When is vowel reduction (not) about predictability?

Deepthi Gopal[1], *Stephen Nichols*[2], *Pavel Iosad*[2], *László Károly*[1]

[1]Uppsala University, [2]University of Edinburgh

15 January 2025

The problem

- A few ways to look at vowel reduction (whatever that is).
  - Vowel reduction is driven by prosodic strength: the further away from a prominent position, the more likely reduction is.
  - Vowel reduction is a consequence of predictability; the more predictable a segment is, the less information is lost if that segment is reduced.
  - Vowel reduction is just duration-driven undershoot in the vein of Lindblom (1963), none of which precludes:
  - Vowel reduction is a driver of / precursor to sound change: all things being equal, the loss of information in the signal should promote reanalysis. This results in, for example, the phonologisation of vowel harmony. (Ohala 1994; Flemming 1997)
- All of this should be interesting to those of us concerned with the mechanisms by which phonological change takes place.

The problem

- Several versions of a connection between vowel reduction and vowel harmony have been drawn in the literature.
  - Pearce (2008, 2012) claims that vowel harmony (VH) in Kera (Chadic) blocks vowel reduction, with harmonic vowels resisting VR where non-harmonic vowels do not.
  - The inverse claim is made by McCollum (2020) for the Turkic language Kyrgyz:
    - In Kyrgyz, non-initial vowels are consistently more centralised than their initial-syllable counterparts.
    - McCollum's argument is that this is driven by *predictability*: since backness and rounding harmony entirely determine the quality of a vowel in a non-initial syllable, reduction is minimally information-destroying and therefore favourable.
  - Both framings essentially assume that we can read causality off synchronic facts (/synchronic correlations between properties) in some way.

The problem

In fact, there are plenty of explicit claims about the (directionality of the) diachronic relationship between vowel reduction and vowel harmony.

- On the one hand, if VR = predictability, and VH ⇒ predictability, then VH ⇒ VR; and even VH ⇒ VR ⇒ harmony decay.
  - McCollum (2020) claims exactly this, after Binnick (1991); McCollum (2019) finds larger reduction in Uzbek, which has lost VH almost entirely, than in Kyrgyz which retains it.
  - This link between phonetic reduction and the loss of harmony has been drawn for several cases (Binnick 1991; Shiraishi & Botma 2017; Li 1996).

The problem

In fact, there are plenty of explicit claims about the (directionality of the) diachronic relationship between vowel reduction and vowel harmony.

- At the same time, coarticulation + reduction have been implicated in the phonologisation of VH (Hyman 2002).
  - Especially left-to-right VH, according to Hyman.
  -
- And there is no reason not to think that even after the instantiation of the categorical, phonological process, the gradient phonetic reduction that triggered phonologisation in the first place should be able to stick around (and see the *rule scattering* of Bermúdez-Otero 2007: 506, e.g.).

Negative evidence

- So if we observe, empirically, vowel reduction in a vowel harmony language, what are the possible explanations for how it got there and what it's getting up to?

Negative evidence

- So if we observe, empirically, vowel reduction in a vowel harmony language, what are the possible explanations for how it got there and what it's getting up to?
  - Vowel reduction is a precursor. Phonetic reduction gave rise to phonological harmony, and then stuck around.
    - This may be relatively recent or relatively old; problem of *stability*! ≈ vowel reduction persists in language A because it was present in an ancestral state, without reference to a causal relationship to VH.
  - Vowel reduction arises due to universal phonetic pressures. Nothing to do with VH at all, but also nothing to do with ancestral states e.g.
  - Vowel reduction is a signal of change in progress, or of recent change. If VR, predict VH loss(, or recent innovation of VH?).
  - Vowel reduction is a mechanical consequence of vowel harmony.
- And how do we disambiguate between these?

Negative evidence

- So if we observe, empirically, vowel reduction in a vowel harmony language, what are the possible explanations for how it got there and what it's getting up to?
  - Vowel reduction is a precursor. Phonetic reduction gave rise to phonological harmony, and then stuck around.
    - This may be relatively recent or relatively old; problem of *stability*! ≈ vowel reduction persists in language A because it was present in an ancestral state, without reference to a causal relationship to VH.
  - Vowel reduction arises due to universal phonetic pressures. Nothing to do with VH at all, but also nothing to do with ancestral states e.g.
  - Vowel reduction is a signal of change in progress, or of recent change. If VR, predict VH loss(, or recent innovation of VH?).
  - Vowel reduction is a mechanical consequence of vowel harmony.
- And how do we disambiguate between these? Recapitulates classic problems e.g. inheritance vs. parallel innovation. Or even more cheekily, where does diachrony end and synchrony begin?

