

Tongue root advancement and vowel duration: a gradient effect?

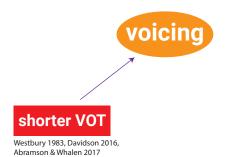
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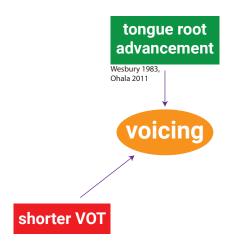
13 April, BAAP 2018 (Canterbury)

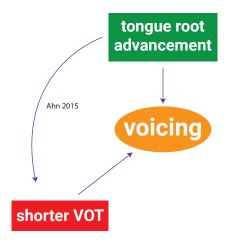
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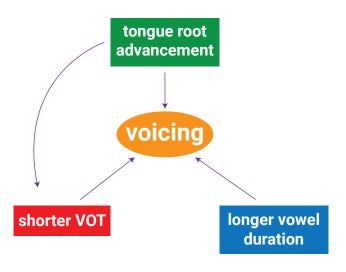


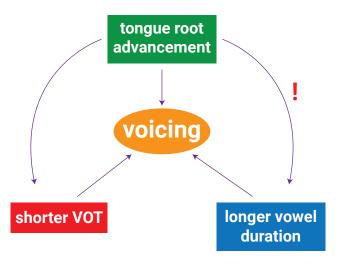


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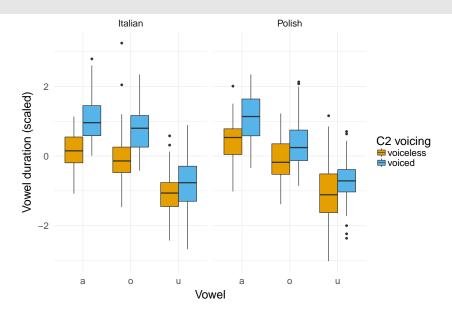
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- Voicing effect (VE): vowels are longer when followed by voiced stops (House & Fairbanks, 1953; Peterson & Lehiste, 1960; Chen, 1970; Klatt, 1973; Lisker, 1974; Fowler, 1992; Lampp & Reklis, 2004)
 - Italian: voicing effect of 35 msec (Farnetani & 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
 - $\cdot C_1V_1C_2V_1$
 - \cdot C₁ = /p/, V₁ = /a, o, u/, C₂ = /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
- Reproducibility
 - https://github.com/stefanocoretta/2018-baap

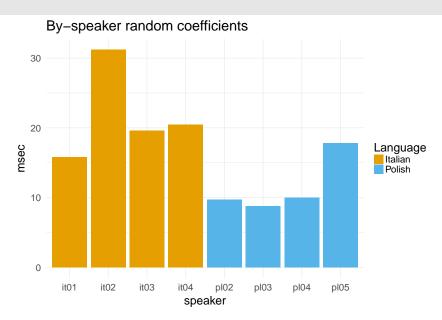
Results: Vowel duration



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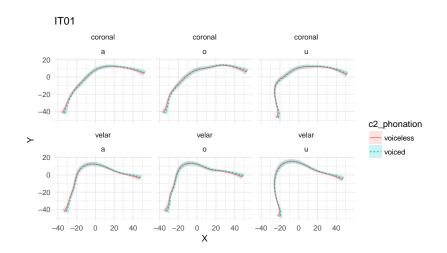
- Linear mixed-effects models (Bates et al., 2015; Kuznetsova et al., 2016)
- Italian: β = 22 msec, χ^2 (3) = 15.8, p = 0.0012434
- **Polish**: β = 12 msec, $\chi^2(3)$ = 12.39, p = 0.0061556

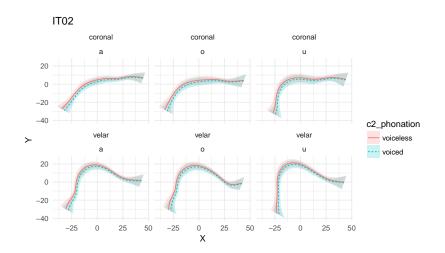
Results: Vowel duration

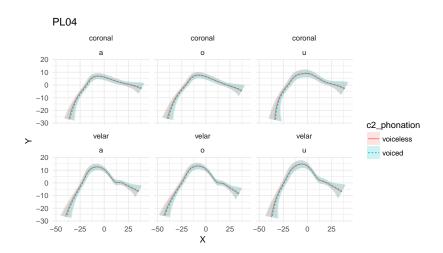


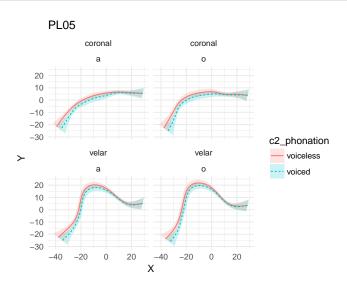
Midsagittal tongue contours

- From within consonant closure (at maximum tongue displacement, Strycharczuk & Scobbie, 2015), polar coordinates (Heyne & Derrick, 2015b,a; Mielke, 2015)
- Generalised additive mixed 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









