Variation, change and phonetic grounding: The case of the mid front vowels of Turkish

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(based on joint work with Deepthi Gopal)

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Introduction

- In Turkish, the front mid vowels **/e, ø/** are lowered to **[æ, œ]** before (non-voiced) coda sonorants, i.e. **/r, l, m, n/** (and, in some cases, **/z/**)
  - This has been noted in previous **descriptive** literature but not in the phonetic or phonological literature – and there has been no experimental investigation
- We need for an up-to-date picture of the Turkish vowel system
- This pattern also raises both **synchronic and diachronic issues**:
  - How is this active class defined? How natural is it? Is class information in this case straightforwardly phonetic or phonological?
  - How did this arise? Is it consistent with pictures of phonological change that assume that new patterns are phonetically well-grounded?

Outline

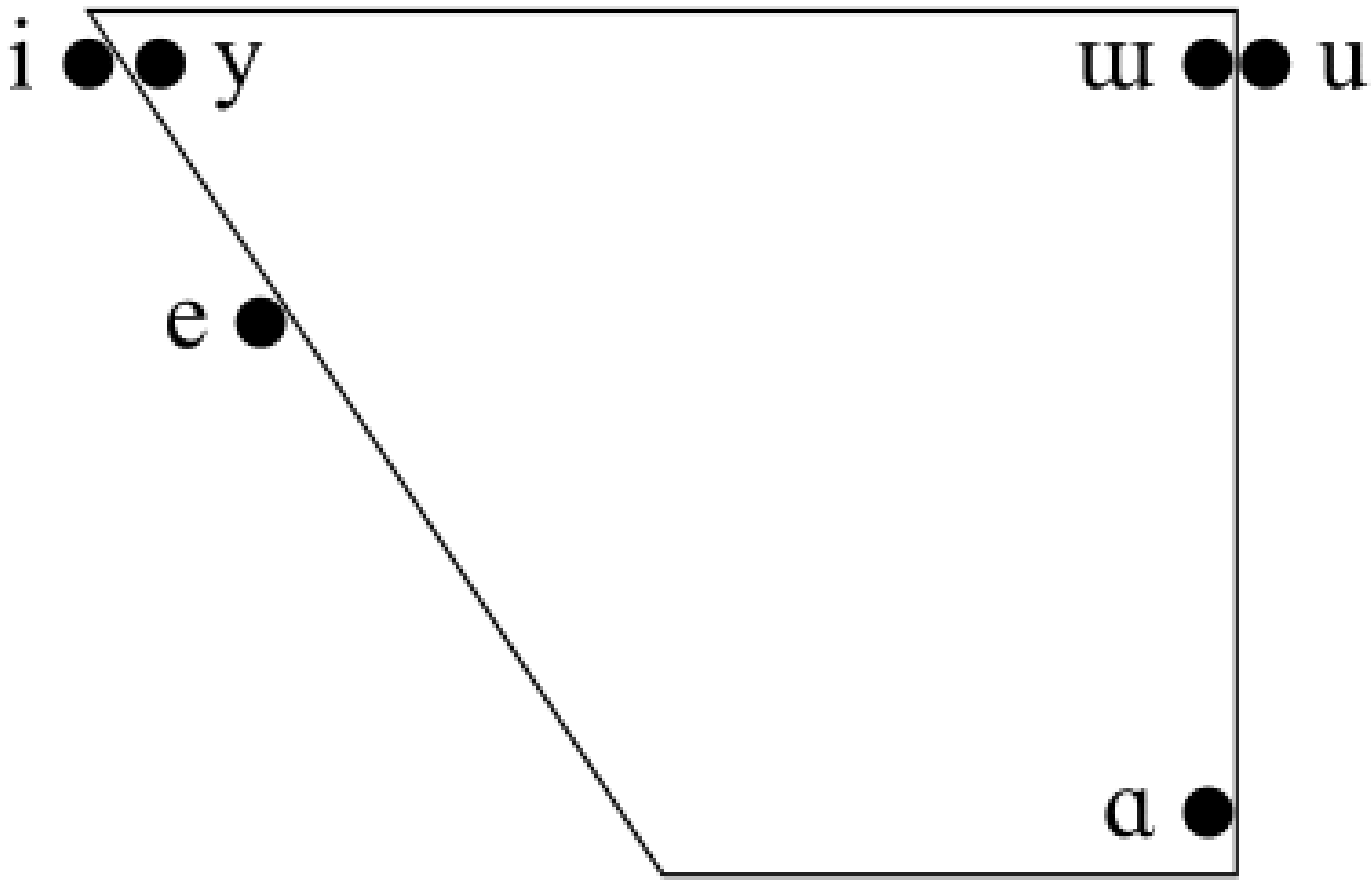
- The case in Turkish
- Theoretical context
- Empirical context
- Experimental data
- Discussion of diachrony
- Poets' corner: Towards better apparent-time data
- Summary

The case in Turkish

The (phonemic) Turkish vowel inventory

	[-back]		[+back]	
	[-round]	[+round]	[-round]	[+round]
[+high]	/i/	/y/	/ɯ/	/u/
[-high]	/e/	/ø/	/ɑ/	/o/

The (phonemic) Turkish vowel inventory



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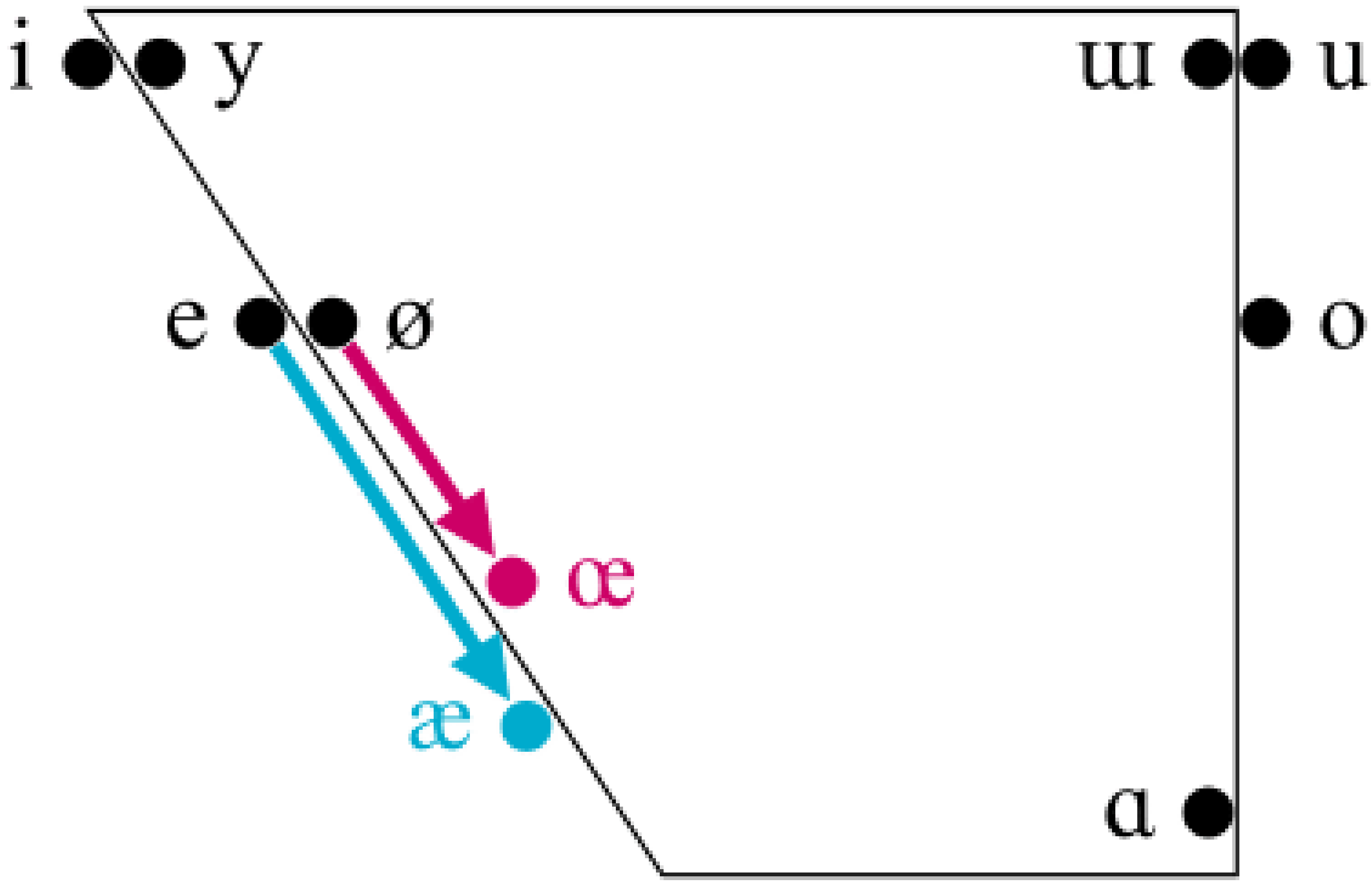

/e, ø/ allophony: previous descriptions

- Lewis (1967): **raising of /e/ in open syllables** but makes no mention of any lower allophone or of any pre-consonantal effects
- Underhill (1976): **lowering of /e/ in closed syllables before /r, l, m, n/** but only for ‘some dialects, especially [...] Istanbul, and more commonly in [...] women than [...] men’
- Kornfilt (1997): **/e, ø/ are lowered before sonorants in closed syllables**, transcribing the lower allophone of /e/ as [ɛ]

/e, ø/ allophony: previous descriptions

- Göksel & Kerslake (2005, 2010): lowering of **/e/** to **[æ]** before coda **/ɾ, l, m, n/** and laxing of final **/i, y, u, e/** to **[ɪ, ʏ, ʊ, ɛ]**
- Yavuz & Balcı (2011): **/e/** as being tense **[e]** before **<ğ>** and lax **[ɛ]** elsewhere, with lowered **[æ]** being 'speaker-dependent', giving the examples *genç* 'young', *Mehmet* (name) and *mendil* 'handkerchief'
- Ketrez (2012): **/e/** may sound **more like English /æ/** in 'some words' when followed by **/ɾ, l, n/** but notes no variation in /ø/

Observable generalisation(s)

- The front mid vowels **/e, ø/** are lowered to **[æ, œ]** before coda **/ɾ, l, m, n/**

/bibeɾ/	[bi.b**æ**ɾ]	‘pepper’
/hejkel/	[hej.k**æ**l]	‘statue’
/gizem/	[gi.z**æ**m]	‘mystery’
/sen/	[s**æ**n]	‘2SG’
/ʃoføɾ/	[ʃo.f**œ**ɾ]	‘driver’
/gøl/	[g**œ**l]	‘lake’
/gømmek/	[g**œ**m.mek]	‘bury.INF’
/dønmek/	[d**œ**n.mek]	‘turn.INF’

Observable generalisation(s)

- The environment for lowering is destroyed by vowel-initial affixation and subsequent syllabification

/biber-i/	[bi.b**e**.ri]	‘pepper-ACC’
/hejkel-i/	[hej.k**e**.li]	‘statue-ACC’
/gizem-i/	[gi.z**e**.mi]	‘mystery-ACC’
/sen-i/	[s**e**.ni]	‘2SG-ACC’
/ʃoføɾ-y/	[ʃo.f**ø**.ɾy]	‘driver-ACC’
/gøl-y/	[g**ø**.ly]	‘lake-ACC’
/gøm-yn/	[g**ø**.myn]	‘bury-IMP.2PL’
/døn-yn/	[d**ø**.nyn]	‘turn-IMP.2PL’

Observable generalisation(s)

- There is also an absence of lowering in other environments, e.g. pre-plosive, pre-fricative, pre-voiceless, pre-glide, open, final, non-final

/bebek/	[b**e**.b**e**k]	‘baby’
/hejkel/	[h**e**j.kæl]	‘statue’
/herkes/	[hær.k**e**s]	‘everyone’
/tɑze/	[tɑ.z**e**]	‘fresh’
/tʃøp/	[tʃ**ø**p]	‘rubbish’
/gøz/	[g**ø**z]	‘eye’
/søjle/	[s**ø**j.le]	‘say.IMP.2SG’
/bɑn.li.jø/	[bɑn.li.j**ø**]	‘suburb’

Observable generalisation(s)

- In addition to sonorants, **/z/** may trigger lowering (especially in the negative aorist suffix)

/gel-mez/	[gæl.m**æ**z]	‘come-NEG.AOR.3SG’
/tep-mez/	[tep.m**æ**z]	‘kick-NEG.AOR.3SG’
/merkez/	[mær.k**e**z ~ mær.k**æ**z]	‘centre, headquarters’
/pekmez/	[pek.m**e**z ~ pek.m**æ**z]	‘molasses’

Observable generalisation(s)

- A further point of variation is that **/e/** raises to something akin to **[i̞~ɪ~e̝]** in unstressed open syllables before high vowels

/deɾi/	[d**ɪ**.ɾi]	‘skin’
/kedi/	[k**ɪ**.di]	‘cat’
/peki/	[p**ɪ**.ki]	‘okay, well’
/deniz/	[d**ɪ**.niz]	‘sea’
/ben-im/	[b**ɪ**.nim]	‘1SG-GEN’
/veɾ-iɾ/	[v**ɪ**.ɾiɾ]	‘give-AOR.3SG’

Theoretical context

Naturalness in phonology

- Sound patterns across languages often seem to be **"natural"**, i.e. they are often traceable to physical characteristics of the vocal tract or properties of the auditory-processing/perceptual system etc.
  - Is this an **artefact of diachrony** or directly encoded in the **phonological grammar** in some way?
  - What is it that we're trying to claim is **"natural"**?
    - The set of sounds involved or the relationship between those sounds?
    - Usually both but…

Naturalness in phonology

- One of the most widely-known ideas in phonological theory is that some sets of segments form **natural classes** and others do not
- Traditional approaches in **generative** phonology (*SPE* et seq.):
  - There are natural classes of segments given by **shared featural specification within the grammar** (e.g. [-voi -son -cont], [+nas], etc.) which we expect to pattern together both within and across languages
- This diagnosis has become increasingly hazy with time

Naturalness in phonology

- Safe description: some sounds share some **uniting phonetic properties** and are substantially more likely to **pattern together in phonological activity** than others cross-linguistically
  - [p, t, k] or [m, n, ŋ] are phonetically similar and frequently act as phonologically-active cross-linguistically
  - [y, f, ŋ] or [ð, ɳ, q] not so much…
- **Approaches arguing for emergence:** both "radically substance-free" (Odden 2006, Blaho 2008) and more "empiricist" (Flemming 2005, Mielke 2008)
  - Asymmetries in the distribution of "natural classes" are about something other than the grammar

Naturalness in phonology

- In Evenki (Tungusic; Nedjalkov 1977), **/v, s, g/** nasalise when preceded by a nasal whereas other non-nasals do not

/oron-**v**i/	[oron**m**i]	‘my reindeer’
/ŋinakin-**s**i/	[ŋinakin**n**i]	‘your dog’
/oron-**g**Atʃin/	[oron**ŋ**otʃin]	‘like a/the reindeer’
/amkin-**d**u/	[amkin**d**i]	‘bed-DAT’
/ekun-**d**a/	[ekun**d**a]	‘somebody, something’

Naturalness in phonology

- The set of phonemes subject to nasalisation in Evenki is a prototypical example of a putatively **unnatural class** (though see Uffmann 2018)
  - Typologically unusual
  - No coherent theory of phonological representations includes /v, s, g/ to the exclusion of /d/
  - /g/ and /d/ differ only in place of articulation but ruling out coronals would also rule out /s/ which does undergo nasalisation
  - Phonetically disunited (if we believe that this is a good description of what these sounds actually sound like)

Naturalness in phonology

- Emergentist approaches to phonological class formation:
  - Predicated on **emergent approaches to "phonological features"**
- Traditionally, in generative phonology, there is posited to exist a small **universal set of phonological features** with all segments in a language bearing some specification for all of these features

Naturalness in phonology

- Traditionally, in generative phonology, there is posited to exist a small **universal set of phonological features** with all segments in a language bearing some specification for all of these features
  - The **typological** argument: the same types of contrast (voiced vs voiceless, sonorant vs obstruent …) tend to recur across languages
    - But is there a good fit between the set of segment classes that occur across all languages and the set of classes predicted by such theories of features?
  - The **acquisition** argument: having a hard-wired universal set of features makes it easier to learn phonology
    - More recent evidence that phonological categories can emerge from iterated learning procedures (e.g. Boersma 1998, Boersma, Escudero & Hayes 2003 …)

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Mielke (2008): no? Database of phonologically-active classes (sets of segments that are either triggers or targets of a pattern). Of 6,077 classes, 1,498 (**24.65%**) don't work in any of the three (innate) feature theories he uses for comparison and the best one (*SPE*) can only account for 4,313 classes (**70.97%**)

- Some seem genuinely "crazy" (Bach & Harms 1972), e.g. Evenki?
- Others seem **L-shaped**, e.g. "all voiceless stops and all dorsals" – more transparently related to pathways of diachronic change?