Negative evidence

- Part of this disambiguatory problem is amenable to the comparative solution
- We look at a set of closely related varieties with the dual aim of

Negative evidence

- Part of this disambiguatory problem is amenable to the comparative solution
- We look at a set of closely related varieties with the dual aim of
    - Establishing the parameters of synchronic typological variation: what is possible?

Negative evidence

- Part of this disambiguatory problem is amenable to the comparative solution
- We look at a set of closely related varieties with the dual aim of
  - Establishing the parameters of synchronic typological variation: what is possible?
  - Developing a typology of diachronic trajectories: do outcomes correlate with synchronic patterning?

The Turkic languages

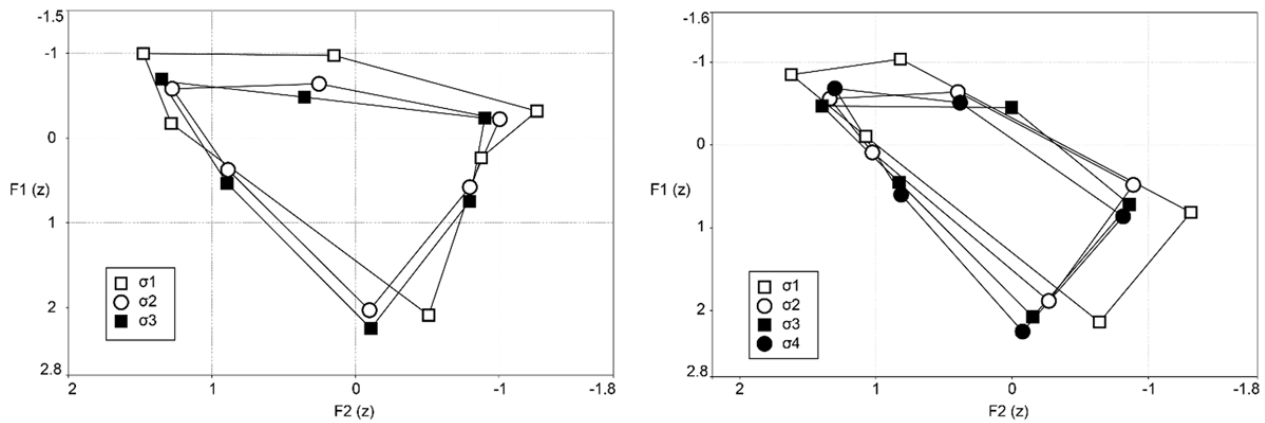
The languages under consideration.

The Turkic languages

- Well-known for generally robust backness harmony (save only Uzbek), and slightly-less-robust rounding harmony.
- Save a few members of the family, not well-known in themselves.
- **Centralisation** of the vowel space reported for several Turkic languages: Kyrgyz (McCollum 2020), Tatar (Conklin & Dmitrieva 2018), Uyghur (McCollum, Durvasula & Abudushalamu 2024), Sakha Chan & Kuang (2023); with or without attendant reports of harmony decay.

The Turkic languages

- Well-known for generally robust backness harmony (save only Uzbek), and slightly-less-robust rounding harmony.
- Save a few members of the family, not well-known in themselves.
- **Centralisation** of the vowel space reported for several Turkic languages: Kyrgyz (McCollum 2020), Tatar (Conklin & Dmitrieva 2018), Uyghur (McCollum, Durvasula & Abudushalamu 2024), Sakha Chan & Kuang (2023); with or without attendant reports of harmony decay.



