

Longer vowel duration correlates with tongue root advancement in Italian and Polish: An ultrasound study

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The voicing effect

- shorter vowels before voiceless stops, longer vowels before voiced stops

Heffner (1937); House & Fairbanks (1953); Belasco (1953); Peterson & Lehiste (1960); Halle & Stevens (1967); Chen (1970); Klatt (1973); Lisker (1974); Raphael (1975); Javkin (1976); Maddieson & Gandour (1976); Farnetani & Kori (1986); Kluender et al. (1988); Laeuffer (1992); Fowler (1992); Hussein (1994); Esposito (2002); Lampp & Reklis (2004); Warren & Jacks (2005); Durvasula & Luo (2012)

Still **no consensus** on source!

Background

Proposed accounts:

- **production**
 - constant articulatory force (Belasco, 1953; Delattre, 1962)
 - durational trade-off (Slis & Cohen, 1969; Lehiste, 1970)
 - laryngeal adjustment (Halle & Stevens, 1967)
 - closing gesture duration (Chen, 1970)
- **perception**
 - misperception (Javkin, 1976)
 - enhancement (Kluender et al., 1988)
- but **problems** (Maddieson & Gandour, 1976; Fowler, 1992)

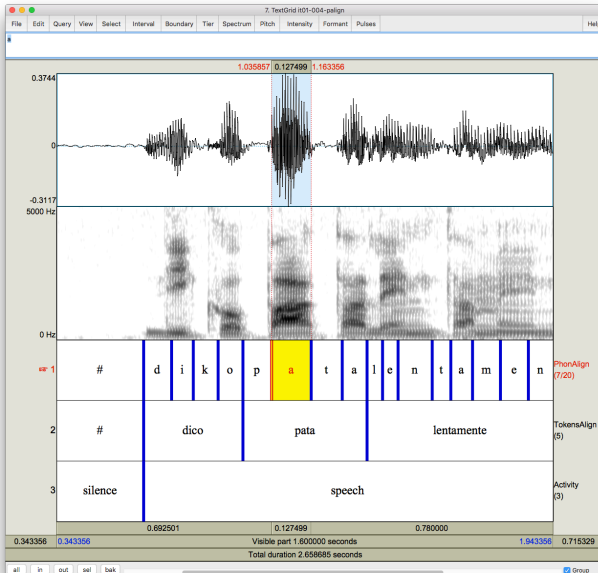
This talk:

- Support for **durational trade-off hypothesis** of the voicing effect
- Link between **vowel duration**, **closure duration**, and **tongue root position**

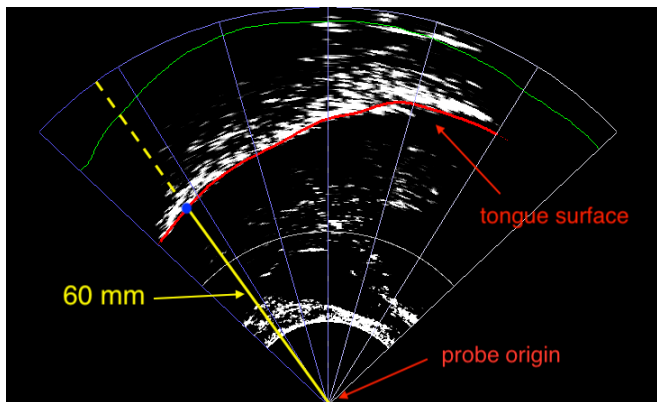
Methods

- **Participants:** 11 Italians (5 F, 6 M), 6 Polish (3 F, 3 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'
- **Measurements**
 - Durational data from acoustics (Boersma & Weenink, 2016)
 - Tongue root position (frontness) from ultrasound tongue imaging (Articulate Instruments Ltd™, 2011, 2008)
- **Reproducibility**
 - <https://github.com/stefanocoretta/2018-labphon>

