

Research Questions

1. Are durational cues to word boundaries present in spontaneous speech as in lab speech?
2. Which of two possible mechanisms – word-initial lengthening or word-final lengthening – best explains our data?

Background

- Acoustic cues to word boundaries**
- F0, amplitude contour, **durational patterns**, allophonic variation, etc.
- Boundary-related lengthening**
- **Word-initial lengthening**
Domain-initial strengthening (DIS)
Strongest at the initial segment and becomes gradually weaker
 - **Word-final lengthening**
Preboundary lengthening
e.g., Phrase-final lengthening
Evidence at word-level is less clear
[Cho & Keating, 2009; Turk & Shattuck-Hufnagel, 2000; Cho, 2016]
- Speech style**
- **Laboratory read speech**
Hyper-articulation, careful speech
 - **Spontaneous speech**
reduction and lenition, casual speech
[Lindblom, 1990]

Methods

Participants

- Native speaker of North American English
- 3 females & 3 males in their 20s


Materials

- 27 pairs of near-homophonous phrases e.g., *beef eater* vs. *bee feeder*; *grade A* vs. *grey day* [Lehiste, 1960]
- One article for each target phrase


What type of the bee feeder is the best?

Many types of honey bee feeders are available on the market. Do you know the differences among them?

- **Open air bee feeder:** Actually, bee feeders constructed out in the open air should never be used. They attract all types of wildlife, like wasps and birds.
- **Entrance bee feeders:** Entrance bee feeders have two basic parts—a feeding tray and an inverted syrup container, which remains on the outside of the hive. They make it easy to see how much feed is left and are easy to refill.



Beef Eater



Beef eater at the Tower of London are the ceremonial guardians. **Why are they called Beef eater?** Nobody knows for sure. The most accepted speculation is that the term originated from the fact that in the past they were allowed to eat as much beef as they liked from the King's table. Eventually, 'beef eater' became a term used to refer to the Body Guard at the Tower of London.

Procedure

- **Conversation** Participants read the article silently first, then explained its content to the confederate.
- **One-week gap** Half the articles were presented in an initial session, and their counterparts one week later.
- **Annotation & analysis**