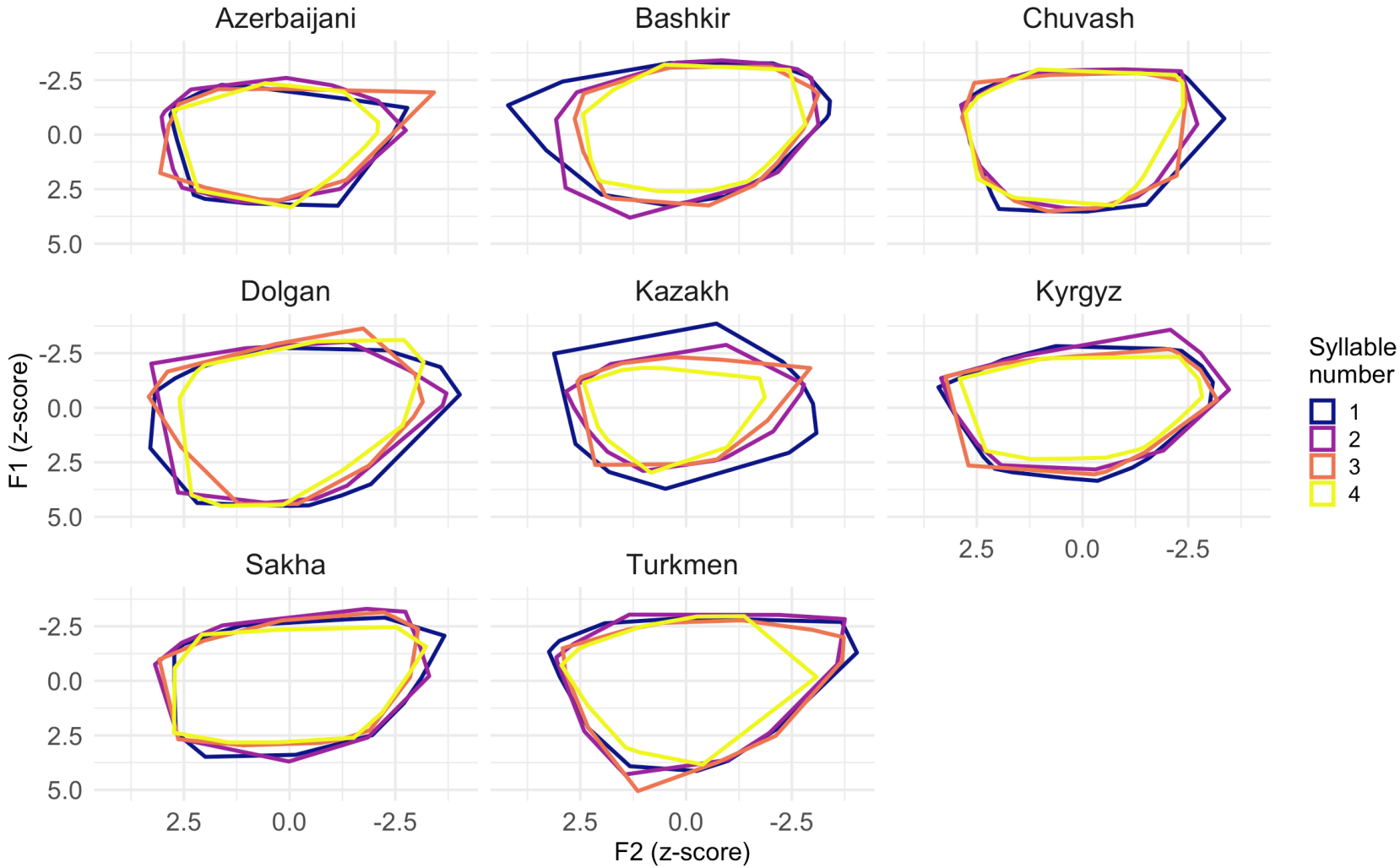
McCollum (2020): Vowel reduction in Kyrgyz.