Naturalness in sound change

- If phonological rules are the end-product of phonological change then one type of **explanation for the distribution of active classes** lies therein:
  - Recurrent pathways of change give rise to recurrent phonologically-active classes
- How closely must the **trajectory of a change** correspond to the predictions we'd make based on the physical properties of the human sound system?

Naturalness in sound change

- How closely must the trajectory of a change correspond to the predictions we'd make based on the physical properties of the human sound system?
  – Consider a phonological rule ℜ triggered by the set of front vowels **[i, e]**
    - If ℜ is palatalisation, $C \rightarrow C^j$ / _ {i, e}, this is "phonetically natural" as [i, e] should be expected to have similar phonetic effects on a following consonant
    - If ℜ is nasalisation, {p, t, k} → {m, n, ŋ} / _ {i, e} no plausible direct phonetic motivation can be adduced
    - The **palatalising alternation is thus more (synchronically) natural** than the nasalising one, even though both involve the same (phonetically, representationally) natural active class of triggering segments

Naturalness in sound change

- How closely must the trajectory of a change correspond to the predictions we'd make based on the physical properties of the human sound system?

  - Most models of sound change converge on the prediction that **front-vowel-triggered palatalisation is more likely to emerge** in any given language than front-vowel-triggered nasalisation
  - Certain accounts in which the mechanism of change is largely **extra-grammatical** and change arises solely from the accumulation of **production–perception** interactions (e.g. Ohala's 1981 hypocorrection but see also the error accumulation model of Baker, Archangeli & Mielke 2011) also make the stronger prediction that change in each individual environment must be directly proportional to the strength of that environment as a phonetic precursor to change

Naturalness in sound change

- Returning to class structure: as cross-linguistic descriptive data improves, we find a wide typology of **"less-natural classes"**, ranging from the most disjointed Evenki-like cases to "mostly-natural" classes
  - Mostly-natural **L-shaped classes**: some phonologically-active classes seem to involve two sub-classes similar to a certain "core" class in different respects without necessarily being similar to each other
  - In Navajo, **/tʰ, k, kʰ, k', x, ɣ, h/** labialise before /o/ – bad class in traditional featural terms; no simple conjunction of features that excludes e.g. **/tsʰ, s, ɬ/**
  - But if we take **/k/** as the **pivot point** then we have "all voiceless plosives" (generalising manner) and "all dorsals" (generalising place)
  - Only makes sense if the pattern has its **diachronic origin** in an effect on /k/

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Potential implication for the formation of phonologically-active classes:

- **There needs to be a (discrete?) decision process that selects segments for active classes following the diachronic origin of the pattern**

The view from Turkish

- What our Turkish case might do for these issues in general phonology:
  - **Good data** (relatively speaking) on a **potentially problematic class**:
    - **/ɾ, l, m, n, (z)/** but not e.g. **/j/** – does this class have representational unity? Phonetic self-similarity?
    - Are all the segments **/ɾ, l, m, n/** good phonetic environments for lowering?
  - Generally believed that there is a relationship between the structure of active classes, and the pathways by which phonological change proceeds but data is relatively thin on the ground – **perhaps Turkish will help**

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/j/ is **unlike other sonorants** in Turkish in more than one respect:

- Though Turkish allows sonorant–obstruent clusters word-finally (e.g. /ders, mert, gentʃ, ɾenk/), /jC/ clusters are quite bad, being found only in recent loans (/tejp, fejk/) and usually broken up by high-vowel epenthesis
- A process of optional (though common) elision of coda /h/ never applies before /j/, e.g. /fi**h**ɾist/ [fiːɾist], /te**h**like/ [teːlike], /me**h**met/[meːmet] but /jɑ**h**jɑ/ ***[jɑːjɑ], /kytɑ**h**jɑ/ ***[kytɑːjɑ]
- Indeed, lowering of /e, ø/ **fails to apply** before /j/, e.g. /t**e**jze/ ***[t**æ**jze], /**ø**jle/ ***[**œ**jle]

The view from Turkish

- The argument: Turkish mid-vowel lowering is a believable example of a Navajo-style **L-shaped generalisation**, providing us with diachronic guesses about the history of this change in Turkish itself – and thereby also insights into how class formation might work
  - And is in line with predictions about the **emergent** nature of phonological information:
    - Classes in new phonological patterns look like existing phonological activity and analogy, unlike universal/non-language-specific conceptions of the feature

Empirical context

A typology of vowel-height effects

- Our case is the **intersection of two broader typologies** of phonetically well-motivated phenomena:
  - – Vowel quality effects conditioned by syllable structure
    - **Closed-syllable laxing** is well-established but only sometimes depends on the manner of articulation of the coda consonant and, if so, usually only licensed with consonants that are particularly good phonetic precursors
  - – Height effect triggered by sonorants
    - **Sonorant-triggered height effects** are common but rarely dependent on syllable structure and rarely independent of the choice of segment
      - ☞ Different sonorants turn out to have different predicted phonetic effects

Closed-syllable laxing

- There is a general cross-linguistic tendency towards **laxer vowels in closed syllables** and **tenser vowels in open syllables**, often phonologised (sometimes dependent on coda type, sometimes independent)
  - **French** *loi de position*, e.g. [e.tʁɑ̃.ʒ**e**] ‘foreign.M’, [ʁi.gɔ.l**o**] ‘funny.M’ but [e.tʁɑ̃.ʒ**ɛ**ʁ] ‘foreign.F’, [ʁi.gɔ.l**ɔ**t] ‘funny.F’
  - **Kayan** (Austronesian; Blust 2013) high vowels lower before by **/h, l, ɾ, ʔ/**, e.g. /lak**i**ʔ/ [lak**e**ʔ] ‘male’, /hiv**i**h/ [hi.v**e**h] ‘lower lip’, /bak**u**l/ [ba.k**o**l] ‘basket’ /tum**i**ɾ/ [tu.m**e**ɾ] ‘heel’

Closed-syllable laxing

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  - **Storme (2017):** survey of 18 languages for which something like this holds; where acoustic "laxness" equates to 2D movement in the vowel space, less peripheral in both F1 and F2
  - In this survey, /e o/ are **less frequently targeted** than /i u/ (7 of 17 languages that have them); processes usually **triggered by rhotics and dorsals** if segment-specific

Closed-syllable laxing

- Closed-syllable vowel laxing has been attributed in various cases (Féry 2003, Botma & van Oostendorp 2012) to the existence of a **close relationship between length, quality and syllable structure**: vowels are shorter in closed syllables than open syllables (see e.g. Maddieson 1985)
  - One issue: actually, **empirical generalisations about the relationship between quality and duration are variable** and difficult to straightforwardly align with the demands of articulation or the typology of laxing
    - If derived from the loss of duration in closed syllables, (non-low) lax vowels should be shorter than tense vowels but often lower vowels are longer (e.g. Lindblom 1960, Lehiste 1970, Maddieson 1997, Gussenhoven 2007)

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- Storme (2017) instead claims that it is due to **perceptually-driven enhancement of post-vocalic contrasts between consonants** as the derivation of lowering and centralising effects from the loss of duration is not justified

☞ In Turkish, this is actually very unclear

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If there is an F1–duration correlation:

- A positive correlation between **F1 and duration** should hold both across categories and within categories; given multiple tokens of a single vowel, the highest instances thereof should be shorter than the lowest instances
- But this effect **does not have to be constant in magnitude** across categories: the lowest and highest vowels are inherently constrained so there are durational ceilings at the extremes of these categories
- If realisations of an individual vowel systematically shift in height as the result of phonological change, we should expect an **attendant pattern in duration**

Sonorant-triggered height effects

- Frequent, especially with respect to **individual sonorant segments** and **especially rhotics** (typically don't involve syllable structure restrictions)
  - Strong articulatory and acoustic properties of the **rhotics** often **favour the development of height effects** of preceding vowels:
    - Most widely cited: lowering of F3 (Ladefoged 2003) (but see also Lindau 1985)
    - Mid-vowel lowering before coda rhotics is widely attested, e.g. in certain Ibero-Romance varieties (Bradley 2010), Swedish /ɛ, ø/ (Riad 2014), Faroese /e/ (Árnason 1999)

Sonorant-triggered height effects

- Frequent, especially with respect to individual sonorant segments and especially rhotics (typically don’t involve syllable structure restrictions)
  – The situation of the **laterals** is **less straightforward**:
    - **Phonetically:** Many accounts of disparities between rhotics and laterals in degree and even direction of effect on F1
      - Velarised /l/ correlates with a lower F2 but Carter & Local (2007) also report higher F1 as a secondary correlate
      - The transition to a palatalised /l/ from mid vowels instead involves a sharp drop in F1 (=raising) and a sharp increase in F2
    - **Phonologically:** non-velarised laterals are often ignored in languages with vowel-lowering rules

Sonorant-triggered height effects

- Frequent, especially with respect to individual sonorant segments and especially rhotics (typically don't involve syllable structure restrictions)
  - **Nasals** have **variable correlates** and can be associated with both phonetic raising and lowering
    - In (European) Portuguese, the non-high vowels /e, o/ are lowered in unstressed word-final syllables closed by an sonorant (thereby neutralising the /e–ɛ , o–ɔ/ contrasts, e.g. [ʁɨˈvɔɫv**ɛ**ɾ] 'revolver', [ˈʒuni**ɔ**ɾ] 'junior', [ˈaɫk**ɔ**ɫ], [ˈsɛm**ɛ**n] 'semen', [ˈkɔɫuf**ɔ**n] 'colophon' (Vigário 2000)
    - Possible phonologisation of the **variable correlates** of the nasals: Anticipatory nasalisation should drive an **increase in F1** (Krakow et al. 1988) but the nasal anti-formant (Beddor 1993, Beddor et al. 1986) causes perceptual **raising** in low-mid and low vowel

Sonorant-triggered height effects

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Phonetic **take-away** message for our case from Turkish:

- Some unambiguously good phonetic triggers for lowering: **[ɾ]**
- Some triggers whose effect depends on secondary articulation: **[$ɫ^j$ ~ $ɫ^ɣ$]**
- Some with competing/contradictory potential effects: **[m, n]**

Experimental data

Production study

- Experimental investigation of the status of pre-consonantal height effects in Turkish vowels
- Recorded **13 native Turkish speakers**
  – Aged **20–39**; 3 males (excluded from analysis for now) and **11 females**

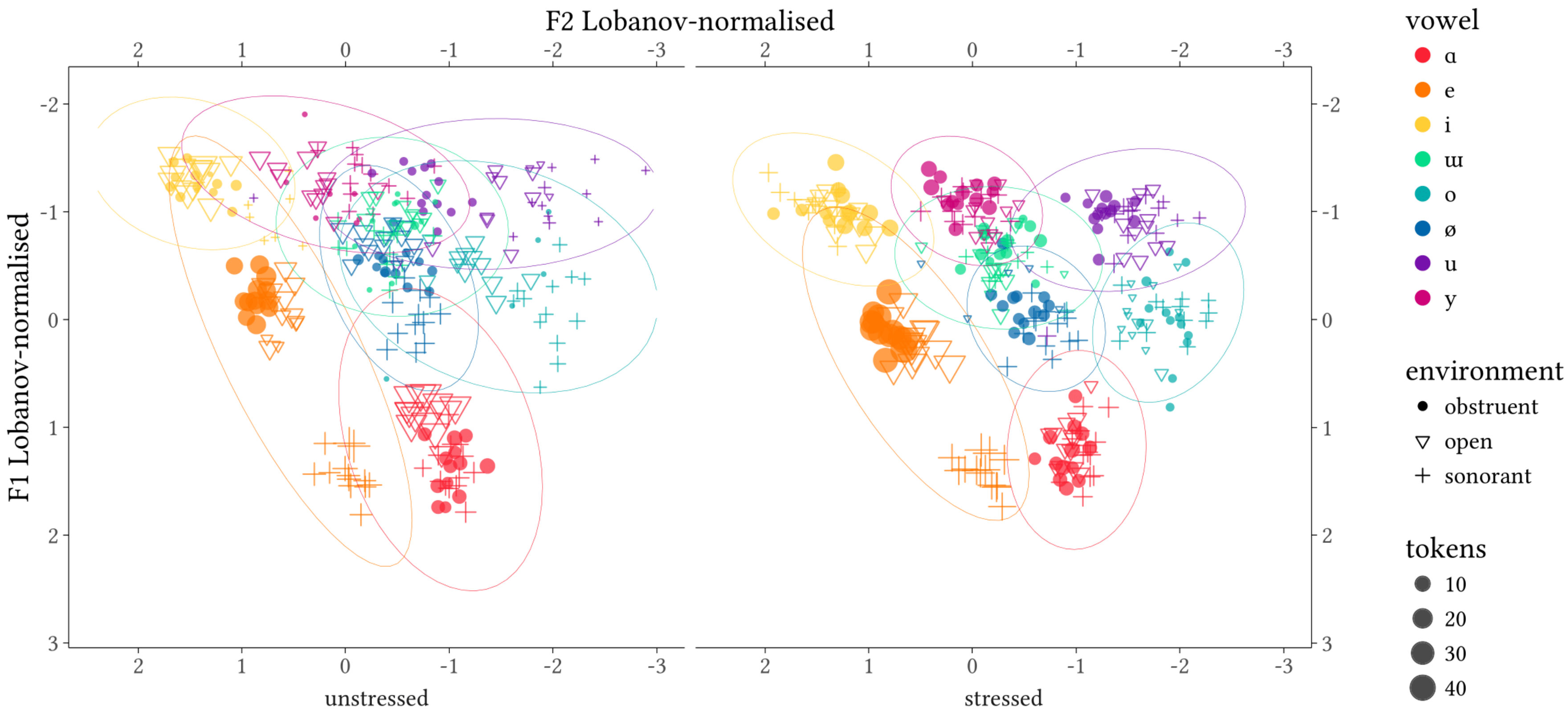
Production study

- **120 instances of /e/** in stimuli – 42 obstruent-closed, 40 sonorant-closed and 38 open; 70 total were (primary) stressed and the remainder unstressed
- **32 instances of /ø/** in stimuli – 8 pre-obstruent and open, 16 pre-sonorant
  - /ø/ is very rare in non-initial syllables and also lower-frequency than /e/
  - The distribution of /ø/-containing words was therefore particularly skewed with respect to stress (almost no /ø/ in stressed open syllables)