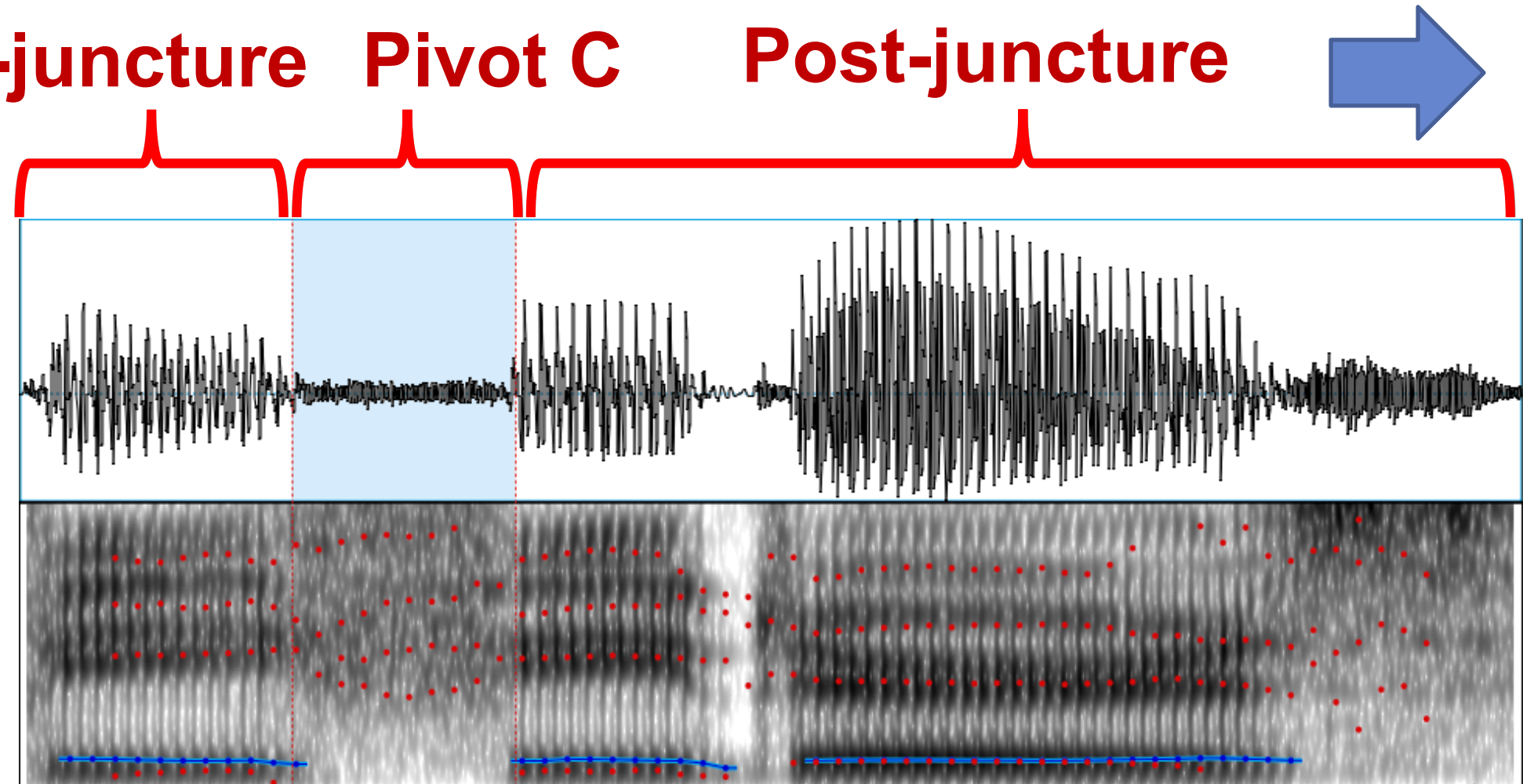
355 tokens

- 133 *coda* tokens
- 222 *onset* tokens

Voiceless	Voiced	Nasal	Fricative	Cluster					
/p/	/t/	/k/	/b/	/d/	/n/	/m/	/f/	/s/	/st/
67	26	21	42	33	30	17	41	56	22

- Exclude unusual pronunciations & salient boundary cues
- **Prosodic-phrasing information**
 - the presence/absence of an intonational boundary adjacent to the phrase (i.e., ip/IP)