The data

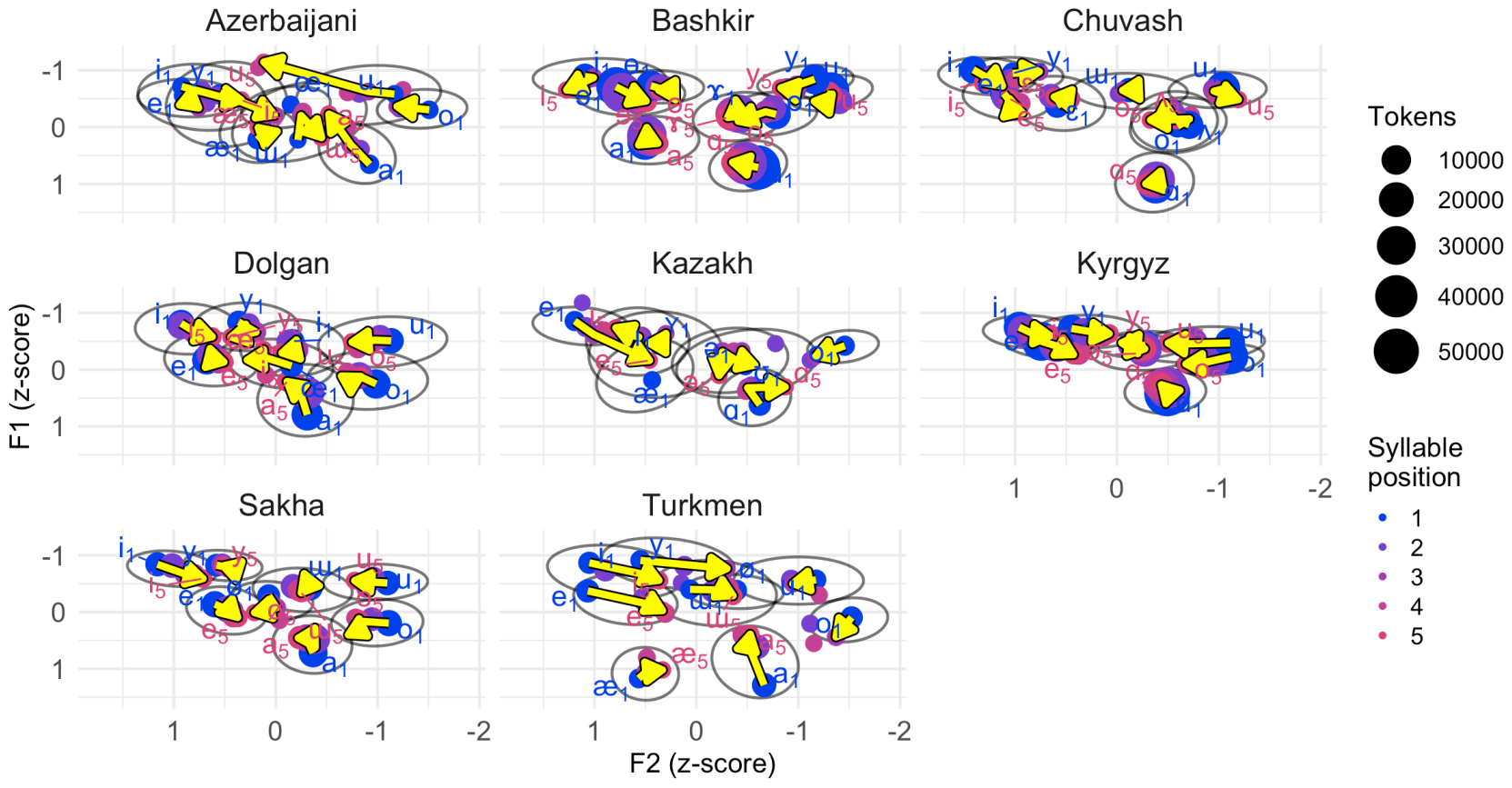
- We use two datasets:
  - 1,340,918 vowel tokens extracted from the 'validated' subsets of the Mozilla Common Voice corpora (Ardila, et al. 2020) of Azerbaijani (27 speakers, 2 hours), Bashkir (177 speakers, 230 hours), Chuvash (108 speakers, 120 hours), Kazakh (140 speakers, 2.2 hours), Kyrgyz (251 speakers, 35 hours), and Turkmen (70 speakers, 2.8 hours), and from the INEL corpus of Dolgan (48 speakers, 12 hours) (Däbritz, Kudryakova & Stapert 2022; Däbritz 2020), all segmented using the Montreal Forced Aligner.
  - 32,641 vowel tokens extracted from a 'mini-corpus' of read texts (2.5 hours total) collected by Károly (2022), covering 24 of the Turkic languages with one speaker each; for these data points, segmentation was manually-corrected.