Production study

- Some tokens were excluded due to devoicing, interference from non-modal voicing, etc.
- **1,746 total tokens of /e/** and **383 total tokens of /ø/** measured for analysis, with 2,511 measured for the remaining 6 underlying vowels as comparison (560 /i/, 366 /y/, 258 /ɯ/, 250 /u/, 258 /o/, 843 /ɑ/)
- Also collected 300 tokens of /e/ to test **systematic patterns of exceptionality**
- Praat was used to extract F1, F2 and duration for vowels
- Data processing and statistical analysis in R

Distribution and categoricity



- Strong height effects for open vowels in non-final/unstressed syllables; the tendency for vowels to be **higher in unstressed open syllables is weak only for /e/**
- Tokens corresponding to pre-sonorant **/e/** have essentially **no overlap** with those in an unclosed or obstruent-closed syllable; **/ø/** is less discontinuous, but there is a **clear effect**

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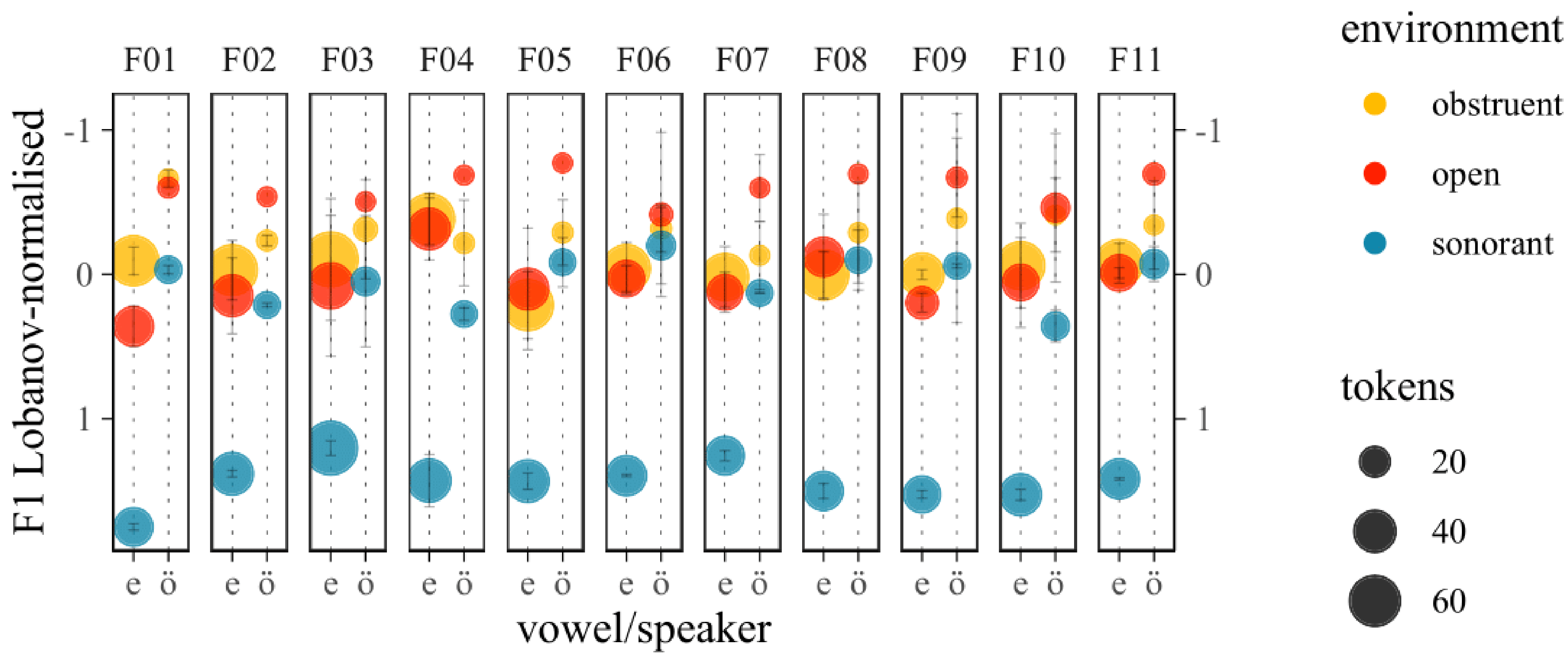

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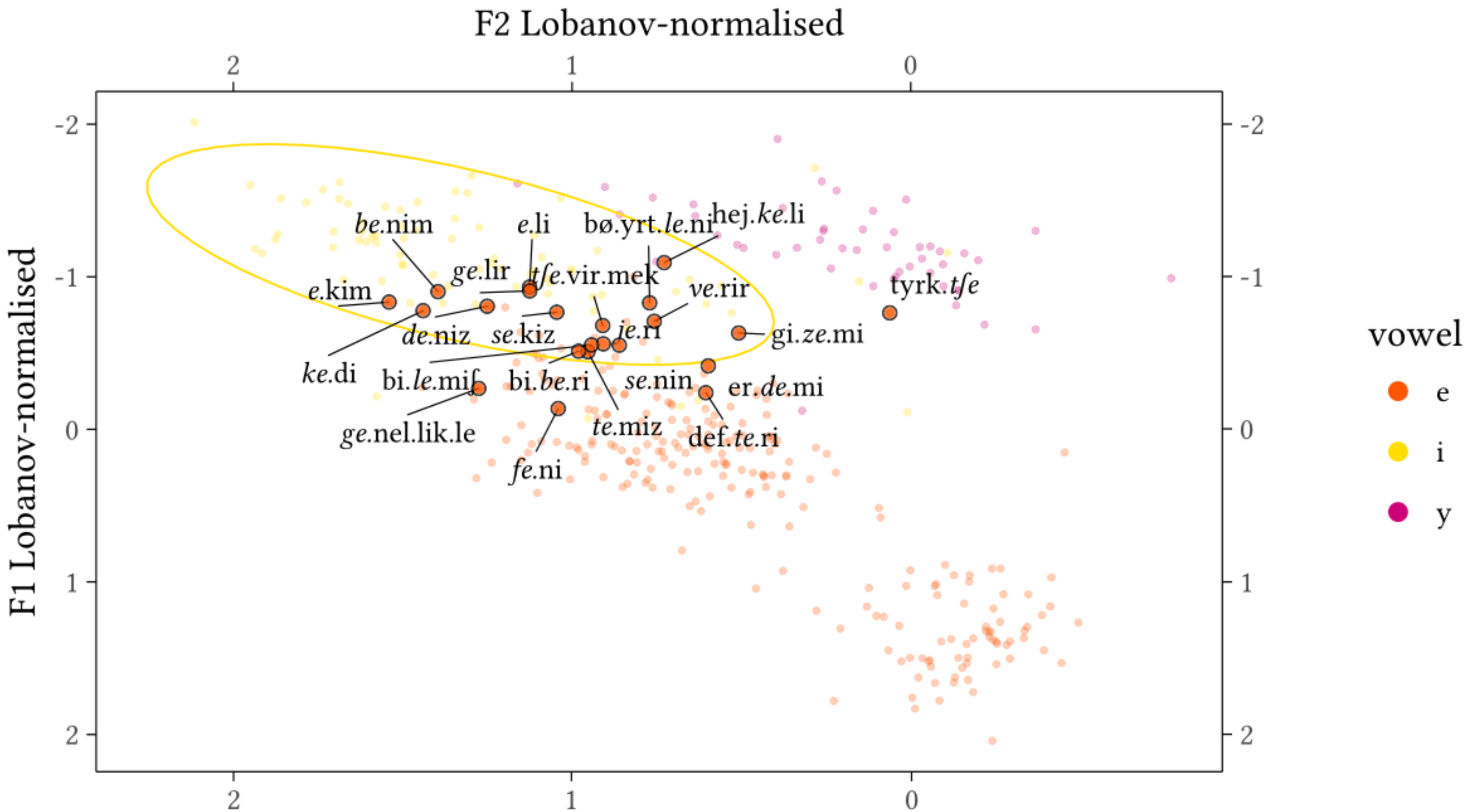
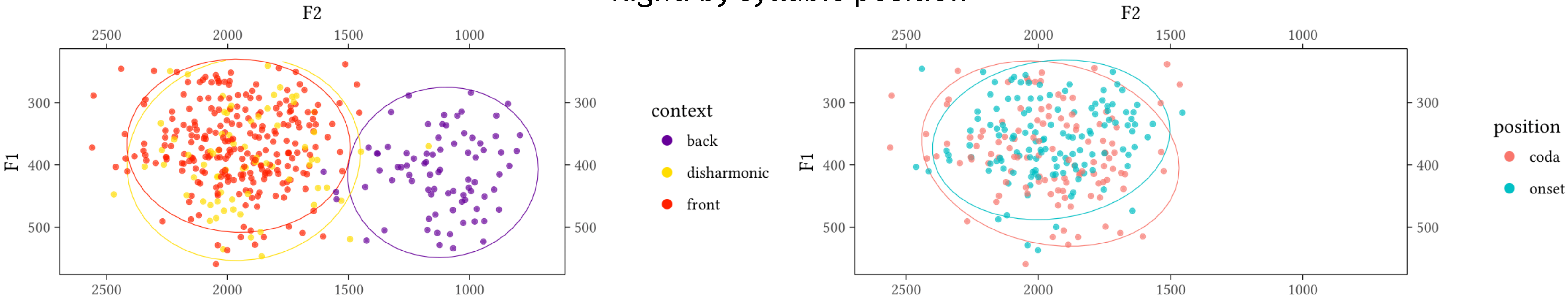


- F1(obstruent) < F1(open) < F1(sonorant) holds **even more strongly for /e/** in the absence of tokens **followed by a high vowel** (in the next syllable)

Individual triggering segments

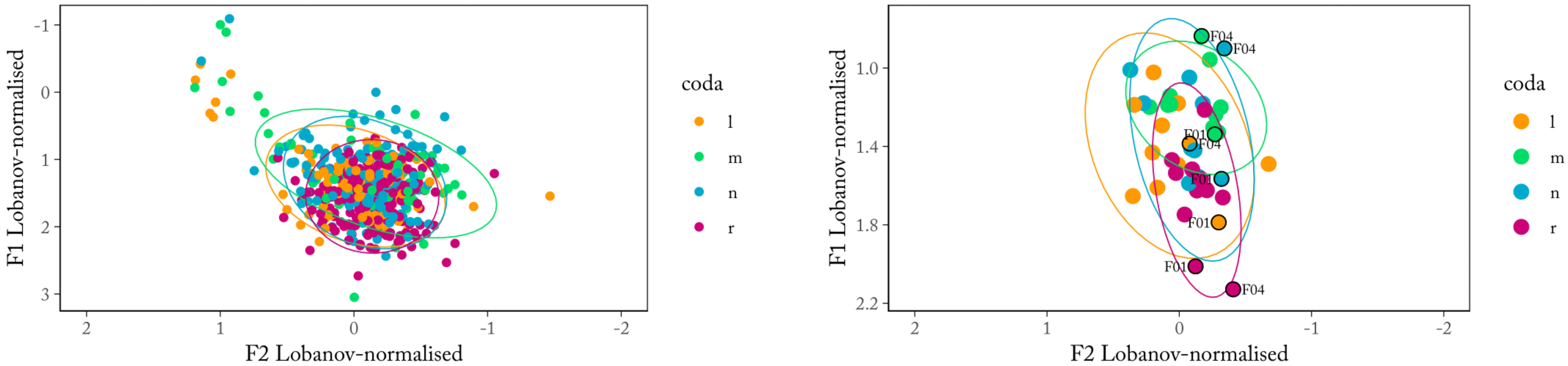
F1–F2 space for /l/ measured at midpoint by vocalic environment
Left: by adjacency to front/back vowels or both (= disharmonic)
Right: by syllabic position



- Different coda sonorants constitute **different sizes of phonetic trigger for lowering** (= higher F1)
- Turkish **/l/** has an allophonic distribution conditioned by the backness of adjacent vowels, with all laterals environment relevant to us **palatalised** and so **not expected to be good triggers**
- Extracted **627 tokens** of the **/l/** from all speakers coded according to adjacent vowels
- **No evidence that coda /l/ is a good trigger** for lowering of front /e, ø/

Individual triggering segments

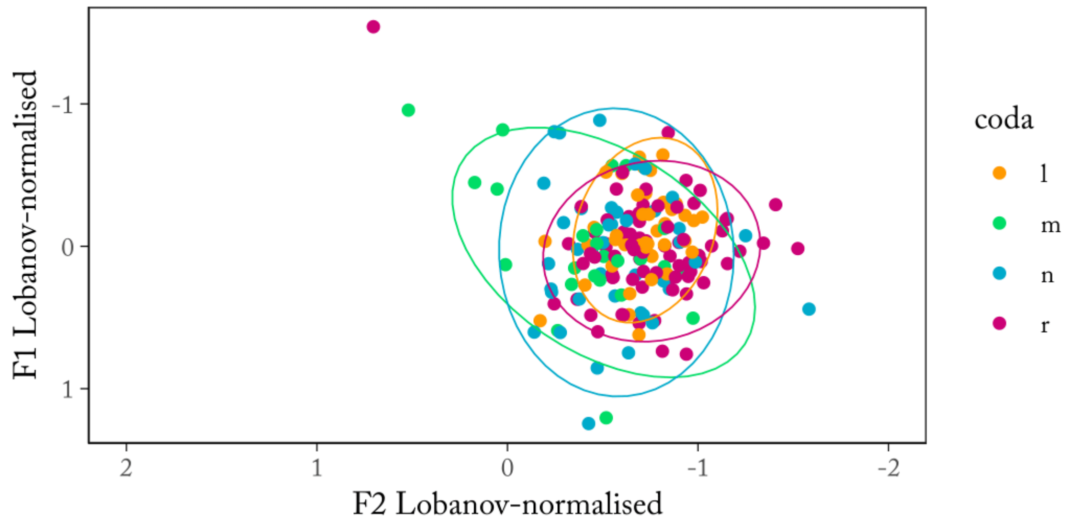
F1–F2 space for pre-sonorant /e/ – all tokens (left) and speaker means (right)



