

Degree of articulatory constraint predicts locus equation slope for /p, t, s, f/

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Background

Degree of Articulatory Constraint Model (Recasens, Pallarès, & Fontdevila, 1997; Iskarous, Fowler & Whalen, 2010)

- For a segment: ↑ DAC = ↑ tongue dorsum involvement = ↑ resistance to co-articulation

Prosodic Strengthening model (Cho, 2005; Keating, 2006; de Jong, 1995)

- In prosodically strong positions, segments have ↑ velocity, ↑ amplitude, and/or ↑ duration of movement
- Gestures for consecutive sounds pushed farther apart temporally
- Can this in turn reduce co-articulation?

Locus equations (LE) can quantify co-articulation (Krull, 1988; Sussman, McCaffrey & Matthews, 1991; Lindblom & Sussman, 2012)

- ↑ LE slope = ↑ co-articulation

Central questions

Do DAC model's predictions for /p, t, s, f/ extend to LE as a measure for co-articulation?

- If yes, expect LE slopes to rank /p/ > /t/ > /s/ > /f/.

Does contrastive focus reduce co-articulation for /p, t, s, f/?

- If yes, expect LE slopes to be shallower under contrastive stress. (Duez 1992)
- Does it depend on what segment is being contrasted?

Methods

- Confederate led a scripted dialogue; 32 participants produced a CV sequence in a carrier phrase (80 dialogues total per participant) (Ohala, 1994; Maniwa, Jongman & Wade, 2009):
 - V was one of /i/, /æ/, /ɑ/, /oʊ/, or /u/
 - C (the TARGET) was one of /p/, /t/, /s/ or /f/
- To elicit contrastive focus, confederate "misheard" portion of dialogue:
 - In Control condition, preceding word was misheard
 - In Prominent condition, TARGET was misheard for another C (the CONTRAST)
- Four different TARGET-CONTRAST pairs evaluated:
 - /p-t/, /t-s/, /t-f/, and /s-f/

To test DAC hypothesis...

Effect of TARGET on LE slope

To test contrastive focus hypothesis...

Effect of condition (Prominent vs Control) on LE slope
Effect of TARGET-CONTRAST pair on LE slope

Sample Dialogues

CONFEDERATE

PARTICIPANT

CONTROL

Green peep?
What? Great peep?

Have you heard of "grey peep?"

No, GREY peep.
No! GREY peep.

PROMINENT

Grey what?
What? Grey teep?

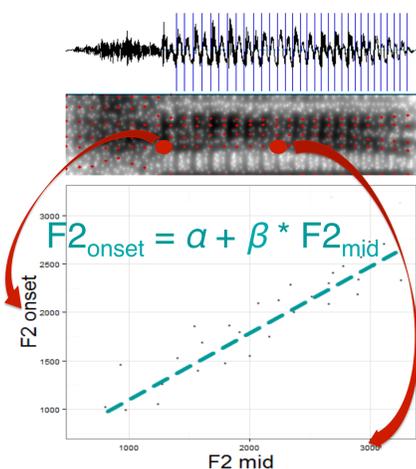
Have you heard of "grey peep?"

Grey PEEP.
No! Grey PEEP.

CONTRAST

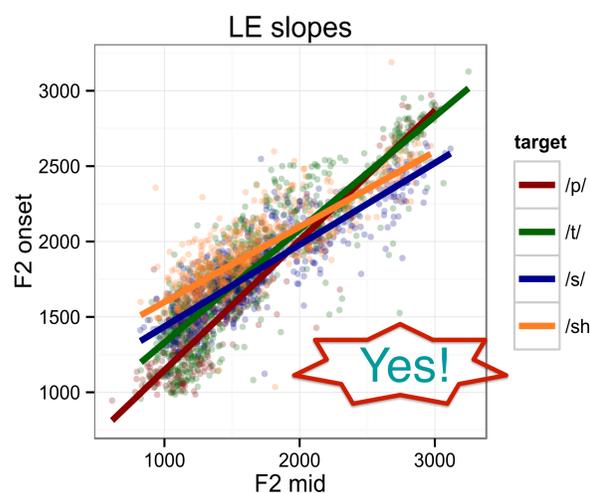
TARGET

Deriving LEs: A schematic



- 2533 tokens hand measured
- Mixed effects linear regression (lmer in R) for each target/contrast pair
- fixed effects of F2 mid, Condition and Target and interactions
- random slopes and intercepts by participant

DAC model predicts LE slope?

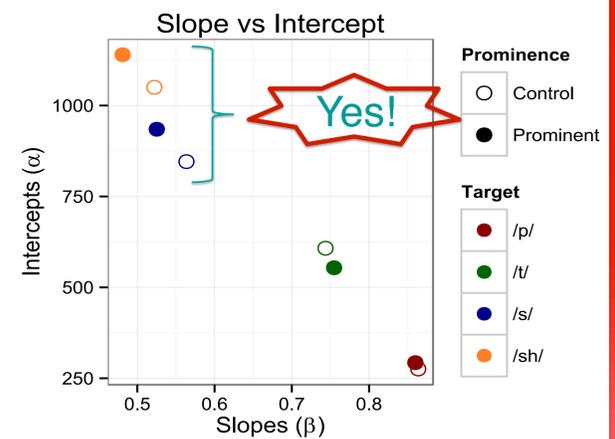


As predicted, LE slopes:

/p/ > /t/ > /s/ > /f/

target	Estimate	Std. Err.	t value	Pr(> t)
/p/ vs. /t/	-121.8	22.9	-5.31	1.31e-07 ***
/t/ vs. /s/	-255.0	17.8	-12.66	< 2e-16 ***
/s/ vs. /f/	-40.6	14.4	-2.82	0.00481 **

Contrastive focus shifts LE slope?



Focus decreases co-articulation for /s/ and /f/

Target	Estimate	Std. Err.	t value	Pr(> t)
/p/	7.5	20.4	0.37	0.7135
/t/	-5.2	16.8	-0.31	0.75917
/s/	-30.1	13.7	-2.19	0.02851 *

No significant effect of target-contrast pair

Discussion

- Segments with more restrictive tongue shape requirements have shallower slopes as predicted by DAC
 - More posterior place of articulation = shallower LE slope
 - Sibilants shallower than stops (due to requirements for frication)

- Prominence decreases the LE slope of sibilants, but not stops.
 - Why? Cole, Cho & Kim (2003) found increased slope for voiceless stops, possibly due to longer VOTs with prominence
- Nature of the misheard segment does not modulate LE slope
 - is the goal of clear speech to separate acoustically confusable segments, or to produce prototypical segments?

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