Prosodic modulation and the role of the segmental gestural molecule

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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/ /\tilde{KP}/ /p/ /k^w/

  - Oral and non-oral gestures
    /n/ /m/ /k'/ /6/
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)?

<table>
<thead>
<tr>
<th>H1. Within-segment timing</th>
<th>H2. Across-segment timing</th>
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<tbody>
<tr>
<td>The lag between the gestures is <em>not affected</em> by the duration and the magnitude of the gestures</td>
<td>The lag between the gestures <em>increases</em> with the duration and magnitude of the earlier gesture</td>
</tr>
</tbody>
</table>
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

π-gesture

Segment internal coupling
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, \(\text{ADV}_{\text{AP}}\text{[NOUN number]}\) VERB
  - Sam slowly cleaned [four chalkboards].

- AP boundary
  SUBJECT, \(\text{AP}_{\text{[ADJ NOUN]}\text{[number]}\text{[NOUN]}}\) VERB
  - Sam cleaned four [large chalkboards].

- AP boundary+focus
  SUBJECT, \(\text{AP}_{\text{[ADJ NOUN]}\text{[number]}\text{[NOUN]}}\) VERB
  - Sam cleaned four [large chalkboards].

- IP boundary
  SUBJECT, \(\text{AP}_{\text{[ADJ NOUN]}, \text{IP}[\ldots]}\) VERB
  - This film called [large chalkboards], .......
Data analysis

- Oral gesture (TT)
  - ROI analysis

- Velum gesture (VEL)
  - Centroid tracking analysis
Tracking VEL lowering (/ama/)

(Oh & Lee, 2018)
Measurements

- TT constriction duration
- Onset lag
- VEL lowering duration
- TT constriction magnitude
- VEL lowering magnitude

• 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

Shaw et al., (2019)
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.
Onset-to-target lag

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