- Different coda sonorants constitute **different sizes of phonetic trigger for lowering** (= higher F1)
- But there is no statistical evidence that different coda sonorants affect **degree of /e/-lowering** for the majority of speakers
- Though **F01 and F04** show a slightly larger effect of **rhotic** (but, for both, pre-lateral lowering is greater than pre-nasal lowering)

Individual triggering segments

F1–F2 space for pre-sonorant /ø/ – all tokens



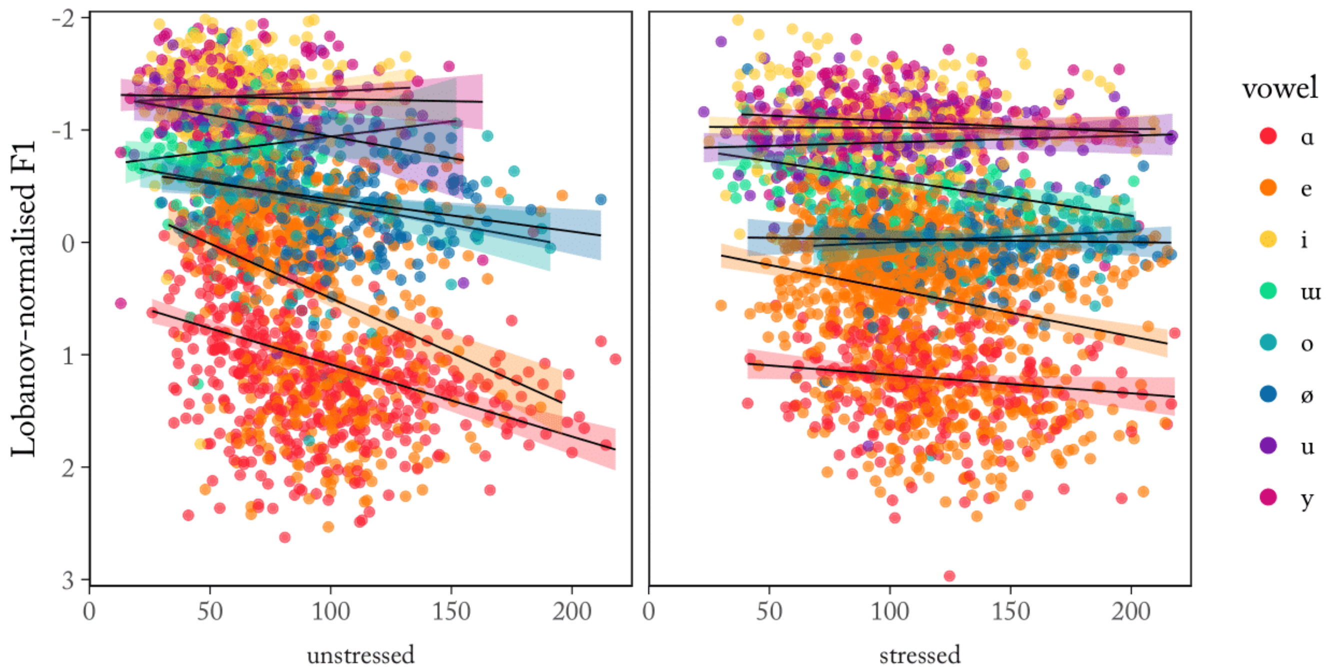
- Different coda sonorants constitute **different sizes of phonetic trigger for lowering** (= higher F1)
- However, there **is** a statistically significant effect for **/ø/**
- Very difficult to tell from this plot but mixed-effects model shows **/ø/** to be **consistently lower** than before **/r/** than other sonorants

Duration

- Earlier we cast doubt on the phonetic **F1–duration relationship** cross-linguistically
  - An alternative explanation for any apparent positive correlation between duration and F1 is that is **phonological**
  - Each vowel (category) has an independent phonologised duration target and it happens that these targets are shorter for higher vowels
  - Then why should a separation in durational targets arise and phonologise?
    - Solé & Ohala (2010): phonologisation **"overrides"** what is presumed to be the original mechanical bias, i.e. the use of duration as a marker of phonological identity is ultimately phonologised from an uncontrolled but not exceptionless phonetic preference for shorter higher/long lower vowels

Duration

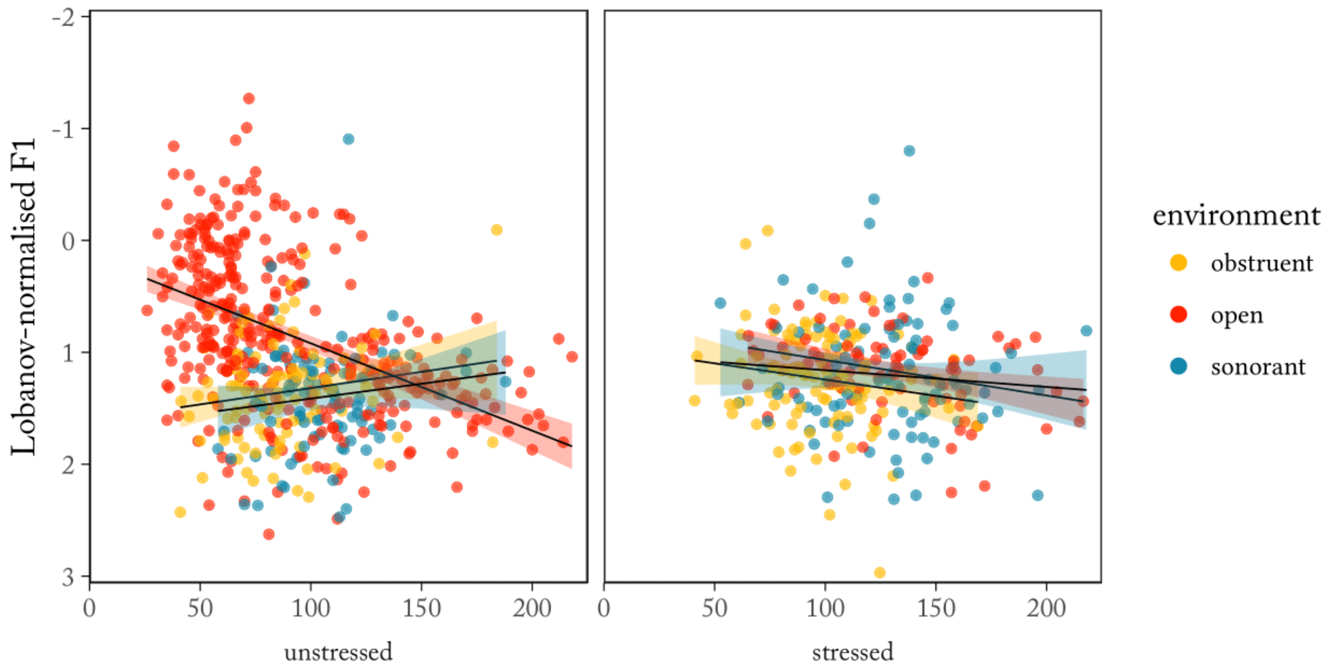
F1–duration linear-model fit for all unstressed and stress vowels



- Data pared down to only "reasonable" measurements of duration: points more than 3 standard deviations (39.75 ms) away from the mean (99.04 ms) were dropped, giving an adjusted range of 12–219 ms (lost about 5% of the data this way)
- For **most vowels**, there is **no meaningful relationship** between F1 and duration

Duration

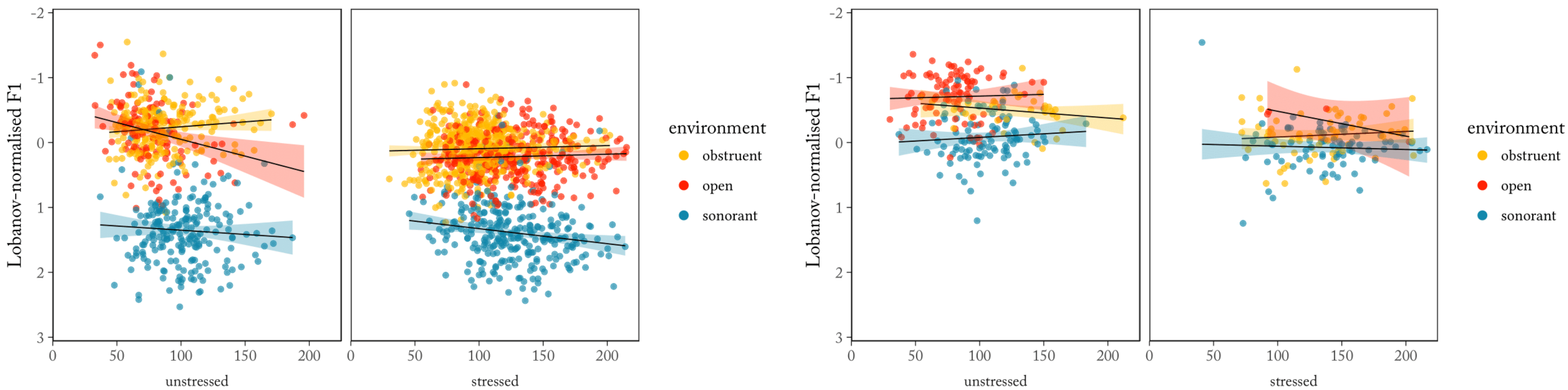
F1–duration linear-model fit for /ɑ/ by syllabic environment



- Data pared down to only “reasonable” measurements of duration: points more than 3 standard deviations (39.75 ms) away from the mean (99.04 ms) were dropped, giving an adjusted range of 12–219 ms (lost about 5% of the data this way)
- For **/ɑ/**, this is really **reduction of unstressed vowels in open syllables**

Duration

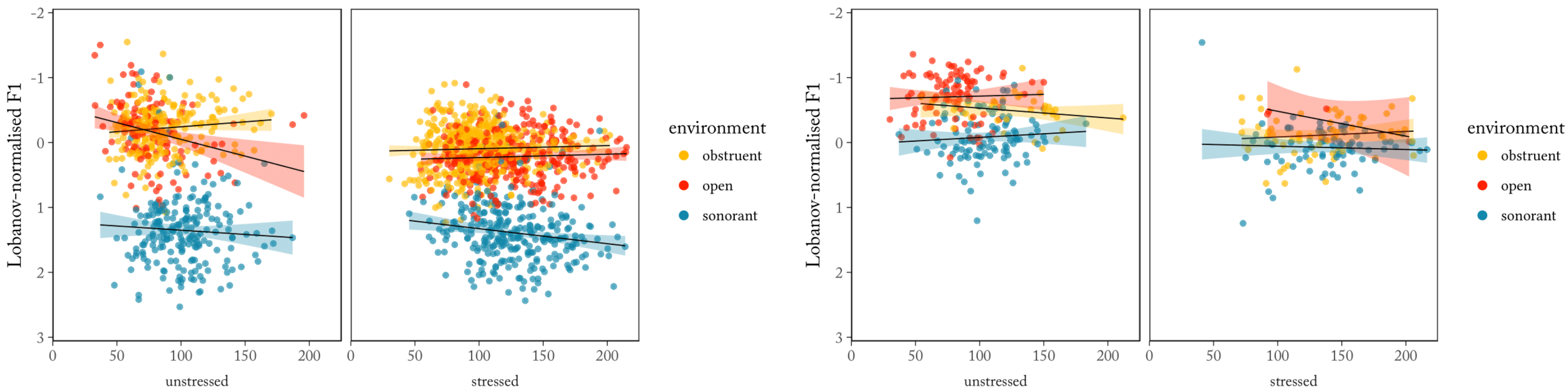
F1–duration linear-model fit for /e/ (left) and /ø/ (right) by syllabic environment



- Data pared down to only “reasonable” measurements of duration: points more than 3 standard deviations (39.75 ms) away from the mean (99.04 ms) were dropped, giving an adjusted range of 12–219 ms (lost about 5% of the data this way)
- Similarly for **/e/** and **/ø/**, the slopes are not very interesting across context

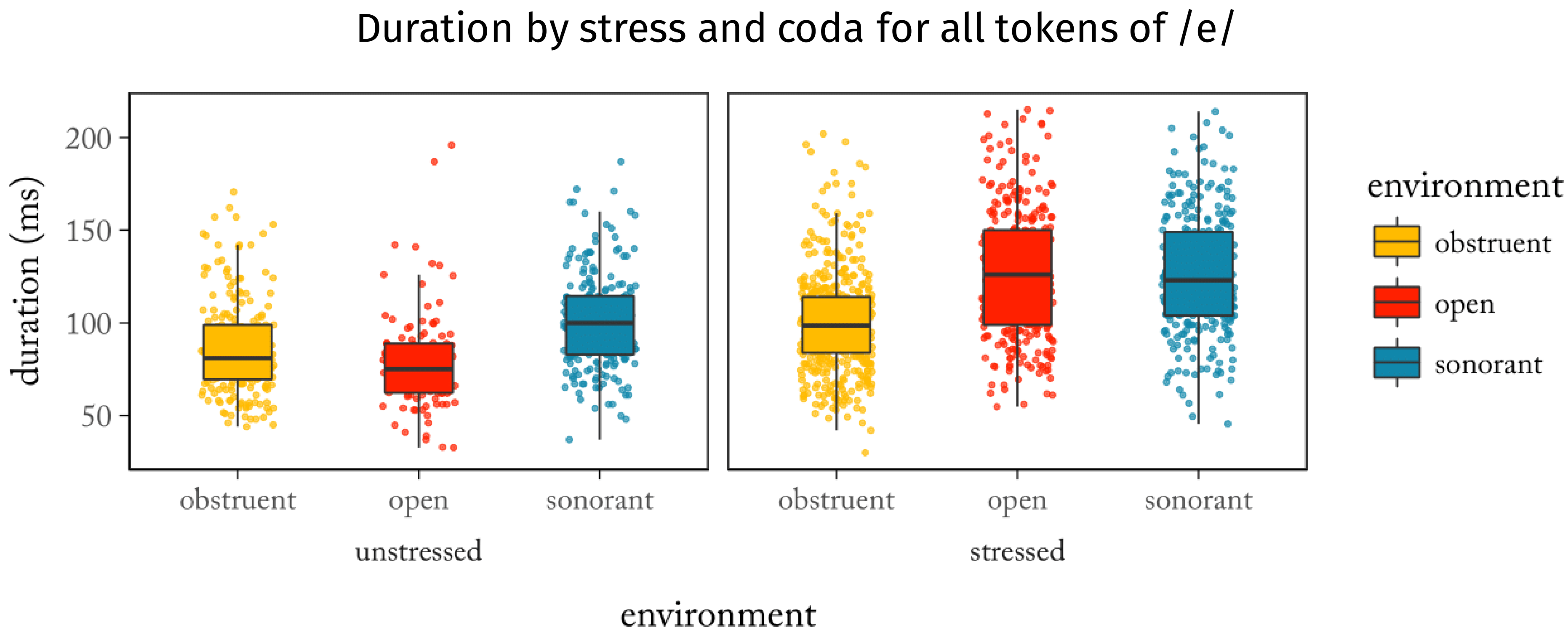
Duration

F1–duration linear-model fit for /e/ (left) and /ø/ (right) by syllabic environment



