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*

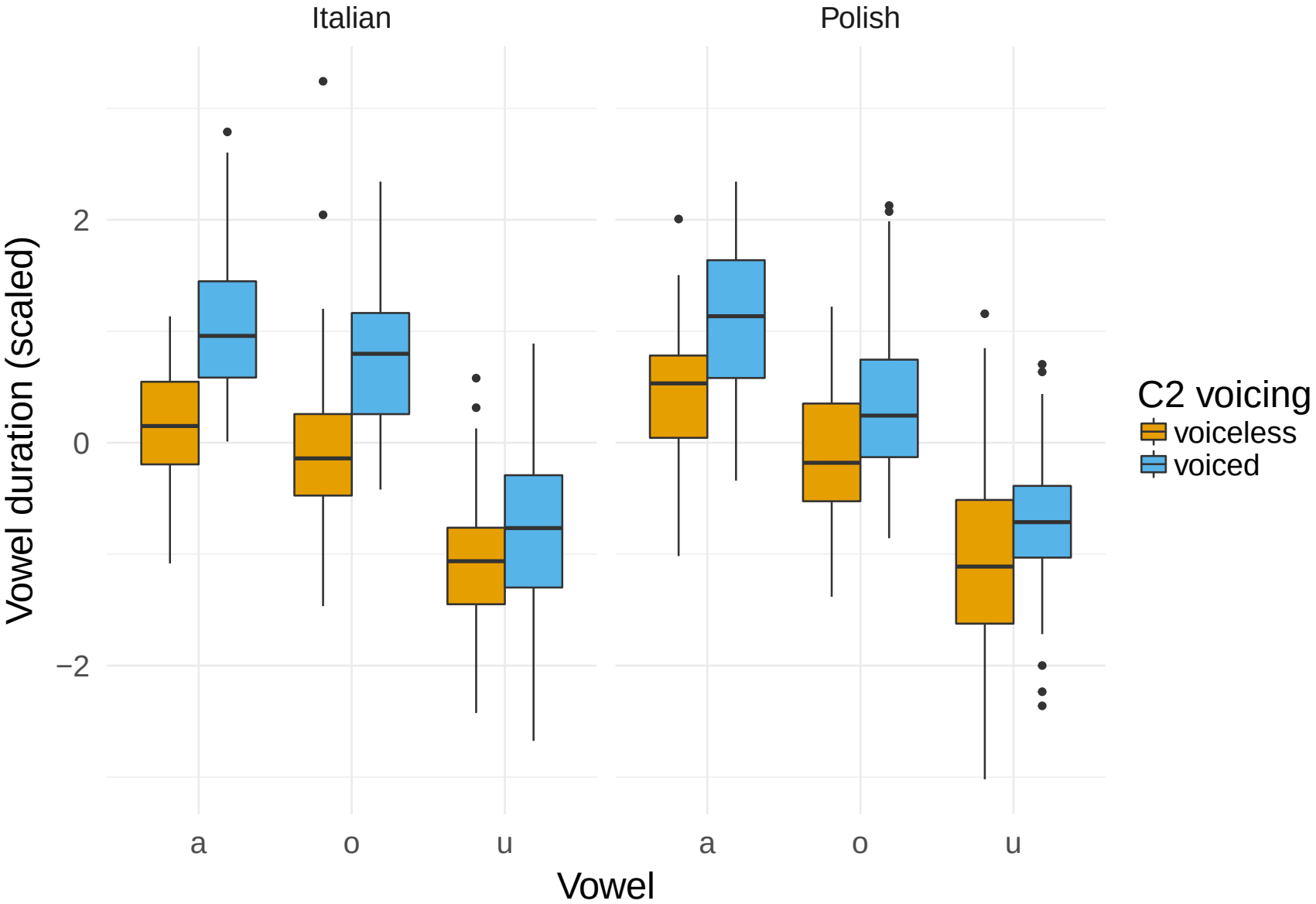
Background

- **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
- Timing of laryngeal and tongue activity
  - simultaneous UTI + EGG + audio

Methods (a summary)

- **Participants**: 4 Italians (2 F, 2 M), 4 Polish (2 F, 2 M)
- **Procedure**:
  - simultaneous ultrasound tongue imaging and audio recording
  - stabilisation headset (Articulate Instruments Ltd™, 2008)
- **Materials**:
  - $C_1V_1C_2V_1$
    - C_1 = /p/, V_1 = /a, o, u/, C_2 = /t, d, k, g/
    - *pata*, *pada*, *paka*, ..., *poto*, *podo*, ...
    - stress on first syllable
  - frame sentence
    - *Dico X lentamente*, 'I say X slowly'
    - *Mówię X teraz*, 'I say X now'
    - no pauses between words