Pre-juncture **Pivot C** **Post-juncture** **Relative duration**

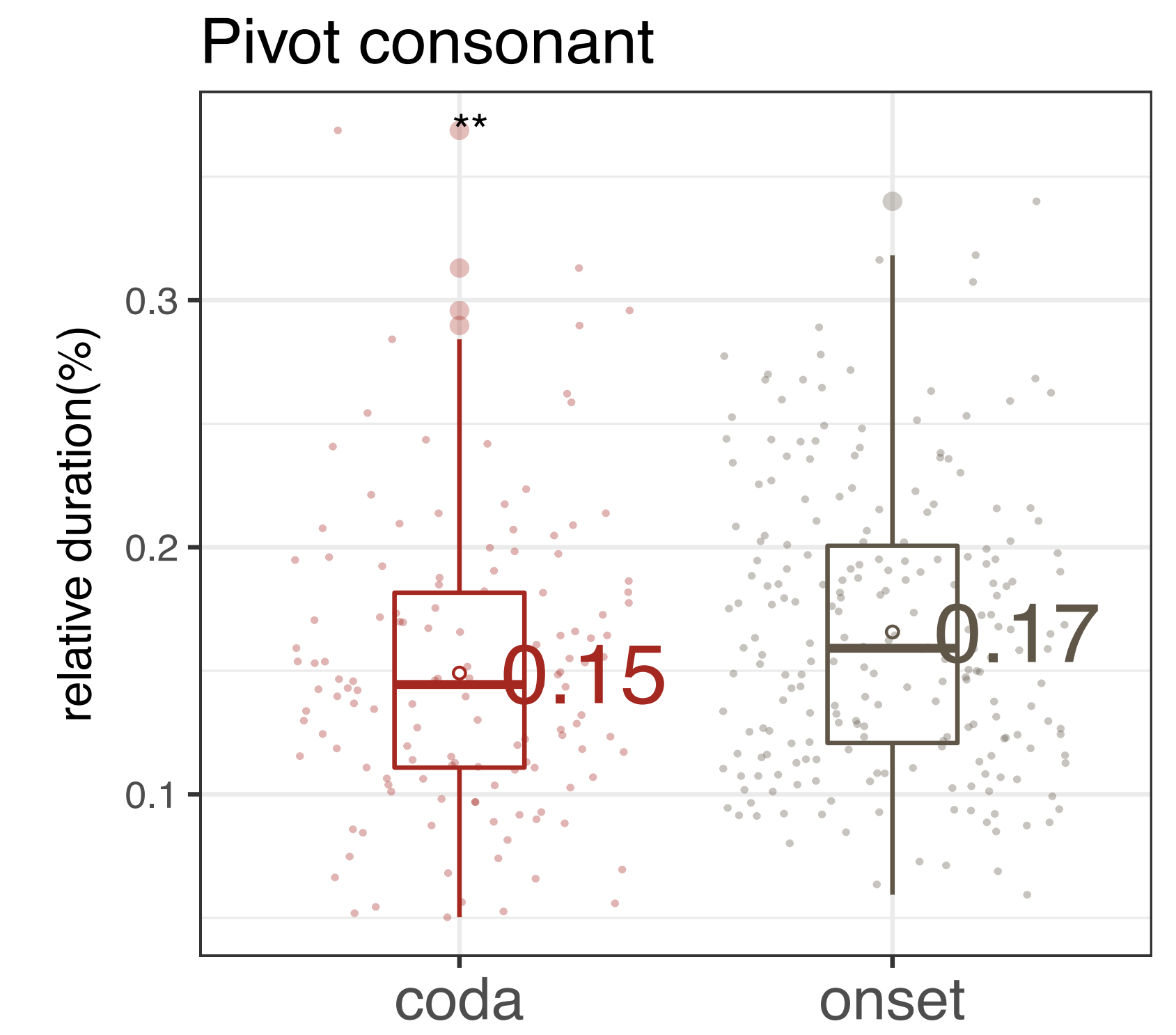


Force aligned (Montreal Forced Aligner)

