Tongue root advancement and vowel duration: a gradient effect?

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Background

- Correlates of voicing
  - *shorter VOT* (Westbury, 1983; Davidson, 2016; Abramson & Whalen, 2017)
  - *tongue root advancement TRA* (Westbury, 1983; Ohala, 2011)
  - *correlation VOT ~ TRA* (Ahn, 2015)
  - *longer vowel duration* (House & Fairbanks, 1953; Peterson & Lehiste, 1960; Chen, 1970; Klatt, 1973; Lisker, 1974; Fowler, 1992; Lampp & Reklis, 2004)
- Relation between vowel duration and TRA

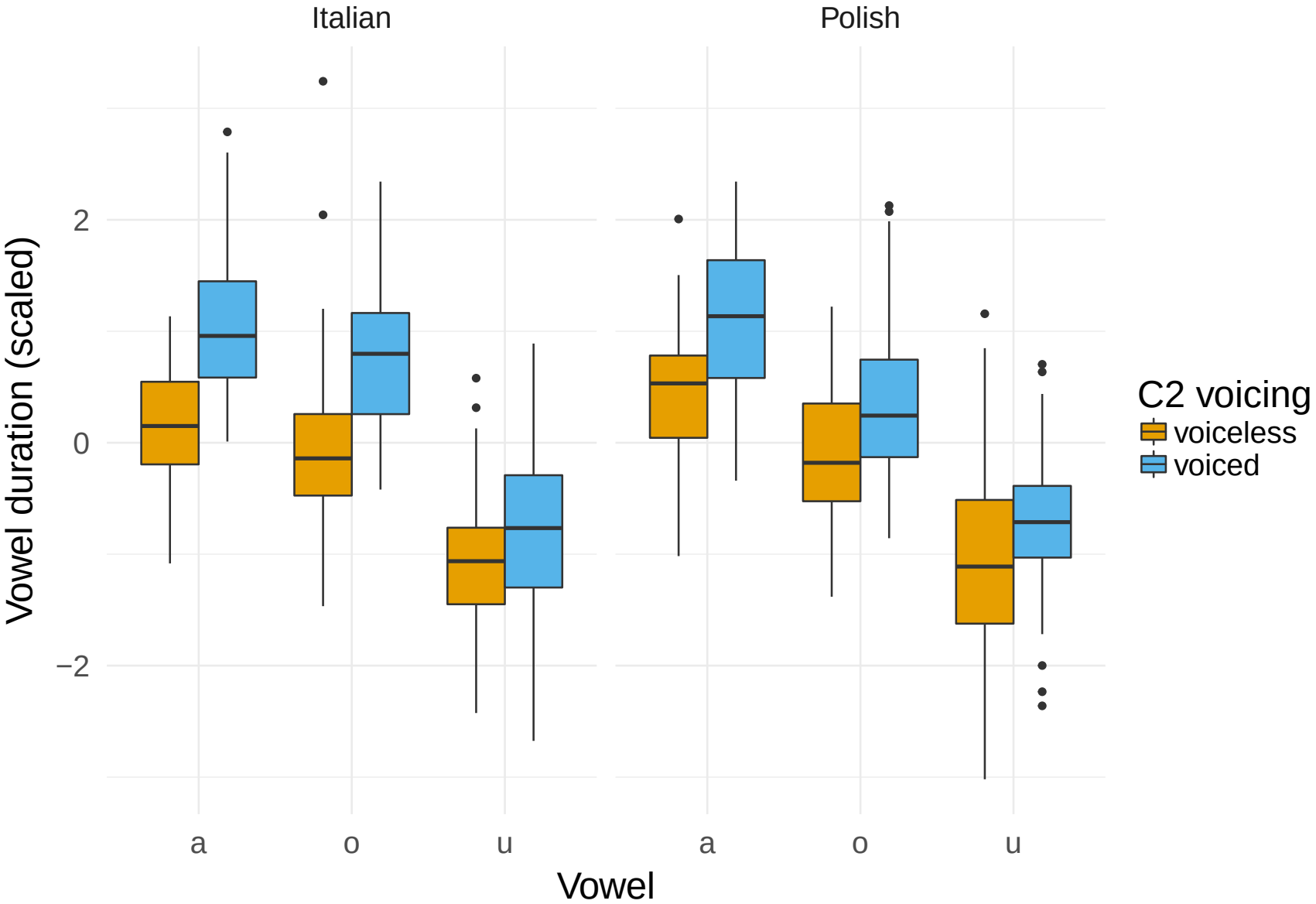
Background

- **Voicing effect** (VE): vowels are longer when followed by voiced stops
  - *Italian*: voicing effect of 35 msec (Farnetani & Kori, 1986)
  - *Polish*: mixed results
    - Keating (1984): no effect
    - Nowak (2006) PhD dissertation: 4.5 msec effect
- **Larger study**: relative timing of laryngeal and lingual activity
  - Simultaneous UTI + EGG + audio
- **This study**: exploratory, data driven