The data

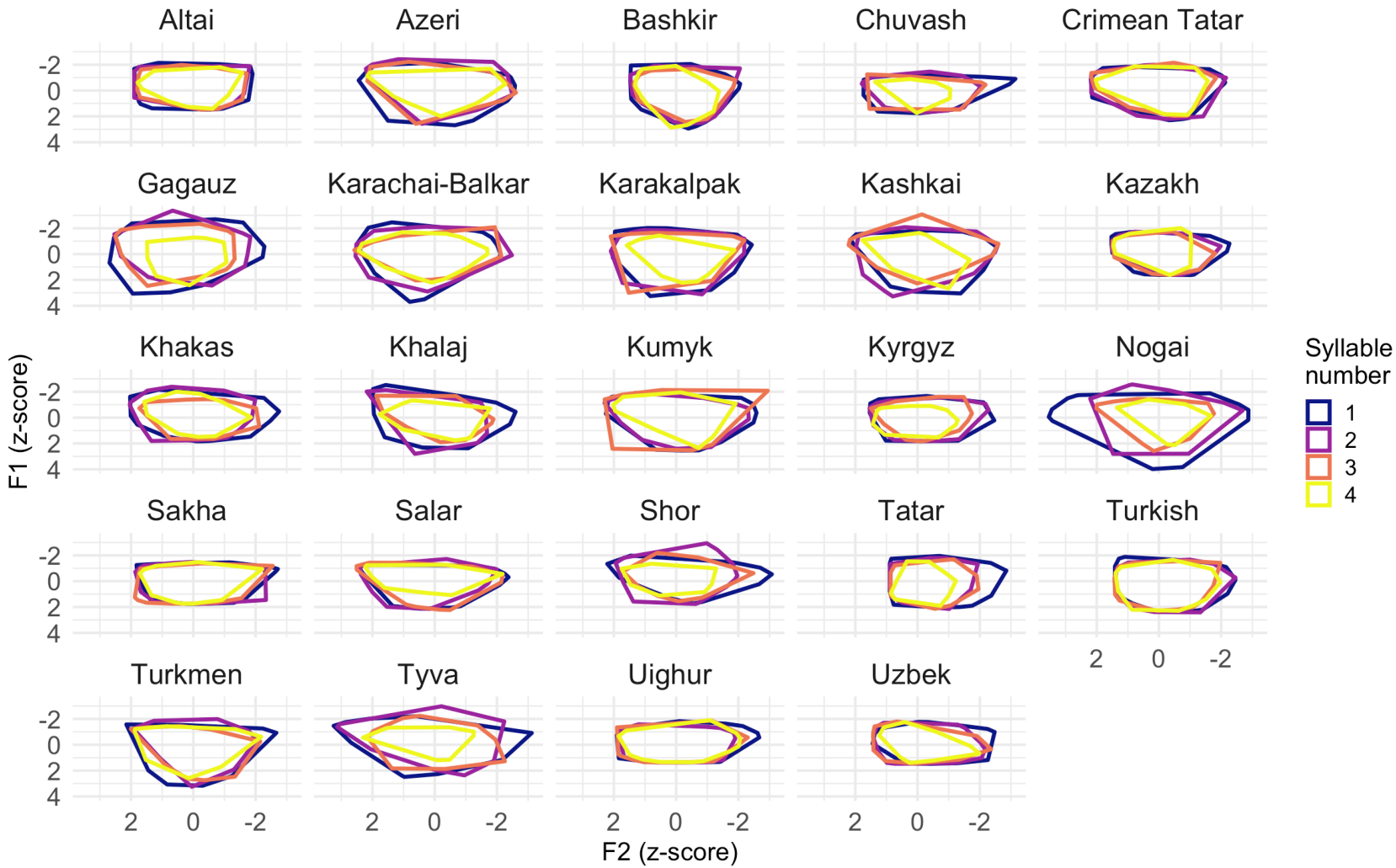
- For all data, F0, F1, F2, and F3 taken at three points (25%, 50%, 75%), and tokens coded for vowel type (phonemic length, rounding, fronting, and height), position within the word, and root vs. affix status where inferrable.



F1 × F2 space for short monophthongs in 8 Turkic languages (Common Voice), showing polygons corresponding to the total spread of the data in each syllable.



