Acoustic evidence for consonant cluster organization across contexts

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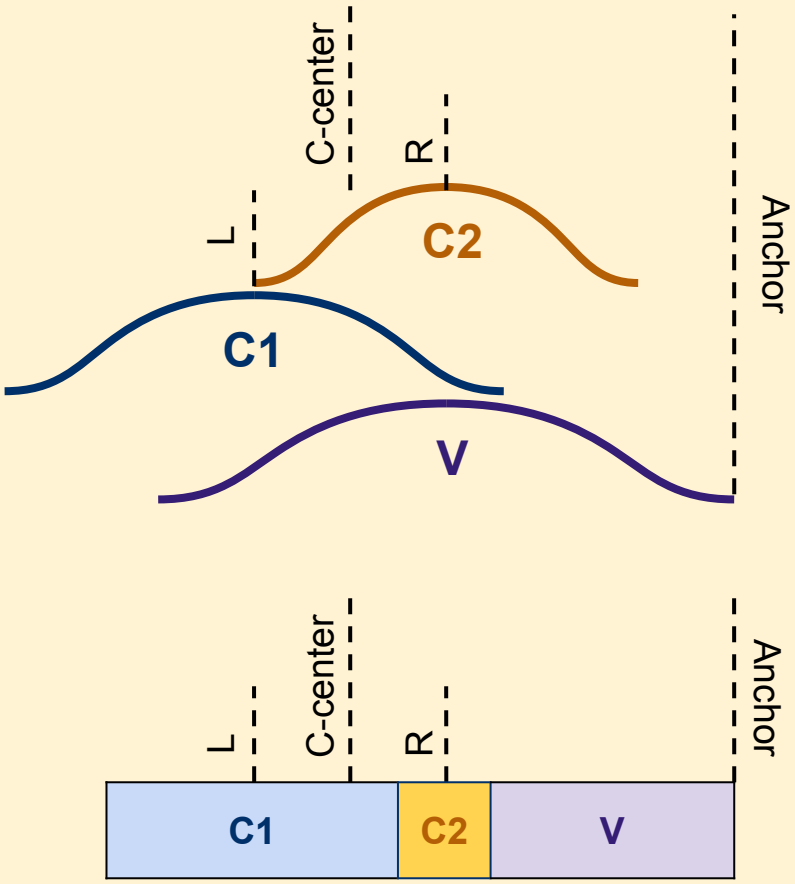
OSF link

C-centers

Articulatory C-center: the observation, in articulation, that the ***mean of the midpoints*** (or other landmarks) of onset consonants has stable timing to the vowel (Browman & Goldstein 1988)

- varies across languages, across different onset clusters…

Acoustic C-center: the inference of articulatory c-center timing from stable timing of the ***mean of the acoustic midpoints*** of onset consonants to a vowel anchor (Durvasula et al. 2021)

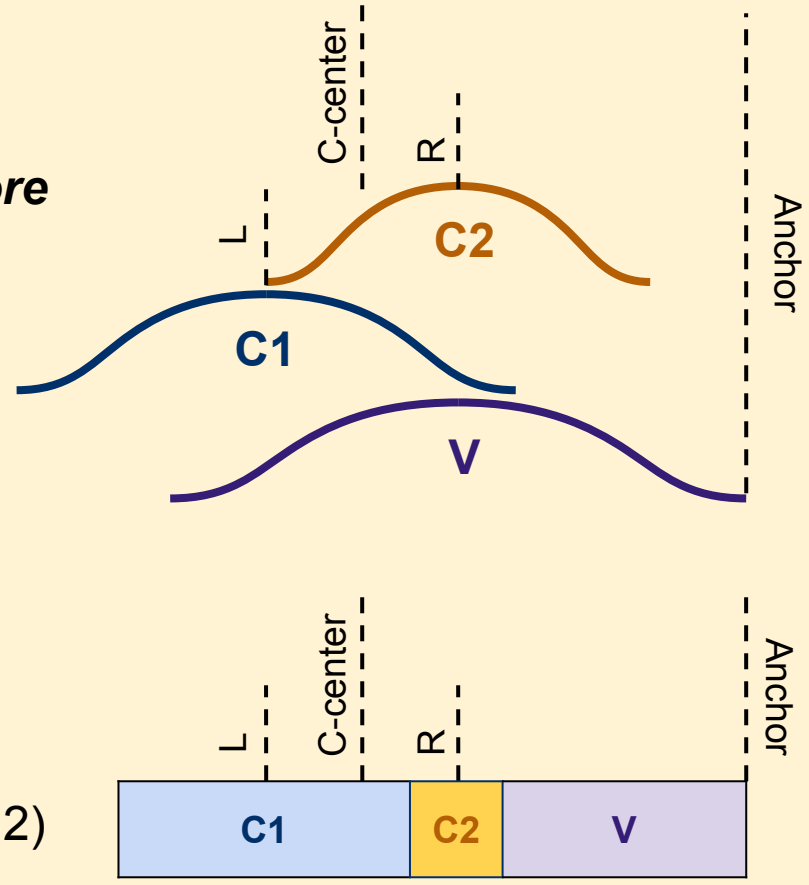


Our Study

Does the acoustic C-center hold across more contexts?

