Prosodic modulation and the role of the segmental gestural molecule

Laboratory Phonology 17

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Variable intergestural timing

- Intergestural timing varies as a function of prosody and speech rate

- Variability in timing is mostly examined across segments (e.g., CV, CC coordination)

Beňuš & Šimko, 2014; Byrd, 1996; Byrd & Choi 2010; Cho, 2001; Katsika, 2018; Marin & Pouplier, 2010; Mücke, 2014; Saltzman & Byrd, 2000

Segment–internal intergestural timing

- Gestures *within a segment* have a particularly high degree of cohesiveness (compared to those across segments)

  Byrd, 1996; Fowler, 2015; Hoole & Pouplier, 2015; Kelso et al., 1984; Maddieson & Ladefoged, 1989; Munhall et al., 1994

- This tight coupling leads to segment–specific stable coordination pattern
  - Timing is resistant to individual gestural variations?
  - Timing is resistant to prosodic variations?

Across- vs. within-segment timing

Consonantal sequences

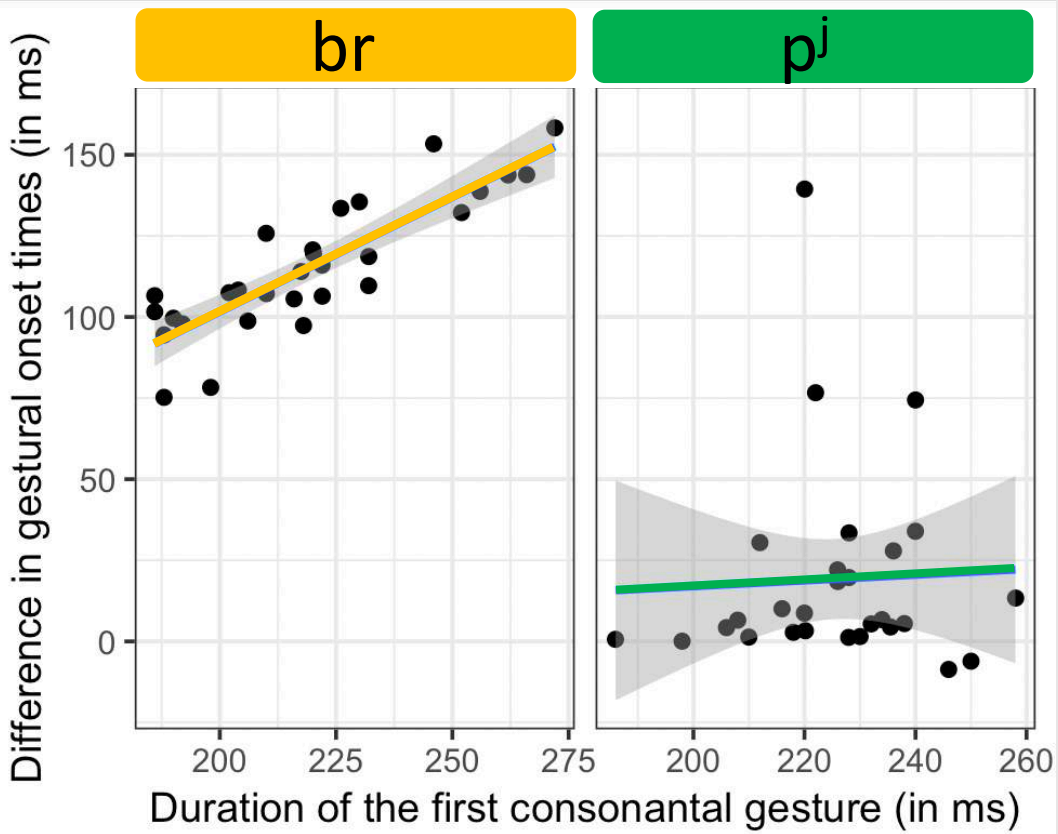
- As gestural duration varies, intergestural timing covaries

Complex segments

- The lag between gestural onsets are strictly coordinated, and are not affected by the duration of gestures

⟶ Segment timing: Lack of covariance

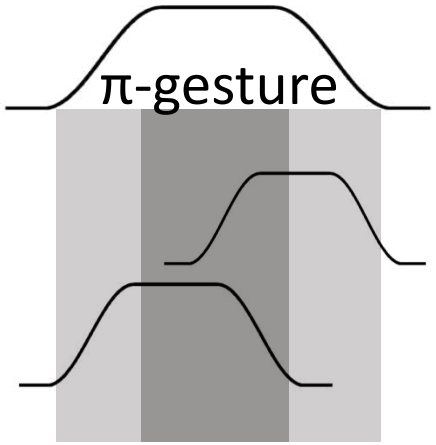
From Shaw et al., (2019)



Transgestural gestural slowing

- In the vicinity of a phrasal boundary, gestural activation trajectories temporally stretch

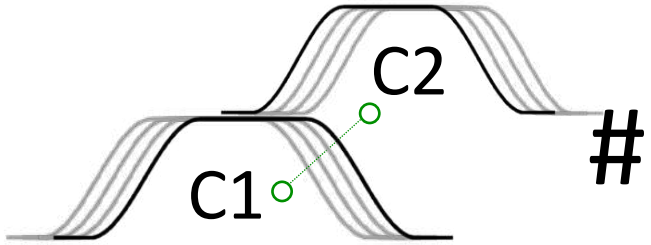
- This boundary–induced local slowing may:
  - Lengthen gestural duration
  - Reduce gestural overlap (thus increase intergestural lag)
  - Increase spatial magnitude



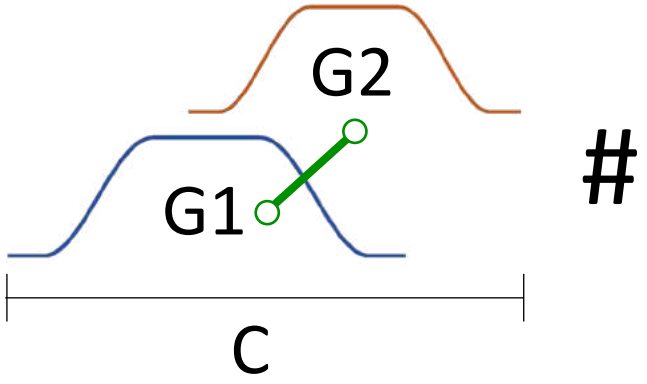
(Saltzman & Byrd 2000; Byrd & Saltzman 2003)