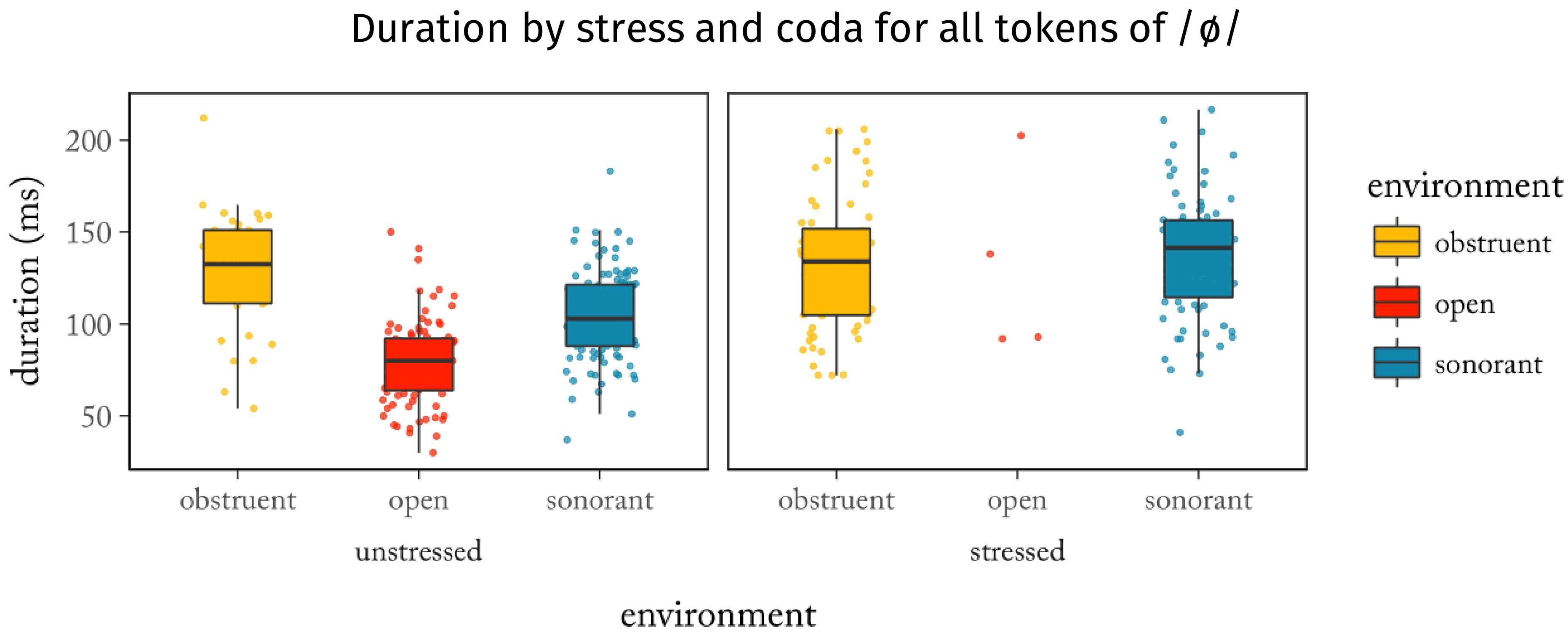
- Data pared down to only "reasonable" measurements of duration: points more than 3 standard deviations (39.75 ms) away from the mean (99.04 ms) were dropped, giving an adjusted range of 12–219 ms (lost about 5% of the data this way)
- More interesting: **effect of conditioning environment on duration**

Duration



- Data pared down to only “reasonable” measurements of duration: points more than 3 standard deviations (39.75 ms) away from the mean (99.04 ms) were dropped, giving an adjusted range of 12–219 ms (lost about 5% of the data this way)
- **Unstressed /e/**: sonorant > obstruent > open; **stressed /e/**: sonorant ~ open > obstruent

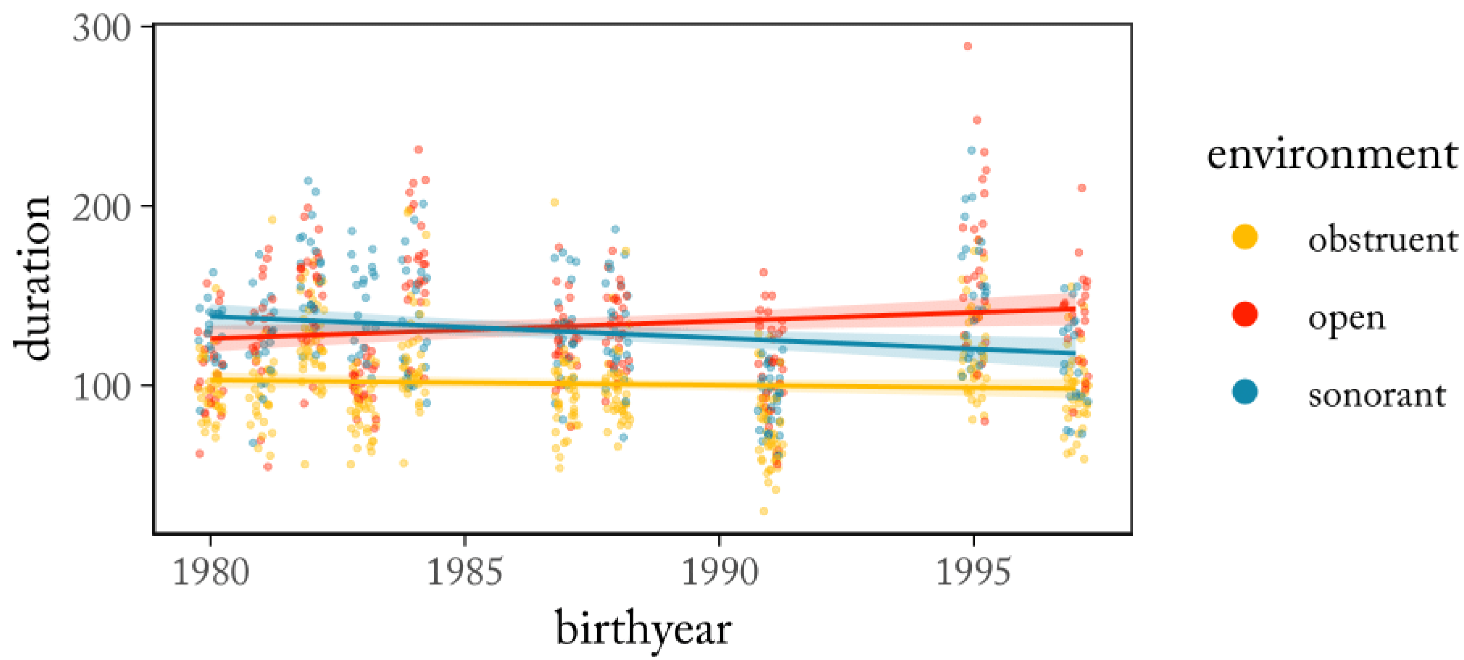
Duration



- Data pared down to only “reasonable” measurements of duration: points more than 3 standard deviations (39.75 ms) away from the mean (99.04 ms) were dropped, giving an adjusted range of 12–219 ms (lost about 5% of the data this way)
- **Unstressed /e/:** sonorant > obstruent > open; **stressed /e/:** sonorant ~ open > obstruent
- **Unstressed /ø/:** obstruent > sonorant > open; **stressed /ø/:** sonorant ~ obstruent

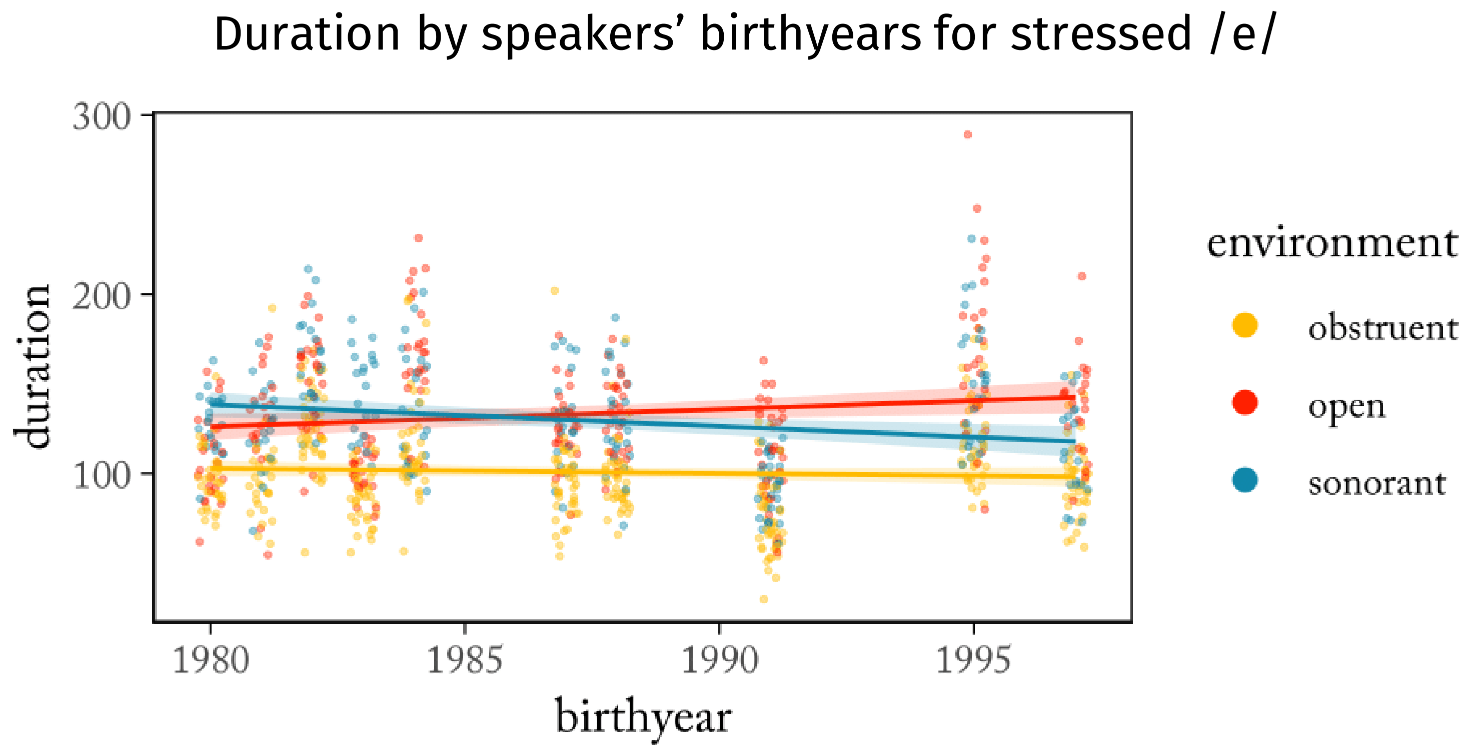
Duration

Duration by speakers' birthyears for stressed /e/



- Patterning for individual speakers is **variable but constrained**
- In **stressed /e/** there is an actual potential reversal due to age:
  - For **older** speakers: stressed sonorant > open > obstruent
  - For **younger** speakers: open > sonorant > obstruent

Duration

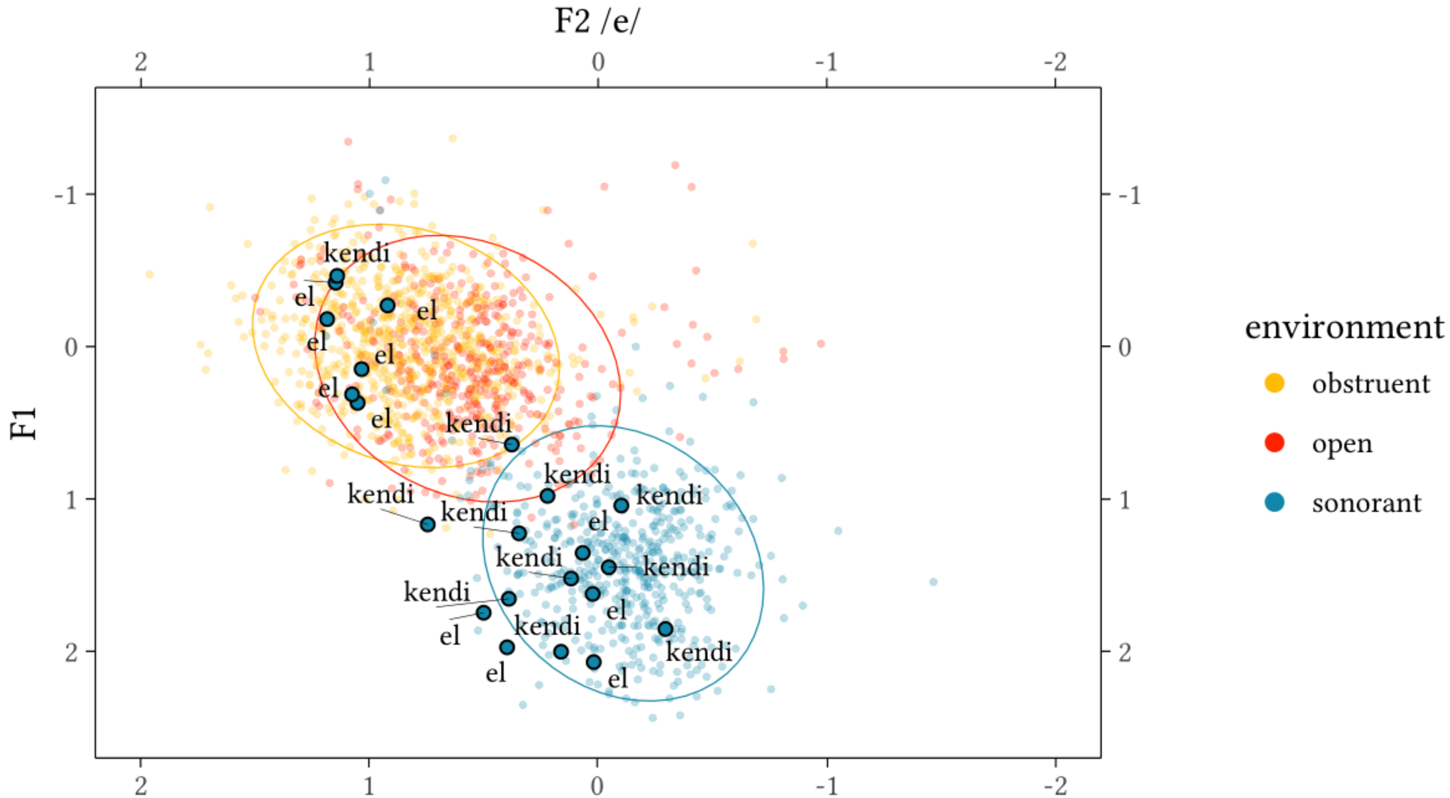


- Possible that **patterning in duration is a reflection of the original conditions of phonologisation**
- For speakers who are behind in the change, a few traces of the original environment for phonologisation are seen and these traces disappear for speakers who are further ahead
- Potentially dubious due to the lack of good apparent-time depth here