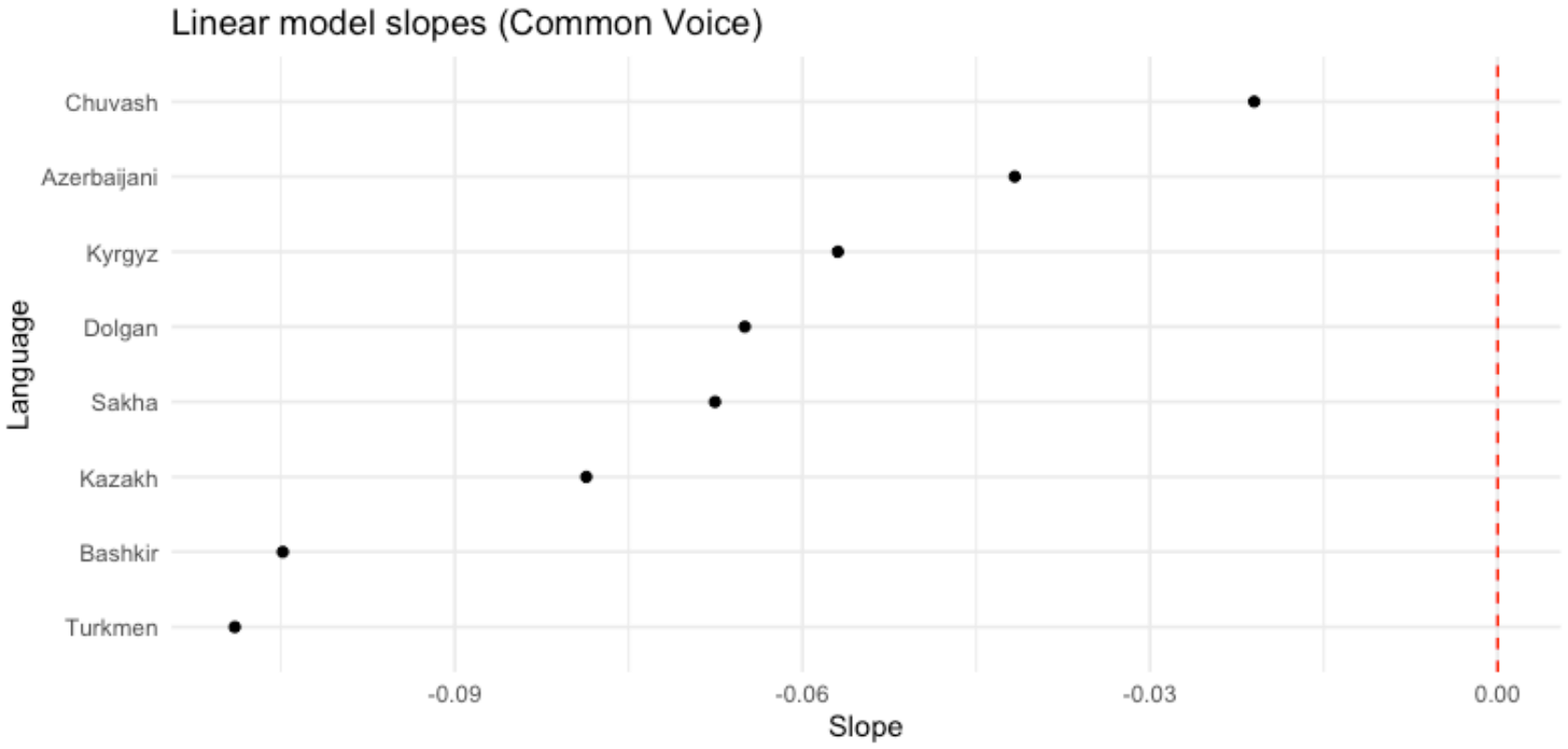
F1 × F2 space for short monophthongs in 8 Turkic languages (Common Voice), showing ellipses corresponding to 50% of the total spread of the data, and points corresponding to the median F1-F2 values by category and syllable number; arrows indicate the magnitude and direction of change in F1 × F2 space between syllables 1 and 5.