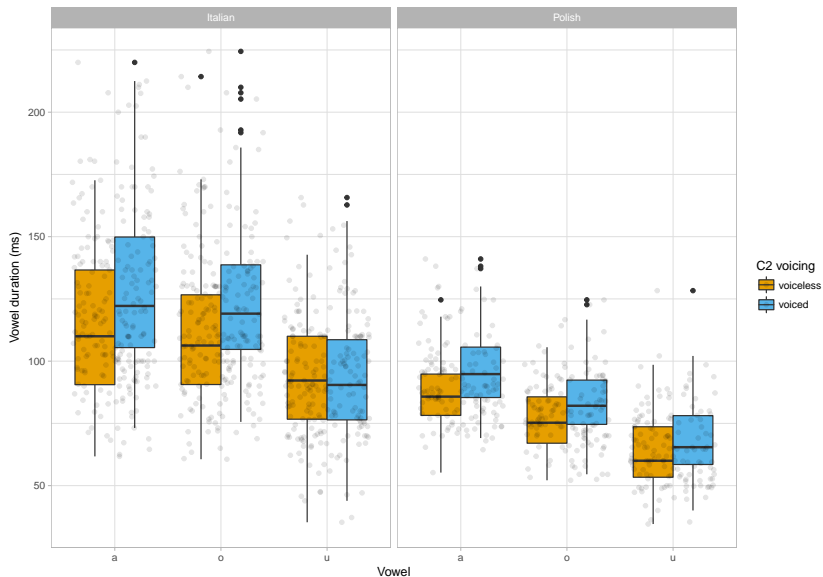
Methods: Acoustic landmarks



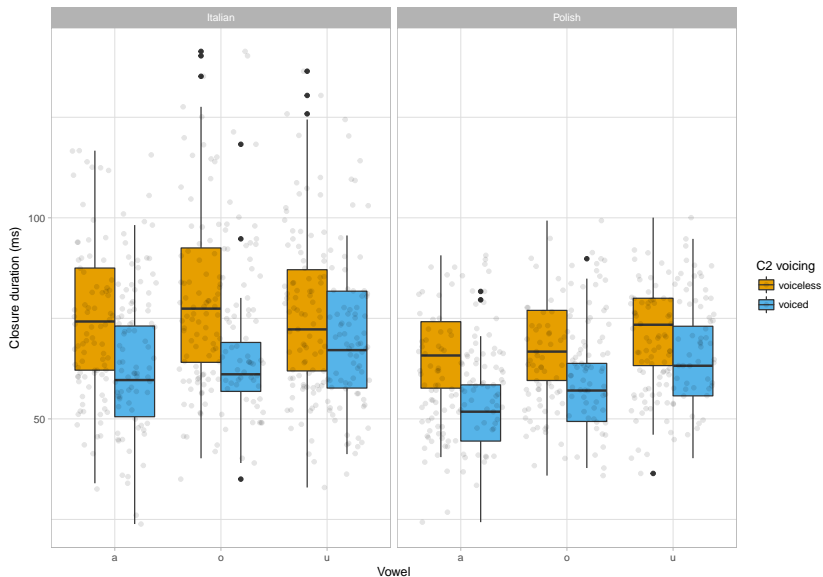
Methods: Tongue root position



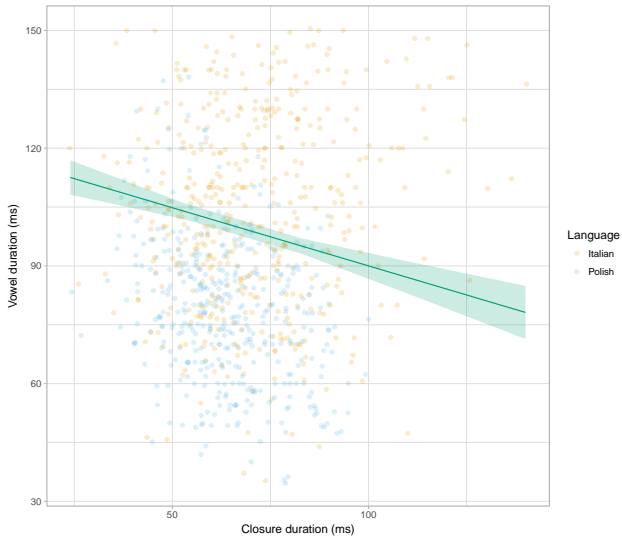
Results: Vowel duration



Results: Closure duration



Results: Vowel and closure duration



Results: Interim summary

In Italian and Polish:

- Vowels are **15 ms longer** when followed by a voiced stop
- Consonant closure is **16 ms shorter** if it is a voiced stop
- Vowel duration is inversely correlated with closure duration

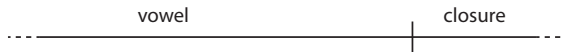
Durational trade-off?