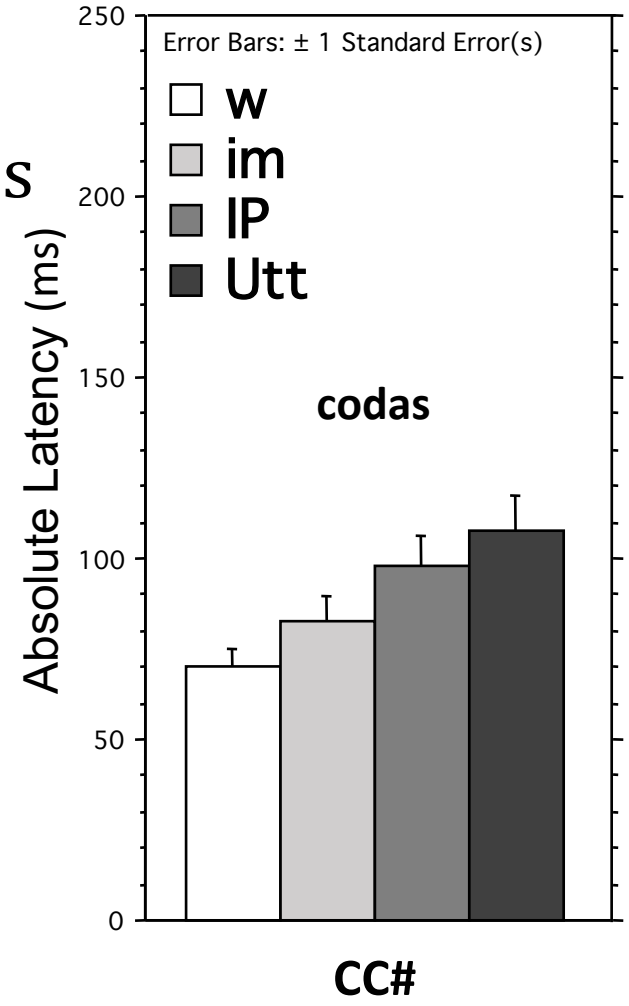
Timing variability/stability

- CC# timing: **malleable** to prosodic modulations



- C# timing: **resistant** to prosodic modulations





(Byrd & Choi, 2010)

Segmental gestural molecule

- Segments with multiple gestures
  - Multiple oral gestures
    /l/ /r/ /w/ /k͡p/ /pʲ/ /kʷ/
  - Oral and non–oral gestures
    /n/ /m/ /k’/ /ɓ/

Segment–specific goals

- Distinct coordination goals may serve to underlie phonologically contrastive organization of gestures
- These goals may be relevant to aerodynamic, acoustic, or perceptual goals

• Doubly–articulated stops	(perceptual recoverability)
• Non–pulmonic consonants	(aerodynamic goal)
• Pre–, post–nasal and nasal consonants	(?)

Goal

- Use variations in individual gestures and prosody to probe temporal coordination patterns within a segment

- Investigate velum–oral coordination in nasal consonants to understand a segment–specific goal for nasals

Research questions

A. Is the lag between the gestures of a segmental molecule relatively **insensitive** to the variation of the individual gestures (compared to across-segment lags)?

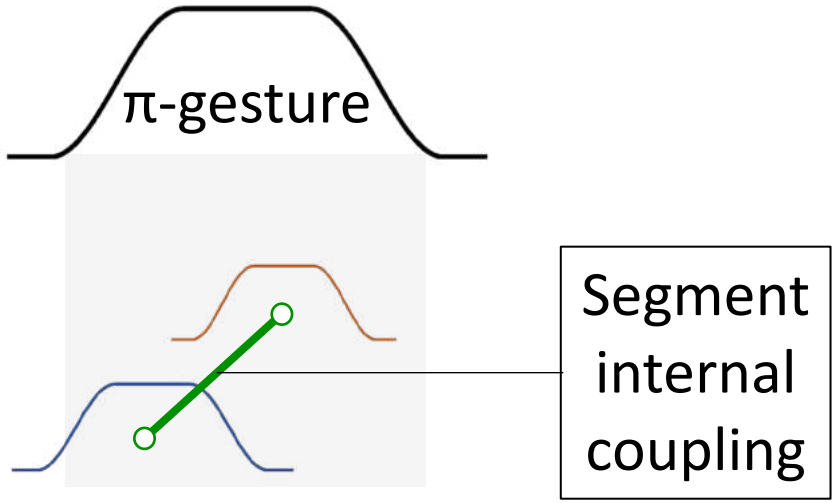
H1. Within-segment timing	**H2. Across-segment timing**
The lag between the gestures is *not affected* by the duration and the magnitude of the gestures	The lag between the gestures *increases* with the duration and magnitude of the earlier gesture

Research questions

B. How do prosodic effects play a role in segment–internal gestures and their timing?

H. Segment–timing stability

Intergestural lag **remains stable** across prosodic variations



Methods

- Data acquisition
  - Mid–sagittal vocal tract speech imaging data using **real–time MRI**
- Subjects
  - Five native Korean speakers
- Target items
  - Coda nasals at boundaries: /**n**#p/ /**n**#t/ /**n**#n/
- Prosodic conditions
  - Wd, AP, AP+focus, IP (7/8 reps each)

Stimuli example

- Wd boundary

  SUBJECT, **ADV** $_{AP}$[**NOUN** number] VERB
  - *Sam slowly cleaned [four chalkboards].*

- AP boundary

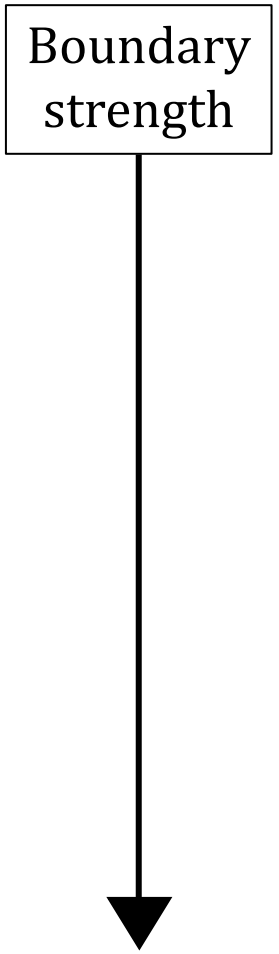
  SUBJECT, $_{AP}$[**ADJ NOUN**] $_{AP}$[number] VERB
  - *Sam cleaned four [large chalkboards].*

- AP boundary+focus

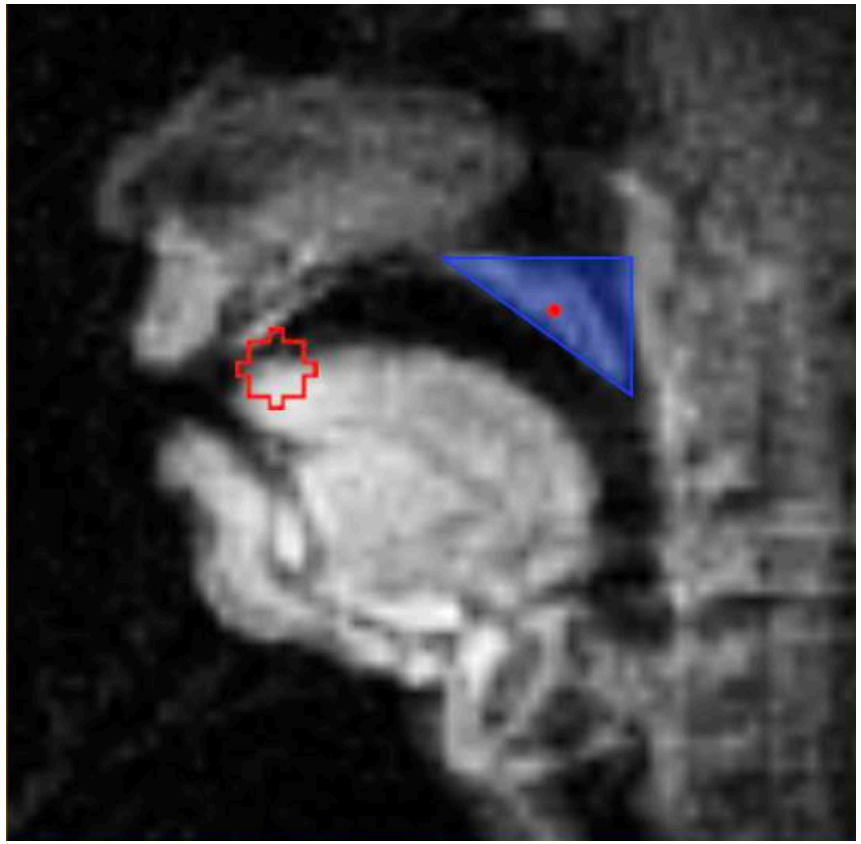
  SUBJECT, $_{AP}$[**ADJ NOUN**] $_{AP}$[number] VERB
  - *Sam cleaned four [large chalkboards].*