Methods (a summary)

- **Participants**: 4 Italians (2 F, 2 M), 4 Polish (2 F, 2 M)
- **Targets**
  - $C_1V_1C_2V_1$
  - C_1 = /p/, V_1 = /a, o, u/, C_2 = /t, d, k, g/
  - *pata*, *pada*, *paka*, ..., *poto*, *podo*, ...
- **Frame sentence**
  - *Dico X lentamente*, 'I say X slowly'
  - *Mówię X teraz*, 'I say X now'
- **Data**
  - Durational data from acoustics
  - Tongue contours from ultrasound tongue imaging

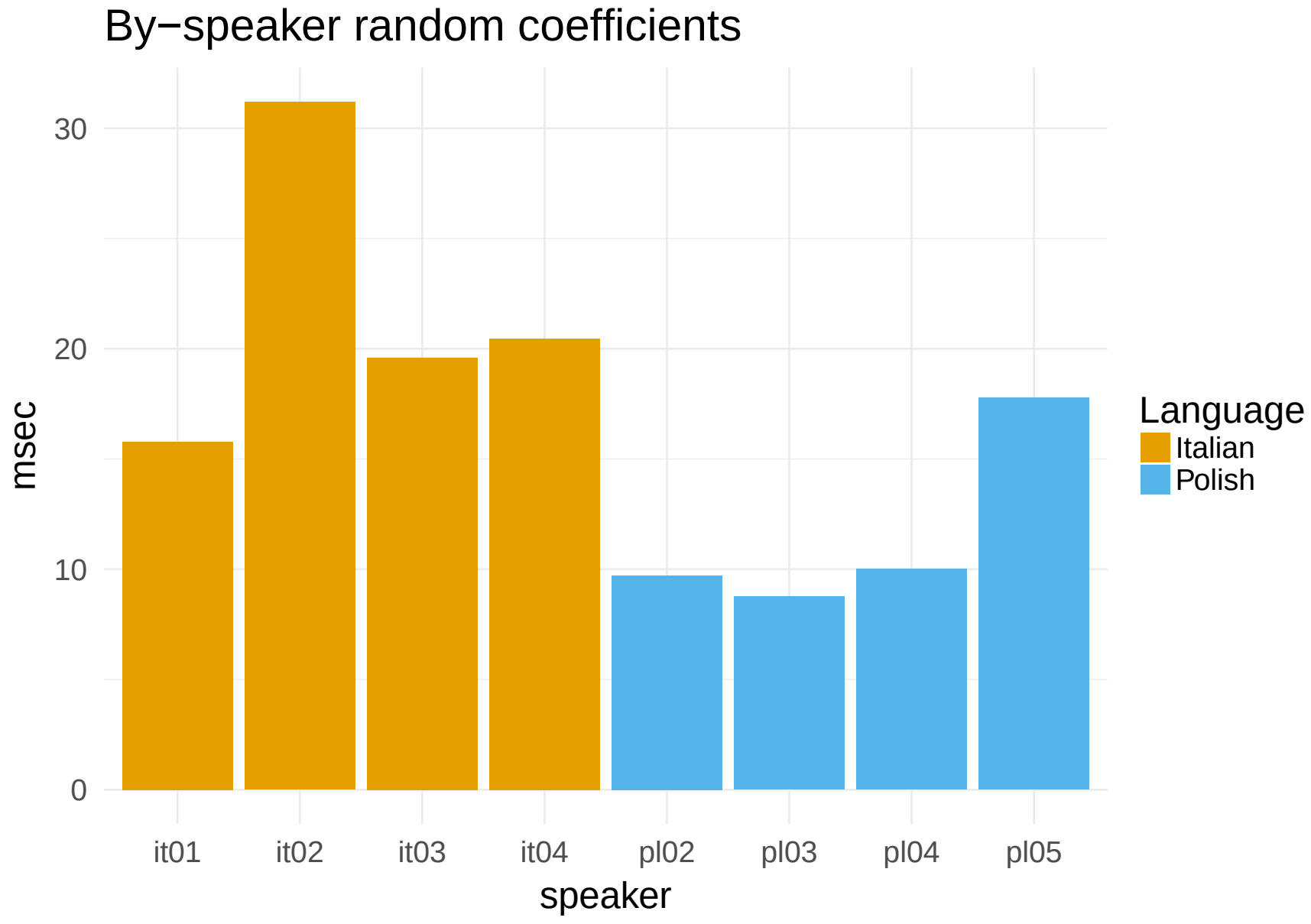
Results: Vowel duration



Results: Vowel duration

- Linear mixed-effects models (Bates et al., 2015; Kuznetsova et al., 2016)
- **Italian**: β = 22 msec, $\chi^2(3)$ = 15.8, p = 0.0012434
- **Polish**: β = 12 msec, $\chi^2(3)$ = 12.39, p = 0.0061556