- 18 Am. English speakers
- Reading target words on a screen
  Say ____ again
- Forced-aligned, then measured:
  - L edge: C1 midpoint
    R edge: C2 midpoint → C-center
  - Anchor: end of V

- Replication (12) and extensions (32+24+12)
  → 72 * 10 reps = 720 tokens/speaker



Replication: *sm-, sn-*

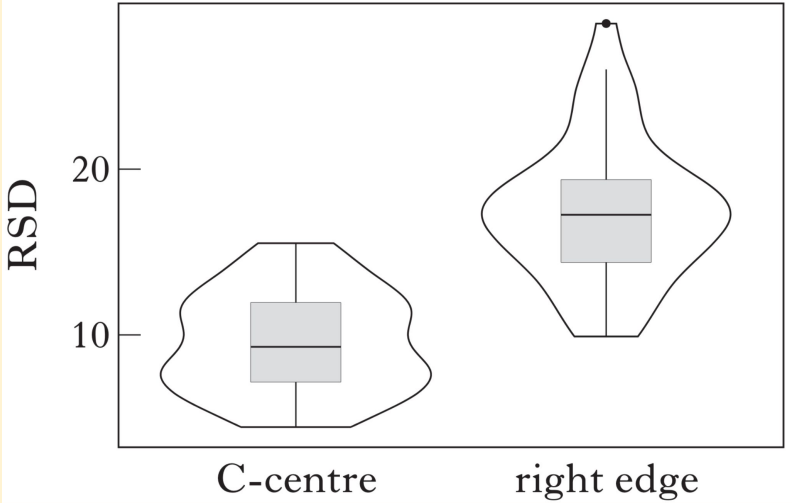
C-center timing predicts:

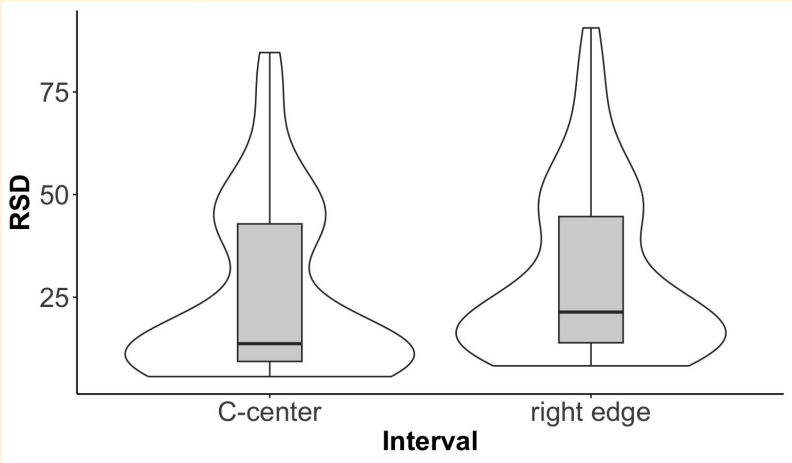
1. C-center-to-anchor: CC = C

2. R-edge-to-anchor: CC < C

3. C-center-to-anchor more stable (lower RSD: relative standard deviation) than R-edge-to-anchor across all items

RSD: our data (bottom) consistent with Durvasula et al. (top). (Also true later!)