- IP boundary

  SUBJECT, $_{AP}$[**ADJ NOUN**], $_{IP}$[……]
  - *This film called [large chalkboards], ……*

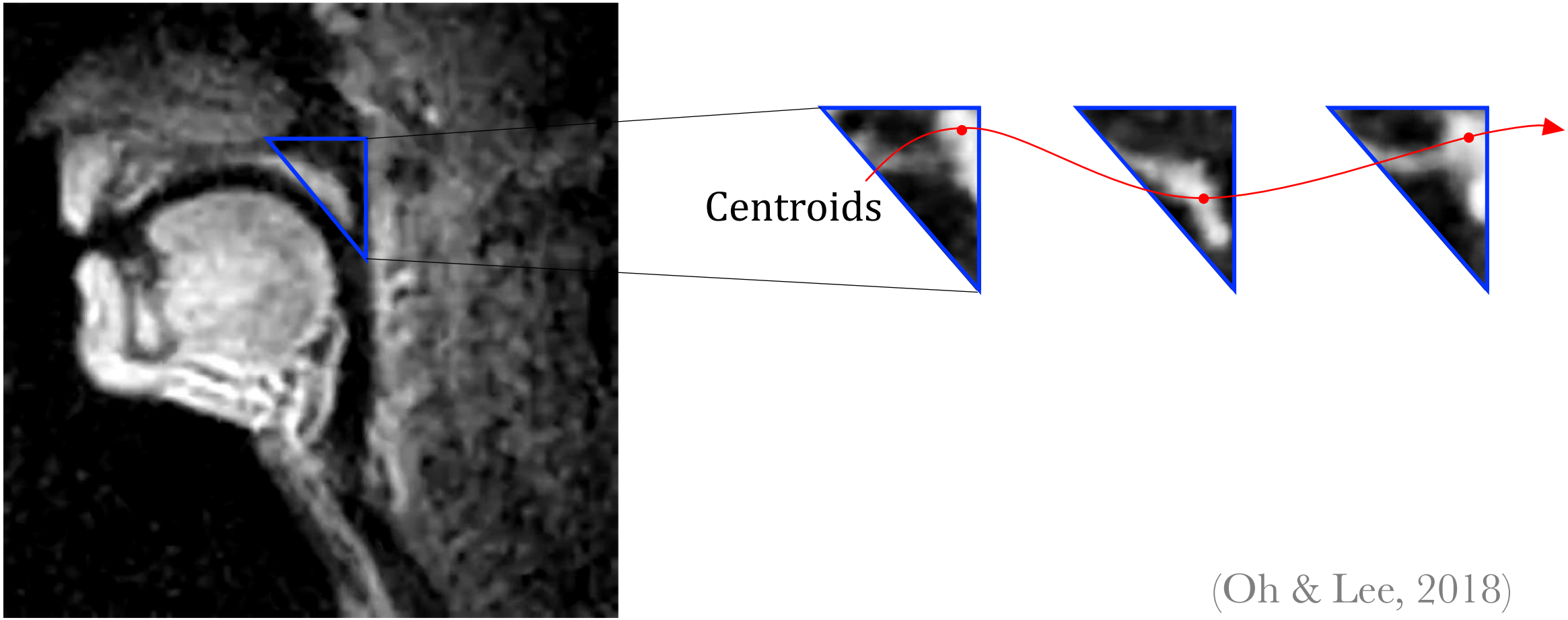


Data analysis



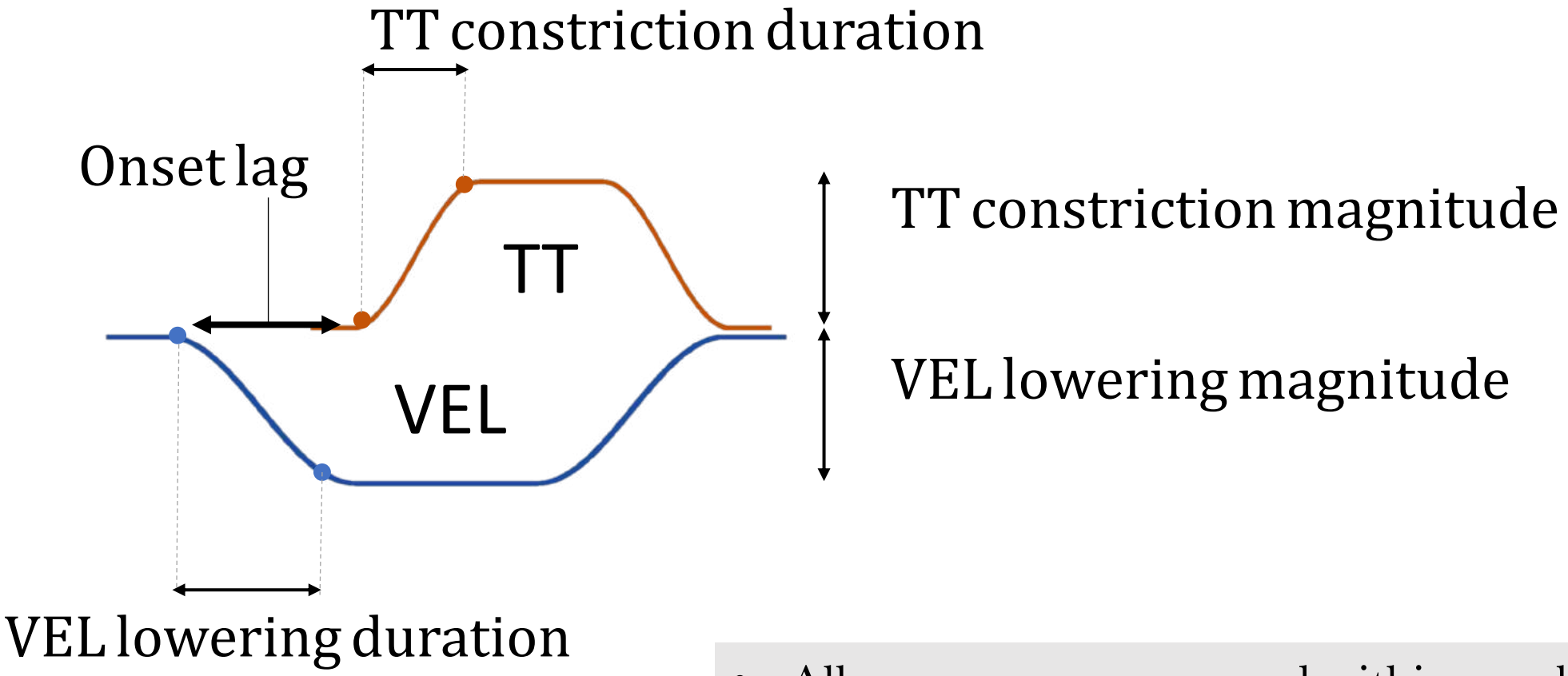
- Oral gesture (TT)
  - ROI analysis
- Velum gesture (VEL)
  - Centroid tracking analysis

Tracking VEL lowering (/ɑmɑ/)



(Oh & Lee, 2018)