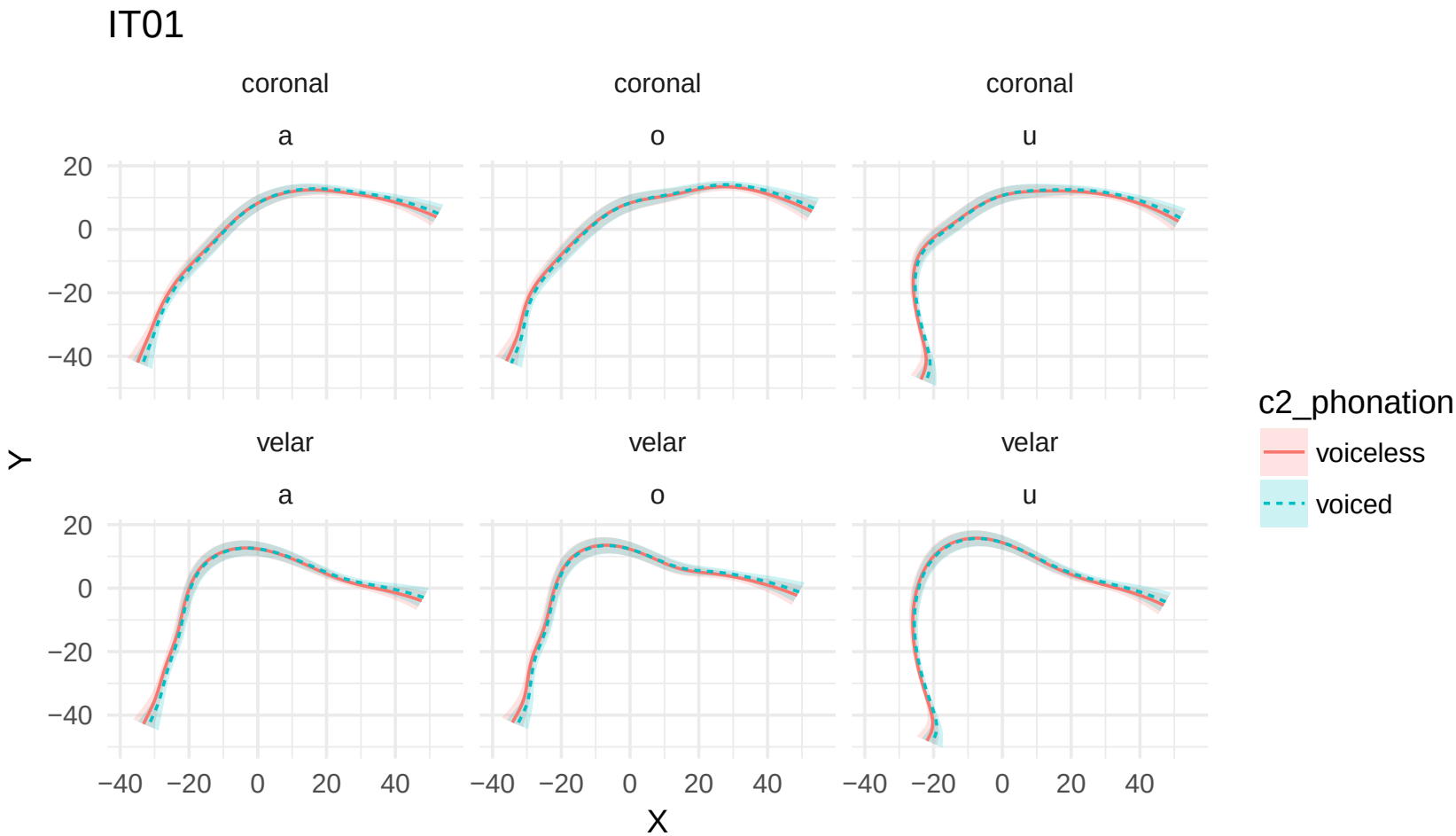
Results: Vowel duration



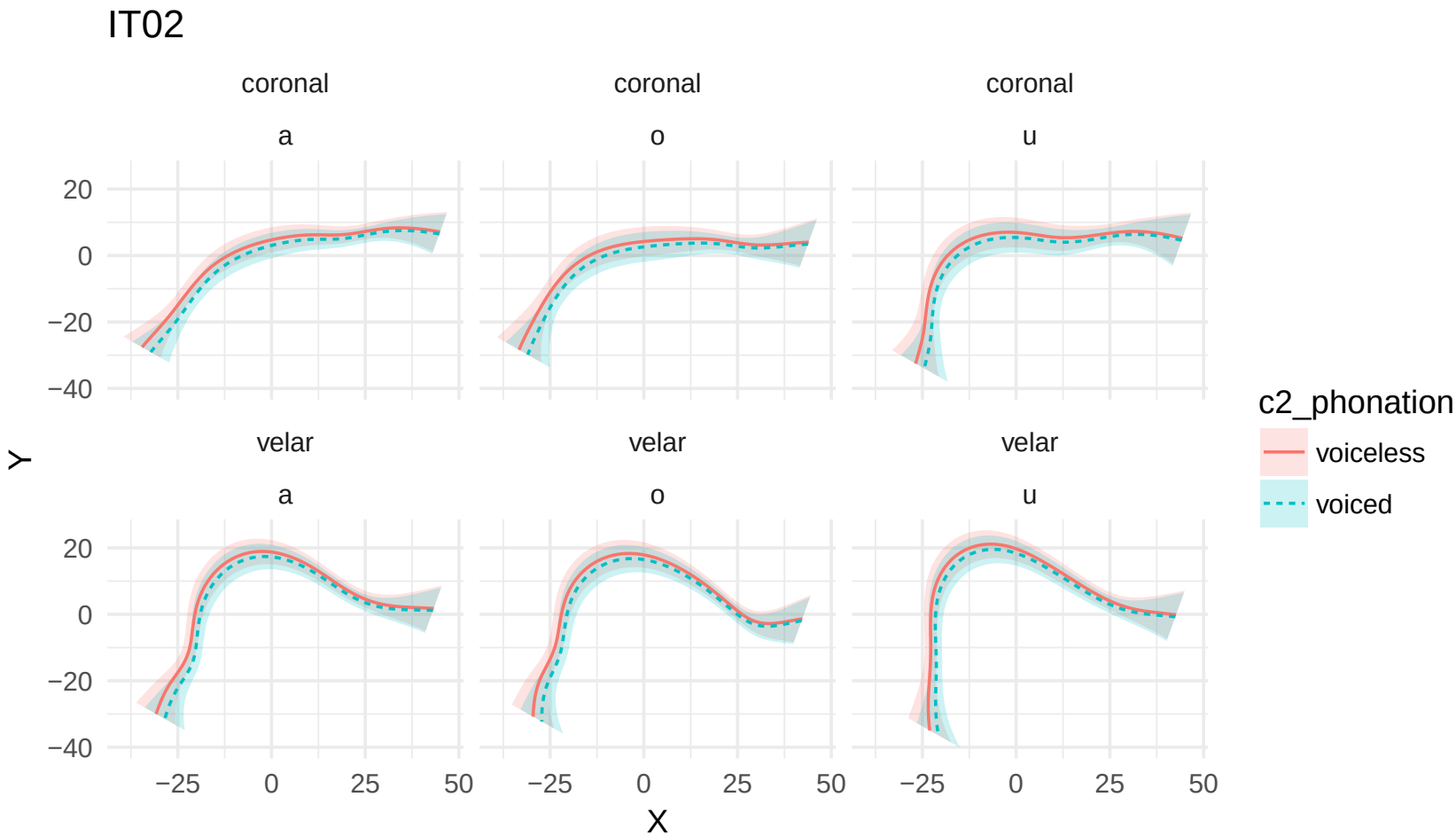
Results: Tongue contours

- **Midsagittal tongue contours**
    - From *within consonant closure* (at maximum tongue displacement, Strycharczuk & Scobbie, 2015), polar coordinates (Heyne & Derrick, 2015b,a; Mielke, 2015)
- **Generalised additive mixed effects models (GAMMs)** (Wood, 2006; Sóskuthy, 2017; van Rij et al., 2017)
- **Polar GAMMs** with the `rticulate` R package (Coretta, 2018a,b)
- **General trends**
    - Idiosyncratic use of TRA
    - 2 speakers with relatively greater TRA