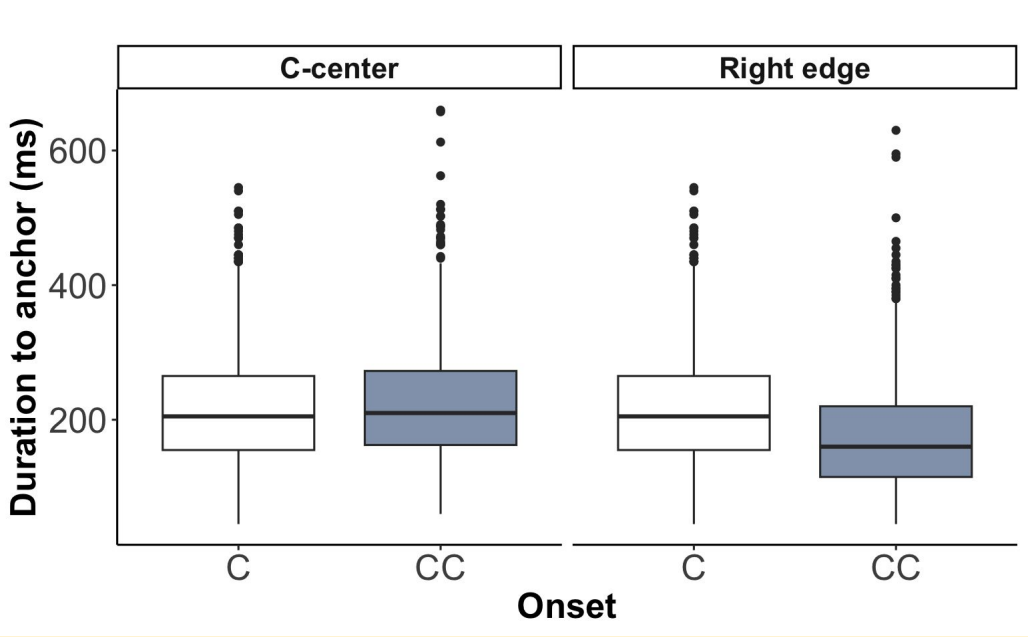
CC stop + liquid clusters: *rise / cries*

English syllable organization should be similar across CC onsets

***cries*(CC), *as compared to rise*(C):**

1. C-center-to-anchor: CC = C
2. R-edge-to-anchor: CC < C

… and it is!



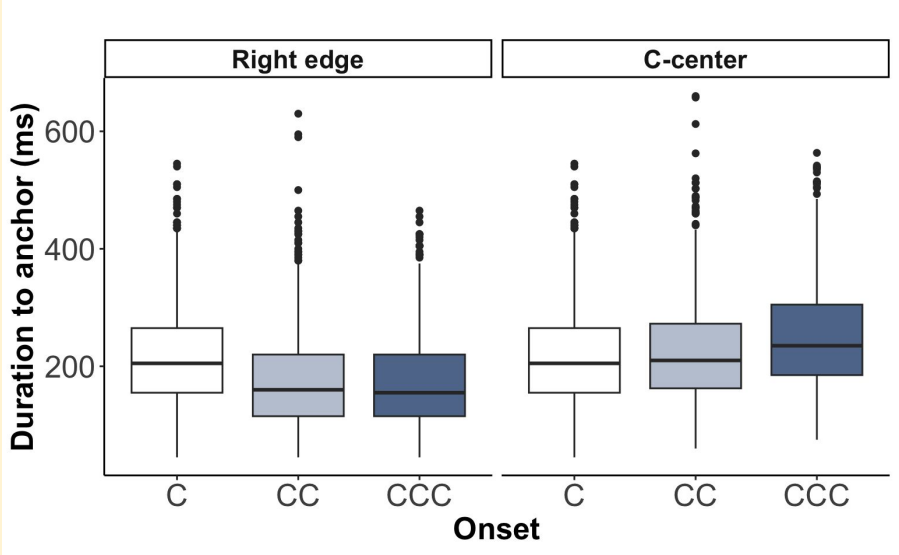
CCC /s/ + stop + liquid clusters: *rise / cries / scries*

Add an /s/ – does it have C-center-like timing, or is it different?

1. C-center-to-anchor: CCC > (CC = C)

… because it's long,
… or because /s/ is different?

2. R-edge-to-anchor: (CCC = CC) < C
… /s/ in CCC is different, as predicted



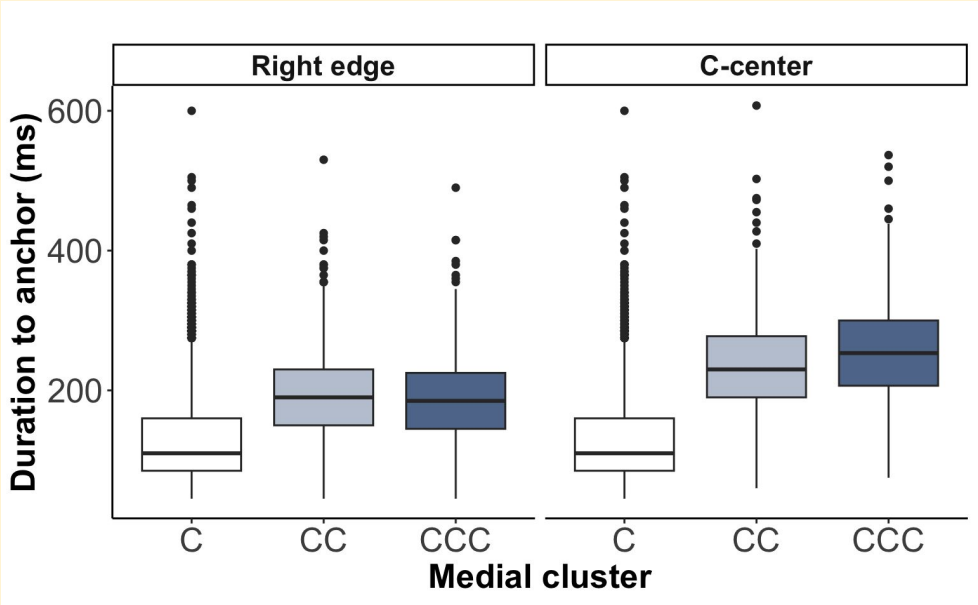
Medial clusters: *arise / decries / descries*
unrumb / uncrum / unscrum