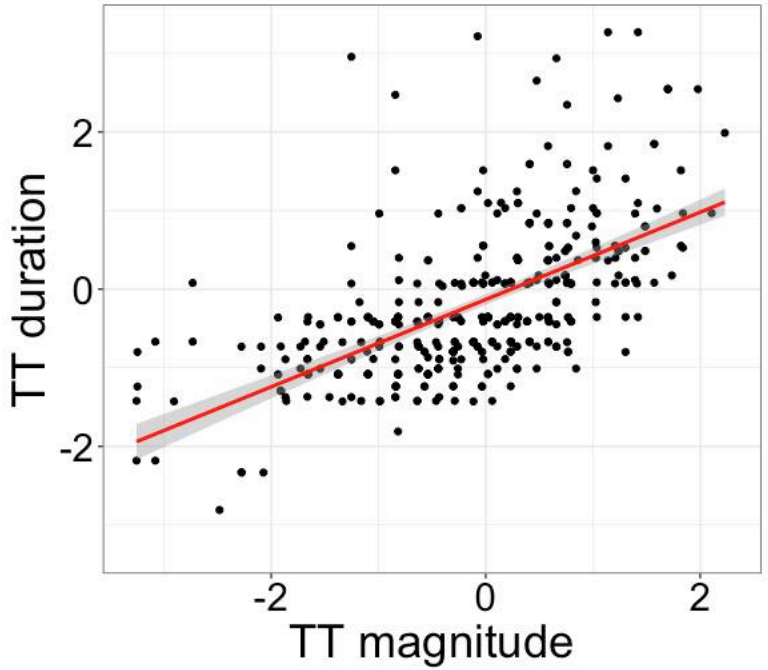
Measurements

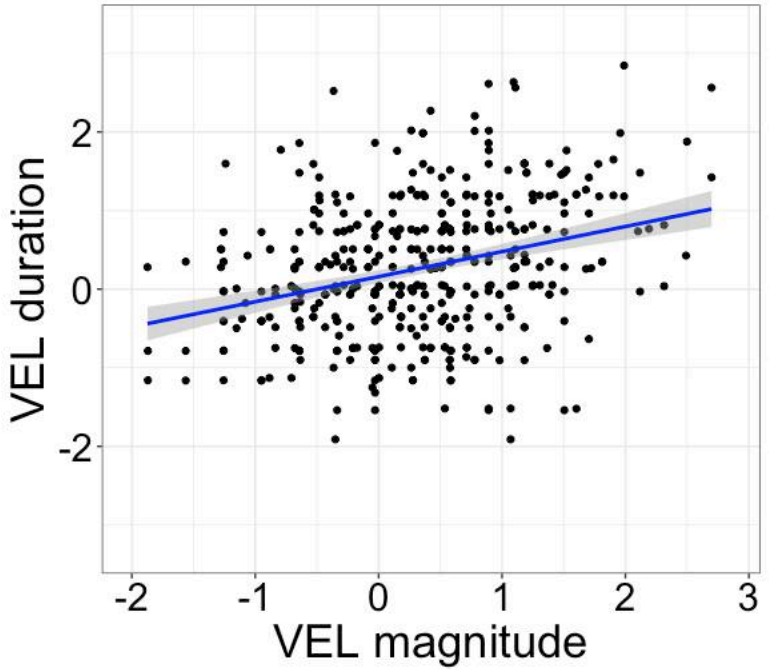


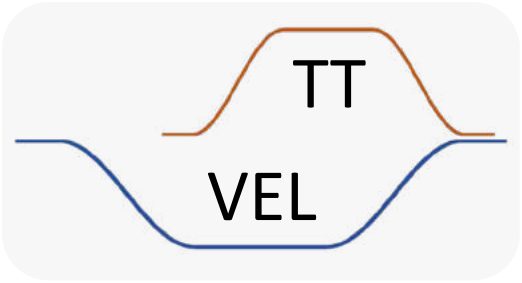
- All measures are z-scored within speaker
- Significance level is set as $p < .01$