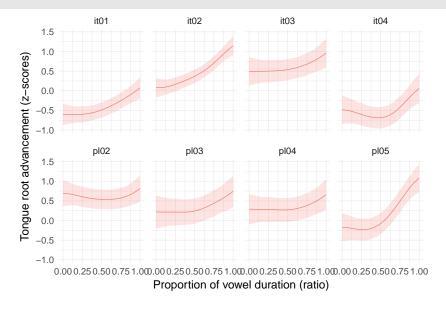
Discussion: Results summary

- 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

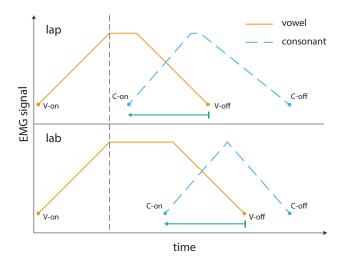
Discussion

- 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



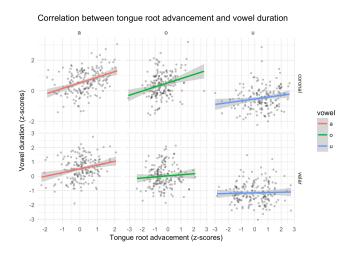
Discussion: Electromiography (EMG, Raphael, 1975)



Discussion

- Raphael (1975): sustained muscular activity in vowels followed by 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?

Conclusion

THANK YOU!

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References i

References

Bates, Douglas, Martin Mächler, Ben Bolker & Steve Walker. 2015. Fitting linear mixed-effects models using lme4. *Journal of Statistical Software* 67(1). 1–48.

Chen, Matthew. 1970. Vowel length variation as a function of the voicing of the consonant environment. *Phonetica* 22(3). 129–159.

Coretta, Stefano. 2018a. rticulate: Ultrasound Tongue Imaging in R. R package version 1.3.1.9000.

https://github.com/stefanocoretta/rticulate.

References ii

Coretta, Stefano. 2018b. Using generalised additive models (GAM) with polar coordinates for assessing tongue contours. https://github.com/stefanocoretta/rticulate.

Farnetani, Edda & Shiro Kori. 1986. Effects of syllable and word structure on segmental durations in spoken Italian. *Speech communication* 5(1). 17–34.

Fowler, Carol A. 1992. Vowel duration and closure duration in voiced and unvoiced stops: There are no contrast effects here. *Journal of Phonetics* 20(1). 143–165.

References iii

- Halle, Morris & Kenneth Stevens. 1967. Mechanism of glottal vibration for vowels and consonants. *The Journal of the Acoustical Society of America* 41(6). 1613–1613.
- Heyne, Matthias & Donald Derrick. 2015a. Benefits of using polar coordinates for working with ultrasound midsagittal tongue contours. *The Journal of the Acoustical Society of America* 137(4). 2302–2302.
- Heyne, Matthias & Donald Derrick. 2015b. Using a radial ultrasound probe's virtual origin to compute midsagittal smoothing splines in polar coordinates. *The Journal of the Acoustical Society of America* 138(6). EL509–EL514.

References iv

House, Arthur S. & Grant Fairbanks. 1953. The influence of consonant environment upon the secondary acoustical characteristics of vowels. *The Journal of the Acoustical Society of America* 25(1). 105–113.

Keating, Patricia A. 1984. Universal phonetics and the organization of grammars. *UCLA Working Papers in Phonetics* 59.

Klatt, Dennis H. 1973. Interaction between two factors that influence vowel duration. *The Journal of the Acoustical Society of America* 54(4). 1102–1104.

References v

Kuznetsova, Alexandra, Per Bruun Brockhoff & Rune Haubo Bojesen Christensen. 2016. lmerTest: Tests in linear mixed effects models. https://CRAN.R-project.org/package=lmerTest. R package version 2.0-33.

Lampp, Claire & Heidi Reklis. 2004. Effects of coda voicing and aspiration on Hindi vowels. *The Journal of the Acoustical Society of America* 115(5). 2540–2540.

Lisker, Leigh. 1974. On "explaining" vowel duration variation. In *Proceedings of the Linguistic Society of America*, 225–232.

References vi

- Mielke, Jeff. 2015. An ultrasound study of Canadian French rhotic vowels with polar smoothing spline comparisons. *The Journal of the Acoustical Society of America* 137(5). 2858–2869.
- Nowak, Pawel. 2006. *Vowel reduction in Polish*: University of California, Berkeley dissertation.
- Peterson, Gordon E. & Ilse Lehiste. 1960. Duration of syllable nuclei in english. *The Journal of the Acoustical Society of America* 32(6). 693–703.
- Raphael, Lawrence J. 1975. The physiological control of durational differences between vowels preceding voiced and voiceless consonants in English. *Journal of Phonetics* 3(1). 25–33.

References vii

- Sóskuthy, Márton. 2017. Generalised additive mixed models for dynamic analysis in linguistics: a practical introduction. arXiv preprint arXiv:1703.05339.
- Strycharczuk, Patrycja & James M. Scobbie. 2015. Velocity measures in ultrasound data. Gestural timing of post-vocalic /l/ in English. In *Proceedings of the 18th International Congress of Phonetic Sciences*, 1–5.
- van Rij, Jacolien, Martijn Wieling, R. Harald Baayen & Hedderik van Rijn. 2017. itsadug: Interpreting time series and autocorrelated data using GAMMs. R package version 2.3.

References viii

Wood, Simon. 2006. *Generalized additive models: An introduction with R.* CRC Press.