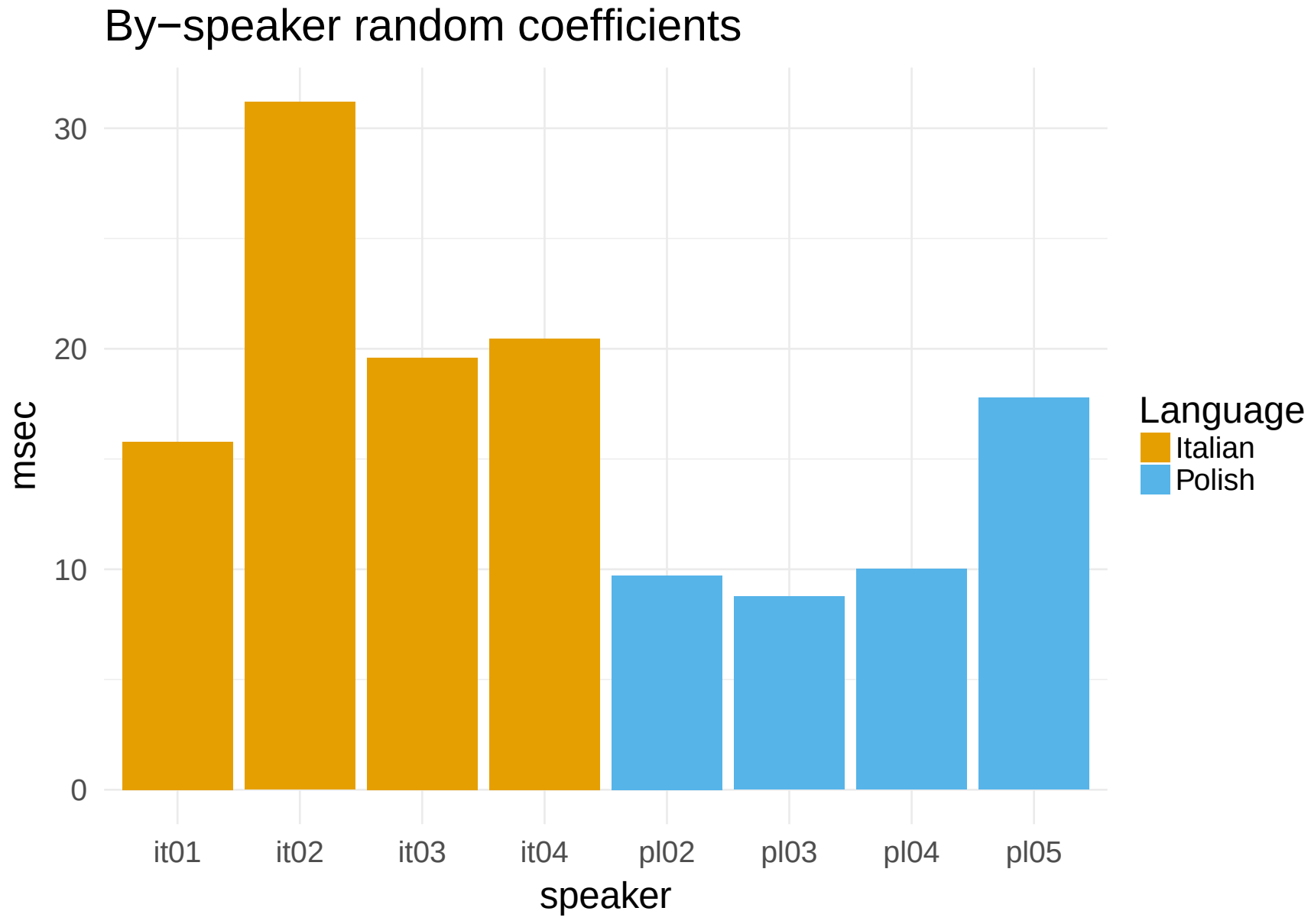
Results: Vowel duration



Results: Vowel duration

- Linear mixed-effects models (Bates et al., 2015; Kuznetsova et al., 2016)
- Italian
  - `voicing + place + vowel + sentence duration + voicing:vowel`
  - `(1+voicing|speaker) + (1|word)`
  - β = 22 msec, $\chi^2(3)$ = 15.8, p = 0.0012434
- Polish
  - `voicing + place + vowel + sentence duration + voicing:vowel + place:vowel`
  - `(1+voicing|speaker) + (1|word)`
  - β = 12 msec, $\chi^2(3)$ = 12.39, p = 0.0061556

