Asymmetries in the kinematics of Australian English vowel gestures

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INTRODUCTION

- Consonants modelled split-gestural control [1, 2, 3, 4, 5]
  i. Movement to target (formation interval; FI)
  ii. Movement from target (release interval; RI)
- Split-control not widely applied to V gestures
- German tense/lax contrast: 2 independently controlled intervals [6,7,8]
- German lax vowels:
  - stiffer FIs compared to tense [6]
  - same RI stiffness as tense Vs [6]
  - truncated FIs compared to tense [6,7,8]
- Australian English (AusE): non-rhotic English variety
- Length contrasts some V pairs e.g., /ɐː-ɐ/ (*'bard-bud'*)
- /ɐː-ɐ/ differ primarily in duration, overlapping acoustic targets [9]

RESEARCH QUESTIONS & HYPOTHESES

Are /ɐː/ & /ɐ/ in AusE produced with similar kinematics to German?

- H1: FI of /ɐ/ will be stiffer than FI of /ɐː/
- H2: RI stiffness of /ɐ/ will not differ from RI stiffness of/ɐː/
- H3: FI of /ɐ/ will be truncated in AusE compared to FI of /ɐː/
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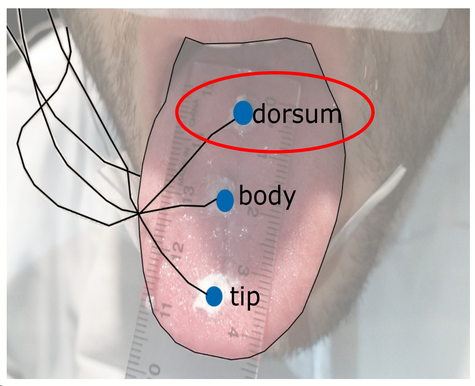
Is there evidence for split-gestural control in vowels?

- H4: FI duration will differ from RI duration
- H5: FI stiffness will differ from RI stiffness
- H6: V. length will be implemented in FI & RI differently
  - V. length will condition FI & RI duration differently
  - V. length will condition FI & RI stiffness differently

METHODS

PARTICIPANTS:

- 9 F AusE speakers (M = 19.5 years)
- Electromagnetic articulography



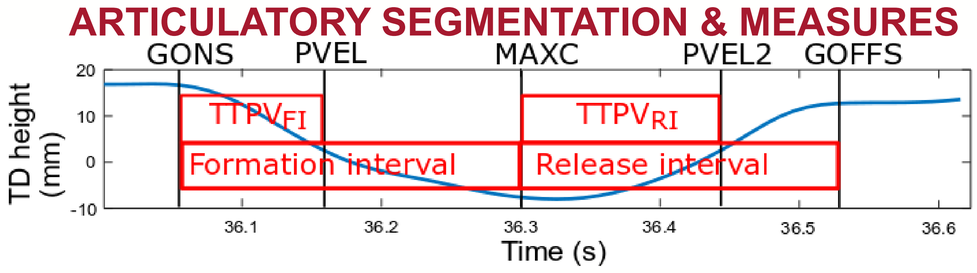
ELICITATION MATERIALS:

- /ɐː-ɐ/ - 'parp' vs. 'pup'
- Carrier phrase: *Fee pVp heat*
- Presentation time:
  - normal rate: 1500 ms + 500 ms pause
  - fast rate: 750 ms + 500 ms pause
- 16 repetitions each vowel per speaker (8 normal + 8 fast)

DATA SEGMENTATION & ANALYSIS:

- Articulatory landmarks from sensor tangential velocities in MView [10]
- TD: /ɐː-ɐ/
- FI duration = GONS-MAXC (ms)
- RI duration = MAXC-GOFFS (ms)
- Stiffness*: time to peak velocity (TTPV):*
  - $TTPV_{FI}$ = GONS-PVEL (ms)
  - $TTPV_{RI}$ = MAXC-PVEL2 (ms) [11, 12]
- Shorter TTPV = stiffer gesture [11, 12, 13]
- Truncation: *Acceleration Ratio (AR):* $\frac{\text{Time to peak velocity (ms)}}{\text{FI duration (ms)}}$
- AR > 0.5 = truncated movement [11, 12]
- 250/288 tokens analysed

ARTICULATORY SEGMENTATION & MEASURES



STATISTICAL ANALYSIS:

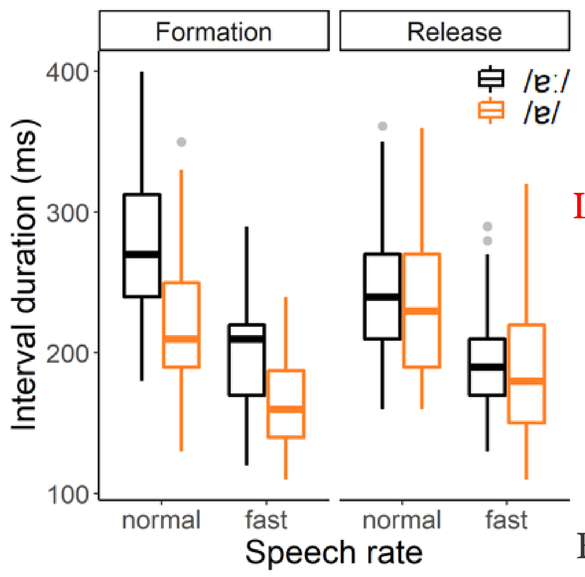
- Linear mixed effects models constructed in R [14]
- Dep. Var. ~ V. length × S. rate {× Interval} + (1 | speaker)
- Intercepts: Long = 0, Normal = 0, Formation interval = 0