Hand adjusted

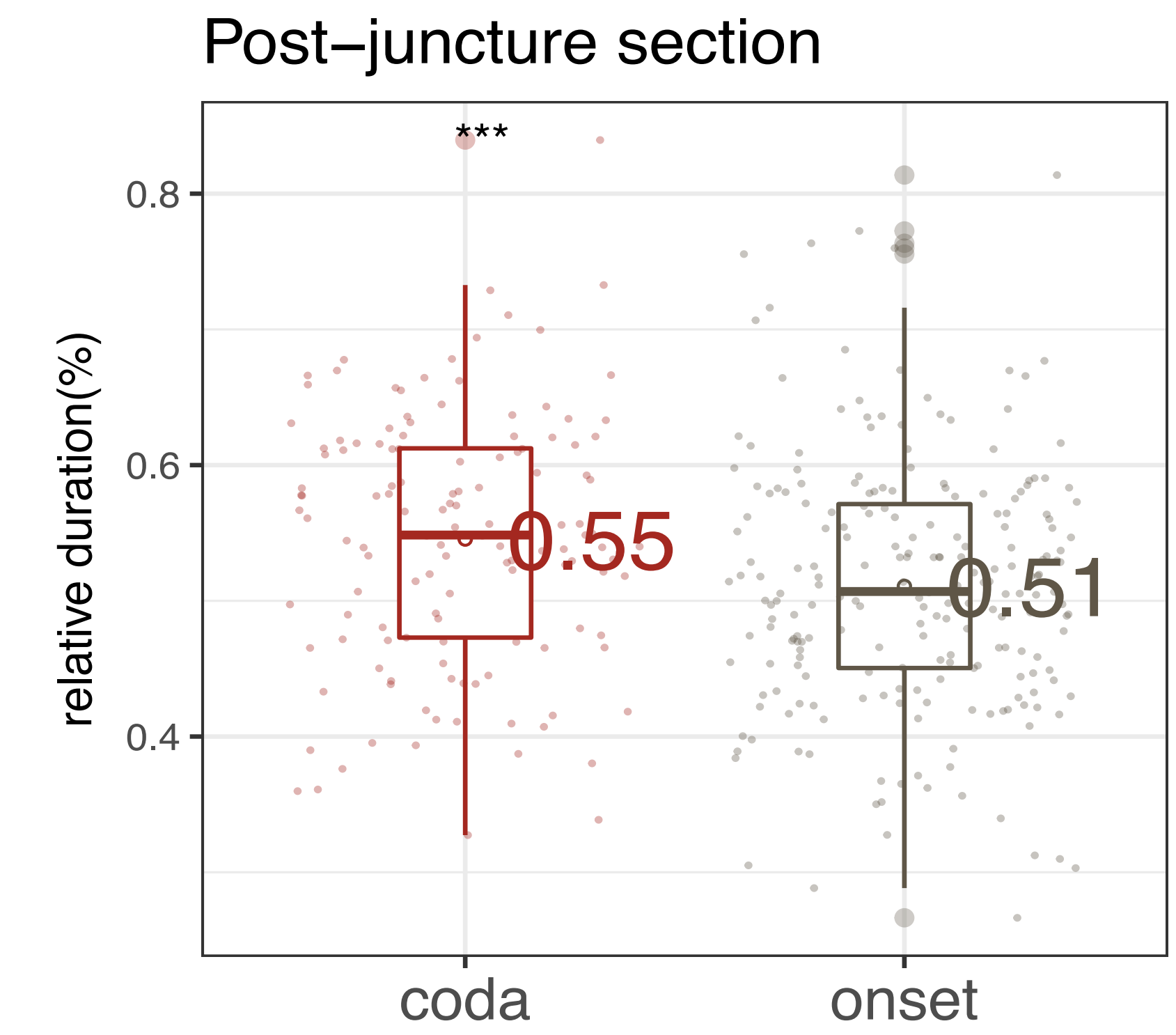
Results

1. Pivot consonant duration – Evidence for word-initial lengthening



Pivot consonants – longer in onset position
(POSITION: $\beta = -0.02, t = -4.23, p < .001$)