Results: Vowel duration



Results: Tongue contours

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

Results: Tongue contours

Discussion

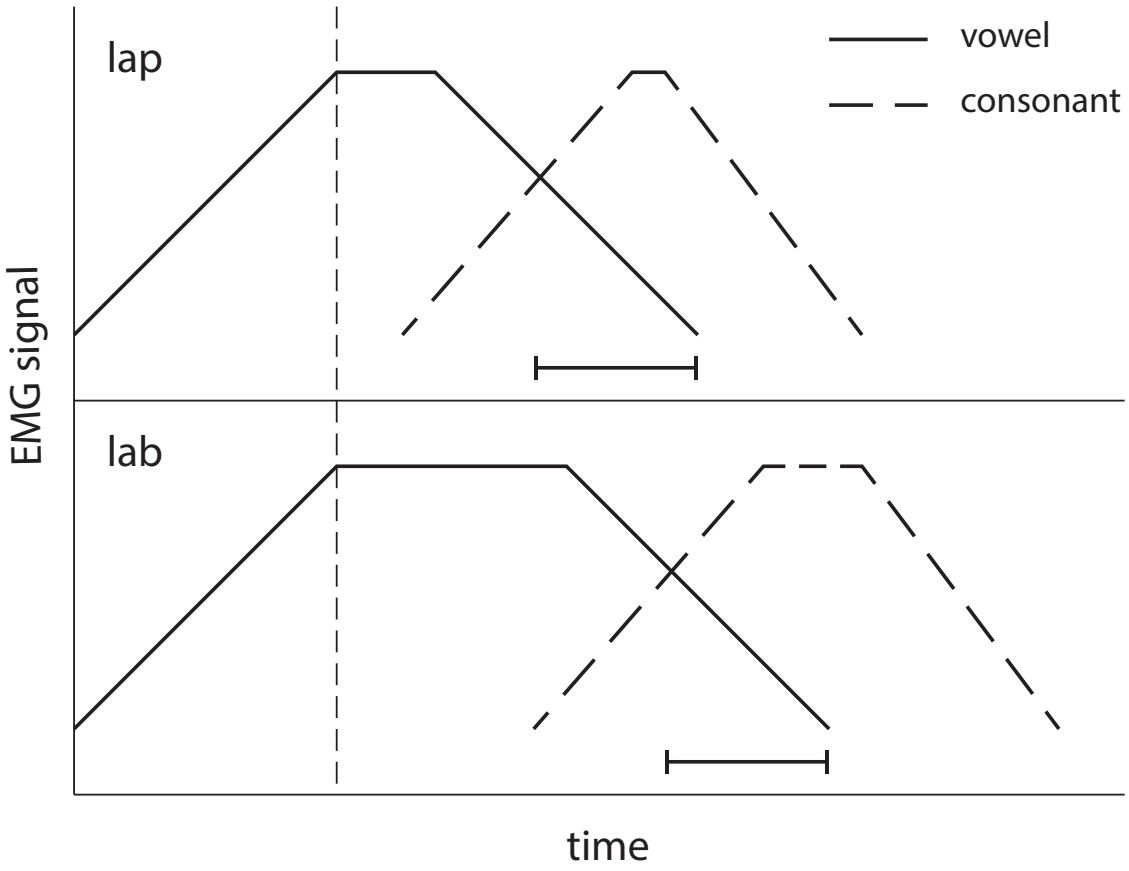
- Results summary
  - **effect of voicing on vowel duration**
    - Italian: +22 msec
    - Polish: +12 msec
  - **tongue contours**
    - 4 of 8 speakers (IT01, IT02, IT03, PL05) show TRA at maximum displacement
    - 2 of 8 (IT01, IT02) also at closure onset
  - 2 speakers (IT02, PL05) with stronger VE and greater TRA