Do we observe c-centers medially?

Unclear:

- Resyllabification (L)
- RSD *more* variable CCC>CC>C

- /un/-prefixed clusters even noisier, Inconsistent RSD



Summary

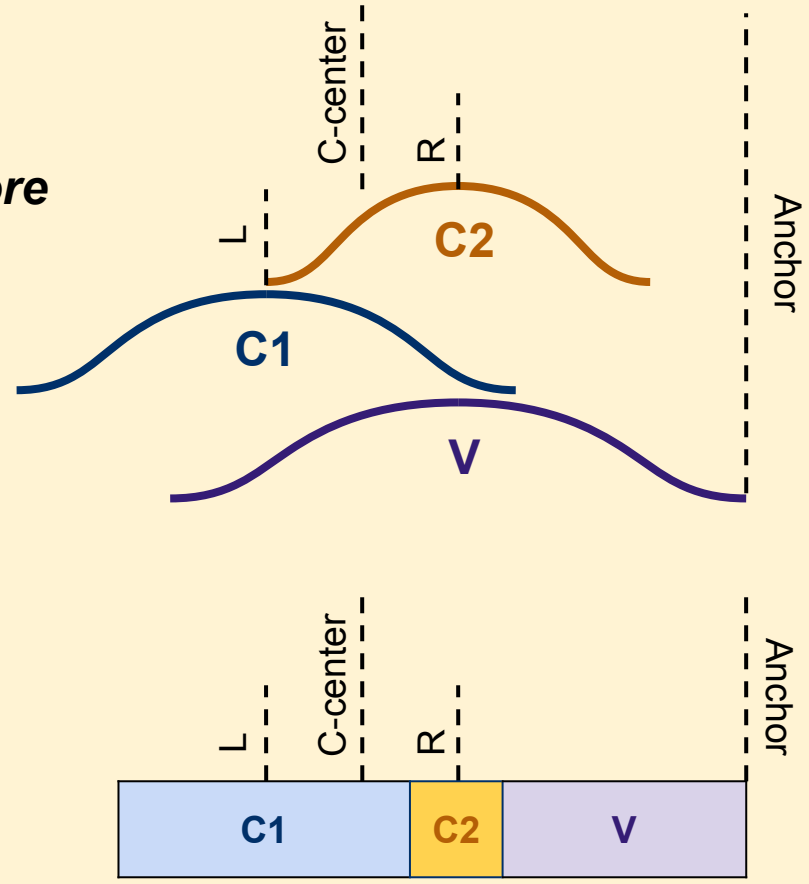
Does the acoustic C-center hold across more contexts?

Yes: s+nasal,
stop+liquid
C2 & C3 in stop+liquid

No: s+stop+liquid

Unclear: word-medial contexts

Useful evidence about articulatory timing is available from acoustic data alone, for word-initial clusters.



References

Browman, Catherine P. & Louis Goldstein. 1988. Some Notes on Syllable Structure in Articulatory Phonology. *Phonetica* 45(2–4). 140–155.

Durvasula, Karthik, Mohammed Qasem Ruthan, Sarah Heidenreich & Yen-Hwei Lin. 2021. Probing syllable structure through acoustic measurements: case studies on American English and Jazani Arabic. *Phonology* 38(2). 173–202.

Durvasula, Karthik & Yichen Wang. 2023. Revisiting CV timing with a new technique to identify inter-gestural proportional timing. In Radek Skarnitzl & Jan Volín (eds.), *Proceedings of the 20th International Congress of Phonetic Sciences*, 1975–1979. Guarant International.

Marin, Stefania & Marianne Pouplier. 2010. Temporal organization of complex onsets and codas in American English: Testing the predictions of a gestural coupling model. *Motor Control* 14(3). 380–407.

Sotiropoulou, Stavroula, Erika Pillmeier, Argyro Katsika & Adamantios Gafos. 2015. Dissecting the Consonant Duration Ratio. *Proceedings of the 15th International Congress of the Phonetic Sciences*.