Exceptionality

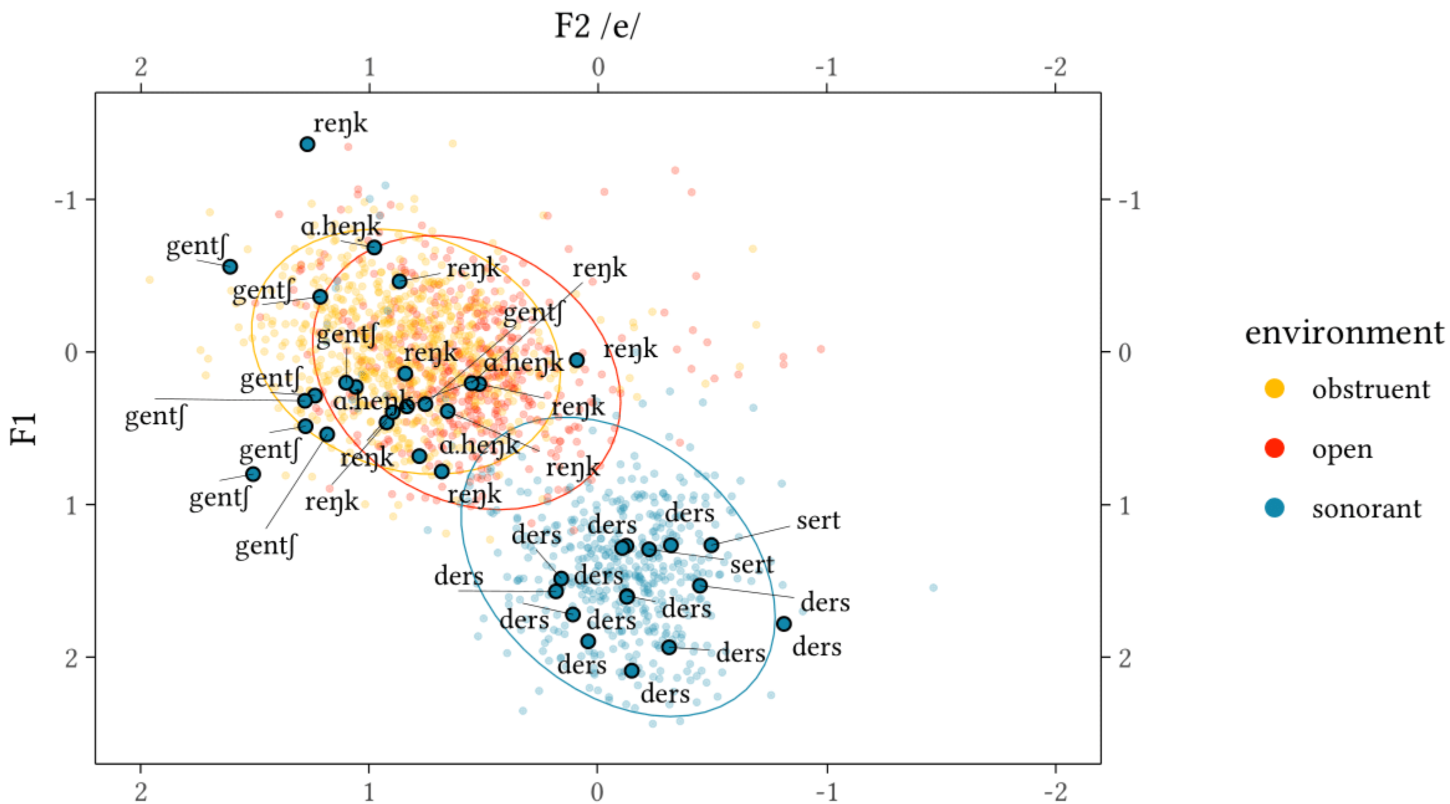
- From what we have seen thus far, the pattern is **discontinuous in phonetic space** and persists across a large test set for all participants
- It also varies under **resyllabification** in a manner consistent with phonologised positional restrictions
- However, there are two categories of **exceptions**:
  - Pre-sonorant non-undergoers
  - Pre-obstruent undergoers
- Exceptions seeminlgy apply only to **/e/** not **/ø/**:
  - Broadly consistent with a model in which the "phonological" status of lowering in /e/ is further advanced and thus amenable to effects violating strict phonetic conditioning (see e.g. Bermúdez-Otero 2015)

Exceptionality



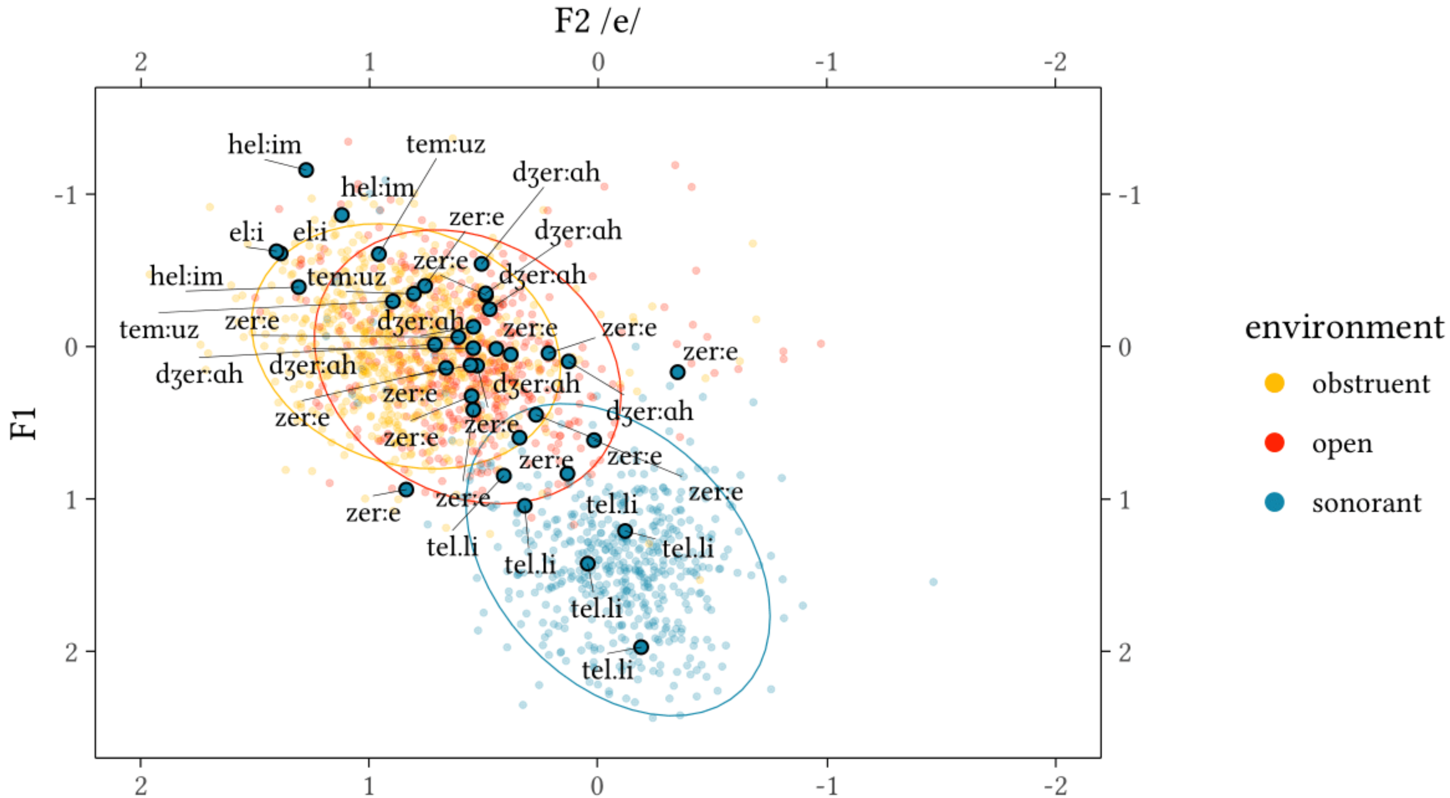
- Certain **high-frequency** items such as [el ~ æl] 'hand' and [kendi ~ kændi] 'self' show some degree of optionality across speakers as to whether they participate in lowering

Exceptionality



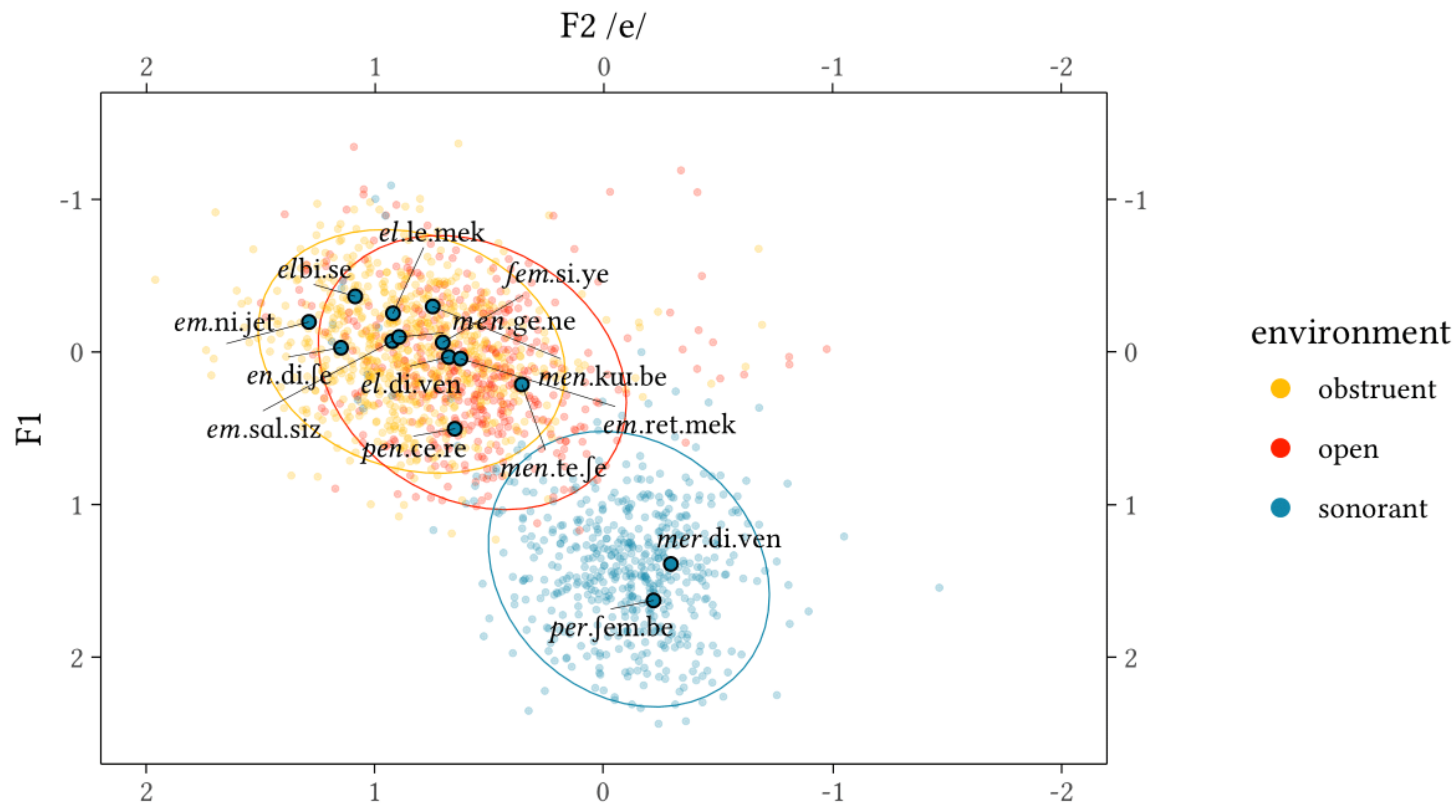
- Lowering appears to be **blocked before final nasal–obstruent** clusters, e.g. [ɾ**e**ŋk, *ɾ**æ**ŋk] 'colour', [g**e**ntʃ, *g**æ**ntʃ] 'young' but **not before final rhotic–obstruent** clusters, e.g. [d**æ**ɾs, *d**e**ɾs] 'lesson', [s**æ**ɾt, *s**e**ɾt] 'hard'
- In this, all speakers are consistent