Duration x Magnitude

- Positive correlation between duration and magnitude

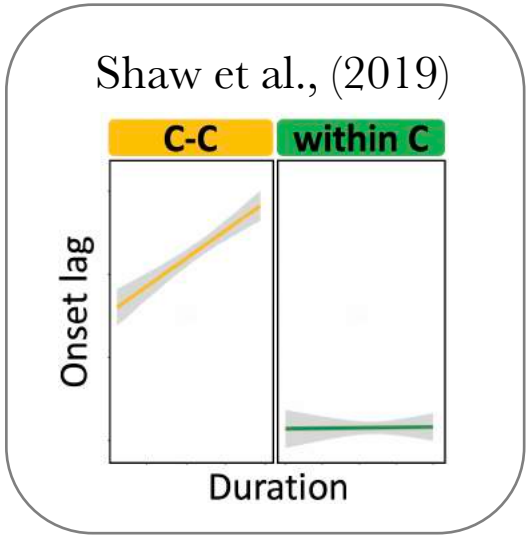


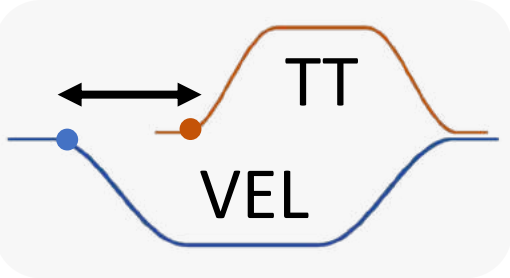


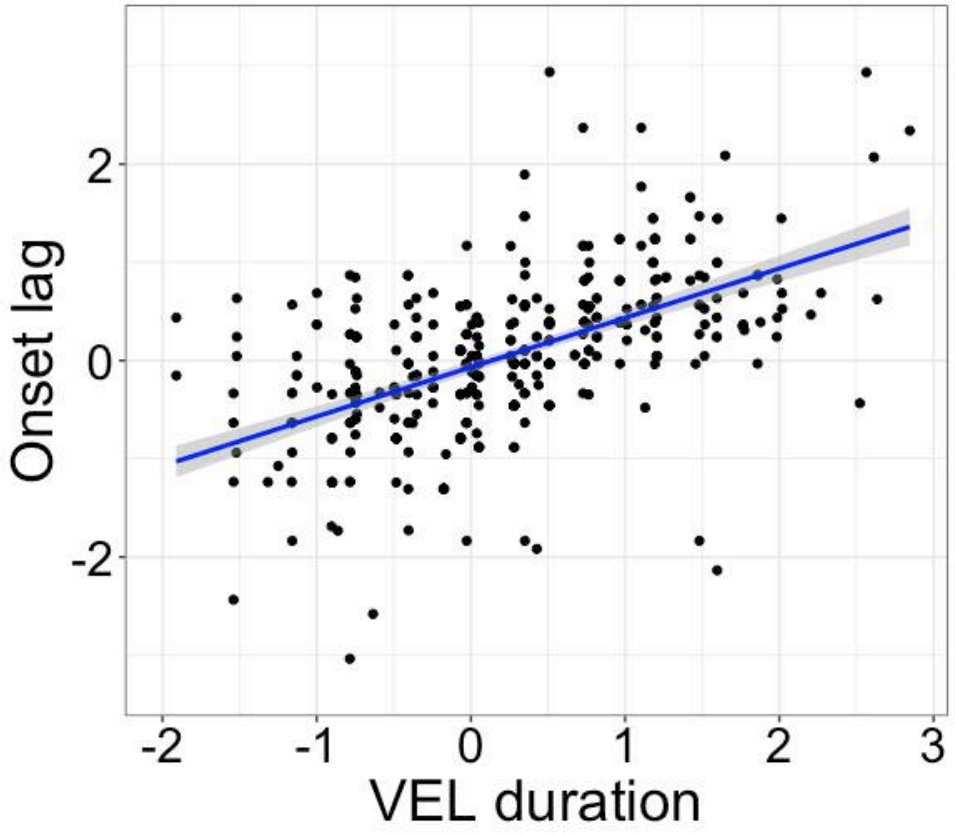


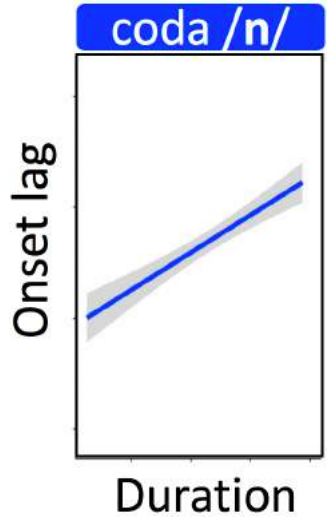
Relative timing x Duration

- Onset lag in /n/ *increases* with the duration of the VEL gesture



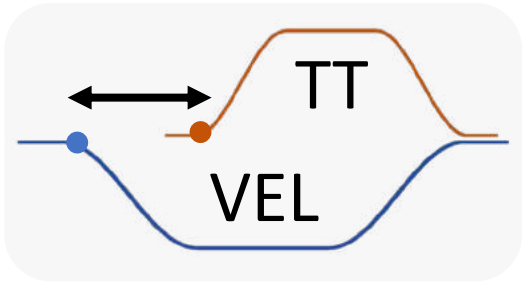


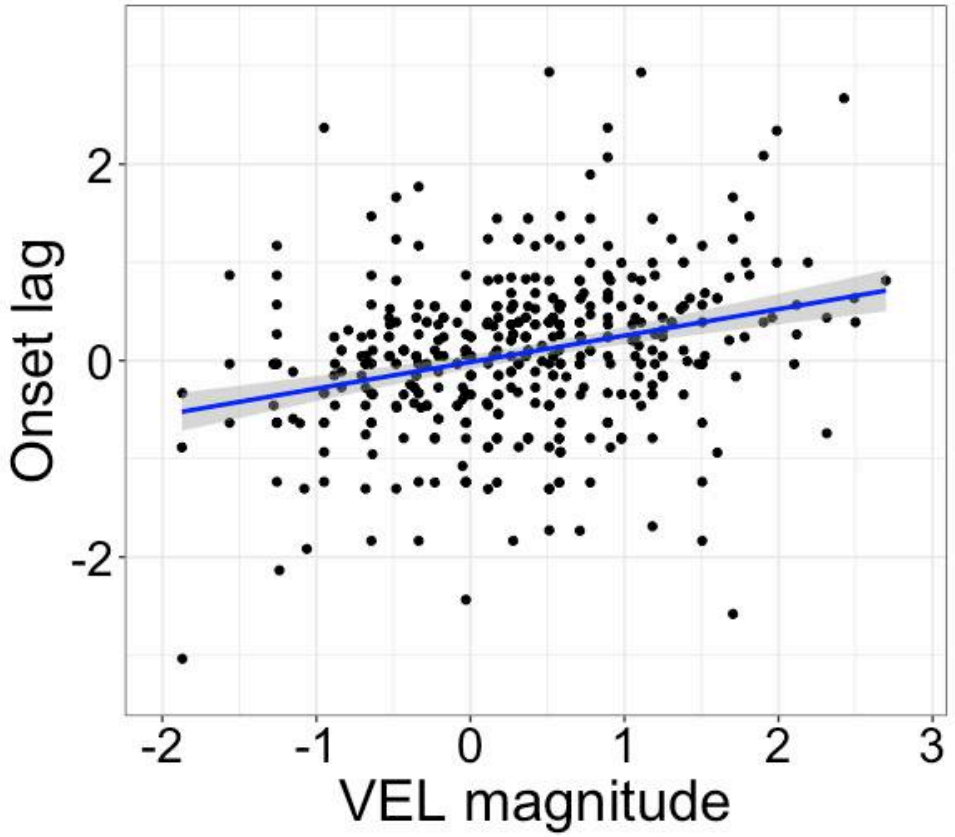




Relative timing x Magnitude

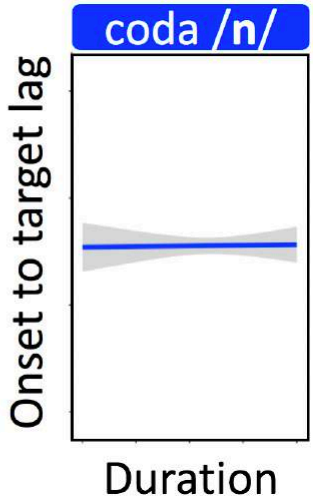
- Onset lag in /n/ *increases* with the magnitude of the VEL gesture