REFERENCES

[1] Nam (2007). *Proc. ICPHS2007, 1: 625-629.* [2] Nam et al (2009). *Approaches to phonological complexity,* 16: 299-328. [3] Nam (2007). *LabPhon9,* 483-506. [4] Tilsen et al. (2012). *JPhon,* 40: 764-779. [5] Browman (1994). *LabPhon3,* 331-353. [6] Hertrich et al. (1997). *JASA,* 102: 523-536 [7] Hoole et al., (1994). *ICLSP, 53-56.* [8] Hoole et al. (2002). *Silben. & Tonakz.* 129-152. [9] Cox (2006). *AJL,* 26: 147-179. [10] Tiede (2005) [11] Byrd et al. (2000). [12] Cho (2006). *LabPhon8,* 519-548. [13] Saltzman et al. (1989). *Ecol. Psych.,* 1: 333-382. [14] Bates (2010) *Springer.*

RESULTS

INTERVAL DURATION

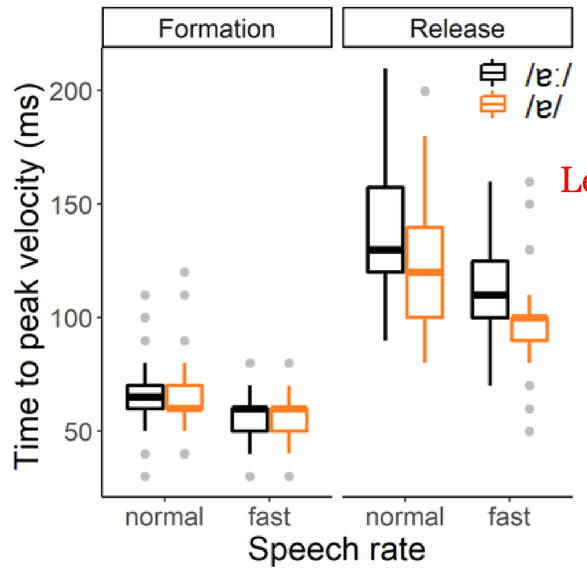


Length (β =-63 ms, $p < .001$) ***
Rate (β =-80 ms, $p < .001$) ***
Interval (β =-38 ms, $p < .001$) ***
Length × Int. (β = 56 ms, $p < .001$)***
Rate × Int. (β = 42 ms, $p < .001$) ***

Interval duration summary

/ɐ/ shorter than/ɐː/
fast Vs shorter than normal Vs
FI longer than RI
FI more impacted by V. length than RI
FI more impacted by rate than RI

STIFFNESS: TIME TO PEAK VELOCITY

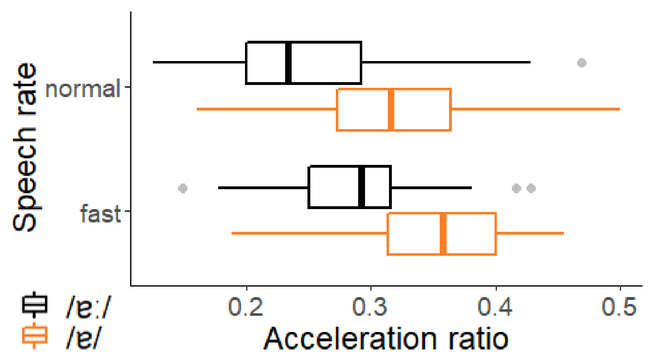


Length (p = .863)
Rate (β =-7.9 ms, p = .026) *
Interval (β = 70 ms, $p < .001$) ***
Length × Int. (β =-12 ms, p = .007) ***
Rate × Int. (β =-16 ms, p = .001) **

TTPV summary

/ɐ/ same TTPV as /ɐː/
Fast Vs shorter TTPV than normal Vs
FI shorter TTPV than RI
FI less impacted by V. length than RI
FI less impacted by rate than RI

TRUNCATION: ACCELERATION RATIO



Length (β = 0.07, $p < .001$) ***
Rate (β = 0.03, p = .018) *

AR summary

/ɐ/ longer AR than /ɐː/
Fast Vs longer AR than normal Vs

SUMMARY

	Duration		Stiffness: TTPV		Truncation: AR
	FI	RI	FI	RI	
V. Length	/ɐ/ < /ɐː/	/ɐ/ < /ɐː/	/ɐ/ = /ɐː/	/ɐ/ < /ɐː/	/ɐ/ > /ɐː/
Interval	FI > RI		FI > RI		
V. Length x Int	FI > RI		FI < RI		

/ɐː-ɐ/ produced with different kinematics to tensity in German

- No diff. in stiffness for FI of /ɐ/ & /ɐː/
- RI of /ɐ/ stiffer than RI of /ɐː/
- FI of /ɐ/ not truncated compared to /ɐː/

There is evidence for split-gestural control in AusE vowels.

- FI duration differs from RI duration
- FI stiffness differs from RI stiffness
- V. length & speech rate implemented in FI and RI differently
  - Diff. in duration between /ɐ/ & /ɐː/ larger for FI
  - Only stiffness of RI differs between /ɐ/ & /ɐː/

CONCLUSIONS

- /ɐ/ has shorter FI and RI than /ɐː/
- /ɐ/ same FI stiffness, but stiffer RI compared to /ɐː/
- /ɐ/ has higher acceleration ratios compared to /ɐː/
  BUT /ɐ/ acceleration ratios < 0.5, not truncated
- Evidence for split-gestural control in AusE vowels