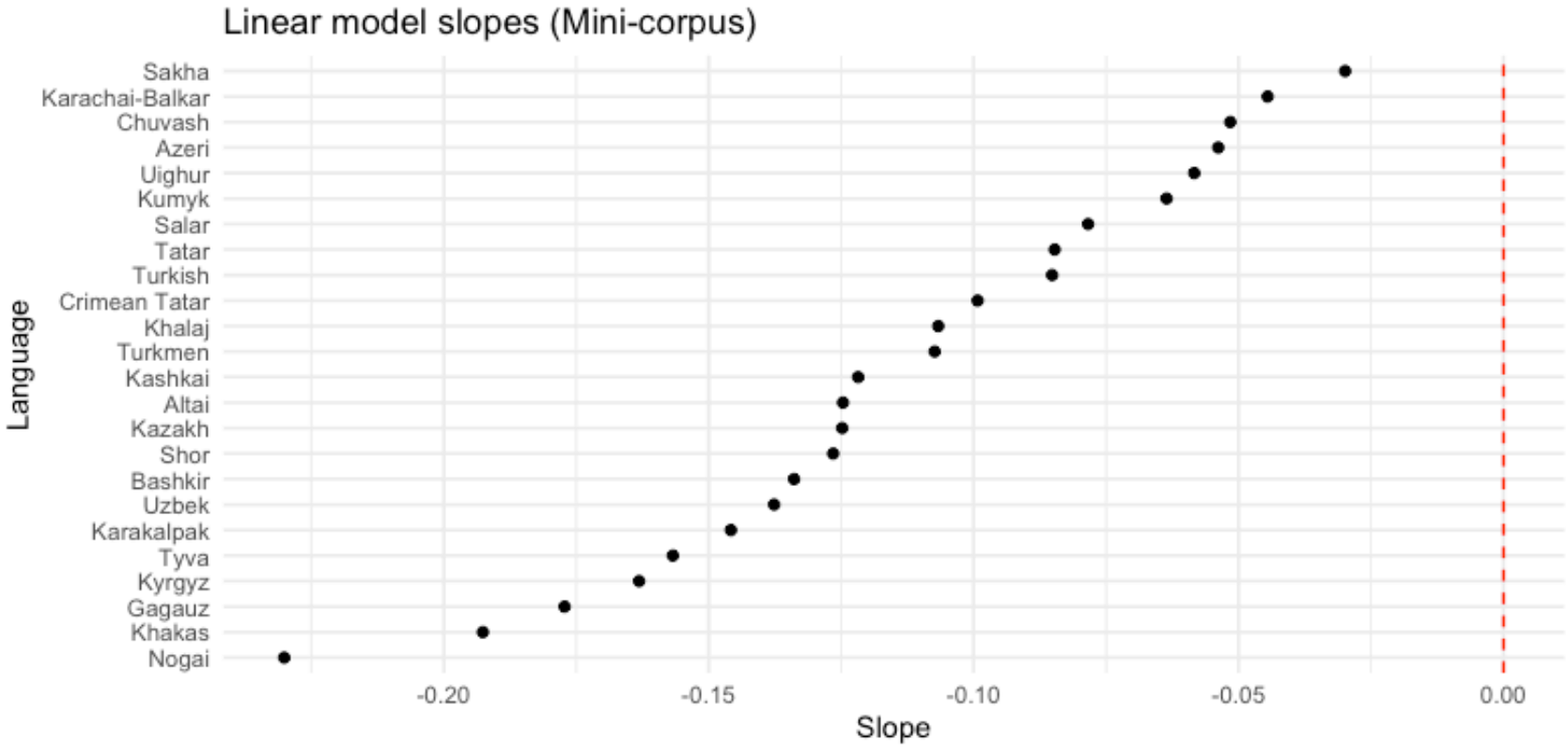


F1 × F2 space for short monophthongs in 24 Turkic languages, showing polygons corresponding to the total spread of the data in each syllable.

The data

- A quick and slightly dirty way to try to quantify ‘centralisation’:
  - For each language, a centroid was calculated as the speaker-weighted mean of (normalised) F1 and F2 across all vowel tokens in word-initial syllables; this represents the centre of the vowel space, under the presumption that syllable 1 contains the least reduced vowels. Euclidean distance then taken between the centroid and each token.
  - Two linear mixed-effects regressions were fit (one per corpus) predicting distance from the centroid as a function of syllable number, with vowel identity as a covariate. The models included random intercepts and slopes for language, and random intercepts for speaker for the Common Voice corpus (but not for the ‘mini-corpus’).
  - Slope sign corresponds to centralisation (negative slope $\rightarrow$ distance from centre decreases rightward in the word), we hope.


Linear model slopes (Common Voice)
Chuvash
Azerbaijani
Kyrgyz
Dolgan
Sakha
Kazakh
Bashkir
Turkmen
Language
-0.09
-0.06
-0.03
0.00
Slope


Linear model slopes (Mini-corpus)
Language
Sakha
Karachai-Balkar
Chuvash
Azeri
Uighur
Kumyk
Salar
Tatar
Turkish
Crimean Tatar
Khalaj
Turkmen
Kashkai
Altai
Kazakh
Shor
Bashkir
Uzbek
Karakalpak
Tyva
Kyrgyz
Gagauz
Khakas
Nogai
-0.20
-0.15
-0.10
-0.05
0.00
Slope


Dolgan
Sakha
RUSSIAN FEDERATION
Chuvash
Tatar
Khakas
Shor
Tyva
Bashkir
UKRAINE
Kazakh
Altai
Karakalpak
Uighur
Gagauz
Karachai-Balkar
Kyrgyz
Salar
Uzbek
Turkish
Azerbaijani
Turkmen
Khalaj

Negative evidence

- If we want to claim that every one of these languages shows centralisation across the word, what does this mean for the diagnostic value of VR in these languages?
- VH is mostly stable across Turkic despite at least some VR
- A straightforward interpretation is that VR does not necessarily imply harmony loss

Negative evidence

- If we want to claim that every one of these languages shows centralisation across the word, what does this mean for the diagnostic value of VR in these languages?
- VH is mostly stable across Turkic despite at least some VR
- A straightforward interpretation is that VR does not necessarily imply harmony loss
- Less clear what (if anything) this means for the phonologisation of harmony
- Tentatively, if reduction postdates Common Turkic, then harmony is not diachronically contingent on it

Быйан! Təşəkkür edirik! рəхмəт! Пысăк тав сана! сагъ олунъыз!
пасиба! Saa olunuz! Сау бол! Рахмет! !ت ش ك ور Рақмет!
спасиба! Кёп баракалла! Чоң рахмат! Бек савболынъыз!
Махтал! рəхмəт! Teşekkürler! Sagboluň! Четтирдибис! !ره م ه ت
Rahmat!