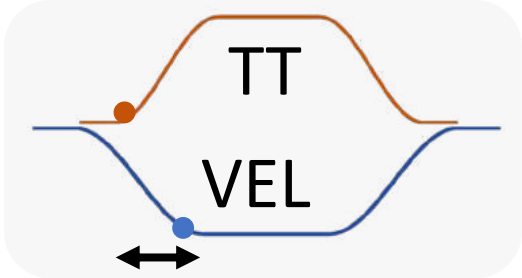


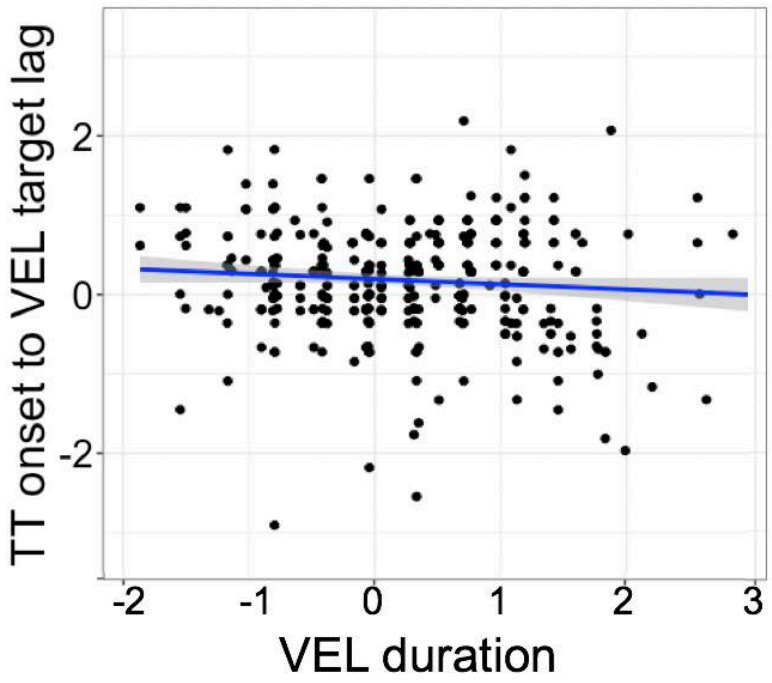


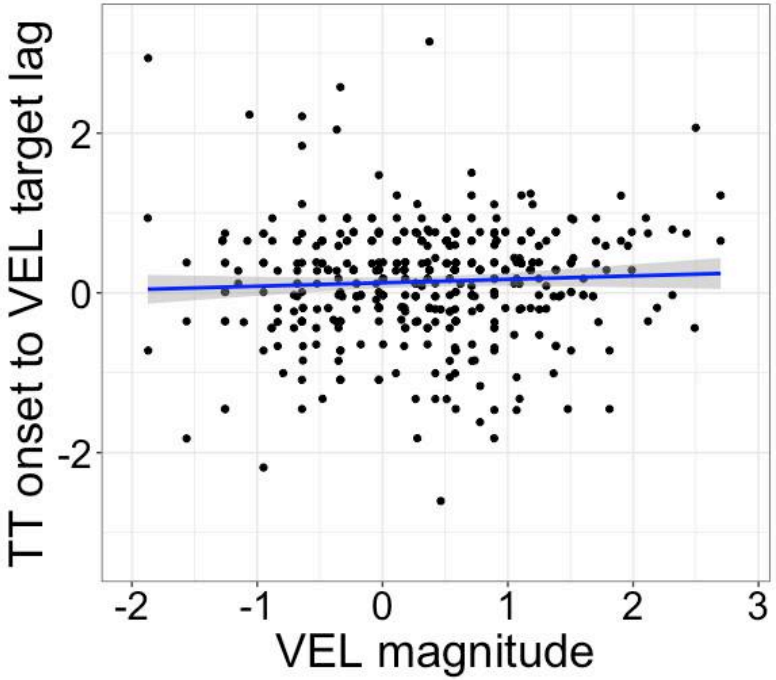
Onset–to–target lag

- TT onset to VEL target lag in /n/ is *not affected* by the duration and magnitude of gestures









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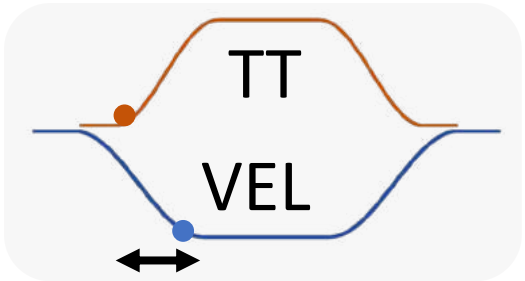
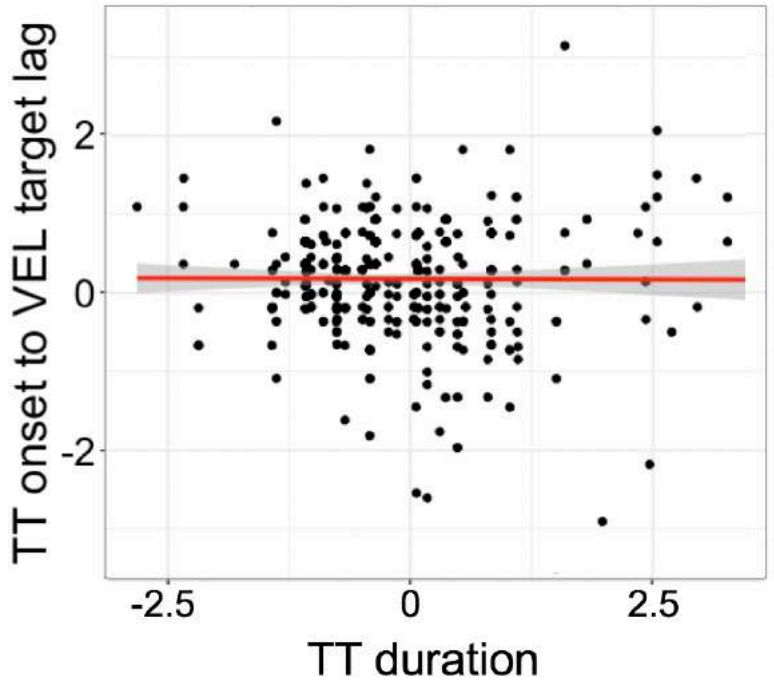
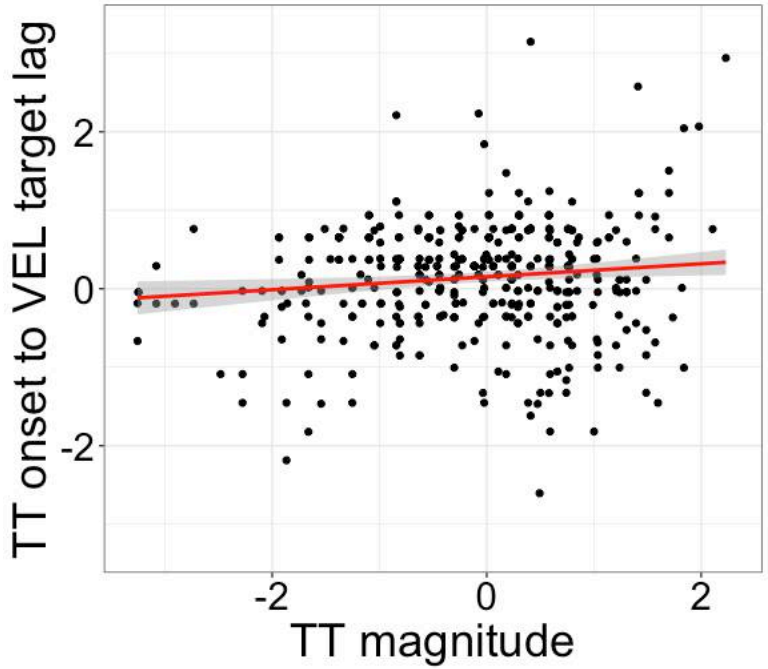
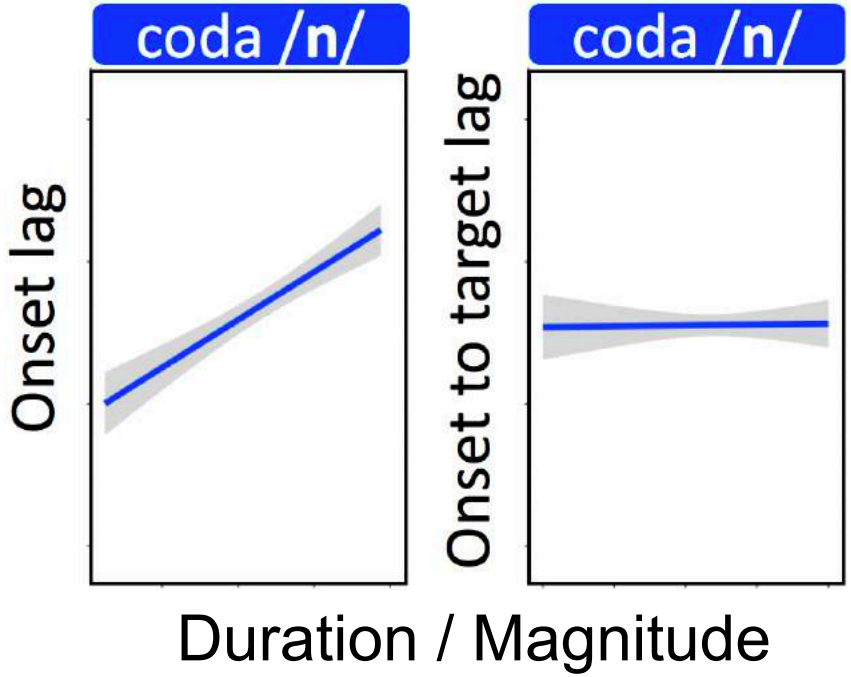