Exceptionality



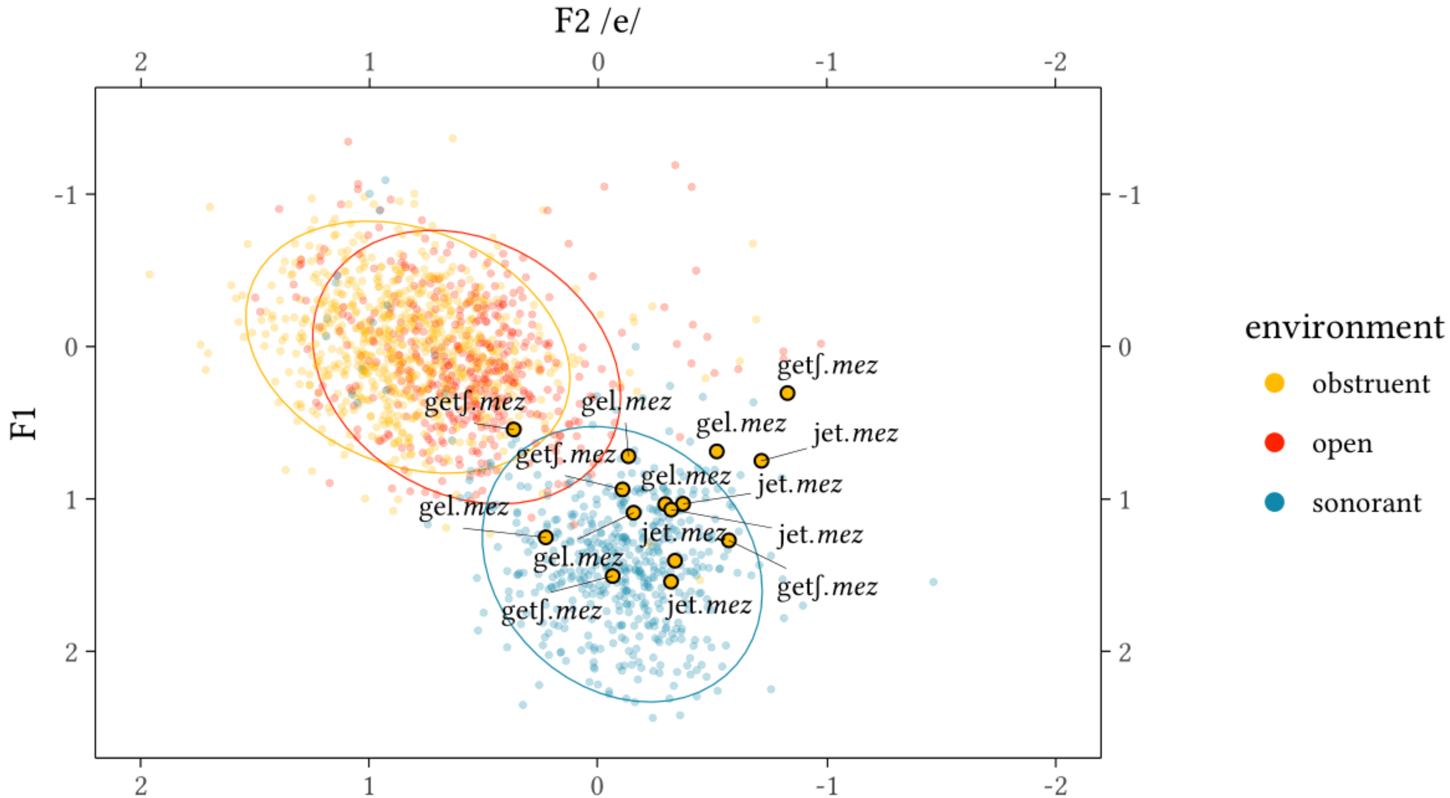
- There is a small class of (mainly?) loanwords in which **non-morphological geminates** seem to be syllabified into the onset of the following syllable and thus **block lowering**
- E.g. [z**e**rːe] 'molecule', [dʒ**e**rːah] 'surgeon', [h**e**lːim] 'halloumi', [t**e**mːuz] 'July' (cf. [t**æ**l-li] 'wired')

Exceptionality



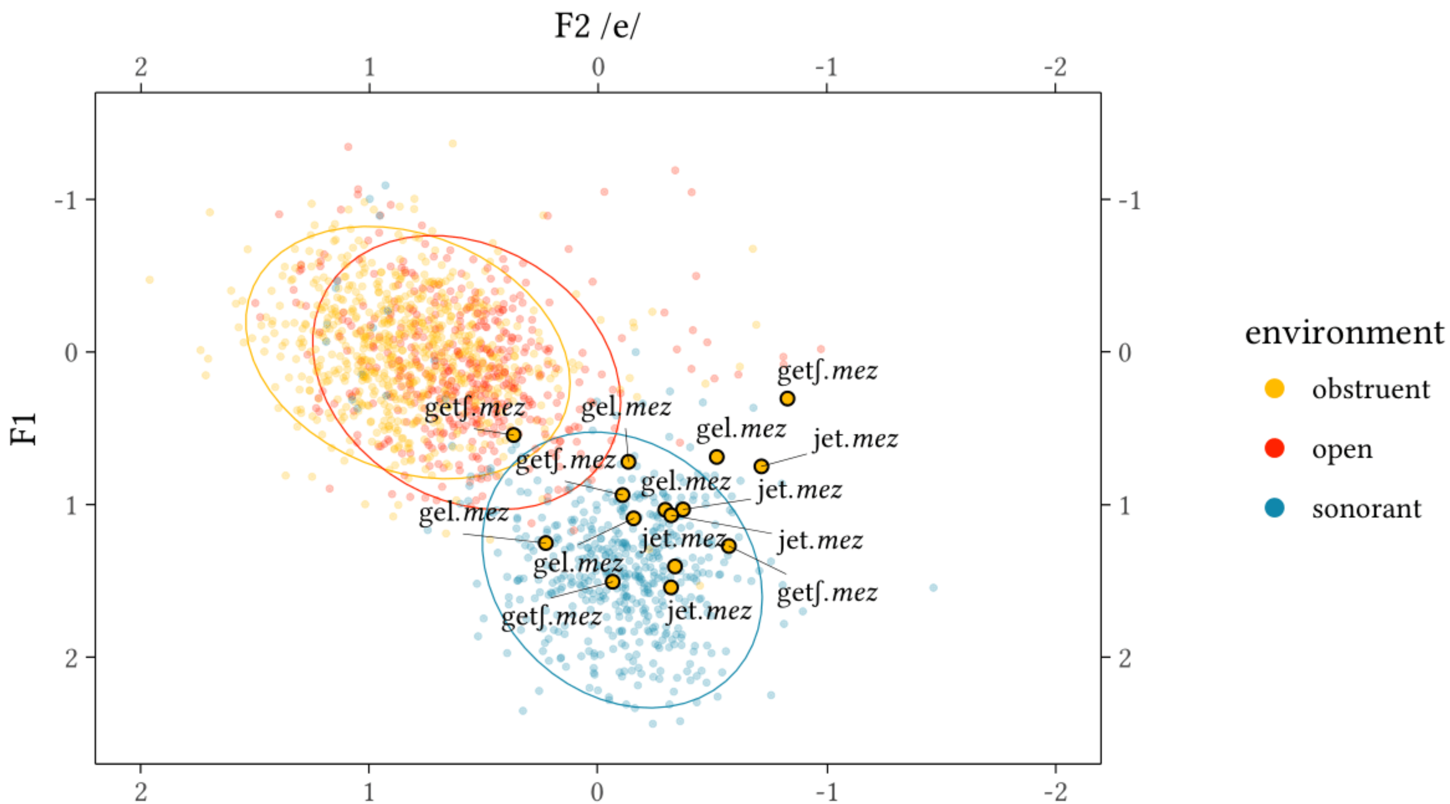
- Though there is no general prohibition on lowering in initial syllables of multisyllabic words (e.g. [g**æ**l.dim] 'come.DIR.PST.1SG', [v**æ**r.mi.ʃim] 'give.INDIR.PST.1SG')
- However, **lowering fails in a poorly-characterised set of word-initial sonorant-coda syllables**
- (N.B. to avoid clutter, unlike other figures, in this plot, points represent by-word averages)

Exceptionality



- Coda voiced fricatives are relatively low-frequency in Turkish save the **negative aorist /-mAz/**
  - In 1,337,898 morphologically-complex types (parsed by Bilgin 2016, derived from the corpus of Sak, Güngör & Saraçlar 2008), there were **91,798 <z>-final types**, of which **2,104 were <ez>-final**; of these, **only 62 did *not* contain the negative aorist**

Exceptionality



- Coda voiced fricatives are relatively low-frequency in Turkish save the **negative aorist /-mAz/**
  - /-mAz/ is frequent and **highly susceptible to /e/-lowering**

Discussion of diachrony

Some guesswork

- This sample is a **limited window** into the variation that exists in Turkish
  - The range in **apparent time is narrow** and the set of participants is **fairly homogeneous** in sociolinguistic terms, especially excluding male speakers

Some guesswork

- This sample is a **limited window** into the variation that exists in Turkish
- Exploring the trajectory of change and the historical context for innovation is necessarily reliant on **other strands of evidence and argumentation**

Western Anatolian rhoticity loss:

- This is an oft-cited example of compensatory lengthening triggered by **syllable-final /ɾ/-deletion** (Korkmaz 1965; Sezer 1986; Kavitskaya 2002) incidentally shows additional **/ɾ/-triggered height effects**, even when the rhotic is absent on surface

(Sezer 1986: 241)	*Standard Turkish*	*Western Anatolian*
‘there is’	/vɑɾ/	[vɑː]
‘give.DIR.PST.3SG’	/veɾdi/	[væːdi]
‘go.AOR.3PL’	/gidileɾ/	[gidilæː]
‘cook.AOR.3SG’	/piʃiɾiɾ/	[piʃiɾæː] [*sic*]
‘give.AOR.3SG’	/veriɾ/	[viriː]

Some guesswork

Some guesswork

- This sample is a **limited window** into the variation that exists in Turkish
- Exploring the trajectory of change and the historical context for innovation is necessarily reliant on **other strands of evidence and argumentation**

Trabzon sonorants and velars:

- In traditional Eastern Anatolia, /e–æ/ is phonemic (as e.g. Azerbaijani); in Trabzon, Brendemoen (2002: 53, 55) describes an ongoing **merger to /i/ between phonemic /e/ and /i/, unless blocked by following /ɾ l ɣ ŋ/** (= liquids + dorsals?), with further free variation between **[e]** and **[æ]** in pre-sonorant and pre-velar positions **/ɾ l k ɣ ŋ n/ excl. /m/**

	Standard	*Trabzon*		*Standard*	*Trabzon*
‘male’	/eɾkek/	[eɾkek ~ eɾkik]	‘come.DIR.PST.3SG’	/geldi/	[gældi]
‘many’	/køp/	[kep ~ kip]	‘going.AOR.SIMUL’	/gideɾken/	[gidæɾgæn]
‘do/reach’	/et/	[et ~ it]	‘similar’	/benzeɾ/	[bænzeɾ]
‘come’	/gel/	[kel, *kil]	‘1SG’	/ben/	[bæn]
‘saddle’	/ejeɾ/	[ezeɾ, *eziɾ]	‘food’	/jemek/	[jemæk]

Some guesswork

- This sample is a **limited window** into the variation that exists in Turkish
- Exploring the trajectory of change and the historical context for innovation is necessarily reliant on **other strands of evidence and argumentation**

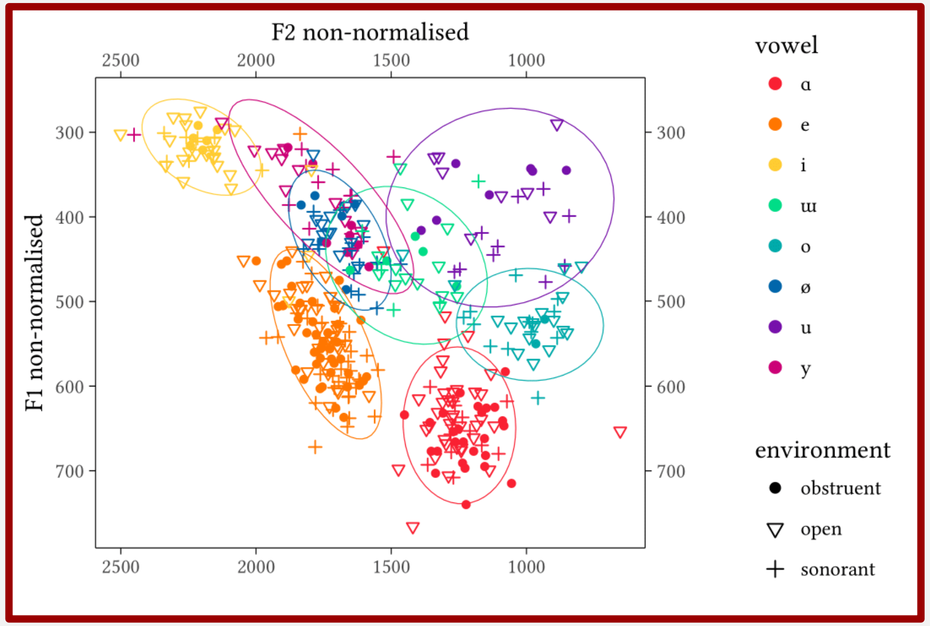
If we take all these data as read, then the **attested space of variation is slightly expanded**:

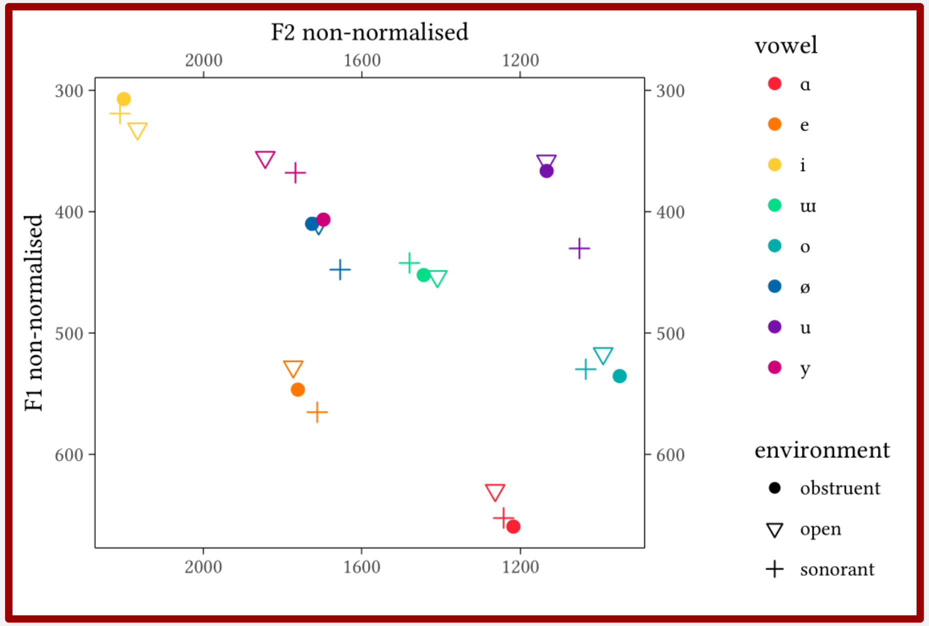
Dialect	*Rule type*	*Triggers*
Trabzon (NE Anatolia)	/e/–[i] blocked, /e/–[æ] promoted	/ɾ, l, ŋ, ɣ/ block; /ɾ, l, k, ɣ, n, ŋ/ cause
General Eastern Anatolia	/e, æ/ have phonemic status	—
Western Anatolia	/e/–[æ] allophony	/ɾ/
“Standard” Turkish	/e/–[æ], /ø/-[œ] allophony	/ɾ, l, m, n/

Some guesswork

- This sample is a **limited window** into the variation that exists in Turkish
- Exploring the trajectory of change and the historical context for innovation is necessarily reliant on **other strands of evidence and argumentation**

Data for one divergent speaker: single speaker from Kars (M03), excluded from overall analysis, shows a bit of spread in the realisations of /e/ and **some statistically significant pre-rhotic lowering** (F1 increase of 53.33 ± 15.68 Hz, $F(1,115) = 7.353$, $p < 0.008$) but **not the same system**