Discussion

- **TRA hypothesis**: *Longer vowel duration allows for greater tongue root advancement.*
- Similar reasoning to that of Halle & Stevens (1967)
    - longer vowels allow for laryngeal adjustments from spontaneous voicing of vowels to obstruent voicing of voiced consonants

Discussion

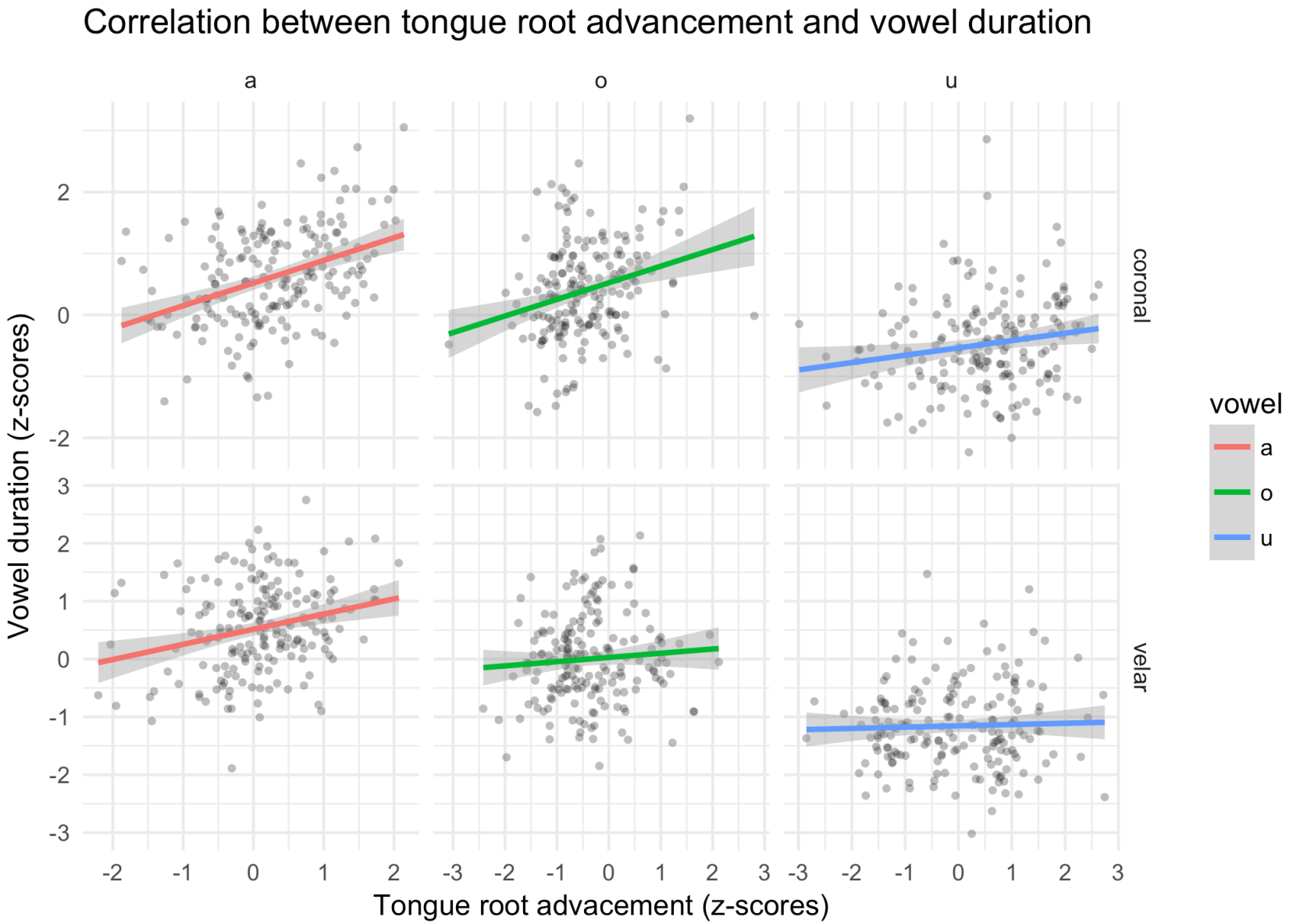
- Raphael (1975): electromiography (EMG)



Discussion

- Sustained muscular activity in voiced consonants
  - *time to allow tongue root advancement?*
- If the TRA hypothesis is correct, we might see a **positive correlation between vowel duration and degree of TRA** (but caveat!)

Discussion: Vowel Duration ~ TRA



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