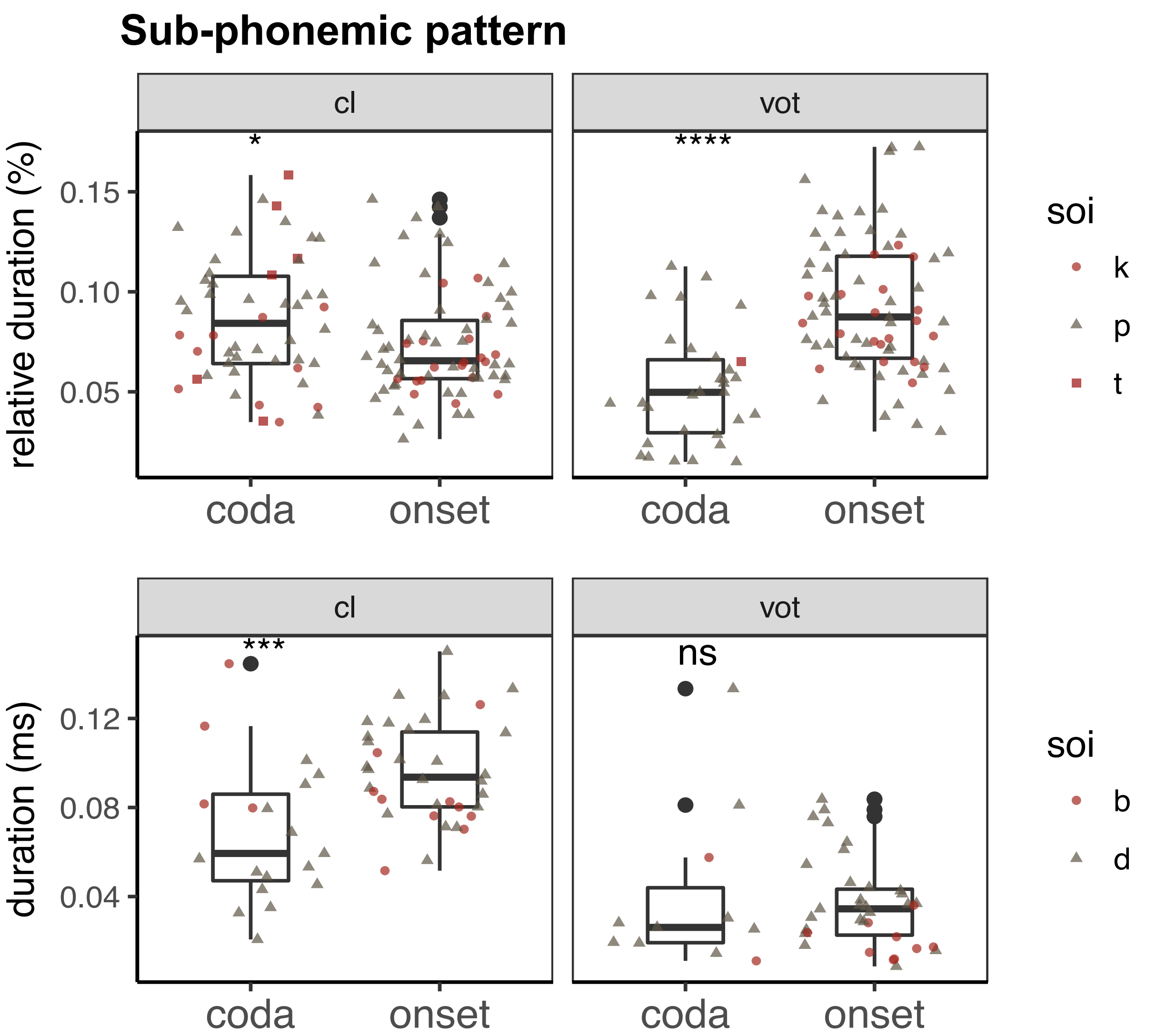
2. Post-juncture section – Evidence for word-initial lengthening



Post-juncture section duration – Longer when it involved an onset (POSITION: $\beta = 0.12, t = 3.28, p < .01$)

3. Pre-juncture section – No clear evidence for word-final lengthening

Pre-juncture duration e.g., [bi:] in bee vs. beef – Do not differ significantly



- Voiceless stops:**
- Probably an allophonic contrast
- Voiced stops:**
- VOT – Not significant;
 - Constriction duration – longer for *onset* ($W = 455, p < .05$)
 - Similar results for *fricatives* and *nasals*

***An interaction** The effect existed when there was an ip/IP boundary after the phrase ($\beta = 0.28, t = 7.73, p < .001$).
→ *Phrase-final lengthening* expanded the durational space
→ enabled us to observe the word-level effect

Model Prediction

Predictors

- Pivot consonant duration
- Post-juncture section duration
- Pivot consonant type
- Prosodic-phrasing information

Response

- Boundary prediction (*coda* vs. *onset*)

Method

- Random Forest model [Strobl et al., 2009] (ntree = 1000, mtry = 2)

Results

- **Out-of-bag classification accuracy of 64%**
- → Word-initial lengthening was an important cue assisting in word-boundary. Still, durational cues alone are not sufficient to segment word boundaries in many instances of spontaneous speech.

Follow-up Work

Perception study

- **Can listeners correctly identify the boundary placement in spontaneous speech?**
- **Are word-initial lengthening effects identified in this study are perceptually relevant?**
 - Phrases were played in isolation to 30 Native English listeners in a 2AFC segmentation task
 - Accuracy was above chance (73.1%)
 - Measures of word-initial lengthening were good predictors of performance
 - Accuracy varied according to the pivot consonant type