Supported by Riksbankens Jubileumsfond grant P23-0791 (2024–2027) `The trajectory and distributional typology of phonological change'.

References I

Ardila, Rosana, et al. 2020. Common voice: A massively-multilingual speech corpus. In Nicoletta Calzolari et al. (eds.), *Proceedings of the twelfth language resources and evaluation conference*, 4218–4222. Marseille, France: ELRA. https://aclanthology.org/2020.lrec-1.520/.

Bermúdez-Otero, Ricardo. 2007. Diachronic phonology. In Paul de Lacy (ed.), *The Cambridge handbook of phonology*, 497–517. Cambridge: Cambridge University Press.

Binnick, Robert I. 1991. Vowel harmony loss in Uralic and Altaic. In William G. Boltz & Michael C. Shapiro (eds.), *Studies in the historical phonology of Asian languages* (Current issues in linguistic theory 77), 35–52. Amsterdam: John Benjamins.

Chan, May Pik Yu & Jianjing Kuang. 2023. The acoustics of vowel harmony in Sakha. In Radek Skarnitzl & Jan Volín (eds.), *Proceedings of the 20th International Congress of Phonetic Sciences – ICPhS 2023*, vol. 19 331, 3296–3300. Prague: International Phonetic Association. https://www.internationalphoneticassociation.org/icphs-proceedings/ICPhS2023/full_papers/331.pdf.

Conklin, Jenna & Olga Dmitrieva. 2018. Acoustics of Tatar vowels: Articulation and vowel-to-vowel coarticulation. *Journal of the Acoustical Society of America* 144(3). 1940. doi:10.1121/1.5068486.

Däbritz, Chris Lasse. 2020. The INEL Dolgan corpus: Insights into an endangered language of Northern Eurasia. *Finno-Ugric Languages and Linguistics* 9(1–2). 67–77. http://full.btk.ppke.hu.

Däbritz, Chris Lasse, Nina Kudryakova & Eugénie Stapert. 2022. INEL Dolgan corpus. version 2.0. Archived at University of Hamburg. Publication date 2022-11-30. https://hdl.handle.net/11022/0000-0007-F9A7-4.

Flemming, Edward S. 1997. Phonetic detail in phonology: Towards a unified account of assimilation and coarticulation. In Keiichiro Suzuki & Dirk Elzinga (eds.), *Proceedings of the 1995 southwestern workshop in optimality theory (swot)* Coyote Papers, Tucson, AZ: University of Arizona.

Hyman, Larry M. 2002. Is there a right-to-left bias in vowel harmony? Talk given at the 9th International Phonology Meeting, Vienna, Austria, 1 November. http://www.linguistics.berkeley.edu/~hyman/Hyman_Vienna_VH_paper_forma.pdf.

Károly, László. 2022. *Modern Turkic Languages: An introduction with accompanying audio* (Bibliotheca Turcica 2). Molnar & Kelemen Oriental Publishers.

Li, Bing. 1996. *Tungusic vowel harmony: Description and analysis*: University of Amsterdam PhD thesis.

Lindblom, Björn. 1963. Spectrographic study of vowel reduction. *The Journal of the Acoustical Society of America* 35(11). 1773. doi:10.1121/1.1918816.

McCollum, Adam G. 2019. *Gradience and locality in phonology: Case studies from Turkic vowel harmony*: University of California, San Diego PhD thesis.

References II

McCollum, Adam G. 2020. Vowel harmony and positional variation in Kyrgyz. *Laboratory Phonology* 11(1). 25. 1–28. doi: 10.5334/labphon.247.

McCollum, Adam G., Karthik Durvasula & Xiayimaierdan Abudushalamu. 2024. O gradience, where art thou? Examining backness harmony in Uyghur. Rutgers University and Michigan State University, ms. https://ling.auf.net/lingbuzz/007939.

Ohala, John J. 1994. Towards a universal, phonetically-based, theory of vowel harmony. In *Proceedings of the 3rd international conference on spoken language processing (icslp 94)*, 491–494. Yokohama, Japan.

Pearce, Mary. 2008. Vowel harmony domains and vowel undershoot. *UCL Working Papers in Linguistics* 20. 115–140.

Pearce, Mary. 2012. Effects of harmony on reduction in Kera. *Linguistic Variation* 12(2). 292–320.

Shiraishi, Hidetoshi & Bert Botma. 2017. On the diachronic origin of Nivkh height restrictions. In Geoff Lindsey & Andrew Nevins (eds.), *Sonic signatures*, 201–214. Amsterdam: John Benjamins.