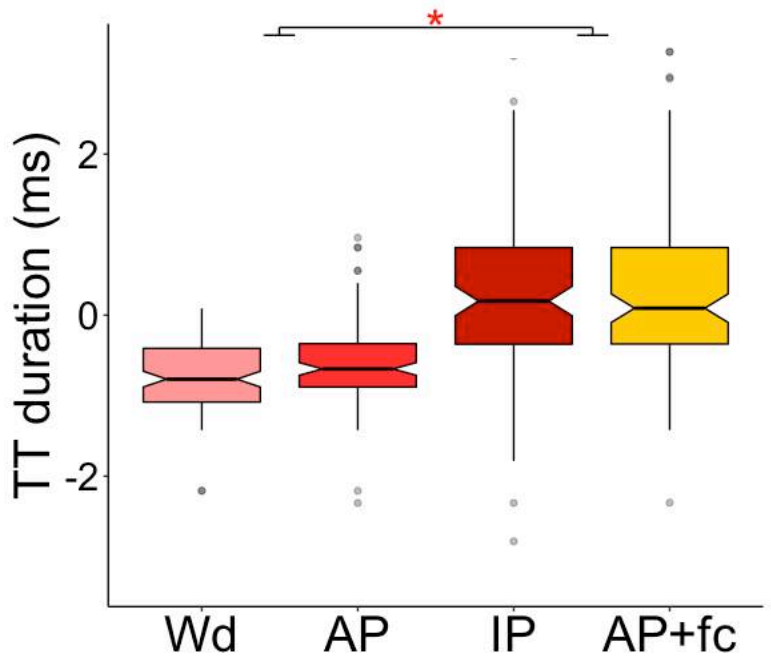
Segment–specific timing

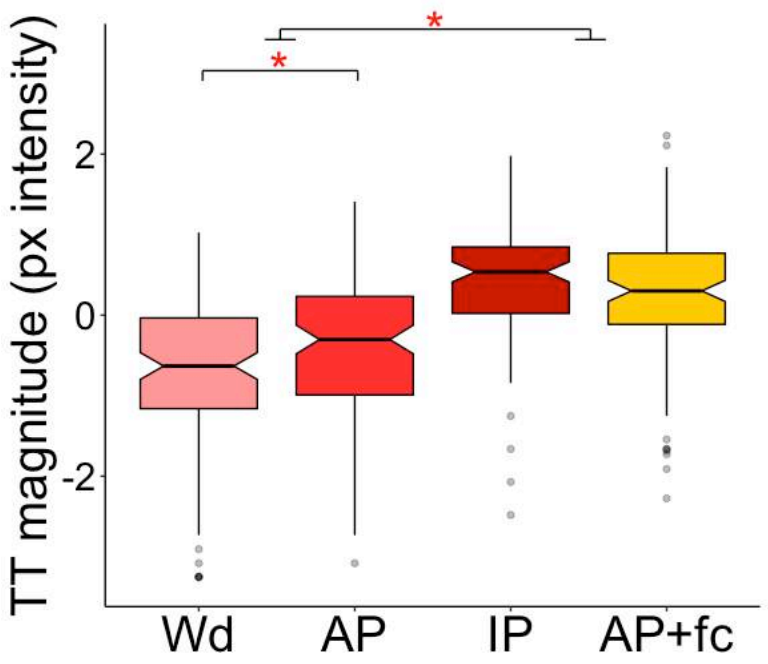
- Korean coda nasals
  - Oral onset to velum target lag shows consistency over gestural duration/magnitude



Prosodic effects on the oral gesture

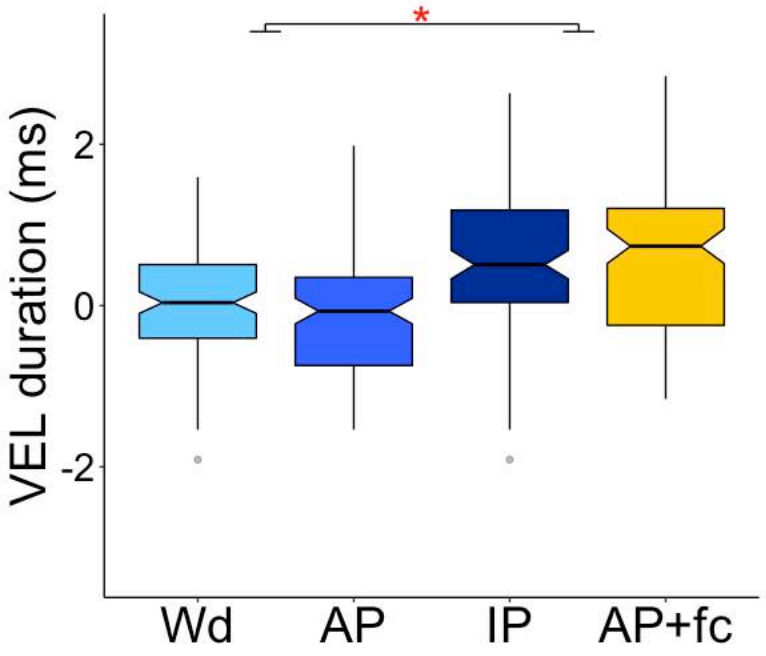
- Boundary & focus effects on TT duration & magnitude