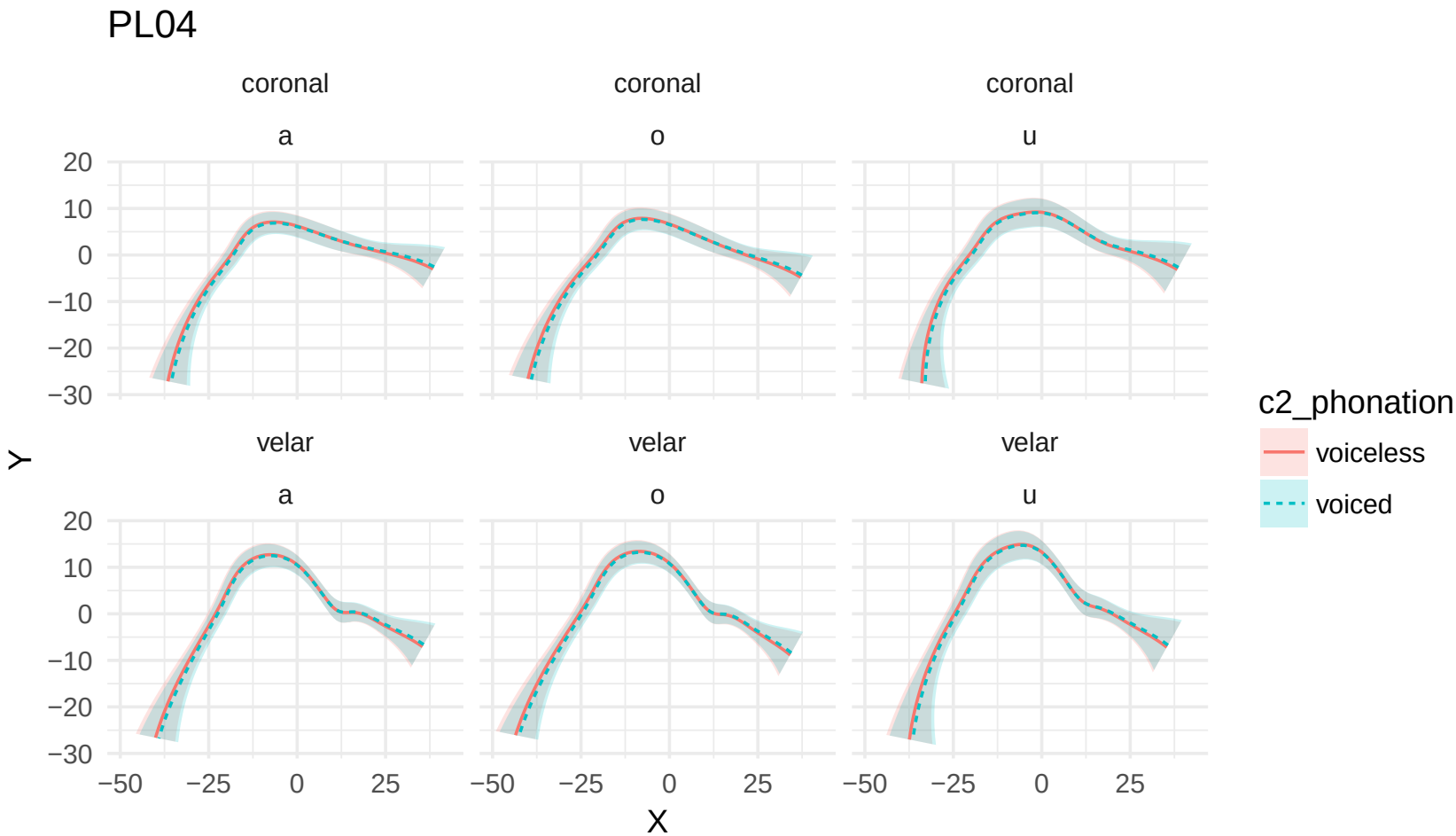
Results: Tongue contours



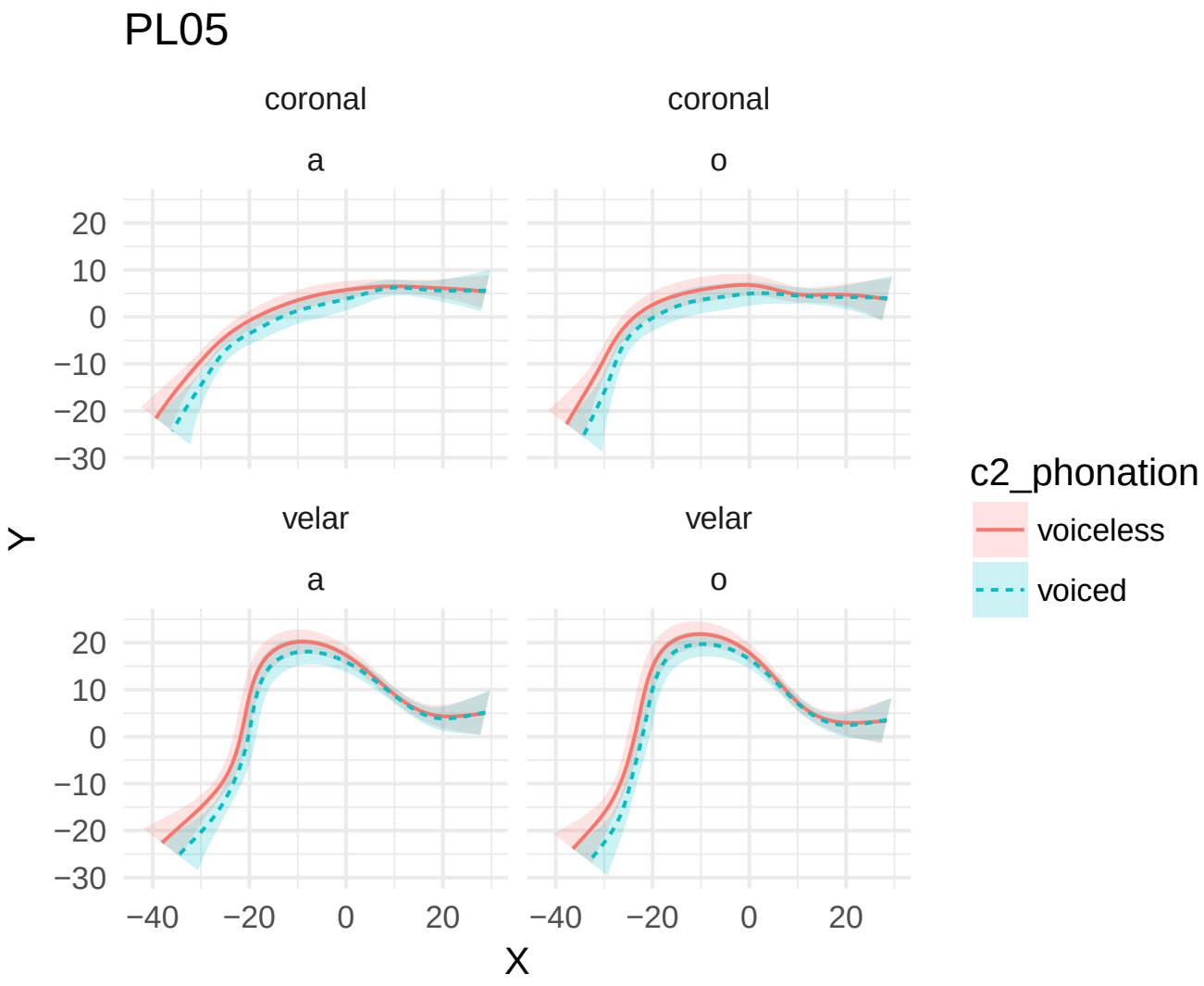
Results: Tongue contours



Results: Tongue contours



Results: Tongue contours



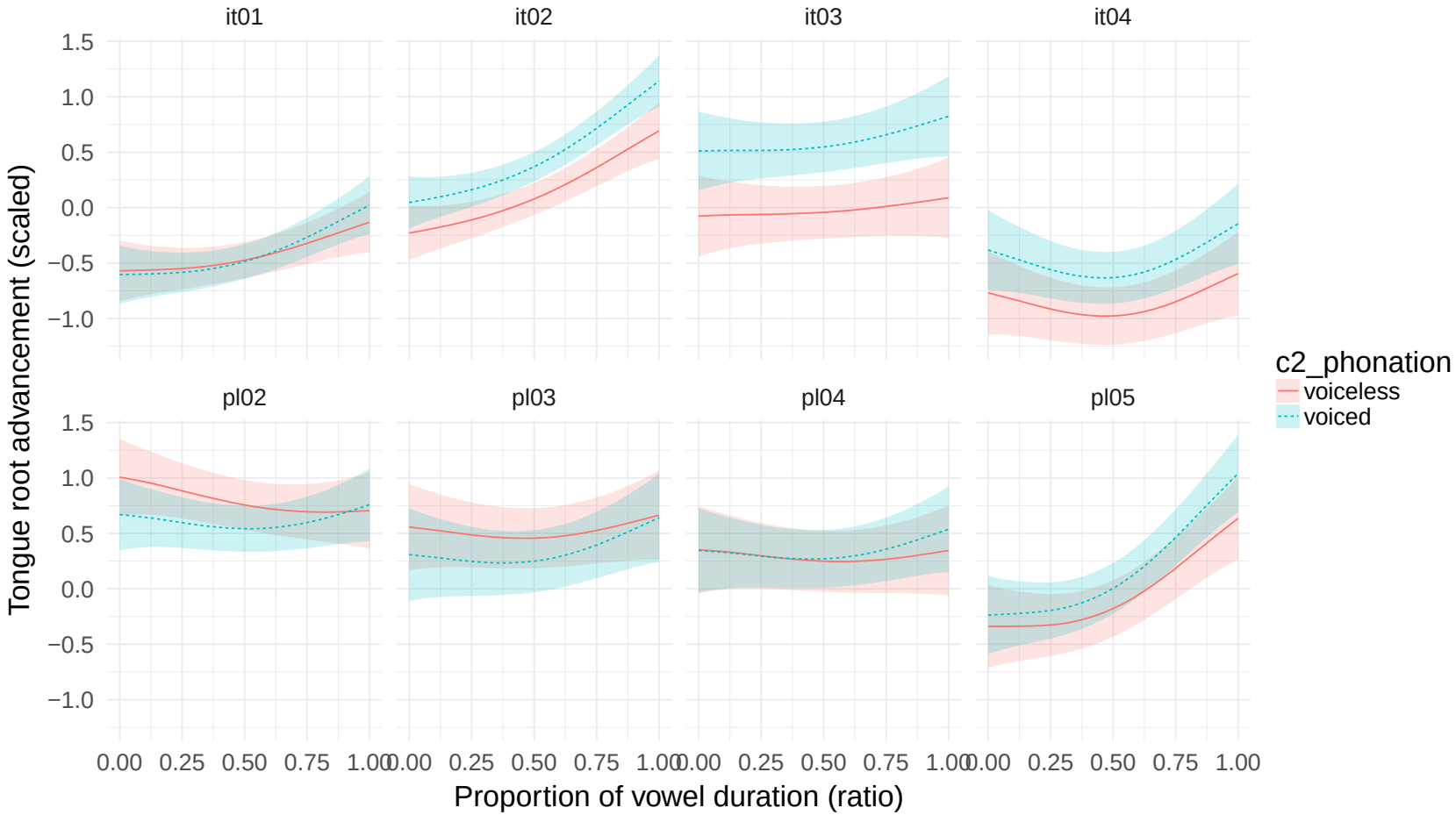
Discussion: Results summary

