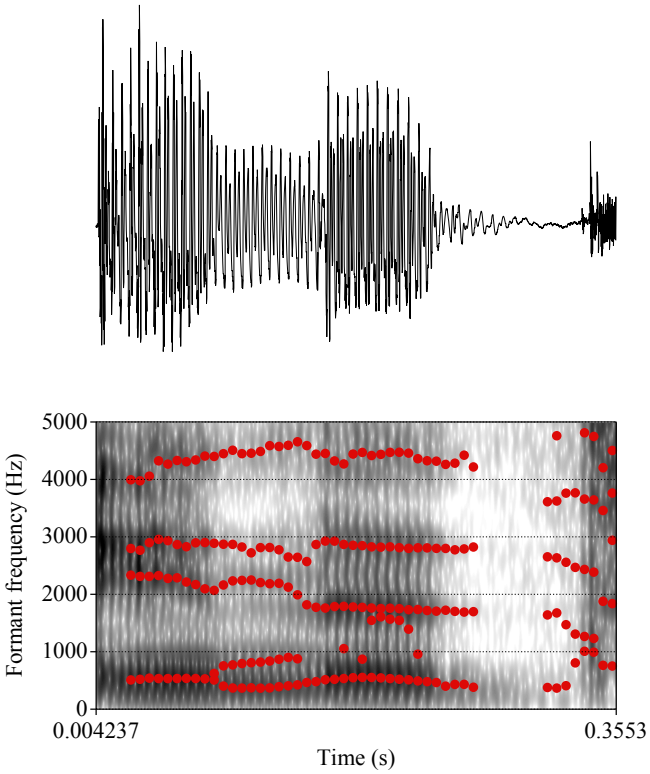

Figure 6: Munster *ionad* ‘place’

Exceptionality: preliminary conclusion

- If there is an allophonic backness pattern in Modern Irish, it is not surface-true
- ☞ Lexical specificity/variability (poorly understood)
- ☞ Derivational opacity
- If there is a 'vertical' system in Irish, it is only found at some deep level

3.2 Phonemicization revisited

What is a phoneme, again?

- Taxonomic phoneme: minimal pairs in surface forms
- Apparent contrast in Irish [gɪtər] *goidtear* ≠ [gʊtə] *guta*
- 'Generative' phoneme: distinct segments found in underlying representation (parsimonious inventory with rules doing much heavy lifting)
- Apparent lack of contrast in Irish? Grammar derives [gɪtər] ← /gɪdʲtər/ (← /gɯdʲtər/?)
- The debate is essentially about the right level of generalization

Lexical phonemes

- Kiparsky (forthcoming) distinguishes
  - 'S-phonemes' ≈ taxonomic phonemes
  - 'M-phonemes' ≈ 'generative' phonemes
  - 'L-phonemes': segments found in the *output* of the *lexical* phonological stratum

  Kiparsky (forthcoming)
  'What language users actually access, and what language change reveals, is not exactly the classical phonemic level, but the level of representations that emerges from the lexical phonology'
- See also e. g. Janda 2003, Bermúdez-Otero 2007, Kiparsky 2015

Lexical phonemes in Irish

- If Kiparsky (forthcoming) is right, then the right level of abstraction is neither surface nor underlying
- We take our results to mean that (at least) [i e u o a] *are* lexical phonemes in Irish
- ☞ Our results exclude the hypothesis that the phonology outputs [ɯ ə a] fed into phonetic implementation
- Any pattern of complementary distribution belongs in the lexical phonology

Lexical phonology and vowel backness

- The complementary distribution pattern is opacified by
  - Inflectional affixation (*goidtear*)
  - Word-level (?) phonology (*luich*, *goirt*)
- This suggests it may belong in the *stem level*
- Consistent with the possibility of outright exceptions like *giobal* (e. g. Kaisse & McMahon 2011, Bermúdez-Otero 2012)

3.3 Conclusion

The status of complementary distribution

- It is plausible that the complementary distribution is established by some pattern(s) in the lexical phonology
- Presumably *some* kind of rule is necessary to account for alternations as in (3)
- We have *not* talked about what the exact analysis is:
  - /ɯ ə a/ → [ɪ ʊ ɛ ʌ a]
  - /ɪ ʊ ɛ ʌ a/ → [ɪ ʊ ɛ ʌ a]
- No opinion on this today!

Summary

- The descriptions of vowel patterning in Irish are broadly confirmed
  - There are five (or more) surface categories of short vowel
  - There is coarticulation between consonants and short vowels, with significant overlap of the front and back categories
- At the 'interesting' level of analysis, Irish definitely has *five* short vowel phonemes

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