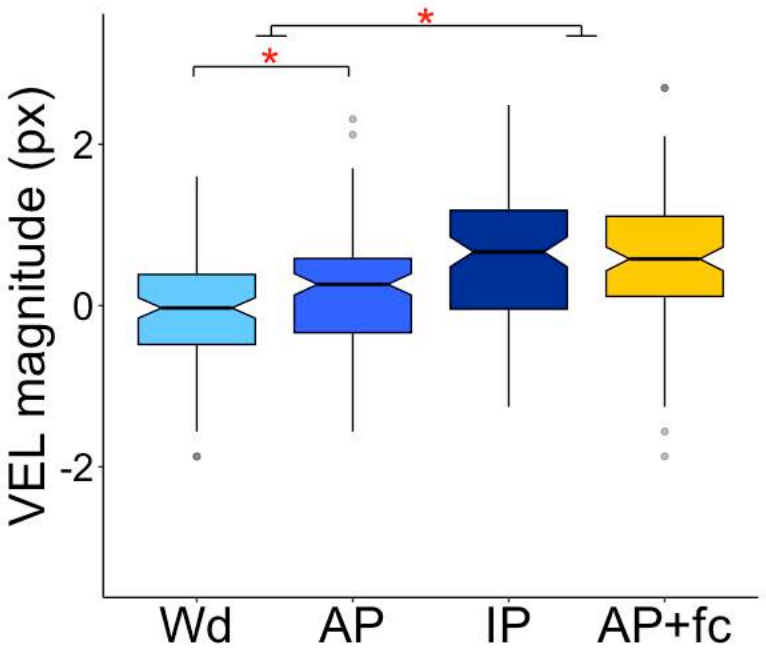




Prosodic effects on the velum gesture

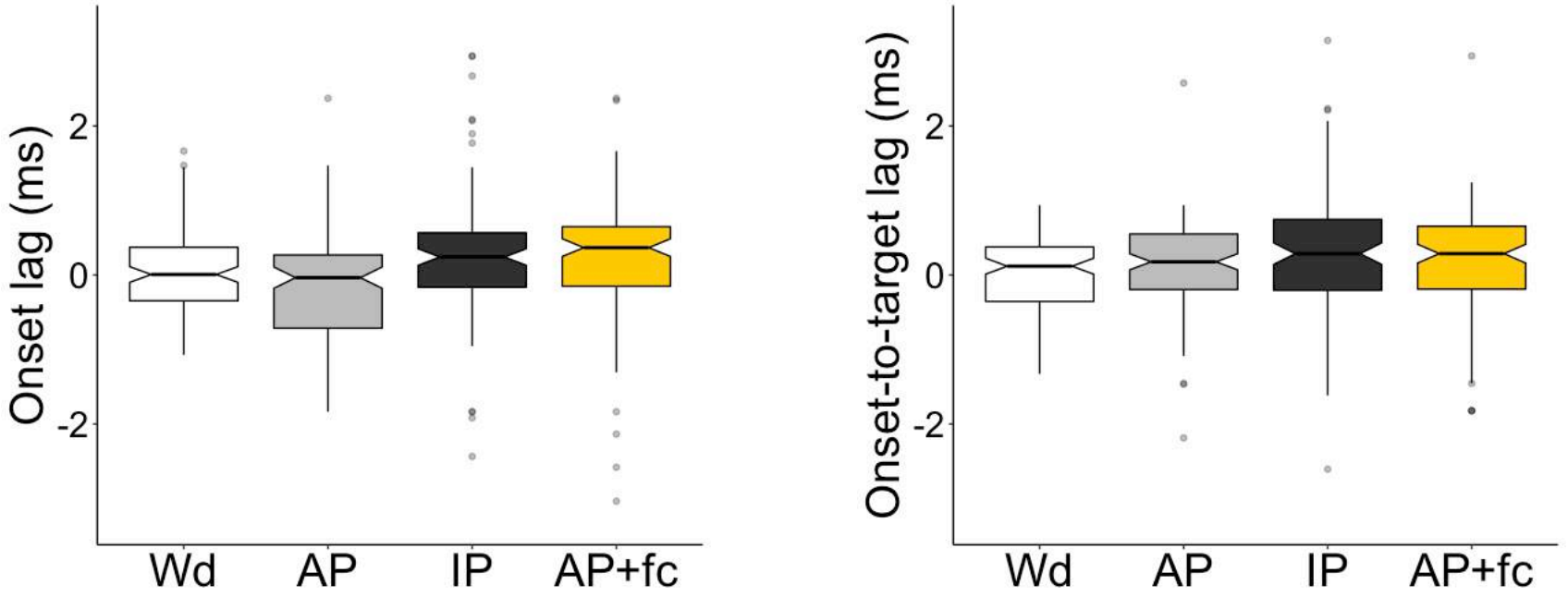
- Boundary & focus effects on VEL duration & magnitude



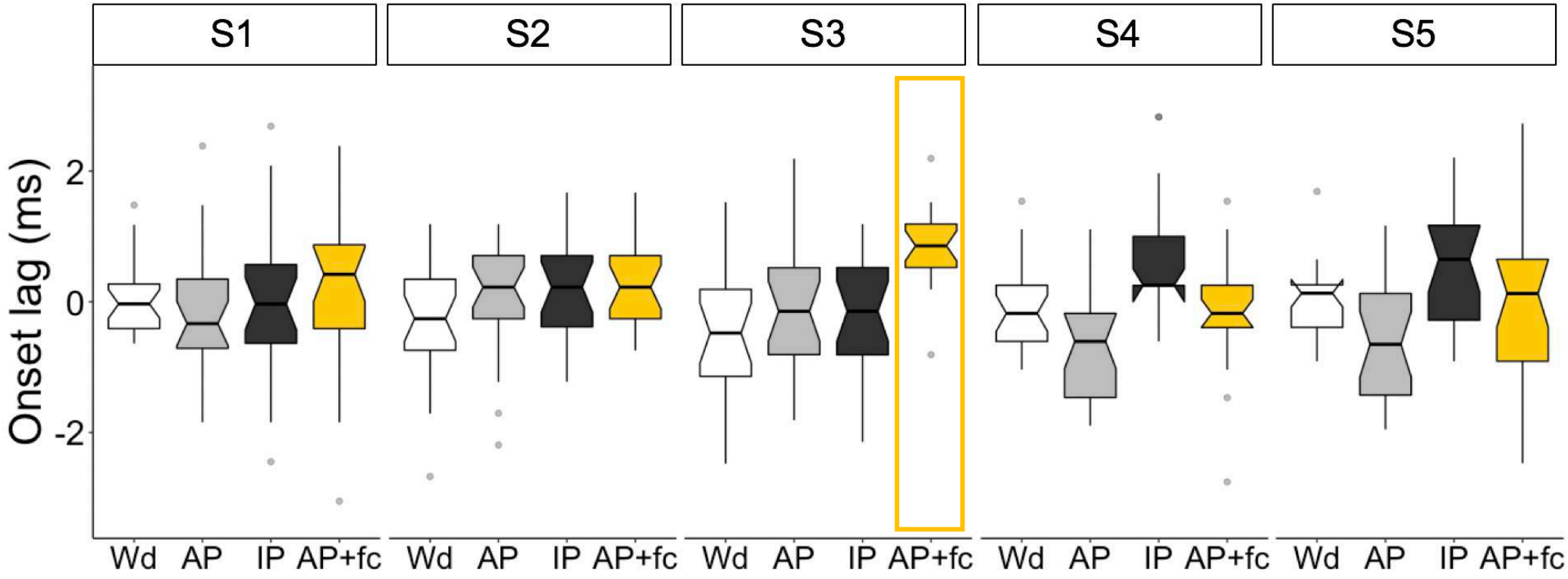


Prosodic effects on the timing

- No effect of prosody on gestural lags

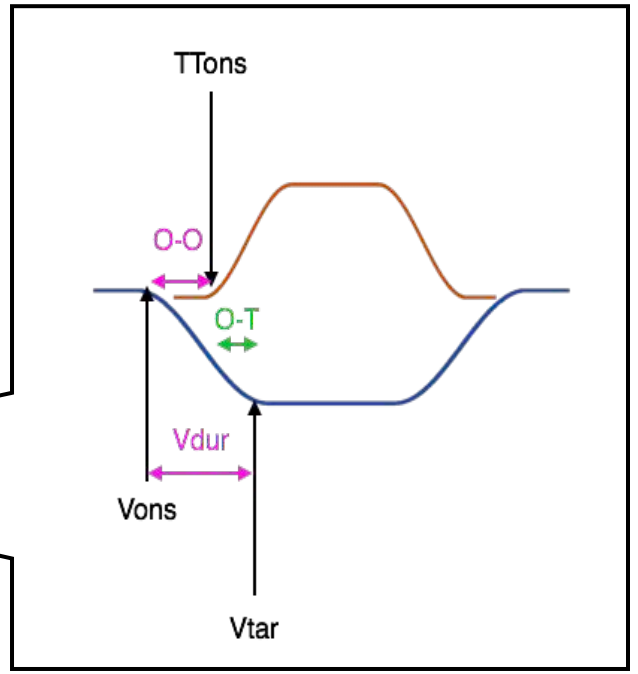


Individual lag variation



Summary

- Segment–specific timing
  - The o–t lag between gestures is independent of the duration and the magnitude of the gestures
- The effect of π–gesture on timing?



- Stable relative timing across prosodic variations
  - This crucial timing stability distinguishes strong segment–internal coupling

Conclusion

Thank you

- **Beňuš, Š., & Šimko, J. (2014).** Emergence of prosodic boundary: Continuous effects of temporal affordance on inter-gestural timing. *Journal of Phonetics*, *44*, 110-129.
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