- **Effect of voicing on vowel duration**
  - Italian: +22 msec
  - Polish: +12 msec
- **Tongue contours**
  - 4 of 8 speakers (IT01, IT02, IT03, PL05) show TRA within closure
- **2 speakers** (IT02, PL05) with stronger VE and greater TRA

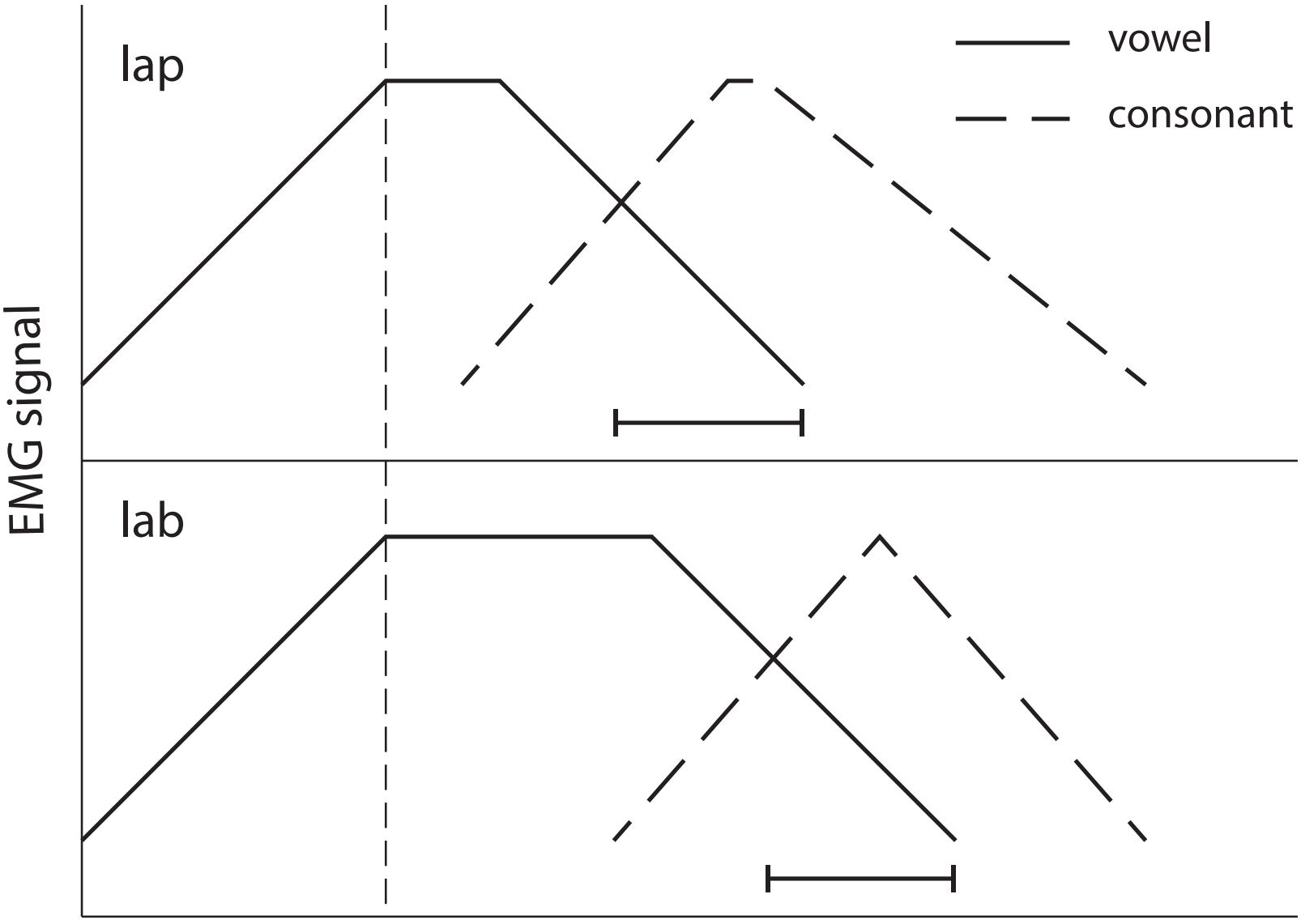
Discussion

- **TRA hypothesis**: *Longer vowel duration allows for greater tongue root advancement.*
    - Cf. with Halle & Stevens (1967): laryngeal adjustments
- If TRA hypothesis is correct:
    - TRA during the vowel
    - Greater TRA in IT02 and PL05