Results: Interim summary

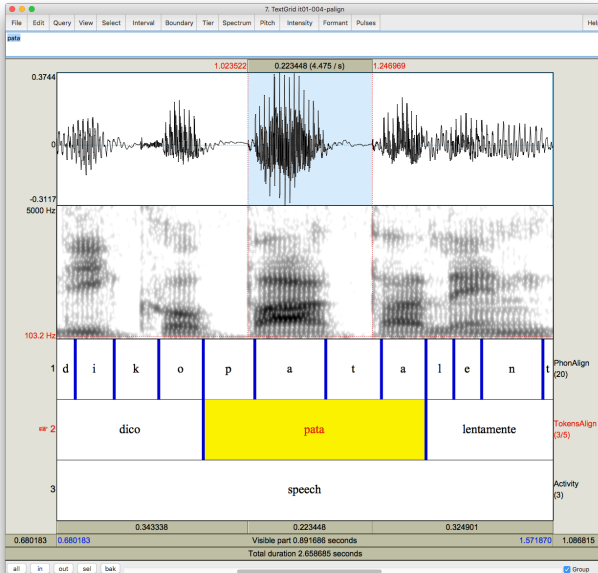
(a) voiceless



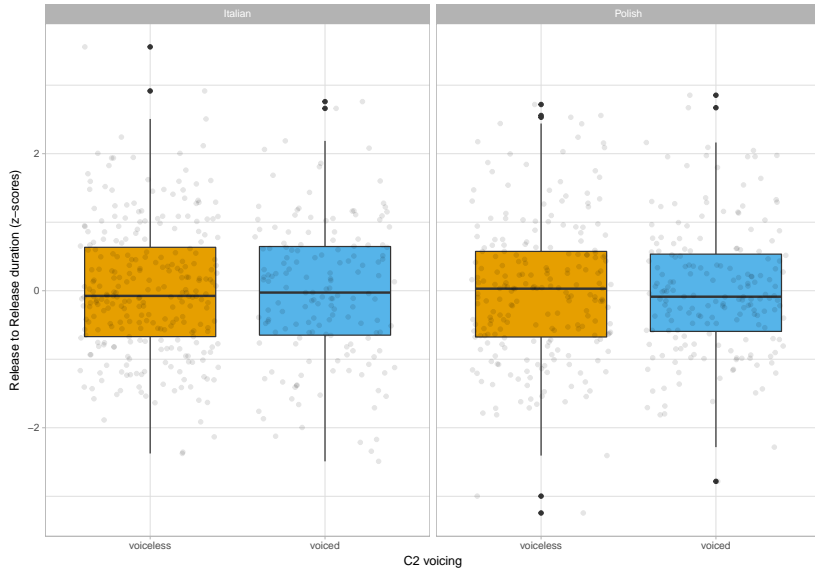
(b) voiced



Results: Release to Release duration

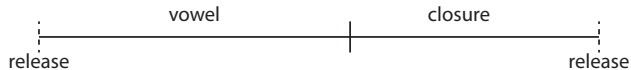


Results: Release to Release duration

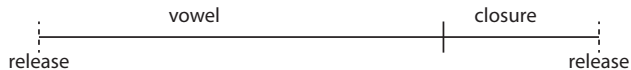


Discussion: Durational trade-off

(a) voiceless



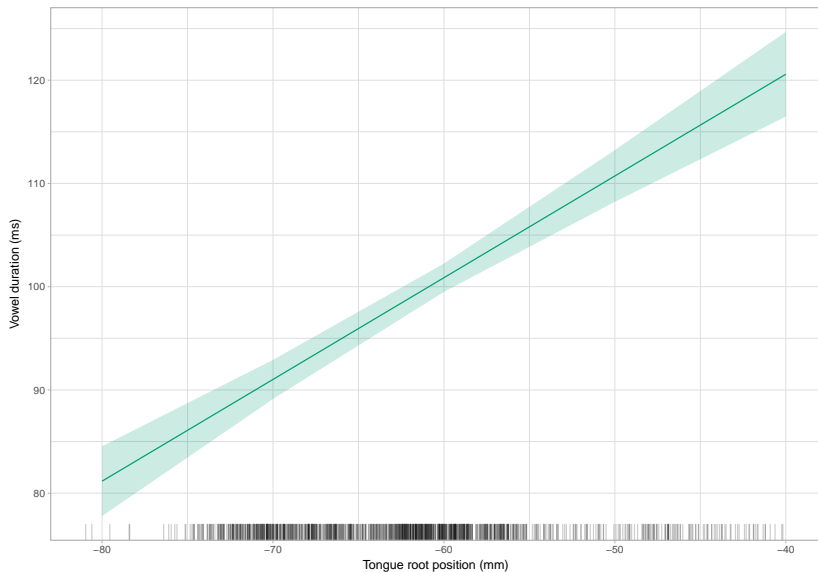
(b) voiced



Discussion: Vowel duration and tongue root position

- **Tongue root advancement** (Aereodynamic Voicing Constraint, Ohala, 2011; Rothenberg, 1967; Westbury, 1983)
- Advancing root during vowel in voiced **and** voiceless stops
 - voiced stops have greater advancement at closure
 - but no interaction between C2 voicing and tongue root position

Discussion: Vowel duration and tongue root position



Discussion: Vowel duration and tongue root position

- Voiced stops have a shorter closure duration
 - but no interaction between C2 voicing and tongue root position
- **Hypothesis:** Closure onset is timed later to allow for more tongue root advancement

Conclusions

- Vowel duration and closure duration are **inversely correlated**
- Vowel duration and tongue root frontness are **directly correlated**
- **Release to Release** invariance supports a durational trade-off account for the voicing effect

Thanks!

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