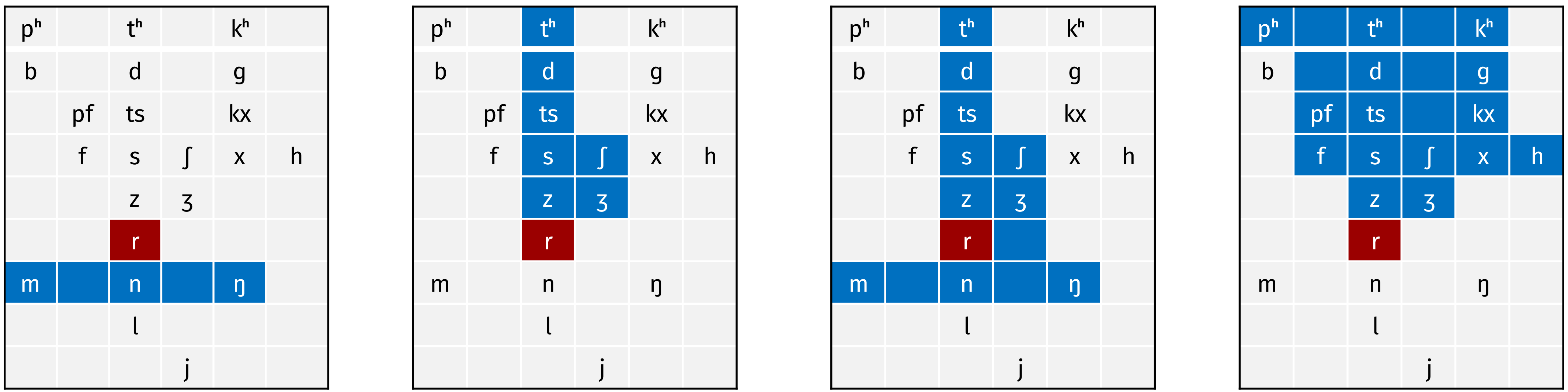


Some guesswork

- A range of patterns in closely-related varieties, are **united** essentially only by the **involvement of the rhotic** which is also the most unambiguously phonetically-good environment for a process of this type
- **The disunity across systems would appear then to essentially be emergent from phonologisation itself:**
  - In asking the question of what happened in Turkish, we are implicitly also asking why it is that the process of phonologisation produced a particular rule, within a particular domain, in the standard variety, a different set of environments in the Trabzon variety and did not generalise beyond the rhotic elsewhere?
  - Both the standard and Trabzon varieties have something which seems phonological, involves **an active class mixing sonorants and obstruents** but **does not necessarily respect phonetic cues**

Generalisation

- A **high degree of phonological variation** exists in the German dialects of north-eastern Switzerland, with phonological systems differing from ‘one village to the next in the same sub-dialect of a single canton’ (Keel 1982)
- In the Swiss German varieties of **Schaffhausen**, an assumed historical rule **lowering pre-rhotic [o] to [ɔ]** has undergone generalisation in various ways:



Generalisation

- In Georgian, syncope occurs in **/VCV(C)/** sequences if the intervening **/C/** is **/m, n, l, r, v/**, optionally also extended to **/b/** (Butskhrikidze & van der Weijer 2001, Butskhrikidze 2002)

/mercxal-is/	[mercxlis]	‘swallow-GEN’
/t’omara-it/	[t’omrit]	‘sack-INST’
/ʃvel-is/	[ʃvlis]	‘deer-GEN’
/bal-eb-i/	[blebi]	‘cherry-PL-NOM’
/xed-av-a/	[xedva]	‘see-TH-INF’
/k’ak’ab-is/	[k’ak’bis]	‘partridge-GEN’
/xoxob-is/	[xoxbis]	‘pheasant-GEN’

Generalisation

- Both Schaffhausen /o/-lowering and the Georgian vowel syncope **apply in environments which are supersets of some "sensible" set of environments**, with respect to both phonetic grounding and natural class behaviour
- It appears that **Turkish mid-vowel lowering works the same way**:
  - Driven by an initial, functionally-grounded and well-motivated effect of a rhotic on a preceding vowel
  - Subsequent extension over the set of mid vowel undergoers and the full consonantal inventory of the language, proceeding according to similarity to the initial trigger
    - ☞ /l/ is therefore a fairly "good" trigger, though very bad phonetically

Poets' corner:

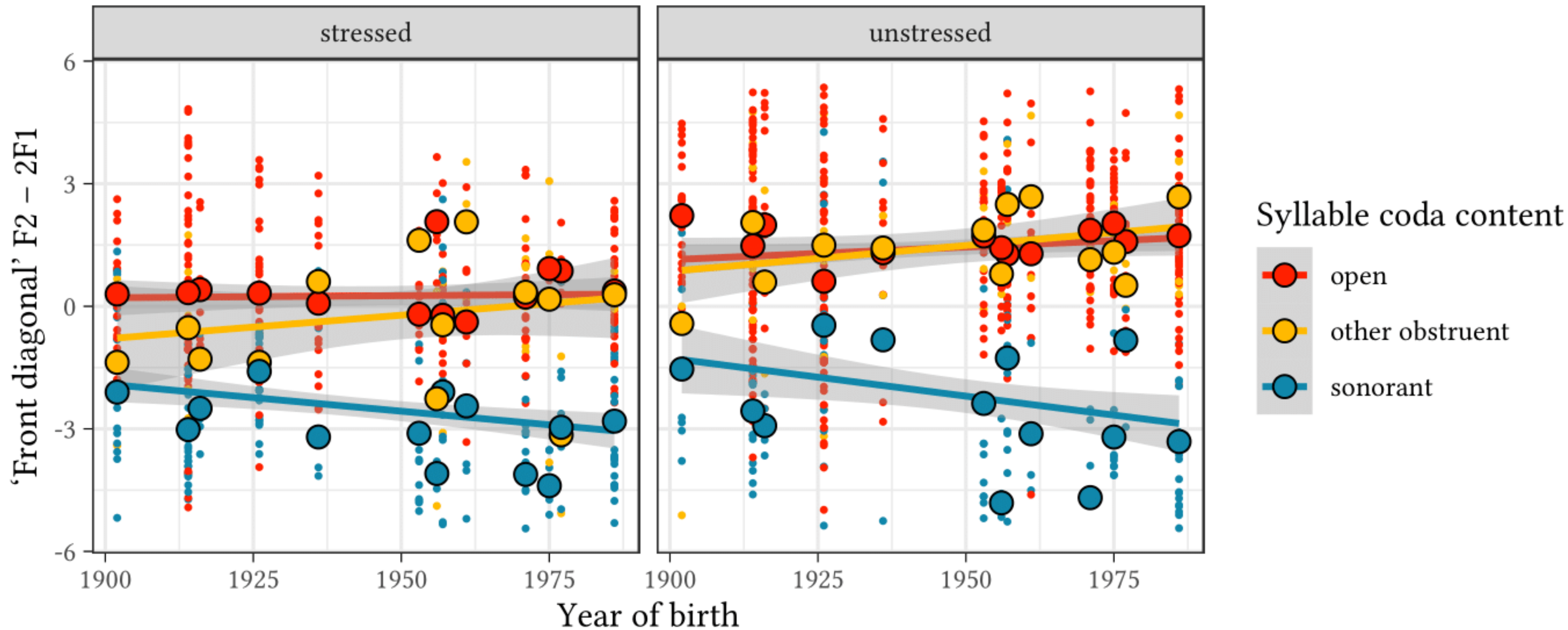
Towards better apparent-time data

Improved diachronic predictions?

- We should be able to do better than guesswork when it comes to diachrony
- **Recent development:**
  - Corpus consisting of 24 Turkish speakers, 19 male and 5 female
  - Recordings of poets reading their own work from `lyrikline.org`
  - Speakers are public figures and so birthyear and place of origin are available
  - Year of birth ranges from 1902 to 1986 (median 1957); very different from our existing data
  - 276 minutes of continuous speech, with median of 10 minutes per speaker
  - 12,630 tokens of **/e/** in all (3,270 before tautosyllabic sonorants, 1,812 before tautosyllabic obstruents, 7,548 in open syllables)

Preliminary data

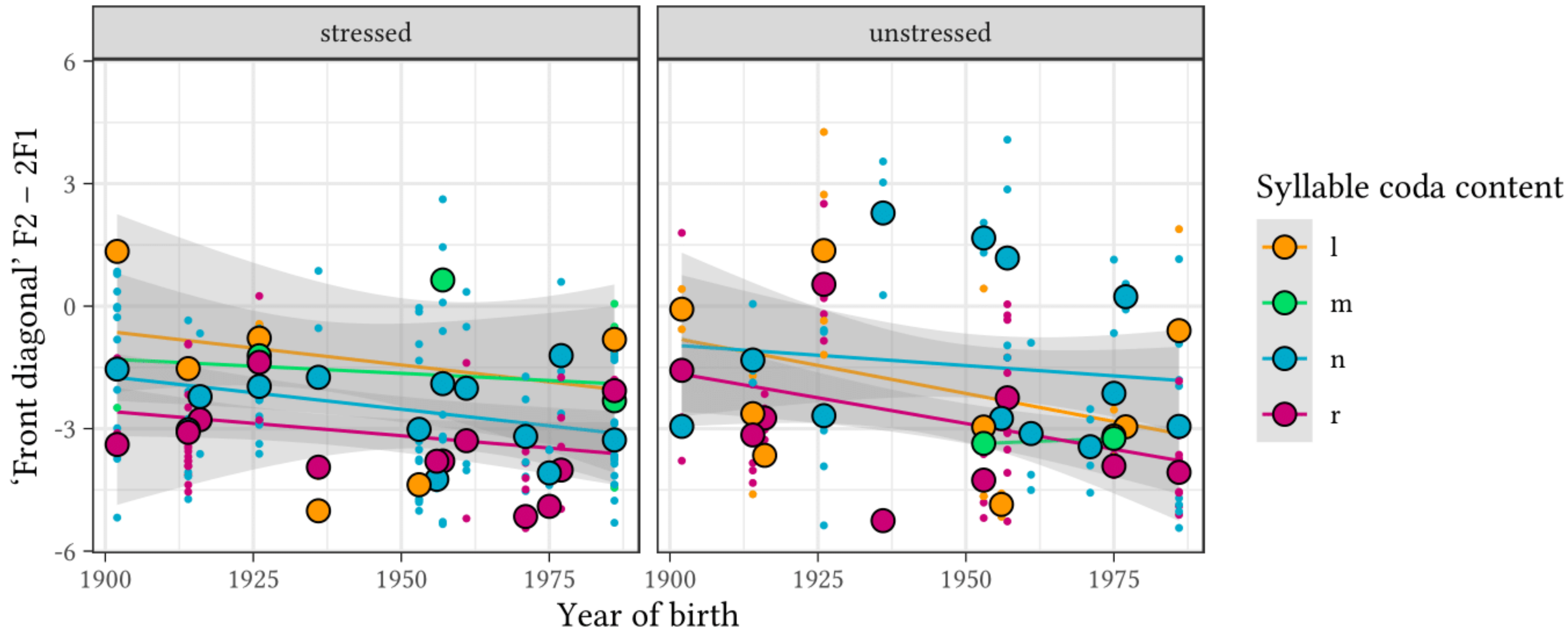
Apparent-time change in the "front diagonal" (F2 – 2 × F1) for /e/ by coda category (14 male speakers)



- This already shows a clear change in apparent time, with **pre-obstruent and open-syllable realisations diverging from pre-sonorant ones**
- Would also seems to support the hypothesis that there has been a **transition from raising in open (stressed?) syllables** to a system where **lowering is condition by coda type**

Preliminary data

Apparent-time change in the "front diagonal" (F2 – 2 × F1) for /e/ by coda sonorant (14 male speakers)



- So far, there are **no statistically significant differences between the individual coda sonorants** (despite the apparent tendency shown by the trend line in this plot)

Summary

Summary

- Empirical evidence for the generalisation that the Turkish front mid vowels **/e, ø/** are subject to lowering conditioned at least by **/r, l, m, n/**
  - /e/ shows a much more **discontinuous and categorical-seeming distribution in phonetic space**, is subject to a larger set of **exceptions** and **lacks individual-segment conditioning**
  - Plausible that the "initial" state of the Turkish system most closely resembled the synchronic state of unstressed **/ø/** in which a process of raising in unstressed open syllables interacts with phonetically-driven, gradient lowering triggered by the rhotic
  - The involvement of palatalised **/l/** is not predicted by phonetics
  - Generalisation to **/z/** seems to be well underway (and is discontinuous)

Summary

- Differences in categoricity and continuity, dependence on trigger and sensitivity to lexical and prosodic effects suggest that **/ø/ is behind /e/ in the process of rule-generalisation**
- The persistence of small-scale effects in the rhotic, the relevance of the rhotic to the state of rules in non-standard varieties and the existence of phonetic effects targeting pre-rhotic vowels in varieties that show no categorical phonological rule suggest a **diachronic pathway involving successive generalisations from a functionally-motivated rhotic precursor**
- There is also evidence of a **transition** from a stress-based to a coda-type-dependent system of allophony

Teşekkür ederim!

Appendix: Metadata

Production-study speaker metadata

ID	Birthyear	Place of origin
F01	1997	İstanbul
F02	1995	İstanbul
F03	1991	İstanbul
F04	1988	İzmir
F05	1987	İstanbul
F06	1985	Fethiye
F07	1983	Bursa
F08	1982	Ankara
F09	1981	İstanbul
F10	1980	Ankara
F11	1978	Ankara
M01	1989	Kayseri
M02	1985	Denizli
M03	1980	Kars

Corpus-study speaker metadata

Name	Gender	Birthyear	Birthplace
Metin Celâl	M	1961	Ankara
Neslihan Yalman	F	1982	Ankara
Metin Cengiz	M	1953	Ardahan
Gonca Özmen	F	1982	Burdur
Reha Yünlüel	M	1967	Edremit
Refik Durbaş	M	1944	Erzurum
Oktay Taftali	M	1958	Erzurum
Haydar Ergülen	M	1956	Eskişehir
Adnan Özer	M	1957	Gazioğlu/Tekirdağ
Tugrul Tanyol	M	1953	İstanbul
Hilmi Yavuz	M	1936	İstanbul
Orhan Veli	M	1915	İstanbul

Name	Gender	Birthyear	Birthplace
Kaan Koç	M	1986	İstanbul
Can Yücel	M	1926	İstanbul
Behçet Necatigil	M	1916	İstanbul
Gökçenur Çelebioğlu	M	1971	İstanbul
Onur Behramoğlu	M	1975	İstanbul
Nilay Özer	F	1976	İstanbul
Efe Duyan	M	1981	İstanbul
Müesser Yeniay	F	1984	İzmir
Mehmet Altun	M	1977	Kars
Nazim Hikmet	M	1902	Thessaloniki
Oktay Rifat	M	1914	Trabzon
Gülten Akin	F	1933	Yozgat