Discussion: TRA during the vowel



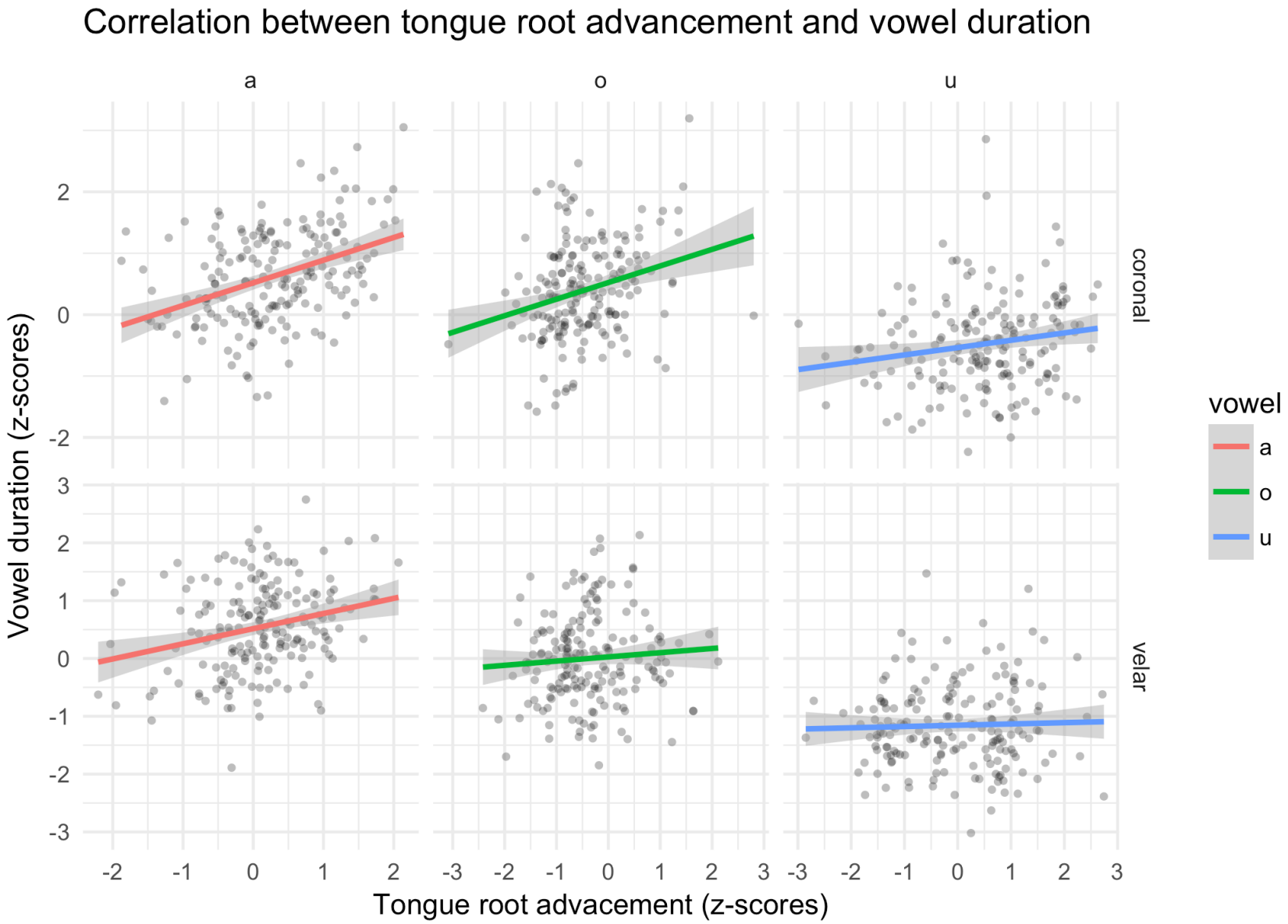
Discussion: Electromiography (EMG, Raphael, 1975)



Discussion

- Raphael (1975): sustained muscular activity in voiced consonants
  - *extra time allows more tongue root advancement?*
- Is this a gradual (linear) relationship?
  - We might see a **positive correlation between vowel duration and degree of TRA** (but caveat!)

Discussion: Vowel Duration ~ TRA



Conclusion

- Durational and ultrasound data from 8 speakers
  - Stronger VE ~ Greater TRA
  - TRA during the vowel
  - Vowel duration ~ TRA
- Future work
  - More speakers
  - Can the TRA gesture account for durational difference?

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